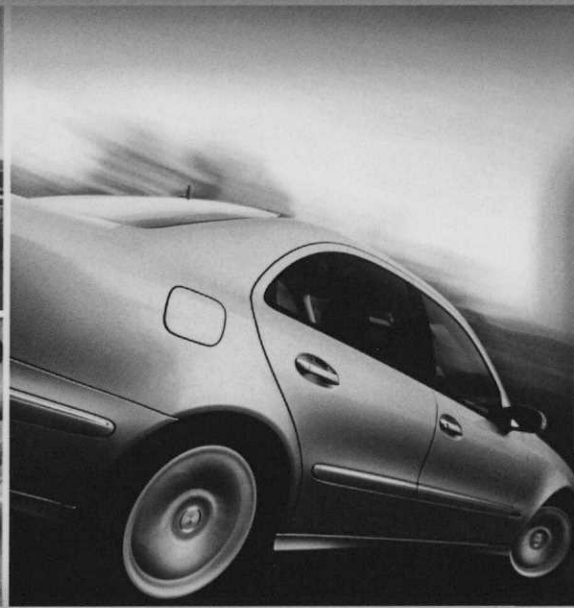
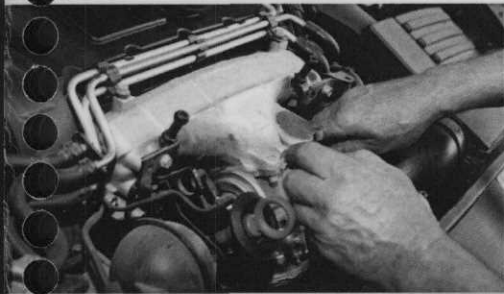
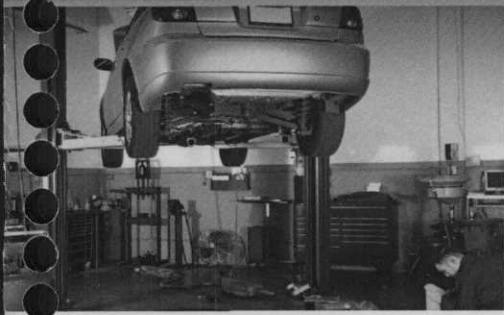


Light Vehicle Diesel Engines



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ASE Test Preparation

Automobile Certification Series

Light Vehicle Diesel Engines (A9)
1st Edition



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**ASE Test Preparation: Automobile
Certification Series, Light Vehicle Diesel
Engines (A9), First Edition**

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Preface

Delmar, a part of Cengage Learning, is very pleased that you have chosen to use our ASE Test Preparation Guide to help prepare yourself for the Light Vehicle Diesel Engines (A9) ASE certification examination. This guide is designed to help prepare you for your actual exam by providing you with an overview and introduction of the testing process, introducing you to the task list for the Light Vehicle Diesel Engines (A9) certification exam, giving you an understanding of what knowledge and skills you are expected to have in order to successfully perform the duties associated with each task area, and providing you with several preparation exams designed to emulate the live exam content in hopes of accessing your overall exam readiness.

If you have a basic working knowledge of the discipline you are testing for, you will find this book will be an excellent guide, helping you to understand the “must know” items needed to successfully pass the ASE certification exam. This manual is not a textbook. Its objective is to prepare the individual who has the existing requisite experience and knowledge to attempt the challenge of the ASE certification process. This guide cannot replace the hands-on experience and theoretical knowledge required by ASE to master the vehicle repair technology associated with this exam. If you are unable to understand more than a few of the preparation questions and their corresponding explanations in this book, it could be that you require either more shop-floor experience or further study.

This book begins by providing an overview and introduction of the testing process. This section will outline what we recommend you do to prepare, what to expect on the actual test day, and overall methodologies for your success. This section is followed by a detailed overview of the ASE task list to include explanations of the knowledge and skills you must possess to successfully answer questions related to each particular task. After the task list, we provide six sample preparation exams for your use as a means of evaluating areas of understanding, as well as areas requiring improvement in order to successfully pass the ASE exam. Delmar is the first and only test preparation organization to provide so many unique preparation exams. We enhanced our guides to include this much support as a means of providing you with the best preparation product available. Section 6 of this guide includes the answer key preparation exam, along with the answer explanations for each question. Each answer explanation also contains a reference back to the related task or tasks that it assesses. This will provide you with a quick and easy method for referring back to the task list whenever needed. The last section of this book contains blank answer sheet forms you can use as you attempt each preparation exam, along with a glossary of terms and additional note pages.

OUR COMMITMENT TO EXCELLENCE

Thank you for choosing Delmar, Cengage Learning for your ASE test preparation needs. All of the writers, editors, and Delmar staff have worked very hard to make this test preparation guide second to none. We feel confident that you will find this guide easy to use and extremely beneficial as you prepare for your actual ASE exam.

Delmar, Cengage Learning has sought out the best subject-matter experts in the country to help with the development of *ASE Test Preparation: Automobile Certification Series, Light Vehicle Diesel Engines (A9), 1st Edition*. Preparation questions are authored and then reviewed by a group of certified, subject-matter experts to ensure the highest level of quality and validity to our product.

If you have any questions concerning this guide or any guide in this series, please visit us on the web at <http://www.trainingbay.cengage.com>.

For online test preparation solutions for ASE certifications, please visit us on the web at <http://www.techniciantestprep.com> to learn more.

ABOUT THE SERIES ADVISOR

Mike Swaim has been an Automotive Technology Instructor at North Idaho College, Coeur d'Alene, Idaho, since 1978. He is an Automotive Service Excellence (ASE) Certified Master Technician since 1974 and holds a Lifetime Certification from Mobile Air Conditioning Society. He served as Series Advisor to all nine of the 2011 Automobile/Light Truck Certification Tests (A Series) of **Delmar, Cengage Learning** ASE Test Preparation titles, and is the author of *ASE Test Preparation: Automobile Certification Series, Undercar Specialist Designation (X1), 5th Edition*.

The History and Purpose of ASE

ASE began as the National Institute for Automotive Service Excellence (NIASE). It was founded as a non-profit, independent entity in 1972 by a group of industry leaders with the single goal of providing a means for consumers to distinguish between incompetent and competent technicians. It accomplishes this goal through the testing and certification of repair and service professionals. Though it is still known as the National Institute for Automotive Service Excellence, it is now called "ASE" for short.

Today, ASE offers more than 40 certification exams in automotive, medium/heavy duty trucks, collision repair and refinish, school bus, transit bus, parts specialist, automobile service consultant and other industry-related areas. At this time, there are more than 385,000 professionals nationwide with current ASE certifications. These professionals are employed by new car and truck dealerships, independent repair facilities, fleets, service stations, franchised service facilities and more.

ASE's certification exams are industry-driven and cover practically every on-highway vehicle service segment. The exams are designed to stress the knowledge of job-related skills. Certification consists of passing at least one exam and documenting two years of relevant work experience. To maintain certification, those with ASE credentials must be re-tested every five years.

While ASE certifications are a targeted means of acknowledging the skills and abilities of an individual technician, ASE also has a program designed to provide recognition for highly qualified repair, support and parts businesses. The Blue Seal of Excellence Recognition Program allows businesses to showcase their technicians and their commitment to excellence. One of the requirements of becoming Blue Seal recognized is that the facility must have a minimum of 75 percent of their technicians ASE certified. Additional criteria apply, and program details can be found on the ASE website.

ASE recognized that educational programs serving the service and repair industry also needed a way to be recognized as having the faculty, facilities and equipment to provide a quality education to students wanting to become service professionals. Through the combined efforts of ASE, industry and education leaders, the non-profit organization entitled the National Automotive Technicians Education Foundation (NATEF) was created in 1983 to evaluate and recognize academic programs. Today more than 2,000 educational programs are NATEF certified.

For additional information about ASE, NATEF or any of their programs, the following contact information can be used:

National Institute for Automotive Service Excellence (ASE)
101 Blue Seal Drive S.E.
Suite 101
Leesburg, VA 20175
Telephone: 703-669-6600
Fax: 703-669-6123
Website: www.ase.com

Overview and Introduction

Participating in the National Institute for Automotive Service Excellence (ASE) voluntary certification program provides you with the opportunity to demonstrate you are a qualified and skilled professional technician who has the “know-how” required to successfully work on today’s modern vehicles.

EXAM ADMINISTRATION

Through 2011, there are two methods available to you when taking an ASE certification exam:

- Paper and pencil
- Computer Based Testing (CBT)

Note: Beginning 2012, ASE will no longer offer paper and pencil certification exams. They will offer and support CBT testing exclusively.

Paper and Pencil Exams

ASE paper and pencil exams are administered twice annually, once in the spring and once again in the fall. The paper and pencil exams are administered at over 750 exam sites in local communities across the nation.

Each test participant is given a booklet containing questions with charts and diagrams where required. All instructions are printed on the exam materials and should be followed carefully. You can mark in this exam booklet but no information entered in the booklet is scored. You will record your answers using a separate answer sheet. You will need to mark your answers, using a #2 pencil only. Upon completion of your exam, the answer sheets are electronically scanned and the answers are tabulated.

Note: Paper and pencil exams will no longer be offered by ASE after 2011. ASE will be converting to a completely exclusive CBT testing methodology at that time.

CBT Exams

ASE also provides CBT exams, which are administered twice annually, once in the winter and once again in the summer. The CBT exams are administered at test centers across the nation. The exam content is the same for both the paper and pencil and CBT testing methods.

If you are considering the CBT exams, it is recommended that you go to the ASE website at <http://www.ase.com> and review the conditions and requirements for this type of exam. There is also an exam demonstration page that allows you to personally experience how this type of exam operates before you register.

Effective 2012, ASE will only offer CBT testing. At that time, CBT exams will be available four times annually, for two-month windows, with a month of no testing in between each testing window:

- January/February – Winter CBT testing window
- April/May – Spring CBT testing window
- July/August – Summer CBT testing window
- October/November – Fall CBT testing window

Please note, testing windows and timing may change. It is recommended you go to the ASE web site at <http://www.ase.com> and review the latest testing schedules.

UNDERSTANDING TEST QUESTION BASICS

ASE exam questions are written by service industry experts. Each question on an exam is created during an ASE-hosted “item-writing” workshop. During these workshops, expert service representatives from manufacturers (domestic and import), aftermarket parts and equipment manufacturers, working technicians, and technical educators gather to share ideas and convert them into actual exam questions. Each exam question written by these experts must then survive review by all members of the group. The questions are designed to address the practical application of repair and diagnosis knowledge and skills practiced by technicians in their day-to-day work.

After the item-writing workshop, all questions are pre-tested and quality-checked on a national sample of technicians. Those questions that meet ASE standards of quality and accuracy are included in the scored sections of the exams; the “rejects” are sent back to the drawing board or discarded altogether.

Depending on the topic of the certification exam, you will be asked between 40 and 80 multiple-choice questions. You can determine the approximated number of questions you can expect to be asked during the Light Vehicle Diesel Engines (A9) certification exam by reviewing the task list in Section 4 of this book. The five-year recertification exam will cover this same content; however, the number of questions for each content area of the recertification exam will be reduced by approximately one-half.

Note: Exams may contain questions that are included for statistical research purposes only. Your answers to these questions will not affect your score, but since you do not know which ones they are, you should answer all questions in the exam.

Using multiple criteria, including cross-sections by age, race, and other background information, ASE is able to guarantee that exam questions do not include bias for or against any particular group. A question that shows bias toward any particular group is discarded.

TEST-TAKING STRATEGIES

Before beginning your exam, quickly look over the exam to determine the total number of questions that you will need to answer. Having this knowledge will help you manage your time throughout the exam to ensure you have enough available to answer all of the questions presented. Read through each question completely before marking your answer. Answer the questions in the order they appear on the exam. Leave the questions blank that you are not sure of and move on to the next question. You can return to those unanswered questions after you have finished the others. These questions may actually be easier to answer at a later time once your mind has had additional

time to consider them on a subconscious level. In addition, you might find information in other questions that will help you recall the answers to some of them.

Multiple-choice exams are sometimes challenging because there are often several choices that may seem possible, or partially correct, and therefore it may be difficult to decide on the most appropriate answer choice. The best strategy, in this case, is to first determine the correct answer before looking at the answer options. If you see the answer you decided on, you should still be careful to examine the other answer options to make sure that none seems more correct than yours. If you do not know or are not sure of the answer, read each option very carefully and try to eliminate those options that you know are incorrect. That way, you can often arrive at the correct choice through a process of elimination.

If you have gone through the entire exam, and you still do not know the answer to some of the questions, *then guess*. Yes, guess. You then have at least a 25 percent chance of being correct. While your score is based on the number of questions answered correctly, any question left blank, or unanswered, is automatically scored as incorrect.

There is a lot of “folk” wisdom on the subject of test taking that you may hear about as you prepare for your ASE exam. For example, there are those who would advise you to avoid response options that use certain words such as *all, none, always, never, must, and only*, to name a few. This, they claim, is because nothing in life is exclusive. They would advise you to choose response options that use words that allow for some exception, such as *sometimes, frequently, rarely, often, usually, seldom, and normally*. They would also advise you to avoid the first and last option (A or D) because exam writers, they feel, are more comfortable if they put the correct answer in the middle (B or C) of the choices. Another recommendation often offered is to select the option that is either shorter or longer than the other three choices because it is more likely to be correct. Some would advise you to never change an answer since your first intuition is usually correct. Another area of “folk” wisdom focuses specifically on any repetitive patterns created by your question responses (e.g., A, B, C, A, B, C, A, B, C).

Many individuals may tell that there are actual grains of truth in this “folk” wisdom, and whereas with some exams, this may prove true, it is not relevant in regard to the ASE certification exams. ASE validates all exam questions and test forms through a national sample of technicians, and only those questions and test forms that meet ASE standards of quality and accuracy are included in the scored sections of the exams. Any biased questions or patterns are discarded altogether, and therefore, it is highly unlikely you will experience any of this “folk” wisdom on an actual ASE exam.

PREPARING FOR THE EXAM

Delmar, Cengage Learning wants to make sure we are providing you with the most thorough preparation guide possible. To demonstrate this, we have included hundreds of preparation questions in this guide. These questions are designed to provide as many opportunities as possible to prepare you to successfully pass your ASE exam. The preparation approach we recommend and outline in this book is designed to help you build confidence in demonstrating what task area content you already know well while also outlining what areas you should review in more detail prior to the actual exam.

We recommend that your first step in the preparation process should be to thoroughly review Section 3 of this book. This section contains a description and explanation of the type of questions you’ll find on an ASE exam.

Once you understand how the questions will be presented, we then recommend that you thoroughly review Section 4 of this book. This section contains information that will help you establish an understanding of what the exam will be evaluating, and specifically, how many questions to expect in each specific task area.

As your third preparatory step, we recommend you complete your first preparation exam, located in Section 5 of this book. Answer one question at a time. After you answer each question, review the

answer and question explanation information, located in Section 6. This section will provide you with instant response feedback, allowing you to gauge your progress, one question at a time, throughout this first preparation exam. If after reading the question explanation you don't feel you understand the reasoning for the correct answer, go back and review the task list overview (Section 4) for the task that is related to that question. Included with each question explanation is a clear identifier of the task area that is being assessed (e.g., Task A.1). If at that point you still don't feel you have a solid understanding of the material, identify a good source of information on the topic, such as an educational course, textbook or other related source of topical learning, and do some additional studying.



After you have completed your first preparation exam and have reviewed your answers, you are ready to complete your next preparation exam. A total of six practice exams are available in Section 5 of this book. For your second preparation exam, we recommend that you answer the questions as if you were taking the actual exam. Do not use any reference material or allow any interruptions in order to get a feel for how you will do on the actual exam. Once you have answered all of the questions, grade your results using the answer key in Section 6. For every question that you gave an incorrect answer to, study the explanations to the answers and/or the overview of the related task areas. Try to determine the root cause for missing the question. The easiest thing to correct is learning the correct technical content. The hardest things to correct are behaviors that lead you to an incorrect conclusion. If you knew the information but still got the question incorrect, there is likely a test-taking behavior that will need to be corrected. An example of this would be reading too quickly and skipping over words that affect your reasoning. If you can identify what you did that caused you to answer the question incorrectly, you can eliminate that cause and improve your score.

Here are some basic guidelines to follow while preparing for the exam:

- Focus your studies on those areas you are weak in.
- Be honest with yourself when determining if you understand something.
- Study often but for short periods of time.
- Remove yourself from all distractions when studying.
- Keep in mind that the goal of studying is not just to pass the exam; the real goal is to learn.
- Prepare physically by getting a good night's rest before the exam, and eat meals that provide energy but do not cause discomfort.
- Arrive early to the exam site to avoid long waits as test candidates check in.
- Use all of the time available for your exams. If you finish early, spend the remaining time reviewing your answers.
- Do not leave any questions unanswered. If absolutely necessary, guess. All unanswered questions are automatically scored as incorrect.

Here are some items you will need to bring with you to the exam site:

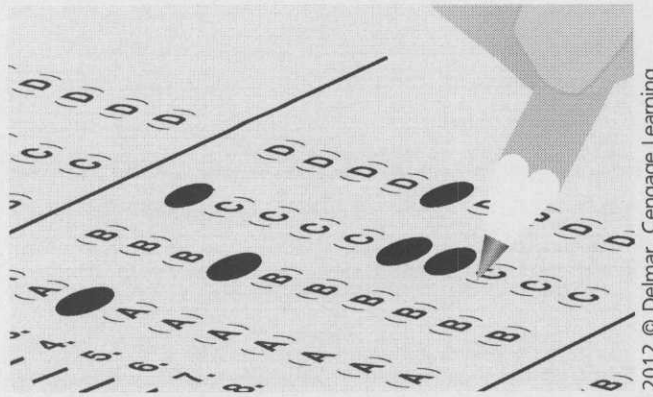
- A valid government or school-issued photo ID
- Your test center admissions ticket
- Three or four sharpened #2 pencils and an eraser
- A watch (not all test sites have clocks)

Note: Books, calculators, and other reference materials are not allowed in the exam room. The exceptions to this list are English-Foreign dictionaries, or glossaries. All items will be inspected before and after testing.

WHAT TO EXPECT DURING THE EXAM

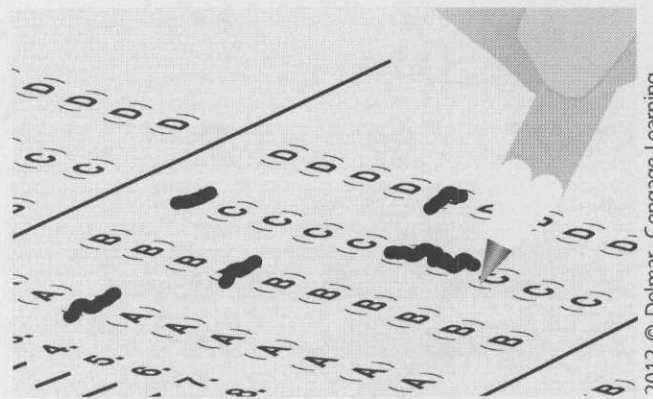
Paper and Pencil Exams

When taking a paper and pencil exam, you will be placing your answers on a sheet that requires you to blacken (bubble) in your answer choice.



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Be careful that only your answers are visible on the answer sheet. Stray pencil marks or incomplete erasures may be picked up as an answer by the electronic reader and result in a question being scored incorrectly.



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Studies have shown that one of the biggest challenges an adult faces when taking a test that uses a bubble-style answer sheet is to place their answers in the correct location. To avoid problems in this area, be extra mindful of how and where you mark your answers. For example, when answering question 21, blacken the correct, corresponding bubble on the answer sheet for question 21. Pay special attention to this process when you decide to skip a question to come back to later. In this situation, many people forget to also leave the corresponding line on the bubble answer sheet blank as well. They inadvertently place their answer for the next question on the answer bubble sheet line that should have been left as a blank placeholder for the unanswered, skipped question. Providing a correct question response on the incorrect bubble answer sheet line will likely result in that question being marked wrong. Remember, the answer sheet for the paper and pencil exam is machine scored, and the machine can only “read” what you have blackened or bubbled in.

If you finish answering all of the questions on an exam and have time remaining, go back and review the answers for those questions that you were not sure of. You can often catch careless errors by

using the remaining time to review your answers. Carefully check your answer sheet for blank answers or missing information.

At practically every exam, some technicians will finish ahead of time and turn their papers in long before the final call. Since some technicians may be doing a recertification test and others may be taking fewer exams than you, do not let this distract or intimidate you.

It is not wise to use less than the total amount of time that you are allotted for an exam. If there are any doubts, take the time for review. Any product can usually be made better with some additional effort. An exam is no exception. It is not necessary to turn in your exam paper until you are told to do so.

CBT Exams

When taking a CBT exam, as soon as you are seated in the testing center, you will be given a brief tutorial to acquaint you with the computer-delivered test, prior to taking your certification exam(s). Unlike paper and pencil testing, when taking a CBT exam, you will not have to worry about stray pencil marks or ensuring that your answers are marked on the correct and corresponding answer bubble sheet line. The CBT exams allow you to select only one answer per question. You can also change your answers as many times as you like. When you select a second answer choice, the CBT will automatically unselect your first answer choice. If you want to skip a question to return to later, you can utilize the “flag” feature, which will allow you to quickly identify and review questions whenever you are ready. Prior to completing your exam, you will also be provided with an opportunity to review your answers and address any unanswered questions.

TESTING TIME

Paper and Pencil Exams

Each ASE paper and pencil exam session is four hours. You may register for and take anywhere from one to a maximum of four exams during any one exam session. It is recommended, however, that you do not register for any combination of exams that would result in you having to answer any more than 225 questions during any single exam session. As a worst-case scenario, this will allow you only slightly more than one minute to answer each question.

CBT Exams

Unlike the ASE paper and pencil exams, each individual ASE CBT exam has a fixed time limit. Individual exam times will vary based upon exam area, and will range anywhere from a half hour to two hours. You will also be given an additional 30 minutes beyond what is allotted to complete your exams to ensure you have adequate time to perform all necessary check-in procedures, complete a brief CBT tutorial, and potentially complete a post-test survey.

Similar to the paper and pencil exams, you can register for and take multiple CBT exams during one testing appointment. The maximum time allotment for a CBT appointment is four and a half hours. If you happen to register for so many exams that you will require more time than this, your exams will be scheduled into multiple appointments. This could mean that you have testing on both the morning and afternoon of the same day, or they could be scheduled on different days, depending on your personal preference and the test center’s schedule.

It is important to understand that if you arrive late for your CBT test appointment, you will not be able to make up any missed time. You will only have the scheduled amount of time remaining in your appointment to complete your exam(s).

Also, while most people finish their CBT exams within the time allowed, others might feel rushed or not be able to finish the test, due to the implied stress of a specific, individual time limit allotment. Before you register for the CBT exams, you should review the number of exam questions that will be asked along with the amount of time allotted for that exam to determine whether you feel comfortable with the designated time limitation or not.

Summary

Regardless of whether you are taking a paper and pencil or CBT exam, as an overall time management recommendation, you should monitor your progress and set a time limit you will follow with regard to how much time you will spend on each individual exam question. This should be based on the total number of questions you will be answering.

Also, it is very important to note that if for any reason you wish to leave the testing room during an exam, you must first ask permission. If you happen to finish your exam(s) early and wish to leave the testing site before your designated session appointment is completed, you are permitted to do so only during specified dismissal periods.

UNDERSTANDING HOW YOUR EXAM IS SCORED

You can gain a better perspective about the ASE certification exams if you understand how they are scored. ASE exams are scored by an independent organization having no vested interest in ASE or in the automotive industry.

Each question carries the same weight as any other question. For example, if there are 50 questions, each is worth 2 percent of the total score. Your exam results can tell you

- Where your knowledge equals or exceeds that needed for competent performance, or
- Where you might need more preparation.

Your ASE exam score report is divided into content “task” areas; it will show the number of questions in each content area and how many of your answers were correct. These numbers provide information about your performance in each area of the exam. However, because there may be a different number of questions in each content area of the exam, a high percentage of correct answers in an area with few questions may not offset a low percentage in an area with many questions.

It should be noted that one does not “fail” an ASE exam. The technician who does not pass is simply told “More Preparation Needed.” Though large differences in percentages may indicate problem areas, it is important to consider how many questions were asked in each area. Since each exam evaluates all phases of the work involved in a service specialty, you should be prepared in each area. A low score in one area could keep you from passing an entire exam.

There is no such thing as average. You cannot determine your overall exam score by adding the percentages given for each task area and dividing by the number of areas. It doesn’t work that way because there generally are not the same number of questions in each task area. A task area with 20 questions, for example, counts more toward your total score than a task area with 10 questions.

Your exam report should give you a good picture of your results and a better understanding of your strengths and areas needing improvement for each task area.

If you fail to pass the exam, you may take it again at any time it is scheduled to be administered. You are the only one who will receive your exam score. Exam scores will not be given over the telephone by ASE nor will they be released to anyone without your written permission.

Types of Questions on an ASE Exam

Understanding not only what content areas will be assessed during your exam, but how you can expect exam questions to be presented will enable you to gain the confidence you need to successfully pass an ASE certification exam. The following examples will help you recognize the types of question styles used in ASE exams and assist you in avoiding common errors when answering them.

Most initial certification tests are made up of between 40 to 80 multiple-choice questions. The five-year recertification exams will cover the same content as the initial exam; however, the actual number of questions for each content area will be reduced by approximately one-half. Refer to Section 4 of this book for specific details regarding the number of questions to expect during the initial Light Vehicle Diesel Engines (A9) certification exam.

Multiple-choice questions are an efficient way to test knowledge. To correctly answer them, you must consider each answer choice as a possibility, and then choose the answer choice that *best* addresses the question. To do this, read each word of the question carefully. Do not assume you know what the question is asking until you have finished reading the entire question.

About 10 percent of the questions on an actual ASE exam will reference an illustration. These drawings contain the information needed to correctly answer the question. The illustration should be studied carefully before attempting to answer the question. When the illustration is showing a system in detail, look over the system and try to figure out how the system works before you look at the question and the possible answers. This approach will ensure that you do not answer the question based upon false assumptions or partial data, but instead have reviewed the entire scenario being presented.

MULTIPLE-CHOICE QUESTIONS

The most common type of question used on an ASE exam is direct completion, which is more commonly referred to as a multiple-choice style question. This type of question contains three “distracters” (incorrect answers) and one “key” (correct answer). When the questions are written, the point is to make the distracters plausible to draw an inexperienced technician to inadvertently select one of them. This type of question gives a clear indication of the technician’s knowledge.

Examples of this type of question would appear as follows:

1. Which of the following would be used to measure crankshaft main bearing clearance on a diesel engine?
 - A. Dial indicator
 - B. Plastigauge™
 - C. Outside micrometer
 - D. Dial caliper

Answer A is incorrect. A dial indicator is used to measure end-play or run out. It would not be useful to measure crankshaft main bearing clearance.

Answer B is correct. Plastigauge™ is the most common method of measuring crankshaft main bearing clearance.

Answer C is incorrect. An outside micrometer is used to measure the outside dimension of a part; however, alone it cannot measure crankshaft main bearing clearance.

Answer D is incorrect. A dial caliper is used to measure outside depth or inside dimensions, but would not be an effective tool to measure crankshaft main bearing clearance.

2. A diesel engine has an accelerator pedal position diagnostic trouble code. The technician wiggles the wiring harness while observing the accelerator pedal position sensor voltage with the scan tool. The sensor voltage changes. Which of the following is the most likely cause of the diagnostic trouble code?
- A. Faulty scan tool
 - B. Faulty ECM
 - C. Faulty accelerator pedal position sensor wiring
 - D. Faulty ECM power supply

Answer A is incorrect. If the voltage value changed while moving the wiring harness, there is no reason to believe the scan tool is faulty.

Answer B is incorrect. If the voltage value changed while moving the wiring harness, there is no reason to believe the ECM is faulty.

Answer C is correct. If the voltage value changed while moving the wiring harness the most likely cause is the wiring harness.

Answer D is incorrect. If all other items associated with the ECM are normal and the voltage value changed while moving the wiring harness, the most likely cause is the wiring harness.

TECHNICIAN A, TECHNICIAN B QUESTIONS

The type of question style that is most popularly associated with an ASE exam is the “Technician A says . . . Technician B says . . . Who is right?” type of question. In this type of question, you must identify the correct statement or statements. To answer this type of question correctly, you must carefully read each technician’s statement and judge it on its own merit to determine if the statement is true.

Sometimes this type of question begins with a statement about some analysis or repair procedure. This is often referred to as the stem of the question and provides the setup or background information required to understand the conditions on which the question is based. This is followed by two statements about the cause of the concern, proper inspection, identification, or repair choices. You are asked whether the first statement, the second statement, both statements, or neither statement is correct. Analyzing this type of question is a little easier than the other types because there are only two ideas to consider, although there are still four choices for an answer.

Technician A, Technician B questions are really double true-or-false questions. The best way to analyze this type of question is to consider each technician’s statement separately. Ask yourself, is A true or false? Is B true or false? Once you have completed this individual evaluation of each answer choice, you will have successfully determined the correct answer choice. An important point to remember is that an ASE Technician A, Technician B question will never have Technician A and B directly disagreeing with each other. That is why you must evaluate each statement independently.

An example of this type of question would appear as follows:

1. A noise is coming from the accessory drive on the front of a diesel engine. Technician A says the serpentine belt can be removed to help determine if it is the source of the noise. Technician B says water dripped on the belt can help determine if the belt is the source of the noise. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. The belt can be removed and the engine ran for a short time to determine if the belt is the source of the noise. Also if the noise disappears when a few drops of water are put on the running belt, the technician knows the belt is the source of the noise.

Answer D is incorrect. Both Technicians are correct.

EXCEPT QUESTIONS

Another type of question form used on the ASE exams contains answer choices that are all correct except for one. To help easily identify this type of question, whenever they are presented in an exam, the word “EXCEPT” will always be displayed in capital letters. With this type of question, the one incorrect answer choice will actually be counted as the correct answer for that question. Be careful to read these question types slowly and thoroughly; otherwise, you may overlook what the question is actually asking and answer the question by selecting the first correct statement.

An example of this type of question would appear as follows:

1. A diesel engine is being checked for an engine oil leak. All of the following could be used to help locate the source of the leak EXCEPT:
 - A. Black light
 - B. White powder
 - C. Vacuum gauge
 - D. Oil dye

Answer A is incorrect. A black light can be used to help locate the source of a leak.

Answer B is incorrect. White powder can be used to help locate the source of a leak.

Answer C is correct. A vacuum gauge is not used to locate engine oil leaks.

Answer D is incorrect. Oil dye can be used to help locate an engine oil leak.

LEAST LIKELY QUESTIONS

For this type of question style, look for the answer choice that would be the LEAST LIKELY cause of the described situation. To help easily identify this type of question, whenever they are presented in an exam, the words “LEAST LIKELY” will always be displayed in capital letters. Read the entire question carefully before choosing your answer.

An example of this type of question would appear as follows:

1. A vehicle equipped with a diesel engine overheats when pulling a trailer. Which of the following would be the LEAST LIKELY cause?
 - A. Slipping fan clutch
 - B. Seized fan clutch
 - C. Restricted charge air cooler
 - D. Restricted radiator

Answer A is incorrect. A slipping fan clutch may not fully engage and would fail to provide sufficient air flow across the radiator to keep the engine cool.

Answer B is correct. A seized fan clutch would run all the time; this may cause a low power complaint, but would not cause the engine to overheat.

Answer C is incorrect. A restricted charge air cooler would also restrict the air flow across the radiator. This could result in an engine overheating condition.

Answer D is incorrect. A restricted radiator could result in an overheated engine.

SUMMARY

The question styles outlined in this section are the only ones you will encounter on any ASE certification exam. ASE does not use any other types of question styles, such as fill-in-the-blank, true/false, word-matching or essay. ASE also will not require you to draw diagrams or sketches to support any of your answer selections. If a formula or chart is required to answer a question, it will be provided for you.

Task List Overview

INTRODUCTION

This section of the book outlines the content areas, or *task list*, for this specific certification exam, along with a written overview of the content covered in the exam.

The task list describes the actual knowledge and skills necessary for a technician to successfully perform the work associated with each skill area. This task list is the fundamental guideline you should use to understand what areas you can expect to be tested on, as well as how each individual area is weighted to include the approximate number of questions you can expect to be given for that area during the ASE certification exam. It is important to note that the number of exam questions for a particular area is to be used as a guideline only. ASE advises that the questions on the exam may not equal the number specifically listed on the task list. The task lists are specifically designed to tell you what ASE expects you to know how to do and to help you prepare to be tested.

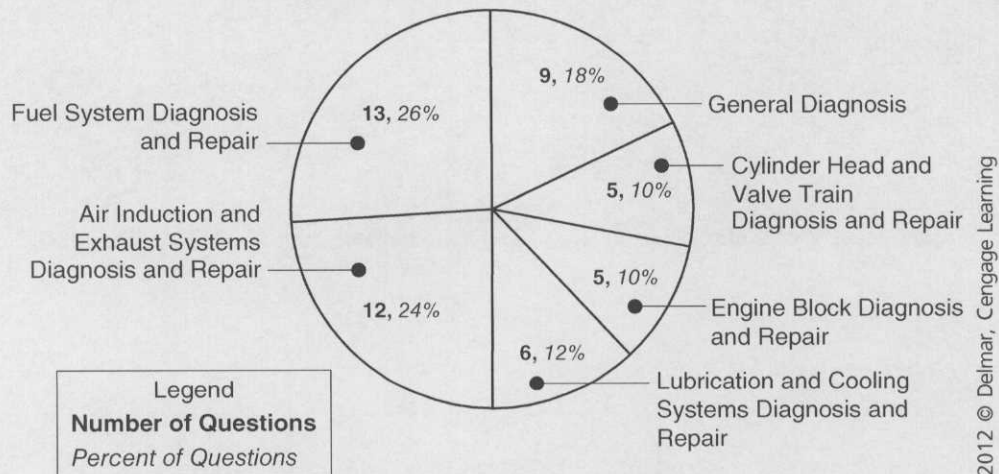
Similar to the role this task list will play with regard to the actual ASE exam, Delmar, Cengage Learning has developed six preparation exams, located in Section 5 of this book, using this task list as a guide. It is important to note that although both ASE and Delmar, Cengage Learning use the same task list as a guideline for creating these test questions, none of the test questions you will see in this book will be found in the actual, live ASE exams. This is true for any test preparatory material you use. Real exam questions are *only* visible during the actual ASE exams.

Task List at a Glance

The Light Vehicle Diesel Engines (A9) task list focuses on six core areas, and you can expect to be asked approximately 50 questions on your certification exam, broken out as outlined here:

- A. General Diagnosis (9 Questions)
- B. Cylinder Head and Valve Train Diagnosis and Repair (5 Questions)
- C. Engine Block Diagnosis and Repair (5 Questions)
- D. Lubrication and Cooling Systems Diagnosis and Repair (6 Questions)
- E. Air Induction and Exhaust Systems Diagnosis and Repair (12 Questions)
- F. Fuel System Diagnosis and Repair (13 Questions)

Based upon this information, the graph shown here is a general guideline demonstrating which areas will have the most focus on the actual certification exam. This data may help you prioritize your time when preparing for the exam.



Note: The actual number of questions you will be given on the ASE certification exam may vary slightly from the information provided in the task list, as exams may contain questions that are included for statistical research purposes only. Don't forget that your answers to these research questions will not affect your score.

LIGHT VEHICLE DIESEL ENGINES (A9) TASK LIST

A. General Diagnosis (9 Questions)

1. **Verify the complaint and road/dyno test vehicle; review driver/customer concerns and vehicle service history (if available); determine further diagnosis.**

Every good diagnosis starts with verifying the customer's concern. New diesel engines make a variety of sounds/noises that can be considered part of normal operation. Care must be taken to ensure that what the customer perceives as faulty operation actually *is* faulty operation. The road test is an important part of that verification process. Try to duplicate the conditions that generated the complaint. Vehicle service records are extremely valuable in diagnosis. A restricted diesel oxidation catalyst (DOC) may have been caused by the turbocharger, which failed last month. Another example would be, if the cooling system was recently flushed, it is quite possible that a no heater concern is being created by an air lock in the heater core.

2. **Record vehicle identification number (VIN). Identify engine model, calibration and serial numbers to research applicable vehicle and service information, service precautions and technical service bulletins; determine needed actions.**

Vehicle information numbers (VINs) are necessary on every service order. They identify the vehicle in all legal matters. The VIN number provides the technician with the information needed to research service literature and to enter the appropriate information when

connecting a scan tool. The two most used pieces of information are the 8th and 10th digits. The 8th digit represents the engine. On any given model of vehicle, there may be one diesel engine with three or more possible configurations. The configurations will have the same displacement and the same name, but will have different horsepower ratings and/or different emissions configurations. A diagnostic trouble code (DTC) for the engine may have two or more troubleshooting trees, depending on the certification of the engine. Using the wrong troubleshooting tree will almost certainly result in an incorrect diagnosis. The 10th digit of the VIN identifies the model year and has been a universal system since 1981.

B = 1981	G = 1986	M = 1991	T = 1996	1 = 2001	6 = 2006
C = 1982	H = 1987	N = 1992	V = 1997	2 = 2002	7 = 2007
D = 1983	J = 1988	P = 1993	W = 1998	3 = 2003	8 = 2008
E = 1984	K = 1989	R = 1994	X = 1999	4 = 2004	9 = 2009
F = 1985	L = 1990	S = 1995	Y = 2000	5 = 2005	10 = A

Note: There are no Is or Os, Qs, Us or Zs in the 10th digit. In 2010, the sequence started over again at A.

■ 3. Perform a scan tool check and visual inspection for physical damage and missing, modified or tampered components; determine needed repairs.

A visual inspection is a very important start to a proper diagnosis. The technician should be looking for loose mounting on engine-related devices, such as coolers, hoses and plumbing. The underside of the vehicle should be inspected for leaks, loose exhaust components and witness marks, which would indicate recently removed or replaced components. The cause for a DTC for the diesel particulate filter could easily be located during the inspection if the wiring harness was torn off the truck during the last off-road trip. Diesel-powered vehicles are often modified by the customer to produce extra horsepower and torque. These modifications nearly always involve using an engine programmer or “chip” on the engine’s electronic control module (ECM). This may be an electronic modification of the original ECM, or it may be a device installed in the wiring harness. Often these devices will be removed by the customer prior to bringing the vehicle in for repairs. Some items that might indicate to the technician that this is the case would be loose or broken electrical connections; missing locks on connectors; VELCRO® straps on or around the battery, wiring harness, or ECM; and holes drilled in the dash or under the dash for mounting engine programmers. Extra vehicle instrumentation, such as gauges mounted on the “A” pillar are also indications that the vehicle may have been modified. Diagnostic trouble codes like “Unknown Error” or “Unknown Program” are also clues that the ECM has been operating with an aftermarket program. Vehicles that have been modified in this manner will most likely have the warranty voided, and repairs to these vehicles will be complicated due to the fact that the engine is operating outside of what it was designed to do. For example, a customer concern of smoke may be the result of oversize injectors.

■ 4. Check and record electronic diagnostic codes, freeze frame and/or operational data; monitor scan tool data; clear codes; determine further diagnosis.

When the scan tool is connected, the technician should record all active and inactive codes. Most codes will have freeze frame data stored for when the code was set. This

freeze frame data should also be recorded. If this data is erased prior to the diagnosis, it may be harder to diagnose the customer concern. *Live data*, or *streaming data* as it is sometimes referred to, allows the technician see what the ECM is thinking. This is often referred to as a “rational” check. For example, a scan tool is connected to a vehicle that has set overnight, and the data stream is checked. If the coolant temperature sensor indicates 140 degrees F and the fuel temperature sensor indicates 70 degrees F, one of them is incorrect. These types of failures are known as *in range* failures and may not set a DTC because both of these readings are within normal operational parameters. However, a coolant temperature sensor that is shifted 70 degrees F may be the cause of a hard start concern in cold weather. The coolant temperature sensor is usually the main item used by the ECM to determine glow plug/inlet air heater on time. Diagnostic trouble codes can usually be cleared with the scan tool. Some codes may require a special password from the factory. These codes are usually associated with engine failures, such as over-speeding, overheating, and low oil pressure. These are codes that could void a customer’s warranty. Most DTCs will eventually erase themselves if the problem does not reoccur after a set number of drive cycles or cold starts. DTCs can no longer be erased by simply removing the battery cable or ECM fuse.

■ 5. Inspect engine assembly and compartment for fuel, oil, coolant, exhaust or other leaks; determine needed repairs.

Care must be taken to avoid a misdiagnosis during leak detection. Although it is true that gravity will make a liquid flow downward, it is also true that airflow will move liquids as they travel, and surface tension and passages can cause liquids to move upward under certain conditions.

There are many methods to identify leaks. The first step is to attempt to identify the fluid. Pink can be transmission fluid, power steering fluid may be pink or clear, engine oil may be golden or brown/black, and coolant may be green, gold, pink, orange or blue. A black light used with dye tracer has become a recent favorite among technicians in locating fluid leaks. The equipment was previously expensive and fragile; however, that has changed. This method involves pouring a small amount of dye into the liquid that is suspected of leaking, then running the engine and using a black light and yellow goggles to look for the glowing yellow leak indication. Other methods of leak detection include dry powder sprinkled in the suspect area or using a smoke machine. A smoke machine can be used to fill items, such as a crankcase, with smoke to show a tell-tale stream rising from the leaking area. Exhaust leaks can also be identified using a smoke machine, or they can be identified by dark, sooty streams appearing at seams, gaskets and welds.

■ 6. Inspect engine compartment wiring harness, connectors, seals and locks; check for proper routing and condition; determine needed repairs.

A visual inspection is a one of the first steps in a fast, efficient diagnosis and repair. Loose or damaged electrical connectors can cause poor connections, which can result in inaccurate signals being sent to the ECM. Check connector integrity with a visual inspection followed by a 10-pound pull test. A 10-pound pull test means gently tugging on each wire in a connector with approximately 10 pounds of pull. This method works well to find loose terminals within a connector. Loose terminals can easily back out and cause poor connections. The connector seal should be inspected to ensure that it is present and pliable. Connector locks should be complete and operational with no broken

pieces. A broken connector lock often results in an intermittent condition. If necessary, the inspection can be followed up with a voltage drop test. Remember that when performing the voltage drop test, the circuit being tested must be energized.

■ 7. Listen for and isolate engine noises; determine needed repairs.

Current light-duty diesel engines are much quieter than their predecessors; however, there are many more “normal” noises than in previous models. Multi-shot injection systems have made the engines quieter, but usually these systems will revert to a single shot at higher RPMs (revolutions per minute), which sometimes causes a customer concern. Engines equipped with temperature control features using a variable geometry turbocharger (VGT) will cause many different sounds during a warm-up, and these sounds may seem abnormal to the customer. When an unusual noise does appear, many tools can be used to help isolate the source. A technician’s stethoscope can be used to touch various components while the engine is running to help find the source of an unusual engine noise. A variation of a stethoscope called a *ChassisEAR*[®] will also work. A chassis ear has multiple clips that are attached to various places throughout the engine compartment, and the leads from the clips are attached to a central controller box. The controller box has a plug for a set of head phones and a switch to select the various clip connections. The technician can listen to the clips while the vehicle is in operation to help locate the source of the noise. This tool also comes in a version that has wireless clips. The scan tool can be used to operate devices and to stop injection at individual cylinders to help isolate the source of a concern. For example, an engine with a knock that disappears when a given cylinder is cancelled will help the technician find a bearing knock. Belt-driven accessories are often the source of noise concerns. Water can be sprayed on the pulley side of the belt with the engine running to help determine if the noise is generated from the belt or the accessory. If the noise stops when the belt is wet, the belt itself is making the noise. If the noise continues, an accessory is the source. The engine should be shut off, the belt removed and each accessory spun by hand to find the cause.

■ 8. Isolate and diagnose engine-related vibration problems; determine needed actions.

Engine-related vibrations can be isolated with an electronic vibration analyzer (EVA) or a reed tachometer. Both tools will determine the frequency of the vibration, then the frequency can be used to determine which items are causing that frequency.

Vibrations that occur at given RPMs then disappear at other RPMs can be caused by a faulty vibration damper. Vibration dampers come in two styles, rubber bonded and viscous. They are checked for lateral and radial run out. The viscous damper must also be checked for leaks, which may involve heating the damper in an oven.

■ 9. Check engine exhaust for odor and smoke color; determine further diagnosis.

Properly operating diesel engines no longer produce smoke from the tailpipe. Most new diesel engines are equipped with a diesel particulate filter, which traps any soot in the exhaust stream. If a newer light-duty diesel engine is smoking, the source should be located. Black smoke is an indication of over-fueling, either from a lack of air or from too much fuel. A leaking, stuck open or misadjusted injector can be the source. A fuel pump that has been modified or an electronic performance program installed in the ECM will also produce black smoke. White smoke is caused by incomplete combustion. Sources of

incomplete combustion include incorrect injection timing, low fuel pressure and cold combustion chambers. Cold combustion chambers can be the result of inoperative cold start devices, such as air inlet heaters and glow plugs. Blue smoke is an indication of oil in the combustion chamber. Causes include worn rings, worn valve guides and leaking turbocharger shaft seals. Steam or water vapor can be caused by coolant entering the exhaust stream. Sources include the block, head gaskets, heads, exhaust gas recirculation (EGR) coolers, intake manifold gaskets and coolant-cooled turbochargers. It should be noted that when an engine equipped with a diesel particulate filter enters the regeneration mode to clean the soot from the filter, there will be a variety of normal odors and the possibility of smoke. The service literature should be consulted to determine what the manufacturer considers “normal.”

■ 10. Check fuel for contamination, quantity, quality and consumption; determine needed actions.

Contaminated diesel fuel will cause rough running, no-start and low horsepower concerns from the customer. Contaminates include dirt, water and oil. Dirt usually enters the fuel from poor handling practices, water from condensation, and oil from faulty injectors. A fuel sample can be drawn from the fuel tank into a clear container to check for contamination. Fuel cleanliness is a major concern for diesel engine manufacturers. As diesel injection pressures increase, any particles in the fuel act as abrasives and quickly wear down the injection system.

A no-start diagnosis should always begin with checking the level of fuel in the tank. The instrument panel gauge is a good place to start. However, instrument panel fuel gauges are unreliable, and the technician must know that the engine is receiving fuel. Most manufacturers have installed filters at the end of the pickup tube. A restricted in-tank filter can be the source of low fuel supply. Other causes include faulty transfer pumps and lines.

Old diesel fuel can be the cause of hard starting and low power. Most engine manufacturers and fuel distributors recommend that fuel be stored no more than six months. Old fuel will have a distinct odor and a dark color. Fuel that has set is especially vulnerable to contamination from bacteria. An inspection of the fuel filter will usually reveal a slime on the filter element if this is the case.

Fuel consumption concerns can be caused by poor driving habits, modified fuel systems and worn injection components. Prior to diagnosing a fuel consumption concern, the technician needs to verify that there is a problem. A customer's expectations can be unrealistic or their fuel consumption calculation methods may faulty.

■ 11. Perform crankcase pressure test; determine further diagnosis.

Crankcase pressure tests are performed at idle and at other specified loads/RPMs. Crankcase pressure is usually created by the compression that leaks past the compression rings during engine operation. High crankcase pressure is therefore normally caused by worn compression rings; however, there are other causes. A crankcase ventilation system that is restricted can also be the cause. Crankcase pressure specifications vary widely, depending on year, make and model. Always refer to the specification for the engine you are testing. A water manometer is typically the tool of choice for checking crankcase pressure. Some checks are as simple as connecting the manometer to the engine dipstick tube. Other checks involve purchasing or fabricating a restricted orifice and installing it at the end of the crankcase ventilation tube (road draft tube). The Environmental Protection Agency (EPA) now includes emissions from the crankcase as part of the total emissions

from the engine. So since 2007, nearly all new engines have had a closed crankcase ventilation system. This system separates the oil vapor and returns it to the oil pan. These systems will have a crankcase filter and a crankcase pressure sensor. The filter must be serviced on a regular basis. There can be DTCs set for incorrect crankcase pressure. Crankcase pressure that is too high will normally result in an engine with various oil leaks. Too little crankcase pressure can occur if the crankcase ventilation system is connected to the clean air intake system and the air intake system has a restriction. If the air filter is severely restricted, the engine will draw air and oil vapor from the crankcase. This condition can cause high engine oil consumption and engine runaway.

■ 12. Diagnose surging, rough operation, misfiring, low power, slow deceleration and slow acceleration and shutdown problems; determine needed actions.

Air in the fuel system can cause many different symptoms. There are various ways used to determine if air is in the fuel. One method is a fuel return test. In a fuel return test, the return line from the fuel system is submerged in a clear container of fuel. The engine is started and run. After the line purges itself of the air that entered when the line was opened, there should be no more bubbles. If there are air bubbles in the stream, that is an indication of air in the fuel. Sources of air with this test include suction side air leaks (air leaks before the transfer pump), injectors not setting completely and allowing compression to enter the nozzle tip, or loose and leaking injector sleeves, allowing air to enter around the copper or stainless steel sleeve.

Another test involves installing a sight glass (liquid eye) in the fuel supply system right before the transfer side. The sight glass will allow the technician to see the fuel stream while the engine is operating. If air is entering the fuel system on the suction side, there will be a stream of bubbles in the fuel inlet. Surging, rough operation, misfiring, low power, slow deceleration, slow acceleration and improper shutdown can all be caused by air in the fuel.

■ 13. Check cooling system for freeze point, level, contamination, temperature, pressure, circulation, conditioner concentration (if applicable) and fan operation; determine needed repairs.

Freeze point of coolant is checked with a hydrometer or refractometer. Since diesel engine coolant will typically have supplemental coolant additives, the refractometer is usually recommended by the engine manufacturer. Coolant level is checked visually. Most engine monitoring systems have a coolant level sensor. These sensors will normally be connected to the ECM, and the ECM will broadcast low coolant levels to the other modules on the data bus. Fuel contamination of coolant is often caused by faulty sleeves in the cylinder head. Oil contamination of coolant is usually caused by leaking head gaskets and oil coolers. Conditioner concentration is checked with test strips. An over concentration of supplemental coolant additives can cause water pump leaks and restricted coolant flow, which will result in engine overheating. Continuing to operate a diesel engine with low concentrations of additives will result in cylinder wall perforation and excessive rust or scale buildup in the system. Cooling fans can be belt driven or electrically driven. Some vehicles will use a combination of both. Either type of drive can be controlled by the ECM. Fans that operate more than necessary can cause low fuel economy, low engine temperature, and noise concerns from the customer. Fans that do not operate can cause engine overheating problems, especially while pulling a load.

■ **14. Check lubrication system for contamination, oil level, temperature, pressure, filtration and oil consumption; determine needed repairs.**

The first step in checking the lubrication system is to check the oil level in the oil pan. The oil should be between the add and full marks and should not be excessively dirty. While wearing latex or nitrile mechanics gloves, the technician should wipe some oil from the dipstick and rub between their fingers. Excessive grit may indicate contamination. Oil that is thin feeling may indicate fuel contamination; a milky color may indicate coolant contamination. Very low oil levels can cause a no-start condition on engines equipped with a hydraulic electronic unit injector (HEUI) fuel system. Low oil pressure can be caused by diluted oil, excessive bearing clearances, restricted pick up screens and internal oil leaks. Oil consumption can be caused by worn rings, leaks, worn valve guides and turbocharger seals. Caution is advised when diagnosing oil-consumption concerns. A customer may perceive they have an oil-consumption concern when they do not. Proper testing requires the technician to check the oil level in a constant manner over the period of days or weeks and over a period over at least a thousand miles. Some oil consumption is considered normal for some operating conditions. Service literature from the manufacturer should always be consulted before making an oil-consumption diagnosis.

■ **15. Diagnose no cranking, cranks but fails to start, hard starting and starts but does not continue to run problems; determine needed actions.**

No-crank conditions can be caused by low batteries or faulty circuits in the starting system. Cranks but fails to start can be caused by no fuel, air in the fuel, inoperative cold start devices such as inlet air heaters and glow plugs, no signal from engine position sensors, or a faulty ECM. Hard starting and starts but does not continue to run concerns are often caused by air in the fuel supply. (See task A12 in this section for a review on how to perform air in the fuel system tests.)

■ **16. Diagnose engine problems caused by battery condition, connections or excessive key-off battery drain; determine needed repairs.**

Weak batteries can cause many diesel engine problems. The first and most obvious is a no-start or no-crank condition. Battery state can be checked with an open circuit voltage test. A fully charged battery will have an open circuit voltage of 12.68 volts. A battery with an open circuit voltage of 12.4 volts is considered to be about 75 percent charged. Battery load tests can be performed with a carbon pile load device, which actually loads the system like a starting system would, or by using a capacitance test. The capacitance test is newer and considered safer. Battery cable condition is most accurately checked using a digital multi-meter (DMM) and performing a voltage drop test while cranking. A volt drop of 0.3 volts is generally considered the maximum. Key-off battery drain is performed by installing an ammeter in series with the battery cable. This is normally done at the negative cable for safety. Specifications for key-off battery drain can vary considerably, depending on the vehicle. Generally speaking, any reading over 50 milliamps is considered excessive. Important reminders on this test: Make sure that all controllers on the data bus are asleep before recording the reading, and make sure that all drains are being measured. Since many diesel-powered vehicles will have multiple batteries, it is possible that all the drain will not be measured unless the batteries are isolated from each other.

■ 17. Diagnose engine problems resulting from an undercharge, overcharge or a no-charge condition; determine needed action.

Charging system output voltage will normally be in the range of 13.6 to 14.5 volts with no accessories turned on. Undercharged batteries can cause the engine to crank slowly, possibly failing to start. When battery voltage drops below a predetermined level, approximately 10 volts, the ECM will shut down to prevent internal damage. Charging system voltage above specification will sometimes be noticed by lighting system components that are brighter than normal. Excessive charging system voltage can also cause the ECM to shut down to prevent internal damage. Alternators can leak AC voltage while charging, this can be checked by setting the DMM to the AC volt scale and measuring the AC voltage at the alternator output terminals with the alternator charging under load. The normal specification for this test is no more than 0.5 volt AC. If an alternator is diagnosed as the cause of a charging system problem, it is usually replaced and not repaired.

B. Cylinder Head and Valve Train Diagnosis and Repair (5 Questions)

■ 1. Remove, inspect, disassemble and clean cylinder head assemblies.

Cylinder head removal should be performed on a completely cool engine to reduce the chances of warping the cylinder head. Cylinder head bolts should be removed in a sequence exactly opposite to the installation sequence. When lifting the head from the block, care should be taken to prevent damage to the old cylinder head gasket. Valuable diagnostic information can be gained from carefully inspecting the old gasket. Once the head is removed, it should be stored by setting it on wood blocks at either end or using cylinder head stands. Do not set the head directly on the work bench; many diesel engines have injector tips or glow plugs protruding from them, and they are easily damaged.

During cylinder head disassembly, the parts should be kept in order to better facilitate evaluation and diagnosis. Trays can be purchased to help keep the parts organized. If the head has an overhead camshaft (OHC), the caps that hold the camshaft should be removed a little at a time across the length of the camshaft. Completely removing a cam bearing cap, then moving on to the next and removing it, will result in a camshaft that is loaded unequally. This can crack a camshaft.

■ 2. Inspect threaded holes, studs and bolts for serviceability; service/replace as needed.

All threaded holes should be inspected and have a thread chaser run through them to clean them of dirt and straighten any damaged threads. Thread chasers are preferred when simply cleaning a threaded hole because they remove less thread material than a regular tap. Threaded holes can be repaired using a Heli-coil[®] type thread insert. There are many different brands available; however, they all tend to be installed the same way. The damaged hole is drilled oversized, according to the supplied chart. The hole is threaded using the correct tap, and then a set of threads is screwed into the new hole. This set of threads will have the same internal dimensions as the original hole. This method of thread repair will work only if there is enough room to drill the oversized hole and allow the threaded insert to be installed properly. Studs and bolts should have a thread chaser run over them. They should be inspected for pits and stretching. Some manufacturers supply a

head bolt stretch gauge to easily determine if the head bolt has been stretched. It should be noted that some original equipment manufacturers (OEMs) require head bolt replacement every time they are used. These head bolts are designed to be stretched during installation, but once stretched they will not properly hold the head a second time.

■ 3. Measure cylinder head thickness and check mating surfaces for warpage and surface finish; inspect for cracks/damage; check condition of passages; inspect core and gallery plugs; determine serviceability and needed repairs.

Cylinder head thickness needs to be measured if a technician suspects the head has been previously machined. This measurement is often taken from the deck surface of the head to the valve cover gasket sealing surface. A head that has had too much material removed can be more prone to warping. If not properly reassembled, a machined cylinder head allows injector tips, glow plugs and valves to all move deeper into the cylinder during operation. This can cause increased compression, misalignment of injector spray patterns, and contact with the piston. On OHC engines, the cam timing can be affected. Some manufacturers offer cylinder head spacer gaskets to install with the cylinder to help prevent these problems. Mating surfaces are checked for straightness using a straightedge and feeler gauge. A typical maximum warpage specification is 0.003". However, occasionally a much smaller specification can be found, such as 0.001". The service literature must be checked for the engine that is being inspected. Proper surface finish can be checked by visually comparing the surface roughness with a surface roughness comparator.

Passages should be checked for contamination and cracks. Core and gallery plugs should be removed and their holes inspected. If the gallery plugs have threaded plugs, these plugs can be tapered pipe plugs or straight threaded o-rings. Straight threaded o-ring plugs can have standard or metric threads.

■ 4. Inspect valves, guides, seats, springs, retainers, rotators, locks and seals; determine serviceability and needed repairs.

Valve guides are inspected for wear using a small hole gauge (split ball gauge) and outside micrometer, or alternately the valve can be used with a dial indicator. A normal valve stem specification is 0.001" to 0.003". Guides are often replaceable if worn. Integral guides can be reamed, knurled or have an insert installed. Valve seats typically are cut at a 30- or 45-degree angle; however, there are some manufacturers now using alternate seating angles. Valve seats are inspected for width and pitting. Valve seats can be resurfaced by using a grinder or cutter. Either method removes material until all pits are removed. If removing the metal makes the seat too wide, it can be narrowed using a stone or cutter with a different angle than the seating angle. For example, a 30-degree seat is topped with a 15-degree stone and throated with a 45-degree stone. Some cylinder heads use an interference angle. This interference angle has the valve and seat at a one degree difference. This allows the mating surface to be a thin line, which reduces carbon buildup.

Valve springs are inspected for free length, squareness and tension. Valve springs that fail inspection are replaced. Valve retainers and locks are inspected for wear. When a valve is replaced, the locks should also be replaced. Valve seals are always replaced during a cylinder head overhaul. Valve seals can also be replaced on most engines with the cylinder head on the vehicle. This is done by using a cylinder leakage detector to fill the cylinder

with air and hold the valves up. Then the valve springs are removed and the seal replaced. Leaking valve seals can cause oil consumption and smoke. The smoke is most generally noticed at start up or after extended idling.

Valve rotators are designed to rotate the valve when it is open. This causes the valve to seat in a different position each time, which helps reduce carbon buildup. An inoperative valve rotator can usually be identified by carbon buildup on the valve or wear marks on the valve stem tip.

After reassembly, the valve protrusion or recession should be measured. A valve that seats too deep in the head will lower compression. A valve that protrudes too far can raise compression and possibly contact the piston.

■ 5. **Inspect and/or replace injector sleeves, glow plug sleeves and seals; pressure test to verify repair (if applicable); measure injector tip, nozzle, or pre-chamber protrusion where specified by manufacturer.**

Many injectors and glow plugs will seat in the cylinder head in a brass or stainless steel sleeve. The sleeve allows good heat transfer from the injector or glow plug to the coolant. When the sleeves leak, they can allow air and fuel to mix. Air can enter the fuel or cooling system. Fuel can enter into the cooling system, and coolant can enter into the combustion chamber. Testing the sleeve generally involves removing the glow plug or injector and installing a sleeve hold-down device. Then the cooling system is pressurized and the sleeve inspected for leaks. If a leaking sleeve is located, it can often be removed and replaced while the head is still on the engine. Copper injector sleeves will need to have the seating area reamed prior to installing the injector.

After the head is reassembled, the injector tip, nozzle or pre-chamber will need to be inspected for proper protrusion. If these items are not within specifications, it can effect compression. Also it will affect the injector spray pattern into the combustion chamber, which can cause smoke and low power.

■ 6. **Inspect, and/or replace valve bridges (crossheads) and guides; adjust bridges (crossheads) if applicable.**

Valve bridges (crossheads) are used to allow one rocker arm to open two valves. Earlier versions set on a guide that held them in position during operation. These guides needed to be inspected for installed height and diameter. They are replaced if worn. The crosshead had an adjustment screw to ensure the crosshead contacted the valves equally and traveled up and down on the guide squarely. Newer styles of valve bridges (crossheads) are guideless. The valves for this style will have valve stem tips that are taller than normal. The valve bridge (crosshead) is held in position by deep pockets that seat over these extended valve stem tips. These are not adjustable.

■ 7. **Reassemble, check, and install cylinder head assembly and gasket as specified by the manufacturer.**

During cylinder head assembly, the valve stems should be lightly lubricated where they contact the guide. Valve stem height must be measured to ensure rocker arm geometry is correct and that the valve will not be held off its seat by the rocker arm.

During reassembly, the cylinder head and block deck must be clean and dry. The head gasket must be oriented correctly; often the gasket will be labeled "up" or "front" to aid in

Wear rings (sleeves) are used on some models. Wear rings (sleeves) are installed on areas such as the where the rear main seal rides on the crankshaft. This wear ring is replaceable. The advantage of an engine equipped with a wear ring is that the wear surface is replaceable. These wear rings are typically removed with a hammer and cold chisel, but care must be taken to ensure the shaft is not damaged. New wear rings are typically installed with the new seal as a unit, using a seal pusher tool. If the engine did not come with a wear ring and the shaft seal surface is worn, there may be a repair sleeve available that can be installed.

■ **2. Disassemble, clean and inspect engine block for cracks; check mating surfaces and related components for damage or warpage and surface finish; check deck height; check condition of passages, core and gallery plugs; inspect threaded holes, studs, dowel pins and bolts for serviceability; service/replace as needed.**

During disassembly, the parts should be stored in an orderly fashion to aid with failure diagnosis and reassembly. The engine block can be checked for cracks using dye penetrant or Magnaflux inspection, or pressurizing and submerging in water. Mating surfaces can be checked with a straightedge and feeler gauge. Block deck height should be checked if the block is to be resurfaced. Deck height lower than specification can result in excessive piston protrusion, compression and possibly valve-to-piston contact. Core passages should be cleaned using a rifle brush. All threaded holes should be visually inspected and a thread chaser ran through them to ensure that correct torque is achieved during engine reassembly. Bolt should be inspected for pitting and wear. Self-locking nuts should be replaced. The cylinder head mounting surface should be checked for the proper micro-finish using a surface roughness comparator, as mentioned in Task B.3.

■ **3. Inspect and measure cylinder walls for wear and damage; determine needed service.**

Cylinder walls should be measured for oversize as well as taper and out of round. Taper measurements are determined by comparing the size of the cylinder at the top (under the ring groove) to the size of the cylinder at the bottom. Out of round measurements are determined by comparing the measurement of the cylinder in the same plane 90 degrees from each other. Cylinders that are oversized, tapered or out of round beyond specification will have noise and oil-consumption concerns. If a cylinder is beyond the wear limits, different repair procedures are available depending upon the engine.

Some engines will have enough metal that they can be bored oversize, and oversized pistons can be installed. Normal oversize dimensions are 0.010", 0.020", 0.030" or 0.25mm, 0.50mm, 0.75mm. Other repair methods include boring the engine cylinder and installing a sleeve. This method brings the cylinder inside diameter back to the original diameter. Some engines have removable sleeves as original equipment. These sleeves can be removed and replaced without any machine work needing to be performed.

■ **4. Inspect in-block camshaft bearings for wear and damage; replace as needed.**

Inspect the camshaft bearings for scoring, roughness and wear. Camshaft bearings or bearing bores should be measured at a minimum of two different locations with a telescoping gauge or dial bore gauge. Measure the camshaft journals with a micrometer,

and subtract the journal diameter from the bearing diameter to obtain the clearance. If the wear exceeds specifications, replace the bearings.

The type of tool needed to remove and install the camshaft bearings depends upon the engine design. Most overhead valve (OHV) camshaft in-block engines will use a camshaft bushing driver and hammer. The right sized mandrel is selected to fit the bearing. Turning the handle tightens the mandrel against the camshaft bearing. Then the bearing is driven out by hammer blows. The same tool is used to replace the bearings.

When installing cam bearings, it is very important that the bearing insert be properly positioned in the bearing bore. Be absolutely sure that any oil hole(s) in the bearing insert align with oil supply passages in the bearing bore. This may mean that the insert is positioned toward the front of the bore, the back of the bore, or even the center of the bore. The position is not important so long as the oil holes line up.

■ 5. Inspect, measure, and replace/reinstall in-block camshaft; check and correct end-play; inspect, replace/reinstall and adjust cam followers (if applicable).

Camshafts should be inspected for wear marks. The camshaft is a highly loaded part of the engine and camshaft lobes are one of the first places that wear when the engine has a lubrication system failure.

Camshaft lobes can be measured with an outside micrometer. The lobe lift is determined by measuring the lobe across the highest point and measuring again across the base circle, then subtracting the base circle measurement from the lobe measurement. Alternately, the camshaft can be set in the block or on a set of V-blocks and the lobe lift measured with a dial indicator. If the measurement indicates wear, the camshaft is replaced.

Camshaft end-play is normally checked using a dial indicator. A typical specification will be 0.002" to 0.008". End-play that is greater than specification can be caused by a worn camshaft thrust washer or worn thrust surfaces on the camshaft. If either the thrust washer or the cam are worn, they are replaced. Camshaft end-play that is less than specification is generally caused by a failure of the technician to reassemble the components correctly. Excessive camshaft end-play can result in camshaft position sensor damage.

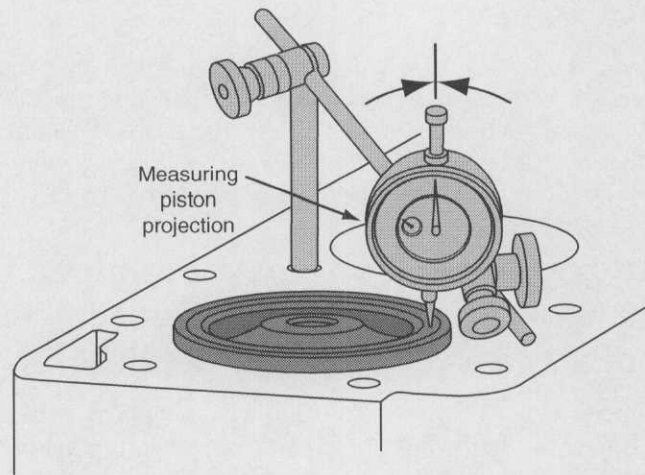
■ 6. Clean and inspect crankshaft and journals for surface cracks and damage; check condition of oil passages; check passage plugs; measure journal diameters; check mounting surfaces; determine needed service.

Crankshaft journals are inspected for cracks visually, and if necessary, using a magnetic field. Cracked crankshafts are generally not repaired, but replaced. Most engine manufacturers will allow a crankshaft that is rough to be ground undersized and a thicker bearing used to take up the clearance. Normal undersizes are 0.010" and 0.020" or 0.25mm and 0.50mm. The bearings for undersized journals will have the back stamped appropriately (e.g., 0.010" US). The US indicates undersized.

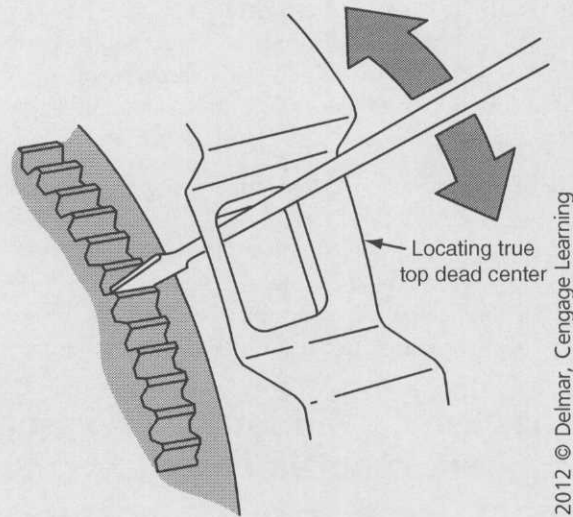
Oil passages should be checked for restrictions, cracks and proper chamfering. Journal diameters are measured for size, taper and out of round. Typically taper and out of round cannot exceed 0.001". If greater, the crankshaft may need to be reground. The flywheel mounting area should be inspected for cracks and warpage. The damper mounting area should be inspected for cracks, warpage and damaged keyways.

■ 7. Determine the proper select-fit components such as pistons, connecting rod and main bearings.

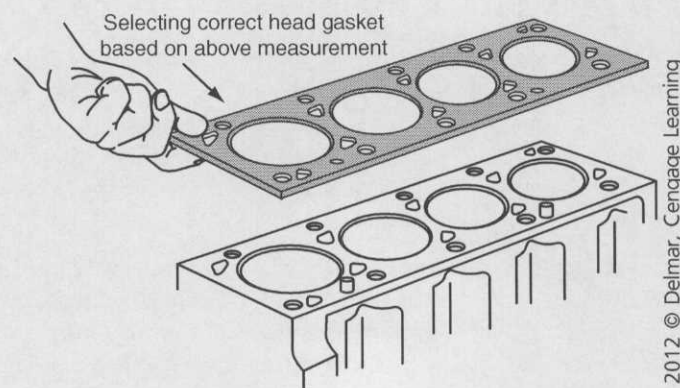
Some components on diesel engines are select fit. An example of select fit would be a head gasket. See the example below of how to select the correct thickness head gasket.



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■ 8. Inspect and replace main bearings; check cap fit and bearing clearances; check and correct crankshaft end-play.

Main bearings should be inspected for wear. Bearings that are worn on opposite corners can indicate a warped main bearing bore or a bent crankshaft journal. Bearings that are worn more on one end than the other may indicate a tapered main bearing journal. Main bearing caps must be installed in the same position as they were removed. Some manufacturers suggest setting the cap on the block, finger tightening the bolts, and then shifting the crankshaft back and forth to square the cap on the block. Main bearing clearances are measured using Plastigauge[®]. If the Plastigauge[®] is wider at one end than the other during this check, then a tapered journal is indicated. Main bearing clearances are normally 0.001" to 0.004". Crankshaft end-play is measured using a dial indicator. The crankshaft is shifted all the way in one direction, the dial indicator zeroed, and the crankshaft shifted all the way in the other direction. Crankshaft end-play specifications vary with the size of the crankshaft but will generally fall between 0.002" and 0.010". Excess crankshaft end-play can be caused by worn crankshaft thrust surfaces and worn thrust bearings. If the thrust surface is worn but smooth, an oversized thrust bearing can often be purchased to take up the clearance. An alternate method to measure end-play is to use a feeler gauge. When installing the main bearings, the back side of the bearing and the surface on which it sets should be dry and clean. The surface of the bearing that is against the crankshaft should be lubricated with clean engine oil or engine assembly lubricant as specified by the manufacturer.

■ 9. Inspect and time the drive gear train components (includes gear, chain and belt systems).

The gear train components should be inspected for worn teeth and bearing surfaces; if worn, the items are replaced. Cam drive gear train components are timed using timing marks stamped on the gears. The crankshaft and camshaft are set to TDC compression #1 and the chain, belt or gears are then installed. Many systems use Woodruff keys to position them; however, some will use tapers without Woodruff keys. If tapers are used, it is important to ensure no oil is between the taper and the gear when the gear is installed. This type of mounting will often have a two-step torque sequence. Care should be taken to follow these steps exactly. If the cam drive system uses timing pins to locate the position of the components, the components are tightened to a low specification, the pins removed, and then the final torque is applied. Failure to follow the recommended procedure can result in the timing pin cracking a gear, camshaft or timing pin boss. Some timing pins are plastic and care must be exercised to prevent damaging the pin during assembly. Timing belts must have the correct tension. Over-tightening the belt will result in premature wear and a noisy belt. After the gear train has been assembled, it is recommended to turn the crankshaft two complete revolutions by hand and check the alignment marks.

■ 10. Inspect, measure or replace pistons, pins and retainers.

Pistons should be inspected for cracks and wear. Erosion on the head of the piston is usually caused by overheating. This overheating can result from poor coolant circulation, insufficient air flow through the engine or over-fueling. Piston diameter is measured 90 degrees from the wrist pin, approximately 1/2" up from the bottom of the skirt. Pistons that are smaller than specification are replaced. Piston pins are full-floating or semi-floating. Full-floating piston pins are held in with retaining clips.

These clips and the mounting recesses in the pistons should be inspected for wear. If the piston is replaced, the piston pin retainers are also replaced. When installing the piston on the rod, check for correct orientation. Installing the piston in the incorrect direction can result in interference with the valve heads, piston cooling nozzles and crankshaft counterbalance.

■ 11. Measure piston-to-cylinder wall clearance.

Piston-to-cylinder wall clearance can be determined by measuring the piston at the location recommended by the manufacturer, then measuring the cylinder bore and comparing the two. The difference between these two numbers is the clearance. An alternate method is to slide the piston into the cylinder bore while sliding a feeler gauge in alongside the piston skirt. Try various sized feeler gauges until the piston nearly locks when inserted.

■ 12. Identify piston, connecting rod bearing and main bearing wear patterns that indicate connecting rod and crankshaft alignment or bearing bore problems; check bearing bore and bushing condition; determine needed repairs.

Bent or twisted connecting rods can be identified by inspecting piston skirt wear. A diagonal wear pattern across the skirt is an indication that the rod is twisted and the piston is being forced up and down in the bore in a sideways motion. Connecting rod bearings that show wear on opposite corners is also an indication that the connecting rod is bent or twisted. Main bearing bore misalignment can be identified by main bearings that show heavy wear at the first and last main bearing. Bore which house bearings need to be inspected to ensure they are smooth and round. The normal out of round/taper specification for a bearing bore is less than 0.001".

When checking the main and rod bearing bores, the caps must be correctly torqued. Main bearing alignment can be checked using a straightedge and a feeler gauge. The block may need to be removed from the engine stand and set on a flat surface to relieve stress. The straightedge is laid in the bearing bore and the technician attempts to slide a feeler gauge under it. If a feeler gauge can be inserted, the main bearing bore is out of alignment and should be repaired. Repairing the main bearing bore will move the crankshaft farther up into the block; this may cause excessive piston projection height, timing chain or belt looseness or timing gear backlash.

■ 13. Check ring-to-groove fit and end gaps; install rings on pistons. Assemble pistons and connecting rods and install in block; check piston height/protrusion and liner protrusion; replace rod bearings and check clearances; check condition, position and clearance of piston cooling jets (nozzles).

Piston ring-to-groove fit can be measured with a new ring inserted backward into the piston and a feeler gauge installed beside it. Many diesel engines use a keystone ring in the top compression ring position; a go/no-go gauge can be used to check this type of ring groove. Piston ring end gap is measured by inserting the piston ring into the cylinder

bore, squaring it with the piston head and using a feeler gauge to measure the distance between the ends of the ring. If this gap is less than specified, it may be acceptable to file or grind the ends of the ring. Piston rings are installed with the ring lowest on the piston first. The oil control may be installed by hand on some models. Compression rings must be installed using a piston ring expander. When installing rings, they are installed with the correct side facing up; this is usually identified with a dot or the word "up" or "top" printed on the ring. If there are no markings, then either side can go up. After cylinder liners are installed in the block, liner projection must be measured. This measurement is usually performed by holding the liner in the block and using a dial indicator. Incorrect liner height can cause head gasket leakage. If the liner projection is too low, it may be possible to raise it using shims. If liner height is not within 0.001" of level when measured in four places around the top, the counter bore where the liner sets will need to be checked to make sure it is level. If it is not level, it may be cut and a thicker liner shim installed. Piston and connecting rod fit can be full-floating or semi-floating. Full-floating designs have snap rings holding the piston pin in place. Semi-floating designs are held in place with an interference fit. This design is usually assembled using heat. After the pistons are installed in the block, piston projection must be checked using a dial indicator. Piston projection lower than specification will cause low compression and hard starting. Piston projection higher than specification can cause piston-to-cylinder head contact. Some engines will have multiple head gasket options and require piston projection to be measured prior to selecting the correct head gasket. Connecting rod bearings should be installed with the back side and the bore clean and dry. Care should be taken to prevent touching the bearing with bare hands; the acids on the skin can etch the bearing surface. Bearing clearance can be checked using Plastigauge[®]. Plastigauge[®] is inserted between the crankshaft journal and the bearing; the cap is installed and torqued. The cap is then carefully removed, and the width of the Plastigauge[®] strip is measured with the gauge on the side of the package. The wider the strip, the less clearance there is. Piston cooling nozzles are checked for cracks and proper positioning. The nozzle must be aimed to correctly spray oil under the piston. A bent or incorrectly positioned nozzle can result in piston overheating and damage in the cylinder bore during operation.

■ 14. Inspect crankshaft vibration damper.

There are two types of vibration dampers used on diesel engines, rubber bonded and viscous filled. Rubber-bonded dampers will have an inner and outer ring separated by a rubber strip. These dampers should be checked for a swollen or missing rubber. This style damper will often have alignment marks to allow the technician to see if the inner and outer rings have slipped in relation to each other. Viscous filled dampers are similar to a hollow doughnut, with a steel ring installed inside. The ring is suspended in a viscous, gel-like substance. These dampers are checked for lateral and radial run out. They should also be measured at a minimum of four places to ensure they are the same thickness all the way around. Some manufacturers recommend that they be heated in an oven for approximately 30 minutes and checked for leaks. A faulty vibration damper can cause the engine to knock. More severe failure can cause broken camshafts and crankshafts.

■ 15. Inspect flywheel/flex plate and/or dual-mass flywheel (including ring gear) and mounting surfaces for cracks, wear and run out; determine needed repairs.

Flywheels should be properly torqued to the crankshaft and checked for lateral and radial run out using a dial indicator. If either measurement is found to be incorrect, the mounting surface should be closely inspected to identify the cause. Flywheels and flex plates should be inspected for wear and cracks. Cracks can often be identified by rust

streaks. Elongated mounting holes are an indication that the flywheel or flex plate has run loose, the flywheel or flex plate along with mounting hardware must be replaced and the end of the crankshaft must be carefully inspected for wear when this occurs. Ring gears are often mounted to the circumference of the flywheel or flex plate and must be inspected for wear. If worn they may be replaced separately on some models. Care must be taken that the new ring gear is not overheated and is oriented correctly during installation. Dual-mass flywheels are a two piece design with springs between to help reduce vibration. These flywheels must be checked for loose or broken springs in addition to the checks mentioned above. Dual-mass flywheels tend to have a high failure rate and will often be replaced with single-mass flywheels.

D. Lubrication and Cooling Systems Diagnosis and Repair (6 Questions)

- **1. Verify engine oil pressure and check operation of pressure sensor/switch and pressure gauge; verify engine oil temperature and check operation of temperature sensor.**

Low oil pressure concerns should be verified using a master gauge. Many low oil pressure concerns are actually gauge or sending unit failures. When low oil pressure is identified, the technician should check the engine oil for proper level and condition. If oil pressure is correct when using a master gauge, the technician can use a gauge tester to determine if the gauge, wiring or sending unit is faulty. Engine oil temperature sensors can be checked for correct operation using an infrared temperature gun and an ohmmeter. Most manufacturers supply a chart indicating the appropriate temperature/resistance correlation.

- **2. Inspect, measure, repair/replace oil pump, housing, drives, pipes and screens; check drive gear clearance.**

When removing and inspecting engine oil pumps, refer to the manufacturer's manual for specific instructions and required tools. Most light-duty diesel engine oil pumps are mounted internally to the engine. Some can be accessed from the crankcase by dropping the oil pan with conventional tools, while other models require the removal of the front engine gear train cover to access them. Remove the bolts that mount the oil pump to the engine, and then carefully remove the oil pump.

Remove the cover from the pump body and inspect it for wear. Remove and inspect the gears or rotors for pitting and wear. Check the diameter of the gears and housing using a micrometer and compare with the manufacturer's specifications. Check gear to housing clearance with a feeler gauge. Check all mating surfaces and the pump body for damage and wear. After reinstalling the gears in the body, check the gear-to-cover clearance with Plastigauge[®] or a feeler gauge. If it fails to meet specifications, replace the worn parts. If the pump has an integral or external by-pass valve, it must also be checked for wear and cleaned. Because oil pumps are well lubricated by the fluid they pump, there will usually be little wear unless they are damaged by foreign particles passing through them. An engine that has been well maintained should have an oil pump showing very little wear.

Inspect the pick-up tube(s) for cracks and damaged mounting flanges. Replace the gaskets or o-rings with new ones. If the engine has a HEUI fuel system, low oil pressure will cause a no-start condition.

■ 3. Inspect, repair/replace oil pressure regulator valve(s) and by-pass valve(s).

Oil filters trap particles that would cause damage to critical components, such as engine bearings. Regular replacement of filter elements and inspection of the housing is necessary. Engines use a variety of materials from cast iron to die-cast aluminum for the housing and steel or plastic for machined parts. For this reason, the technician is often limited to visual inspection and replacement of the filter assembly parts. Cracks anywhere in the housing and nicks on machined surfaces can cause engine failures. Some filter assemblies incorporate a by-pass valve in their housing. These valve assemblies must be removed and inspected for corrosion, wear and other signs of damage during overhaul or any time the filter assembly contains metal particles.

Canister filters can be cut open and the element material examined for content. Metal particles indicate a potential bearing or gear failure. A milky gray sludge indicates water in the oil caused by a possible head or cylinder block leak, which may already have caused bearing damage. Ensure that all gasket surfaces are straight and free of nicks, which could cause an improper seal of the assembly. Apply a small amount of clean engine oil to the seals to lubricate them when installing filter assemblies. Priming or prefilling the filters, whenever possible, is often recommended to ensure adequate oil is present during start up to lubricate internal engine components as well as the turbocharger.

■ 4. Inspect, clean, test, reinstall/replace oil cooler, by-pass valve, lines and hoses.

Complete servicing of the oil cooler assembly should be done as part of a major engine overhaul, or whenever there is oil in the water, water in the oil pan, or a milky gray sludge in the filter. In any of these cases, specific manufacturer's instructions will apply. Many manufacturers recommend pressurizing the cooler with air and submerging in hot water to help locate leaks. Oil coolers with cracked tubes or plates are replaced, not repaired. Look for places where the oil cooler core baffles may have vibrated against the housing. If you find signs of this, replace the cooler core. Inspect for gasket particles and debris that are obstructing fluid flow and clean thoroughly. If the engine has suffered a major bearing failure, the cooler will require replacement, since it is not possible to remove all the bearing particles lodged in the cooler. The cooler by-pass valve should have a slightly worn appearance and must have no signs of scoring. Check the lines and hoses for signs of leaking. Inspect the inside of hoses, since they can deteriorate from the inside first. Replace any hoses with internal cracks.

■ 5. Inspect turbocharger lubrication and cooling systems; repair/replace as needed.

Turbocharger lubrication systems should be checked for clear, unobstructed supply and return lines. A restricted supply line will cause the turbo to receive insufficient oil and ruin the bearings. A restricted return line will cause the bearing housing to flood with oil and the shaft seals to leak. When replacing a turbocharger, the engine should be cranked until there is oil at the turbocharger supply line. This will help prevent a dry start. Remember an engine should never be cranked for more than 30 seconds, and there should be a 2-minute starter cool down period between cranking events. Many turbochargers are now cooled by the engine cooling system. The cooling lines should be checked for restriction, and the associated hoses and seals should be inspected for leaks.

■ 6. Change engine oil and filters; add proper type, viscosity and rating of oil.

Engine oil change intervals can be set by hours, miles, idle time, fuel consumption, oil consumption or by the calendar. Generally speaking most customers will fall into the mileage category with a normal oil change interval being 5,000 miles. It is critical that the engine manufacturers' recommendation be followed when scheduling oil changes.

Most light-duty diesel engines require an oil specifically labeled for diesel engines. 15w40 is still widely used; however, it is becoming more common to see a 5w30 or 10w30 specification. Again, follow the OEM guidelines for the engine and ambient temperature. While some manufacturers recommend pre-filling the filter, it is no longer a general recommendation to pour oil in the filter. It is very likely this will result in unfiltered oil entering the engine. In order to prevent this and still fill the filters prior to starting, install the filters dry, prevent the engine from starting, and crank the engine in 30-second cycles until there is oil pressure on the gauge. Then allow the engine to start. Some OEMs will suggest starting the engine and allowing it to idle only until pressure is observed on the gauge. 2007 and newer diesel engines are equipped with a diesel particulate filter. It is important that the correct oil is used in these engines. If the incorrect oil is chosen, the oil change interval and after treatment maintenance schedule will be shortened. See the chart below for an example.

American Petroleum Institute Classification (API)	Comments
API CH-4/SJ	Not recommended. Lubricating oil drain interval must be reduced by 50 percent. After treatment maintenance interval will be reduced.
CI-4/SL	After treatment maintenance interval will be reduced.
CJ-4/SL	Maximum after treatment maintenance interval. No change in lubricating oil drain interval.

■ 7. Inspect and reinstall/replace pulleys, tensioners and drive belts; adjust drive belts and check alignment.

Drive pulleys and tensioners should be inspected for worn, noisy or loose bearings. This can be done by spinning them by hand and listening. The grooves where the belt runs should be inspected for roughness. A worn or rough pulley groove will quickly destroy a belt. On serpentine belts, pulleys and tensioners, a hand-held wire brush should be used on the grooves to remove the pilling from the old belt. This will allow the new belt to seat correctly. When reinstalling pulleys and tensioners, care should be used to ensure that any spacers, shims or mounts are installed correctly. This helps prevent incorrect belt alignment. Belt and pulley misalignment can result in premature belt edge wear and pulley and tensioner bearing wear. Belt alignment can be checked with a straightedge or a laser belt alignment tool. A noisy accessory drive belt system can oftentimes be quieted by properly aligning the belt and cleaning the grooves.

■ 8. Verify coolant temperature; check operation of temperature and level sensors, switch and temperature gauge.

Verify engine coolant temperature and coolant temperature sensors by comparing the reading on the scan tool and the dash display with the reading of an infrared temperature

gun. The two readings should be very similar. If they are not, a suspect sending unit, gauge or wiring is indicated. Sensor resistance can be checked against a manufacturer's supplied resistance value to determine the correct sensor resistance at a given temperature.

Temperature sensors can have in-range failures. This means that the sensor is reporting a value that is logical to the ECM, but that it is wrong by 15–40 degrees F. This type of failure rarely sets a code, but it can cause a host of drivability issues, such as low power and poor fuel economy. Temperature switches are on/off devices that indicate overheating; they will open and close at given temperatures. The switch status can be checked with an ohmmeter. Temperature gauge operation can be checked with a gauge tester. Gauge testers vary the ground signal to the gauge, and the technician compares the gauge reading to a specification in the service literature. Level sensors are on/off switches that indicate coolant level. They are generally found in the coolant reservoir or in the top tank of the radiator. Their status can be checked with an ohmmeter.

■ 9. Inspect and replace thermostat(s), by-passes, housing(s) and seals.

Thermostat operation can be checked using an infrared thermometer. Start with a cold engine, then as the engine warms, check to make sure that the top tank of the radiator stays cool until thermostat opening temperature. At thermostat opening temperature, the radiator should quickly warm from an ambient temperature to close to the thermostat opening temperature. If the change in temperature is gradual, it may mean the thermostat is not fully closing, thus allowing a leak into the radiator. If the coolant coming into the radiator is not close to the rated thermostat opening temperature, then the thermostat may be opening too soon. This type of failure will result in an engine that operates at a colder than normal temperature. Concerns of poor fuel economy and poor heater performance are often accompanied by this type of failure. This is a much more common concern than the thermostat failing to open, which results in an overheated engine. Thermostat function can also be checked by suspending the thermostat in a pan of water along with a thermometer and warming the water while observing when the thermostat opens.

When replacing a thermostat, the housing and seals should be checked for cracks and sealing surface condition. During replacement, care must be taken to install the thermostat in the correct direction and to make sure the thermostat is setting in the mounting recess fully. Many diesel engines will have a by-pass valve on the bottom of the thermostat. This valve blocks the by-pass passage in the block when the thermostat is open. Blocking the by-pass passage forces the coolant to travel to the radiator when the thermostat is open. If an incorrect thermostat is installed, the passage will not be blocked and an engine overheating condition can result.

■ 10. Flush and refill cooling system; add proper coolant type; bleed air from system.

When flushing and filling a cooling system, the technician must follow EPA recommended procedures. Used coolant is considered a hazardous waste and must be stored in a properly labeled container and recycled or hauled off by a licensed carrier. Used coolant should never be flushed down a drain. Used coolant should not be mixed with other fluids.

When draining the cooling system, the block should be drained as well as the radiator. When installing new coolant, the coolant should be premixed and poured into the cooling system no faster than the manufacturers recommended fill rate. Following the guidelines will help to prevent trapped air in the cooling system. Another method to help prevent trapped air is to open any factory provided air bleeder valves. These valves are typically

found high on the system, possibly in lines connecting to the heater core. If no bleeder valves are factory installed, the technician can loosen a hose or a fitting at the top of the cooling system to help vent the air. The cooling system can also be filled using a vacuum. To do this, pull a vacuum on the system using a tool designed for that purpose, then allow the vacuum to draw coolant into the cooling system. This has become a preferred method by many technicians. There are many different coolants on the market. Many are being advertised as universal coolants. Technicians need to follow OEM guidelines when choosing coolants. Improper selection can lead to increased maintenance frequency, incompatible coolant additives and leaks.

■ 11. Inspect and replace water pump, housing, hoses, and idler pulley or drive gear.

Water pumps are inspected for leaks and noisy bearings. A noisy or leaking water pump is replaced not rebuilt. Water pump leaks can be caused by overconcentration of coolant additive packages as well as overconcentration of antifreeze. A 50/50 coolant mixture is adequate for year-round protection in most cooling systems. Supplemental coolant additive packages can be checked for concentration using test strips. The proper test strip must be chosen for the additive package used. Water pump and idler pulleys are checked for loose and noisy bearings. If the pump is gear driven, the drive gear is visually inspected for wear and gear backlash can be measured. Cooling system hoses are visually checked for deterioration as well as by feeling the hose and squeezing it. The hose may look acceptable on the outside but produce a crackling sound when squeezed by hand. In this example, the hose must be replaced. The hoses need to be checked for signs of abrasion. If the hose has abrasive wear, it can indicate that there is a loose or broken component mount or possibly the hose was incorrectly installed. Hose clamps have torque specifications, which must be followed. Silicon hoses require constant torque hose clamps. Constant torque hose clamps hold constant pressure on the hose throughout expansion and contraction caused by the heating and cooling of the system.

■ 12. Inspect radiator, pressure cap and tank(s); pressure test cooling system and radiator cap; determine needed repairs.

Radiators are usually pressure tested to locate leaks. The pressure tester is installed on the radiator or surge tank if the surge tank is pressurized and pumped up to the rating on the radiator cap. Leak testing is usually performed with the engine cold. This can help locate leaks caused by silicone hoses, which tend to leak more when cold. If the leak is not located with the engine cold, then start the engine and let it warm. The pressure tester can also be used to test the relief setting on the radiator cap. Wet the seal on the cap and install the cap on the pressure tester adaptor. Pump the tester to the relief setting specification located on the cap. The cap should hold pressure until the specification and then release only the excess pressure. The cap should maintain the pressure setting. Inspect the cap visually to check the condition of the vent valve. If the vent valve fails to open, the cooling system will enter into a vacuum as it cools down, and the cooling system hoses will collapse.

Leak detection can also be accomplished using a fluorescent dye. The dye is installed in a cold cooling system, the radiator cap reinstalled and the engine started and warmed. The technician then uses yellow goggles and a black light to search for the source of the leak.

■ 13. Inspect, repair/replace fan, fan hub, clutch, controls and shroud.

The fan can be electric, hydraulic or belt driven. Belt-driven fans will have a thermostatic fan clutch to control fan run time, this clutch can be thermally controlled or controlled by the ECM.

Electric fans are activated by the ECM when the signal from the coolant temperature sensor indicates the engine temperature is exceeding specification. The ECM can also operate the fan when needed, such as when the air-conditioning high side pressure requires it. The ECM can operate the fan through a relay or directly by using a pulse-width modulated (PWM) signal. Electric fans can be a single speed or multiple speeds. Electrically operated fans can usually be activated with the scan tool to aid in troubleshooting. Hydraulic operated fans are found on a few vehicles. These vehicles will use a belt-driven hydraulic pump or the existing power steering pump to drive the fan. These systems will also be controlled by the ECM. The ECM will control the oil flow to the fan to control fan speed.

The thermostatic clutch on a belt-driven fan should be inspected for leaks. The fan usually fails in either the freewheel mode or in the totally locked mode. Turn the engine off and, after the fan stops turning, spin the fan by hand. If the engine is warm, the fan should turn less than one revolution when released. If the fan spins more than one revolution, it is an indication the fan clutch may be slipping and could be the source of an overheating concern. A more thorough test should be completed using the service literature as a guide. If the fan will not spin by hand, it is locked and very likely the source of an engine noise or low fuel economy customer concern.

When the fan is separate from the shroud, as is the case in most belt-driven thermostatically controlled fans, the fan should set $\frac{2}{3}$ of the way into the shroud for maximum air movement. A damaged or missing shroud may cause an engine overheating concern. Visually check for missing or broken air dams under the vehicle. These air dams direct air up and through the radiator; they are easily damaged and can be the source of an engine overheating concern. Fan hubs should be tested for noise by using a stethoscope. They can also be tested by removing the belt and spinning the hub by hand while feeling for roughness. Some manufacturers will have a clearance specification for fan hub axial and radial clearances; this is measured using a dial indicator.

E. Air Induction and Exhaust Systems Diagnosis and Repair (12 Questions)

■ 1. Perform air intake system restriction and leakage tests; determine needed actions.

Air inlet restriction tests are performed when there is maximum air flow. For the test to truly measure the amount of restriction, the engine must be fully loaded. This can be hard to duplicate in the shop unless a dynamometer is available. Therefore, some manufacturers will specify that the test be run at wide open throttle. The normal maximum restriction specification is 20" to 25" H₂O. Either a water manometer or an electronic gauge calibrated to a water manometer scale can be used. Most air cleaner assemblies now come with an air inlet restriction gauge installed from the factory in the air cleaner. This gauge should be inspected at each service interval. The gauge has a ratchet lock mechanism that stores the highest reading indicated since the last time it was reset. It is normal for the gauge for indicate some restriction. If it does not, a ruptured air filter element or leaking air intake piping should be suspected.

■ 2. Perform intake manifold pressure tests; determine needed actions.

Intake manifold pressure tests, also known as turbocharger boost pressure tests, are performed with the engine at full load. In order for the diesel engine to effectively spool the turbocharger to make boost pressure, there must be heat; and for there to be heat, there must be fuel. The most common cause of low-intake manifold pressure is restricted fuel filters. Other causes include malfunctioning wastegate, sticking vanes or sliding volutes on a variable geometry turbocharger (VGT), leaking exhaust manifold gaskets, restricted exhaust systems and restricted air intake systems. Less likely, but still possible, is a failed turbocharger. If the turbocharger impeller wheel is excessively worn, dirt ingestion should be suspected, and the air intake system should be thoroughly inspected for leaks. Excessive intake manifold pressure is seldom a concern but can be caused by aftermarket engine programmers, malfunctioning wastegate or sticking swinging vanes and sliding volutes in a VGT.

■ 3. Inspect, service/replace air induction piping, air cleaner and element.

A visual inspection is the most common method of inspecting the air induction piping. Close attention should be given to areas where contact is made with any other item. The movement between the two items can cause wear to the air intake piping and allow dirt to enter the air system. Dust/dirt streaks anywhere in the system are an indication of a leak and should be inspected. A visual inspection of the air cleaner element will not accurately indicate restriction. The proper method to determine restriction is with an air inlet restriction test. If the air cleaner element is ruptured or torn, an incorrect air cleaner element should be suspected. Occasionally, a gasoline engine air cleaner element will be installed instead of the correct diesel element. The diesel air cleaner element is reinforced to withstand the stronger air pulsations in a diesel engine air intake. Most manufacturers recommend against over-servicing the air cleaner element. The element actually performs better after it has been in service for a while. Also every time the box that contains the element is open, the seal is broken and must be resealed, thus there is a possibility for dirt to enter the air system.

■ 4. Inspect, test and replace turbocharger(s), including variable ratio/geometry turbocharger(s) (VGT), pneumatic, hydraulic, and electronic controls and actuators; inspect, test, and replace wastegate and wastegate controls.

The compressor and turbine wheels must be visually inspected for damage and wear; missing, bent or worn blades are a cause for turbocharger replacement. If the compressor wheel blades are worn, it is an indication of dirt entering the air stream, and the air intake system must be closely inspected for leaks. It should be noted that the same dirt traveled through the engine, most likely damaging the piston rings. Turbochargers are also checked for axial and radial clearances using a dial indicator. If the clearance specifications are exceeded, the turbocharger must be replaced.

A mechanical wastegate should be checked for proper adjustment by using a dial indicator and an accurately regulated shop air source. Because the wastegate canister is spring loaded to keep the gate closed, air pressure is utilized to overcome the spring tension and cause the gate to open. The dial indicator is mounted against the external arm of the wastegate and zeroed out. When the specified air pressure is applied to the wastegate

actuator, the dial indicator needs to move the specified amount of travel. The arm can be adjusted if the travel is out of spec.

An electronically controlled wastegate can be actuated through the diagnostic software to observe for correct operation of the gate or the variable geometry ring. The technician should suspect a malfunctioning wastegate or variable geometry ring when high-boost pressure codes are logged in the ECM for the engine.

The moving components of a variable geometry turbocharger (VGT) are checked for correct operation by activating them with a scan tool. Incorrect operation of these components will most likely set a trouble code. Some manufacturers will allow replacement of the actuators separately from the turbocharger, while others will require the complete replacement of the unit. If the VGT actuator is replaced separately from the turbocharger, usually a computer relearn will need to take place.

■ 5. Inspect and replace intake manifold, gaskets, temperature and pressure sensors, and connections.

Intake manifolds and gaskets are usually replaced due to leaks. These leaks can often be identified by using a smoke machine. Temperature and pressure sensors are checked by observing data on a scan tool. If the engine is key on and engine off and the pressure sensor indicates 5 pounds of boost, there is an obvious problem. Disconnect the sensor and observe the scan tool. If the data changes to zero pounds boost, the sensor is faulty. If the data does not change, either the wiring harness or ECM is faulty. A similar check can be performed on the temperature sensor. It should be noted with both of these sensors that the sensor can fail in range. That is, the sensor can be off by a few degrees or pounds of boost and the ECM not set a trouble code. These types of failures can be easy to miss. A rational check, such as described here, is a good troubleshooting method for these types of failures.

■ 6. Inspect, test, clean and replace charge air cooler and piping system.

The charge air cooler should be visually inspected for damaged fins and mounting adapters. The cooler is tested for leaks by filling with pressurized air and watching for the leak down time. All charge air coolers will leak some; therefore, the rate of leak must be checked against specifications. Charge air coolers must also be tested for restriction. Internal restriction will limit the air flow to the engine. The most common test for internal restriction is to compare boost pressure on the inlet side of the cooler to boost pressure on the outlet side of the cooler. A typical specification would be no more than a 2-psi drop across the cooler. Charge air coolers must also be checked for external restriction. External restriction can result in the air entering the engine being hotter than specification. To test, put the engine under load and measure the temperature of the air entering the intake manifold and compare it to the ambient air temperature. A typical specification would have the incoming air no more than 40 degrees F higher than the ambient air temperature. Charge air coolers are best cleaned with soap and water; caustic chemicals and high-pressure cleaners must not be used. If a turbocharger has failed and contaminated the charge air cooler with oil, the cooler must be thoroughly cleaned internally. Otherwise, the engine could run away when it is restarted.

■ 7. Perform exhaust back pressure and temperature tests; determine needed actions.

Exhaust back pressure checks are performed using a manometer connected to the exhaust system after the turbocharger, prior to the first bend in the exhaust system tubing. The

engine needs to be operated at full load to get the true restriction reading. Readings higher than specification can indicate a restricted muffler, diesel particulate filter or diesel oxidation catalyst (DOC). If any of these items are restricted, the root cause should be located. A faulty after-treatment injection system or an engine component allowing oil to enter the exhaust could be the cause. Failure to repair this condition will simply allow the new unit to become restricted. Lower than normal exhaust back pressure readings are indication of a system leak. High exhaust system temperatures can be an indication of exhaust system restriction; they can also be an indication of engine over-fueling or a leaking after-treatment injector. Currently, exhaust temperature and pressure specifications vary widely, depending on the exhaust system being used and mode of operation. Always check specifications when performing these checks.

■ 8. Inspect, repair/replace exhaust manifold, gaskets, piping, mufflers, exhaust after treatment devices and mounting hardware.

Exhaust leaks can often be identified by the black soot trail they leave. When a leak has been located, the mating surfaces of the leaking components must be inspected and repaired, if necessary, and the gasket replaced. Exhaust piping must be inspected to ensure that appropriate room exists between it and other vehicle components. Exhaust temperatures are higher on new vehicles due to the after-treatment systems installed on new diesel engines. Therefore, these clearances are very important. All brackets and mounts must be secure and not damaged.

■ 9. Inspect, test and repair/replace pre-heater/inlet air heater and/or glow plug system and controls.

Intake air heaters and glow plugs are electric heaters installed in the intake manifold or the combustion chamber. These heaters are controlled by the ECM. The ECM determines how long they should be energized based upon coolant temperature, intake air temperature or in some cases engine oil temperature. Since the heater functions on the electrical resistance principle, the usual failure mode is open. Therefore, the heater or glow plug should be disconnected and a simple ohmmeter test performed. Usually, the resistance will be low if the unit is OK and high if the unit has failed. An alternate method would be to use an amp clamp. Again, normally the amperage draw will be low or nonexistent if the element has failed. Faulty temperature sensor circuits can cause the ECM to energize the heater for an incorrect amount of time. Sticking relays or failed ECMs are to be suspected if the heater or glow plug has failed open. This is almost always the case if all the glow plugs are failed open. Failed glow plugs and/or intake air heaters can cause a diesel engine to be hard to start and blow excessive white smoke on a cold start.

■ 10. Inspect, test, and replace exhaust after treatment system components and controls; check regeneration system.

Most if not all light-duty diesel engines produced since 2007 will have some form of an exhaust after treatment system to help meet EPA emission requirements. The system normally consists of a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF). These items will often be assembled in a single unit. The diesel oxidation catalyst converts NO to NO₂, and during a regeneration event will convert fuel to heat to help clean the

diesel particulate filter. The diesel particulate filter traps the soot that is normally found in the diesel exhaust stream. A pressure differential sensor is used by the ECM to monitor the DPF for restriction. As the DPF becomes restricted, the ECM puts the engine in regeneration mode. During regeneration mode, the temperature of the DPF is raised to the point that the particulates (soot) are converted to CO₂ and N₂. This high-temperature conversion will leave a small amount of ash in the DPF. Eventually, the DPF will fill with ash and will need to be removed and cleaned with a special cleaning machine.

There are different ways that a DPF can be cleaned of soot. If the exhaust stream and DPF are sufficiently warm during normal engine operation, the regeneration can occur during normal driving without any additional fuel being injected into the exhaust stream. This is known as *passive regeneration*.

If passive regeneration cannot occur often enough to keep the DPF clean, then the ECM may start an *active regeneration*, which may occur while driving or while the vehicle is parked. During active regeneration, the ECM turns the EGR valve off and injects fuel into the exhaust stream of the engine, raising the DPF temperature sufficiently to clean the soot.

If the DPF is restricted, a technician can force the engine in to an active regeneration event using a scan tool. When activated, the ECM will turn the EGR off, raise the engine RPM, and inject fuel into the exhaust stream. During this scenario the vehicle must be parked in a safe location. This process can take up to 30 minutes, and it is only necessary if normal driving has not kept the DPF clean.

In addition to the differential pressure sensor, the ECM uses temperature sensors to monitor the DOC and DPF for correct functioning. Any failure of the engine or fuel system that introduces large quantities of oil or fuel into the exhaust stream has the potential to damage the exhaust after-treatment system. Failed after-treatment systems will reduce engine performance and should set DTCs. The appropriate troubleshooting trees should be followed to locate the source of the failure. These systems are very new, and it is vitally important that the most recent troubleshooting information be followed.

■ 11. Inspect, test, service and replace EGR system components, including EGR valve(s), cooler(s), piping, electronic sensors, controls and wiring.

EGR systems are designed to allow some of the exhaust gas to re-enter the engine to help cool the combustion chambers. This in turn helps lower the NO_x emissions. EGR valves can be mounted before or after the cooler. This is commonly referred to as upstream and downstream, or hot side and cold side mounting. Some EGR valves are referred to as “smart” valves because they contain their own microprocessor and communicate on the data bus. EGR valves can stick in the open, closed or mid-way position. When stuck in the open position, low power and surging are common complaints. When the valve is stuck in the closed position, the driver may not have any complaints. Using the ECM and the scan tool is usually the best way to test the valve. The ECM can be commanded to open and close the valve while the technician observes the valve for corresponding operation. This test can be performed with the engine on or off. The EGR cooler cools the exhaust gas with engine coolant. The cooler can leak internally and allow the coolant into the exhaust system and the exhaust gas into the coolant. If coolant passes into the exhaust stream, the normal smells and steam can help identify the leak. Suspect EGR coolers can be pressurized and submerged in hot water to help locate leaks. EGR coolers are replaced, not repaired. EGR systems use pressure differential sensors and mass airflow sensors to allow the ECM to determine that exhaust gas flow has occurred. The pressure differential

sensor will have hoses connecting it to the EGR venture, these hoses are prone to clogging and deterioration from the exhaust heat.

■ 12. Inspect, test and replace EGR air-flow control (throttle) valve and controls.

Some EGR systems utilize an air throttle valve to help promote EGR flow. When the ECM determines that EGR is necessary it will partially close the air flow valve (throttle). This will create a vacuum in the intake manifold, which will help the EGR gases to flow into the intake manifold and on into the cylinders. These throttle valves are similar to the drive-by-wire throttle plates found on late model gasoline engines. These valves can stick, clog or otherwise fail to operate. Usually, a diagnostic trouble code will be set when there is a problem associated with the valve. The technician can also use the ECM and scan tool to command the valve open and shut while observing for proper operation.

■ 13. Inspect, test and replace crankcase ventilation system components.

Crankcase ventilation systems have evolved from simple road draft tubes to very elaborate systems with serviceable filters and pressure sensors. Symptoms of restricted crankcase ventilations systems are leaking seals and blown-out gaskets. The common test method for crankcase pressure is a manometer hooked to the dipstick tube. Some manufacturers require the technician to install a restrictor fitting in the vent line to perform a functional test. Usually, these pressure tests require the engine to be run at wide-open throttle and full load. Some manufacturers may give idle and no-load specifications as well.

Crankcase pressure sensors are used to allow the ECM to identify a restricted crankcase filter. The crankcase filter should be serviced at the recommended intervals.

F. Fuel System Diagnosis and Repair (13 Questions)

■ 1. Inspect, clean, test and repair/replace fuel system tanks, vents, caps, mounts, valves, single/dual supply and return lines, and fittings.

Clean fuel is critical to engine operation. Fuel tanks can be contaminated with dirt, water and bacteria. To properly clean the tank, the fuel tank must be drained, removed and cleaned. In the case of bacterial contamination, the fuel system must be treated with a biocide product to kill the growth; otherwise, it will return. Bacteria is usually identified by a gray/black slimy sludge in the fuel filters. Restricted or plugged fuel tank vents can cause low-power concerns. Fuel tank mounts must be secure and tight. Rust streaks around the mounts are indications of looseness. When a tank has been run loose, the mounting straps should be removed and the tank beneath inspected. The loose strap can wear into the tank and weaken it. Supply and return lines should be securely mounted and have the proper retaining clips in place. Lines that are loose can suffer abrasive wear and should be thoroughly inspected. Most factory fuel lines are quick-connect with a locking pin. Locking pins and tabs must be replaced if missing or broken. Any replacement fittings and lines must be diesel fuel-compatible.

■ **2. Inspect, clean, test, repair/replace fuel transfer and/or supply pump, strainers, fuel/water separators/indicators, filters, heaters, coolers, ECM cooling plates (if applicable) and mounting hardware.**

Fuel supply pumps can be electrical or mechanical. Low fuel supply pressure is a common cause of low power/low turbocharger boost pressure concerns. A fuel pressure gauge can be used to identify low pressure problems. Fuel flow should also be checked. Insufficient fuel flow can result in low power and fuel starvation. Fuel starvation has been associated with many fuel pump failures on light-duty diesel engines. Fuel water separators are used to remove water from the fuel. These filters should be drained at each service interval and as indicated by the Water In Fuel (WIF) lamp on the dash. If the WIF lamp comes on during operation, the driver should immediately stop and drain the filter. Caution should be used if selecting a pour in product to remove the water from the fuel. These products tend to force the water through the injection system and can damage the system. Fuel heaters are electrical resistance heaters and can be checked with an ohmmeter or ammeter. The ECM typically controls these based upon temperature. If these heaters fail to operate, fuel gelling can occur in cold weather. If these heaters fail to shut off, they can lead to low power concerns because of overheated fuel. Fuel coolers are used on some systems. These are fuel-to-air coolers, and some models are mounted in areas where they are easily contaminated with mud. Restricted fuel coolers can result in overheated fuel and low power. ECM cooling plates are mounted under the ECM and have fuel flowing through them. The fuel is used to cool the ECM. These plates can crack and allow air to enter the fuel system. They can also become restricted and result in low power. Fuel filters are the most important component for fuel system life. The technician needs to be vigilant while servicing the fuel filter to ensure only top quality filters that meet all OEM requirements are installed. During installation, care must be taken to prohibit unintentional dirt ingestion. Many OEMs now recommend installing the filter dry and using the fuel system to prime the filter. This prevents unfiltered fuel from entering the system. Restricted fuel filters can be located by performing a pressure drop test across the filter. The normal maximum filter restriction is 5 psi. Low power and low boost pressure is the most common fuel filter restriction concern.

■ **3. Check fuel system for air; determine needed repairs; prime and bleed fuel system; check and repair/replace primer pump.**

There are different methods to check for air in the fuel. One method involves installing a clear piece of hose or liquid eye in the fuel supply line, running the engine and looking for bubbles in the fuel stream. Another method is to remove the return fuel hose and submerge it in fuel, and then look for bubbles. Some manufacturers provide a test port at the fuel filter where this same test can be performed. With all of these tests, there should be no bubbles in a properly operating system. Air in the fuel system can cause low power and surging RPMs. Hard starting, especially after the vehicle has set, can be caused by air in the fuel system.

Most fuel systems now incorporate a priming pump. This pump can be either manually or electrically operated. It is used to prime a fuel system and remove the air. There is often a bleeder screw that should be loosened to allow the air to escape. When fuel without air bubbles exits, the fuel system has been bled, and the screw can be tightened. Usually, primer pumps are replaced when defective, but some OEMs offer repair kits.

■ 4. Inspect, test and repair/replace low-pressure regulator supply and return systems.

Fuel supply systems have a low-pressure side and a high-pressure side. The low-pressure side will have a restrictor fitting or pressure-regulating valve to control the pressure. These valves can stick open, stick shut or leak. When the valve sticks open, fuel pressure will be lower than normal and can cause low power. If the valve is stuck shut, fuel pressure will be higher than normal. This can cause overheated fuel, low power and damaged fuel system components. Fuel pressure tests are performed using the appropriate fuel pressure gauge and specifications. These tests often require the engine to be operated under full load. If a dynamometer is not available, the vehicle can be road tested while a second technician monitors the pressure on the gauge.

■ 5. Inspect, reinstall/replace high-pressure injection lines, fittings, seals and mounting hardware.

Pump-line-nozzle electronic (PLN-E) and common rail fuel systems both use high-pressure injection lines and seals. These lines and fittings are specially designed to seal the high-pressure fuel. Tightening torque specifications must be closely followed. There is a tendency in the industry to over tighten these fittings when they leak. This does not seal the leak; it deforms the line and damages the components. A leaking connection should be tightened to specification. If it continues to leak, it should be disassembled and inspected. Often these components will need to be replaced if tightening to specification does not stop the leak. Some manufacturers recommend replacing these fittings any time they are removed. High-pressure lines and fittings are subject to vibration damage. All clamps should be properly installed. Loose clamps can lead to cracked lines. Loose and missing clamps can lead to a noise complaint from the customer, as these lines will vibrate at a high frequency when left unsecured.

■ 6. Inspect, adjust, and repair/replace electronic throttle and power take-off (PTO) control devices, circuits, and sensors.

Diesel engines now use drive-by-wire technology. The accelerator pedal position (APP) sensor connects to the accelerator pedal and serves as an input, telling the ECM the throttle request by the operator. There is no throttle cable on these engines connecting the accelerator pedal to the fuel system. The throttle position sensor (TPS) attaches to the throttle valve (throttle plate) on engines so equipped and sends a signal to the ECM telling the position of the throttle valve. The throttle valve is open and closed by an electric motor, which is operated by the ECM. The ECM uses this throttle valve to aid in EGR flow. The APP and TPS are traditionally potentiometers. They can have one, two or three potentiometers and may or may not be coupled with an idle validation switch (IVS). If the APP or TPS is adjusted, it is normally adjusted to approximately 1 volt at idle. If replacement is necessary, the APP and TPS can usually be replaced separately from the accelerator pedal or throttle valve. Some manufacturers use a Hall-effect switch instead of potentiometers for their APP and TPS sensors. These sensors send a digital signal instead of an analog signal.

Many manufacturers now use an on/off switch to activate PTO mode. In addition, a switch can be used to raise or lower the RPMs during PTO mode; this switch is usually a momentary switch. The ECM is constantly monitoring these sensors for a faulty signal. If a faulty signal is detected, the ECM will set a DTC and may operate the engine in a

“limp home” mode. A totally failed APP will cause the engine to be limited to an idle RPM only. Voltage output from the sensors can be measured with a voltmeter to determine if the sensor, wiring or ECM is at fault.

■ 7. Perform on-engine inspections and tests, and replace high-pressure common rail fuel system components and electronic controls.

The common rail fuel system consists of the fuel tank, fuel filter assembly, fuel pump assembly, high-pressure junction block, high-pressure common fuel rail or rails, fuel injectors and fuel cooler. The fuel injection system typically has a supply pump and a high-pressure pump. The high-pressure pump is a radial design using three pistons. The pump pressurizes the fuel in the range of 5,000 psi to 23,000 psi. The high-pressure fuel travels from the pump to the junction block, and then to the high-pressure rail(s). The fuel pressure in the high-pressure rail(s) is controlled by the ECM by controlling the fuel inlet to the high-pressure pump. When fuel pressure drops in the high-pressure rail(s), the ECM allows more fuel to flow into the high-pressure pump. The junction block has a pressure relief valve that will open in case of fuel system over-pressurization (approx 26,000 psi); this over-pressurization would only occur in case of a system failure and is not a normal operating condition. The fuel rails have internal or external high-pressure lines that connect to each individual injector. The fuel injector is a solenoid-operated device that is opened by the ECM to allow fuel to flow into the combustion chamber.

High-pressure common rail fuel systems are tested for supply pump pressure and flow, high-pressure pump pressure and drain system pressure and flow. Low supply pump pressure and flow can be caused by restricted fuel filters, a worn pump and insufficient fuel in the tank. Low pressure from the high-pressure pump can be caused by low pressure and flow from the supply pump, a weak high-pressure pump, a faulty fuel pressure control valve (pressure limiter) or a faulty pressure relief valve. The drain system is checked for excess pressure and flow. Excess pressure or flow in the drain system is an indication of a failed injector, pressure relief valve or a restricted drain line. A drain test is performed individually on each item to determine the failed component.

■ 8. Perform on-engine inspections and tests, and replace hydraulic electronic unit injectors (HEUI) components and electronic controls (rail pressure control).

The HEUI (hydraulically actuated, electronically controlled unit injector) system uses engine lube oil as the hydraulic medium to actuate the fuel delivery pulse in its HEUI assemblies. This means that the delivery stroke is actuated hydraulically, switched by the engine management ECM(s) and not confined to any hard limits.

Fuel Supply System

The fuel supply system delivers fuel from the vehicle's tanks to the injector units. Fuel movement through the fuel supply system is the responsibility of a cam-driven plunger pump. This transfer pump pulls fuel from the chassis fuel tank(s) through a fuel strainer. It then charges fuel through a disposable cartridge-type fuel filter and feeds it to the fuel gallery of the fuel/oil supply manifold. A fuel pressure regulator at the fuel manifold outlet is responsible for maintaining a charging pressure of approximately 30 to 60 psi. Fuel is cycled through the fuel supply system and the HEUIs are mounted in parallel from the fuel manifold.

Injection Actuation System

The HEUI system uses hydraulically actuated, electronically controlled injector assemblies to deliver fuel to the engine's cylinders. Engine oil is the hydraulic medium used to actuate the pumping action required of the injector. The engine lubrication circuit provides a continuous supply of engine lube to the HEUI high-pressure pump—a gear-driven, swash-plate hydraulic pump used to boost the lube oil pressure up to values exceeding 3,000 psi. Actual high-pressure oil values are managed by the injection pressure regulator (IPR), which is controlled electronically and actuated electrically. Swash-plate pumps use opposing cylinders and double-acting pistons driven by a swash plate. They are similar in principle of operation to common automotive A/C compressors. The injection pressure regulator manages the high-pressure oil pressure values between a low of 485 psi to highs exceeding 3,500 psi by receiving all the lube pressurized by the high-pressure pump and spilling the excess into the oil reservoir.

The high-pressure oil is then piped to the oil gallery ducting within the fuel/oil supply manifold. From there, the oil is delivered to an exterior annulus in the upper portion of each HEUI. The HEUIs are mounted in parallel and fed by the high-pressure oil manifold. When the HEUI solenoid is energized, a poppet valve is opened by an electric solenoid within the HEUI, permitting the high-pressure lube to flow into a chamber and act on the amplifier piston, actuating the pumping stroke required to convert the HEUI charging pressure to injection pressure values. At the completion of the duty cycle or pulse width (PW), the HEUI solenoid cartridge is de-energized and the poppet valve retracts, spilling the oil acting on the amplifier piston to the rocker housing.

HEUI (Hydraulic Electronic Unit Injector)

The HEUI is an integral pumping, metering and atomizing unit controlled by an ECM switching apparatus. The unit is essentially an EUI that is actuated hydraulically rather than by cam profile. At the base of the HEUI is a hydraulically actuated, multi-orifice nozzle. When the HEUI pumping element achieves the required nozzle opening pressure (NOP) value acting on the sectional area of the nozzle valve exposed to the pressurizing annulus, the valve retracts, permitting fuel to pass around the nozzle seat and exit the nozzle orifice directly to the engine cylinder.

The amplifier or intensifier piston is responsible for creating injection pressure values. When the HEUI is energized, high-pressure oil supplied by a stepper pump acts on the amplifier piston and drives its integral plunger downward into the fuel in the pumping chamber.

A passage connects the pump chamber with the pressure chamber of the injector nozzle valve. The moment the HEUI is de-energized, the oil pressure acting on the amplifier piston collapses, and the amplifier piston return spring, plus the high-pressure fuel in the pump chamber, retracts the amplifier piston/plunger, causing the almost immediate collapse of the pressure holding the nozzle valve open. This results in rapid cessation of the injection pulse.

HEUIs typically have NOPs of 5,000 psi with a potential for peak pressures of up to 24,000 psi. As a general rule, the oil pressure acting on the HEUI amplifier piston is “amplified” seven times in the fuel pump chamber. The droplet sizing is designed to decrease as the length of the injection pulse increases (as the real-time dimension available for combustion decreases). Rapid pressure collapse enabled by HEUIs avoids the injection of larger-sized droplets toward the end of injection that would be difficult to burn completely. At the completion of the HEUI duty cycle or PW, the pressurized oil that actuated the pumping action is spilled to the rocker housing.

Plunger descent rate is fully managed by the ECM, which switches and controls the actuating high-pressure oil valve through the IPR. HEUI injectors are capable of being driven or switched at high rates and the latest versions have plunger and barrel geometry that provides automatic pilot injection. Pilot injection is used to describe an injection pulse that is broken into two separate phases. In a pilot injection fueling pulse, the initial phase injects a short duration pulse of fuel into the engine cylinder, ceases until the moment of ignition and at that point, resumes injection, pumping the remainder of the fuel pulse into the engine cylinder. Pilot injection has been used as a cold-start and warm-up strategy in EUI systems to avoid an excess of fuel in the engine cylinder at the point of ignition, and as a result, minimizes the tendency to cold-start detonation. HEUI systems with the pilot injection feature are designed to produce a pilot pulse for each injection. The input circuit of the HEUI system is comparable with that of any other full-authority system permitting engine management to optimize operation for changing conditions, monitor faults, provide engine protection and meet emission requirements.

HEUI fuel systems are checked for supply system fuel pressure as well as the correct oil pressure in the high-pressure oil rail. The HEUI injectors can be tested electrically using a *click* or *buzz* test. This test is performed key on engine off using the scan tool to activate the injector solenoids with the ECM, while the technician listens for an appropriate click or buzz. The scan tool and ECM can also be used to perform a cylinder contribution test with the engine running. During this test, the ECM turns the injectors off one at a time or in groups in order to determine their level of contribution to engine performance. The scan tool and ECM can also be used to drive the injection actuation oil pressure to preprogrammed levels and observe the injection actuation control valve and injection actuation pressure sensor for appropriate responses.

■ 9. Perform on-engine inspections and tests and replace pump-line-nozzle fuel system (PLN-E) components and electronic controls.

Electronic pump-line-nozzle fuel systems on light-duty diesel engines may include in-line pumps using port-helix metering with the addition of electronic controls or distributor-type pumps with electronic controls. On inline PLN-E fuel systems, the pumping apparatus and fuel control mechanisms remain largely the same. The centrifugal timing advance unit can be replaced with an electronically controlled hydro-mechanical unit, and the governor is controlled by the ECM through rack position motors and sensors instead of springs and weights.

Electronically controlled distributor pumps are also adaptations of existing pumps with enhanced control of injection timing and metering.

■ 10. Perform on-engine inspections and tests and replace electronic unit injector (EUI) components and electronic controls.

Some light-duty diesel engines use EUI systems. The low pressure system used with EUI fueling consists of a suction and charge circuit with fuel movement provided by a positive displacement gear-type pump. Fuel from the low pressure system is typically provided to the EUI by means of a manifold integral with the cylinder head. Fuel is routed through the EUI for purposes of fueling the engine and providing excess fuel used to lubricate and cool.

The EUI is a camshaft actuated, integral pumping, metering and atomizing device that is controlled by the vehicle management computer or ECM. A typical EUI can be divided into circuits as described next.

Control Cartridge

The control cartridge is an ECM switched solenoid with a poppet valve integral with its armature. The poppet valve is held open by spring force. When the poppet valve is open, fuel charged to the EUI by the fuel subsystem is routed through the EUI internal circuitry and allowed to escape to spill into the return circuit. When the ECM energizes the control solenoid, the armature is pulled into the coil, closing the return passage in the EUI, preventing escape of fuel to the return circuit. The ECM energizes the control solenoid by means of a pulse width modulated signal. The energized cycle of the solenoid is known as *duty cycle* or pulse width (PW). Whenever the solenoid cartridge is energized, fuel is trapped in the EUI pump chamber, and the EUI is pumping fuel.

Plunger and Barrel

The pumping element of a EUI consists of a plunger and barrel. The barrel is the stationary member of the pumping element. The plunger is the reciprocating member, and it is spring loaded into its retracted position. The plunger is actuated by cam profile. The injector camshaft may be cylinder-block mounted or overhead. When the injector train is actuated by cam profile, the EUI plunger is driven through its stroke. This means that the actual plunger stroke does not vary, regardless of how the engine is being fueled. Some electronic unit injectors (EUIs) require setting of the EUI plunger height, which is done by turning a screw in the rocker arm. Since plunger height affects timing, this should be accurately adjusted.

Fuel from the fuel subsystem is routed into the EUI pump chamber and passes on to the circuitry in the control cartridge. When the control cartridge solenoid is not energized, fuel is simply allowed to flow through this circuit. When the plunger is actuated by the injector cam, fuel in the pump chamber is displaced. However, an effective stroke cannot begin until the control cartridge is energized. This traps fuel in the EUI circuit, specifically in the pump chamber. As the plunger is driven downward through its stroke, fuel is pressurized to injection pressure values.

Nozzle Assembly

Connected to the EUI pump chamber by means of a duct is a nozzle assembly. This is a simple multiorifice nozzle assembly, a hydraulic switch set to open at a preset hydraulic pressure. The nozzle assembly functions to define nozzle opening pressure (NOP) and atomize the fuel charge to the cylinder. Typical NOPs for EUIs are around 5,000 psi.

EUI systems are full-authority electronic engine management systems with comprehensive programming, self-diagnostic and data management capabilities. Input circuit components are similar to other late-generation systems.

Injector Response Time and Pulse Width

Injector response time (IRT) and pulse width (PW) are indicators of the overall electrical integrity and power balance of the engine. Both parameters can be displayed on any electronic service tool (EST). When attempting to correlate PW, which is measured in milliseconds, with engine crank degrees, as an engine is accelerated from idle speed to high idle speed, the number of crank angle degrees the engine passes through in 1 millisecond will triple. Do not be surprised if the PW average decreases as an engine is accelerated.

Injector Cutout Test

There is no appropriate way to mechanically short out an EUI, so when a cylinder misfire is being diagnosed, the ECM electronics perform this task by electronically cutting out the EUI in sequence and analyzing the performance effect. When an ECM commands an engine to run a specific RPM, an injector cutout test is performed. First the average duty cycle of the EUI in milliseconds is displayed. If the engine RPM is to be maintained during the test (this test is normally run at idle or 1,000 rpm), as each EUI is cut out electronically by the ECM, the PW of the remaining injectors will have to be lengthened if engine RPM is held at the test value. This would be true until a defective EUI was cut out. In this case, there would be no increase in the average PW of the operating EUI. If a four-cylinder engine had one dead EUI, the following would occur if an injector cutout test sequence was performed with the engine running at 1,000 rpm. To run the engine at 1,000 rpm, the three functioning EUIs would produce fueling values read in PW milliseconds that would be averaged on the display. When one of the three functioning EUIs is electronically cut out by the ECM, only two EUIs would be available to run the engine at the test speed of 1,000 rpm, causing the average PW to increase. As each functioning EUI was cut out in sequence, the average PW would have to increase to maintain the test RPM. However, when the defective EUI is cut out, there would be no change in the average PW because it was based on the engine running on three cylinders.

■ 11. Inspect and replace electrical connector terminals, pins, harnesses, seals and locks.

The ECM harness electrically connects the ECM to other modules in the vehicle engine and passenger compartments. Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use wire with high temperature insulation only. With the low current and voltage levels found in the system, it is important that the best possible bond at all wire splices be made by soldering the splices. Molded-on connectors usually require complete replacement of the connector. This means splicing a new connector assembly into the harness. Use care when probing a connector or replacing terminals in them. It is possible to short between opposite terminals. Use jumper wires between connectors for circuit checking. Never probe through the weather pack seals. A connector test adapter kit is used to probe terminals during diagnosis. A fuse remover and test tool should be used when removing a fuse.

When diagnosing, open circuits are often difficult to locate by sight because of oxidation, or the terminal alignment is hidden by the connectors. Merely wiggling a connector on a sensor in the wiring harness may correct an open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections. Before making a connector repair, be certain of the type of connector. Weather pack-and-pull seal connectors look similar but are serviced differently. Some connectors, such as the coolant sensor, use terminals called *micro-connectors*. They are released by inserting a fine pick tool through the front of the connector to disengage a locking tab on the terminal. To remove, bend the tab toward the terminal, then pull the terminal and wire out of the connector. To install, insert the tool into a new connector and bend the tab away from the terminal. Molded plugs and connectors are factory fabricated and must be spliced into the harness. Ensure that correct splice procedures are used to make a good electrical connection.

Pull-to-seat terminals: To install a terminal on a wire, the wire is first inserted through the seal and connectors, then the terminal is crimped on the wire, and the

terminal is pulled back into the connector to seat it in place. To remove this type of terminal:

- A. Slide the seal back on the wire.
- B. Use an insertion tool to release the terminal-locking tab.
- C. Push the wire and terminal out through the connector. If reusing the terminal, reshape the locking tang.

A weather pack connector can be identified by a rubber seal at the rear of the connector. This connector protects against moisture and dirt that could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. To repair a weather pack terminal, use a special tool to remove the pin and sleeve terminals. If removal is attempted with an ordinary pick, there is a good chance that the terminal will be bent or deformed. Unlike standard blade-type terminals, these terminals cannot be straightened once they are bent. Make certain that the connectors are properly seated and all of the sealing rings are in place when connecting leads. The hinge-type flap provides a back-up or secondary locking feature for the connector. They are used to improve the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly. Weather pack connections cannot be replaced with a standard connection.

■ 12. Connect diagnostic tool to vehicle/engine; access, verify and update software calibration settings; perform ECM relearn procedures as needed.

All vehicles since 1996 have had the same diagnostic connector. This connector is usually located beneath the dash on the driver's side. Note that some engines will also have a communications connector mounted directly on them. When accessing vehicle information, the ignition key must be on. When reprogramming an ECM, it is very important the battery voltage is maintained within a certain range, usually 12.4VDC (volts of direct current) to 13.6VDC. Most manufacturers recommend connecting a battery maintainer/charger to the battery during a reprogramming operation to ensure that this voltage is maintained. Additionally, there is usually a key off/key on sequence that must be followed while reprogramming. After reprogramming, the following items may need to be relearned or reset, theft deterrent relearn, turbocharger relearn, fuel injector flow rate reprogramming, engine oil life remaining, transmission oil life remaining, and fuel filter life remaining.

■ 13. Use a diagnostic tool (hand-held or PC-based) to inspect and test electronic engine control system, sensors, actuators, electronic control modules (ECMs/PCMs) and circuits; determine further diagnosis.

Accessing information from the vehicle electronic control modules (ECMs) may be accomplished using each manufacturer's specific electronic service tools (ESTs), PC-based software or aftermarket scan tool. When using the diagnostic tools, the technician will need the correct adapters and multi-pin connectors to access the system. Vehicles are equipped with the (on-board diagnostic) OBD-II connector. The connector will be located in the passenger compartment under the dash on the driver's side. This common connector and the software protocols are established by agreement and enables proprietary software used by various OEMs to communicate with and at least read the parameters and conditions of their competitors' systems. Most engine management

systems must also communicate with other chassis systems to optimize engine performance. Begin by ensuring that the ignition switch is in the off position. The diagnostic equipment must also be off. Then connect your diagnostic equipment and turn it on. Turn on the ignition and observe whether communication is established. The technician will be presented with a series of prompts or menu choices that access different portions of the software. When codes are present, it is useful to record the codes, clear them, and retest to see whether they reappear. Codes that reappear indicate an active code that should be repaired before proceeding. Most self-diagnostics will provide a data stream allowing you to observe the values from each of the sensors and switches that are computer inputs. Any values suspected to be in error should be verified using a digital multi-meter (DMM). There should also be actuator tests that allow you to command the various actuators and observe their operation. An example of this is the injector solenoid tests that are performed with the key on and to the engine off (KOEO). When you select this test, the ECM actuates each injector solenoid in sequence, and their operation may be verified because they are heard. This is referred to by one manufacturer as a *buzz test*. Another example is performed with the key on and to the engine running (KOER) and is referred to as a *cylinder cutout test*. Either one or multiple cylinders, when selected, are cut out, and their effect on idle speed and their relative contribution to engine power output is calculated. Remember, the values observed are those that the computer receives. The values are subject to the computer's sampling rate, and may be influenced by the integrity of the wiring and connectors that convey them.

■ 14. Measure and interpret voltage, voltage drop, amperage and resistance readings using a digital multi-meter (DMM) or appropriate test equipment.

Voltage Testing

The voltmeter is considered by many to be the most useful meter available, and it is relatively inexpensive. The voltmeter is a high-resistance meter, so it can be placed across various power sources without damage to the meter. It is further recommended that a high-impedance digital voltmeter be used whenever working with vehicles that have electronic modules or computer management systems. High-impedance meters will have very high resistance, typically 10 million ohms internal resistance. This is important to prevent unintended damage to the system being tested. Some of the tests that can be performed with a voltmeter are available voltage at the battery and source voltage at virtually any electrical component. The voltmeter can also be used to indicate resistance when performing voltage drop testing. The two test leads are commonly red and black. The red lead is attached to the most positive (higher potential) portion of the circuit, and the black lead may be connected to a good ground or to a point on the circuit with lower voltage (lower potential) than the red lead, depending on the type of test being performed. This places the meter in parallel to the portion of the circuit being tested. For the meter to indicate a voltage, the circuit should be turned on and have current flowing. Most modern meters have additional features that make them more useful, like auto-ranging, touch hold, and min/max.

Voltage Drop Testing

Often it is desirable to know what amount of source voltage is being lost or dropped in a circuit by overcoming resistance. This is measured as *voltage drop*. Voltage drop is the amount of electrical pressure that is lost or consumed pushing current through the circuit. Voltage drop occurs when current passes through various load components and resistances. Most of the voltage should be dropped across the load and not across the

components that convey voltage and control the load. Voltage drop testing to measure resistance has several big advantages over using an ohmmeter. First, it is very accurate. You can find very small resistances where voltage is lost (dropped) passing through connections, relays, switches, fuses, wiring and other voltage conveying components in the circuit. Another advantage is that it is a dynamic test, performed with the circuit live and under load. It is not necessary to isolate the component being tested from the circuit by disconnecting or removing it. Simply connect the voltmeter in parallel with the portion of the circuit being tested, being careful to observe polarity.

Amperage Testing

Amperage testing is different from voltage testing because the meter must be placed in the circuit in series, unless you are using an inductive pickup, which measures current flow by measuring the strength of the magnetic field produced. To use an ammeter, you must disconnect a wire and connect the meter into the circuit. With the meter in series with the rest of the circuit, all of the current flowing must pass through the meter. If the current exceeds the capacity of the meter, it will be damaged. For this reason, digital meters are usually protected by internal fuses. If current exceeds the fuse rating, it will blow and the meter stops working. Measuring about 10 amps is the limit of most digital meters. An inductive pickup is useful for measuring larger current flow. A big advantage in using one is that it may be clamped over almost any portion of the circuit without the need to disconnect anything to place the meter in series in the circuit.

Resistance Testing

Resistance is measured in ohms. The ohmmeter is self-powered and passes a very small current supplied by an internal battery through the circuit being tested. Do not attempt to test a live circuit—that is, one that has voltage in it from any source other than the meters battery. Testing a live circuit can damage an ohmmeter. Several scales are available to permit accurate testing of a wide range of resistance values. Choose the correct range for the task. When a range that is too low is used, the meter may falsely indicate an infinite resistance. Start with the highest range and move to a lower scale if a very low reading is obtained. Auto-ranging meters will select the correct scale. It is frequently necessary to remove the component being tested or otherwise isolate it from the circuit to get accurate results.

- **15. Diagnose engine problems resulting from failures of interrelated systems (for example, cruise control, security alarms/theft deterrent, transmission controls, electronic stability control and non-OEM installed accessories).**

When a vehicle has multiple concerns, it is important for the technician to see if there is a root cause. The systems on a light-duty diesel engine are very interconnected—one failure can cause two or more seemingly unrelated concerns. For example, a vehicle with weak batteries may have a concern of hard to start and a DTC for glow plug failure, as well as a DTC for low voltage at the ECM. If the technician tests the glow plugs and finds them operational, he or she may conclude that the ECM is faulty. In reality, low battery voltage can trigger a DTC for failed glow plugs because battery voltage affects glow plug current draw. A good inspection/overview of the vehicle is always important for a proper diagnosis.

Sample Preparation Exams

INTRODUCTION

Included in this section are a series of six individual preparation exams that you can use to help determine your overall readiness to successfully pass the Light Vehicle Diesel Engines (A9) ASE certification exam. Located in Section 7 of this book you will find blank answer sheet forms you can use to designate your answers to each of the preparation exams. Using these blank forms will allow you to attempt each of the six individual exams multiple times without risk of viewing your prior responses.

Upon completion of each preparation exam, you can determine your exam score using the answer keys and explanations located in Section 6 of this book. Included in the explanation for each question is the specific task area being assessed by that individual question. This additional reference information may prove useful if you need to refer back to the task list located in Section 4 for additional support.

PREPARATION EXAM 1

1. A diesel engine blows excessive white smoke on a cold start. Which of the following could be the cause?
 - A. The air intake grid heater staying on too long.
 - B. The air intake grid heater not staying on long enough.
 - C. The glow plugs staying on too long.
 - D. The glow plugs have too little resistance.
2. Technician A says piston ring side clearance is measured with a feeler gauge. Technician B says piston ring side clearance is measured with a dial indicator. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
3. Technician A says the pressure in the low-pressure fuel supply circuit should be checked every time the fuel filters are replaced. Technician B says the pressure in the low-pressure fuel supply circuit should be checked every time the air filter is replaced. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

4. The acronym DPF stands for:
 - A. Diesel pulsation fixture
 - B. Direct particle filter
 - C. Diesel particulate filter
 - D. Direct premium fluid

5. A customer has a low power concern. All of the following could cause the problem EXCEPT:
 - A. Fuel filter
 - B. Air filter
 - C. Over-fueling
 - D. Injection timing

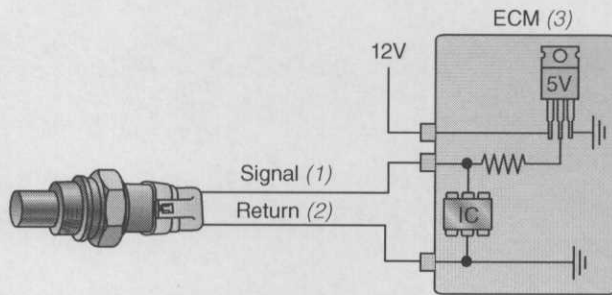
6. The engine ECM has several unrelated and unrecognized DTCs. A technical service bulletin instructs the technician to re-flash the ECM. Technician A says that during the re-flash, a battery charger should be connected to the vehicle battery and set on the boost setting. Technician B says the scan tool used for the re-flash should be connected to an auxiliary power supply to ensure voltage to the scan tool is not interrupted. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

7. The coolant in a light-duty diesel engine smells like diesel fuel. Technician A says this could be caused by a leaking injector tube. Technician B says this could be caused by a leaking intake manifold. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

8. Which of the following would be the most likely procedure for checking an engine oil cooler for a leak?
 - A. Pressurize the oil cooler and let it set overnight.
 - B. Pressurize the oil cooler and submerge in cold water.
 - C. Pressurize the oil cooler and submerge in hot water.
 - D. Apply vacuum to the cooler and submerge in hot water.

9. The cylinder bore has 0.0001" (0.0025 mm) taper. Technician A says to replace the engine block. Technician B says to bore the engine block. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

10. The valve cover gasket is leaking on a diesel engine. Technician A says to replace the gasket. Technician B says to check the valve cover mounting bolts for the correct torque. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
11. A diesel engine has become increasingly harder to start the first start on a cool morning. Technician A says the problem could be low current draw on the glow plug circuit. Technician B says the problem could be a jumped timing chain. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



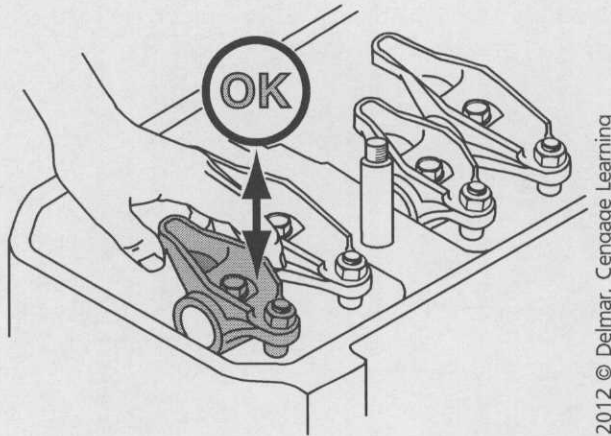
CODE	REASON	EFFECT
Fault code : 154 PID : P105 SPN : 105 FMI ; 4/4 Lamp : Amber SRT :	Intake manifold air temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at intake manifold air temperature circuit.	Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for intake manifold temperature.

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12. An engine has fault code 154 as shown above. If the sensor is disconnected and the engine started, fault code 153, Intake Manifold Temperature Sensor Circuit – Voltage Above Normal, becomes active. What is the most likely cause of fault code 154?
- A. Shorted intake manifold temperature sensor wiring harness
 - B. Open intake manifold sensor harness
 - C. Open intake manifold sensor
 - D. Shorted intake manifold sensor
13. A diesel engine fails to reach operating temperature. All of the following could be the cause EXCEPT:
- A. Leaking internal thermostat housing seal
 - B. Stuck open thermostat
 - C. Radiator fan that operates continually
 - D. Externally restricted charge air cooler

14. Technician A says an inactive trouble code P0046 Turbo/Super Charger Boost Control Solenoid Circuit Range/Performance trouble code can be cleared with a scan tool. Technician B says an inactive trouble code P0046 Turbo/Super Charger Boost Control Solenoid Circuit Range/Performance will clear itself after the appropriate number of drive cycles if no failures are reported by this or any other emission-related diagnostic. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
15. The cruise control will not work on a vehicle that also has an airbag warning light illuminated on the dash. Which of the following is the most likely cause?
- A. A faulty cruise control switch
 - B. A blown accessory fuse
 - C. Damaged air bag acceleration sensor
 - D. Damaged clock spring
16. The oil in a diesel engine is tar-like and black. Maintenance records indicate the engine has been serviced regularly. The most likely cause of this condition is:
- A. Coolant in the oil
 - B. Diesel fuel in the oil
 - C. Engine overheating
 - D. Engine overcooling
17. A cylinder head is being reinstalled on an engine. Technician A says some manufacturers recommend coating the gasket with anaerobic sealant. Technician B says to install the gasket dry. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
18. During reassembly, the technician finds the piston ring side clearance is greater than specification. Which of the following should be done?
- A. Replace the piston rings
 - B. Replace the pistons
 - C. Bore the cylinder oversized
 - D. Knurl the pistons
19. A diesel engine stalls going down the road and will not restart. All of the following could be the cause EXCEPT:
- A. Faulty air inlet heater
 - B. Restricted fuel filter
 - C. Failed camshaft sensor
 - D. Failed crankshaft position sensor

20. The water pump drive pulley serpentine grooves are damaged. Technician A says the grooves can be repaired using a special comb. Technician B says the grooves can be repaired using heat. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
21. An engine is being assembled, and the crankshaft end-play is greater than specification. Technician A says the crankshaft rod journal could be out of round. Technician B says the crankshaft rod journal could be tapered. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
22. When reinstalling an EGR valve on a diesel engine, the gasket should be coated with:
- A. Aerobic sealant
 - B. Anaerobic sealant
 - C. Anti-seize
 - D. Nothing; it should be installed dry.
23. The 8th digit of the vehicle identification number (VIN) indicates:
- A. Model year
 - B. Engine size
 - C. Tire size
 - D. Chassis model
24. A common rail diesel engine will not start. There is no RPM indicated on the tachometer or scan tool while cranking. Which of the following is the most likely cause?
- A. Restricted fuel flow
 - B. Faulty engine position sensor
 - C. Low fuel level
 - D. Stuck closed exhaust gas recirculation valve
25. Which of the following would be the most normal piston-to-cylinder wall clearance specification for a diesel engine with a 4-inch bore?
- A. 0.0001" – 0.0003"
 - B. 0.001" – 0.003"
 - C. 0.008" – 0.015"
 - D. 0.100" – 0.300"



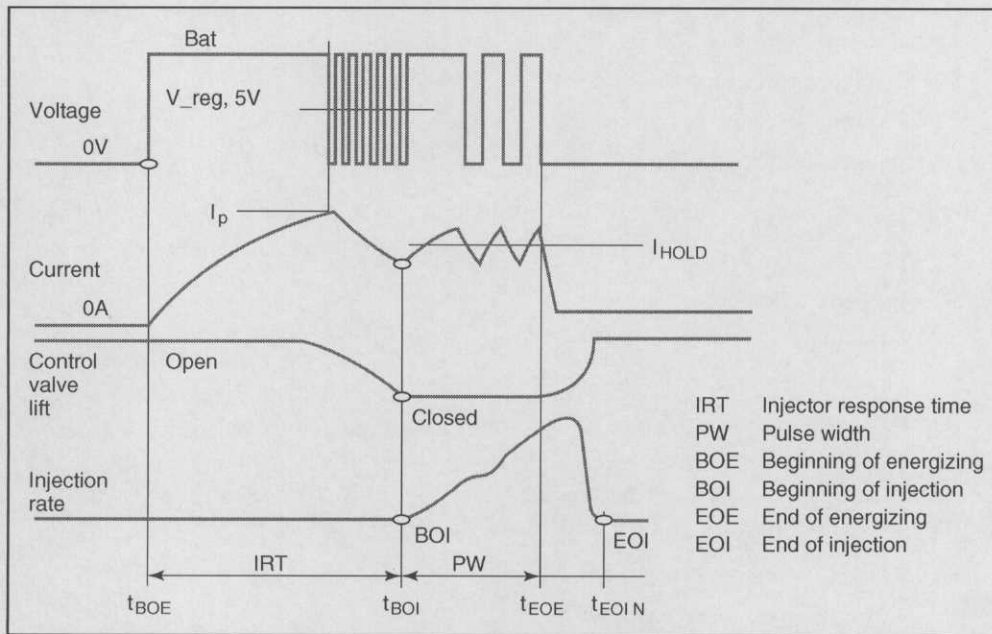
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26. The technician is preparing to adjust the valves. The crankshaft is at TDC and both rockers on Cylinder #1 are loose, as illustrated above. This means that:
- This cylinder can be adjusted.
 - The companion cylinder can be adjusted.
 - The crankshaft needs to be rotated 90 degrees.
 - The crankshaft needs to be rotated 180 degrees.
27. Technician A says when testing the air-to-air charge air cooler, it should be heated. Technician B says a viscous vibration damper should be heated during inspection. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
28. An engine has low oil pressure. This is most noticeable at a hot idle. Which of the following is the most likely cause?
- Worn main bearings
 - Worn piston rings
 - Worn valve guides
 - Worn timing chain
29. A high-pressure injection line is leaking on a diesel engine. The line has been torqued to specification. Which of the following should the technician do?
- Replace the line.
 - Tighten the line.
 - Remove and inspect the line.
 - Replace the line and matching fitting.
30. The DPF differential pressure sensor shows higher than normal differential pressure. Technician A says a leaking hose on the inlet of the DPF differential pressure sensor could be the cause. Technician B says the DPF could be plugged. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

31. A diesel engine is overheating. The technician can force the fan to operate with the scan tool, but the fan will not engage normally when the engine reaches the appropriate temperature. All of the following could be the cause EXCEPT:
- A. Faulty fan motor
 - B. Faulty coolant temperature sensor
 - C. Corrupt ECM programming
 - D. High resistance in the wires leading to the coolant temperature sensor.
32. The timing belt has been replaced on a light-duty 4-cylinder diesel engine. The engine runs OK, but now there is a vibration. Technician A says the VGT turbocharger is out of balance. Technician B says the balance shaft is out of time. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
33. The ECM mounting plate has fuel passing through it. Which of the following is true of this design?
- A. The fuel is cooled by the ECM.
 - B. The ECM is cooled by the fuel.
 - C. The fuel is conditioned by the ECM.
 - D. The ECM is grounded by the fuel.
34. All exhaust valve pushrods on an engine are bent. Which of the following is most likely the cause?
- A. The engine was operated for a long time under a very light load.
 - B. The engine was operated for a long time under a very heavy load.
 - C. The engine was idled for a long time in cold weather.
 - D. The engine was allowed to exceed maximum governed RPM.
35. An engine is being checked for a coolant leak. All of the following could be used to help locate the source of the leak EXCEPT:
- A. Black light
 - B. Pressure tester
 - C. Vacuum gauge
 - D. Coolant dye
36. Valve protrusion is lower than specification. This could result in:
- A. Hard starting
 - B. Increased valve lash
 - C. Decreased valve stem height
 - D. Decreased valve spring installed height
37. Which bearing wear pattern would indicate a bent crankshaft?
- A. Worn lower main bearings.
 - B. Worn upper rod bearings.
 - C. Both halves of the rod bearing worn excessively.
 - D. Both halves of the main bearing worn excessively.

38. All of the following could cause face-plugging of the diesel oxidation catalyst (DOC) EXCEPT:
- A. Leaking turbocharger seals
 - B. Leaking charge air cooler seals
 - C. After treatment injector nozzle leakage
 - D. Worn piston rings
39. A diesel engine equipped with a PLN-E (pump-line-nozzle electronic) system has had repeated injection pump failures. Technician A says the transfer (lift) pump should be checked. Technician B says the vehicle should be checked for aftermarket modifications. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
40. Which of the following is the correct method to remove ash from the DPF (diesel particulate filter)?
- A. Perform a stationary regeneration.
 - B. Perform a rolling regeneration.
 - C. Ash cannot be removed; the DPF must be replaced.
 - D. Remove the DPF and clean it on a bench machine.
41. Fuel filter inlet restriction is being measured on an engine. The specification is 6-10 in Hg. The test results are 1 in Hg. Which of the following is indicated?
- A. The fuel filter is restricted.
 - B. There may be a suction side air leak.
 - C. The fuel filter is serviceable.
 - D. There may be a restriction in the fuel cooler.
42. When the cylinder head bolts are inspected, they are found to be pitted. Which of the following should be done?
- A. Primer the bolts
 - B. Paint the bolts
 - C. Replace the bolts
 - D. Replace the head
43. A cam in-block diesel engine has excessive cam bearing clearance. This would result in:
- A. Retarded camshaft timing
 - B. Advanced camshaft timing
 - C. Excessive oil pressure
 - D. Low oil pressure

44. A diesel engine has oil leaks from the front crankshaft seal and the flywheel housing area. Which of the following is the most likely cause?
- A. The vibration damper is out of round.
 - B. The rear main seal was installed incorrectly.
 - C. The flywheel housing was not properly torqued.
 - D. The engine has excessive crankcase pressure.



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45. An engine with the fuel system shown above has low power. Fuel pressure is checked on the outlet side of the secondary fuel filter, and the results are as follows:
 Actual 78 psi
 Specification 70–90 psi
 Which of the following could be the cause of the low power concern?
- A. High fuel pressure
 - B. Restricted air filter
 - C. Restricted primary fuel filter
 - D. Restricted secondary fuel filter
46. A diesel particulate filter (DPF) will not reach the correct temperature during a regeneration. Which of the following could be the cause?
- A. Insufficient air flow to the DPF.
 - B. Insufficient fuel flow from the after treatment injector.
 - C. Excessive fuel flow from the after treatment injector.
 - D. Excessive air flow to the DPF.

47. An engine oil pick-up tube is cracked. Which of the following would be the most likely result?
- A. Excessive oil pressure
 - B. External oil leak
 - C. Internal oil leak
 - D. Low oil pressure
48. A diesel engine air filter has failed, split and separated in the center. Which of the following could be the cause?
- A. Too much turbo boost
 - B. Too little turbo boost
 - C. Incorrect exhaust back pressure
 - D. Incorrect filter installed
49. Which of the following would most likely be used to test an EGR cooler for internal leaks?
- A. Feeler gauge
 - B. Pressure Test Kit
 - C. Flow meter
 - D. Dial caliper
50. While diagnosing a rough-running engine, the cylinder power balance test reveals low power on cylinder #4. All other cylinders pass the test. The technician measures the resistance of the injector solenoid on cylinder #4 and finds it is within specification. Which of the following could be the cause of the low power on cylinder #4?
- A. Low compression on cylinder #3
 - B. Low compression on cylinder #4
 - C. Water in the fuel
 - D. Restricted fuel filter

PREPARATION EXAM 2

1. The electronic control module (ECM)-driven OEM dash-mounted temperature gauge indicates an overheating engine. When a scan tool is connected, the technician finds no diagnostic trouble codes, and the engine temperature shown on the scan tool is normal. The temperature is verified with an infrared thermometer as the actual engine temperature. Which of the following is the most likely cause?
- A. The engine temperature sensor is faulty.
 - B. The engine ECM is faulty.
 - C. The dash-mounted gauge is faulty.
 - D. The instrument panel control module is faulty.

2. The two outside camshaft bushings as well as the center camshaft bushing show excessive wear. The other bushings show normal wear. Which of the following is the most likely cause?
 - A. Insufficient oil flow to the center bearing
 - B. Insufficient oil flow to the outside bearings
 - C. A bent camshaft
 - D. A bent crankshaft

3. Which tool is preferred by diesel engine manufacturers to measure freeze point of the coolant?
 - A. Hydrometer
 - B. Refractometer
 - C. Mercury manometer
 - D. Water manometer

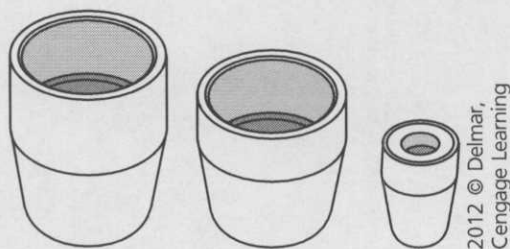
4. Technician A says valve protrusion can be measured with a depth micrometer. Technician B says valve protrusion can be measured with a dial bore gauge. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

5. Technician A says a laser can be used to check accessory drive belt alignment. Technician B says a straightedge can be used to check accessory drive belt alignment. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

6. A diesel engine will start, run and then die. If the fuel system is primed, the engine will again start, run and die. Which of the following is the most likely cause?
 - A. An air leak on the suction side of the fuel system
 - B. A restriction on the return side of the fuel system
 - C. A restricted exhaust
 - D. A restricted intake

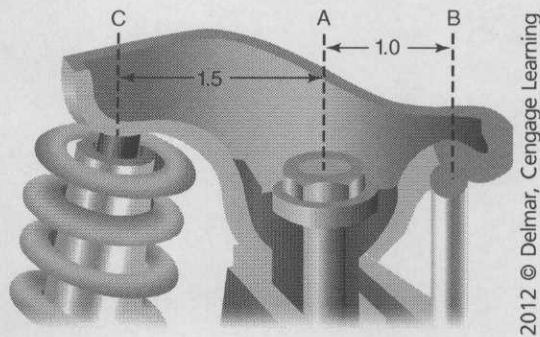
7. Ring end gap is measured using a/an:
 - A. Inside micrometer
 - B. Outside micrometer
 - C. Feeler gauge
 - D. Dial indicator

8. After setting overnight, a diesel engine has a slow cranking speed concern. After the first start of the day, there are no other concerns. Which of the following is the most likely cause of the concern?
- A. Charging voltage is higher than normal.
 - B. Starter current draw is lower than normal.
 - C. Charging amperage is lower than normal.
 - D. Excessive key-off battery drain.
9. Technician A says if the timing belt is being reused, the belt should be reversed so the other side of the teeth are worn. Technician B says if the timing belt is being reused, the belt tension should be increased 10% over the factory specification because it is a used belt. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
10. Technician A says a restricted crankcase ventilation system can cause excessive oil consumption. Technician B says a restricted crankcase ventilation system can cause high engine oil pressure. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
11. A diesel engine has a broken crankshaft. All of the following could be the cause EXCEPT:
- A. Stuck open EGR valve
 - B. Engine over-fueling
 - C. Using ether as a starting aid
 - D. Faulty vibration damper/harmonic balancer



12. Technician A says the EUI (electronic unit injector) system tools shown above could be used to install injector o-rings. Technician B says the EUI (electronic unit injector) system tools shown above could be used to calibrate injector height. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

13. A diesel engine cranks normally but will not start. This is most likely caused by:
- A. Low resistance in the battery cables
 - B. High resistance in the battery cables
 - C. Low fuel supply pump pressure
 - D. Low water pump pressure
14. The main bearing journal is 0.003" smaller on one end than the other. Technician A says this is referred to as journal out of round. Technician B says this is an acceptable measurement, and the crankshaft can be reused without machining. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
15. Technician A says a mercury manometer could be used to measure air intake restriction. Technician B says a water manometer could be used to measure air intake restriction. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



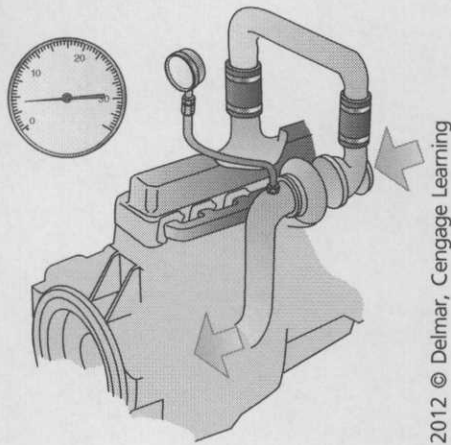
16. Technician A says the rocker arm shown above is an injector rocker. Technician B says the rocker arm shown above is non-adjustable. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
17. An engine has an intermittent low power concern. There are no active diagnostic trouble codes. There is an inactive trouble code for low boost pressure sensor voltage. Technician A says a poor electrical connection on the boost pressure sensor could be the cause. Technician B says a leaking radiator could be the cause. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

18. A technician is installing a software calibration update for the ECM. Which of the following is LEAST LIKELY to be performed?
- A. Installing a battery maintainer on the vehicle battery
 - B. Rewiring the ECM data link connector
 - C. Downloading the calibration update file from the factory website
 - D. Driving the vehicle after repairs
19. Technician A says that a faulty intake manifold pressure sensor can cause low power. Technician B says that after installing Plastigauge[®], the crankshaft should be rotated one full turn. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
20. A small amount of oil is present where the charge air cooler hose seals against the charge air cooler pipe. Which statement is incorrect?
- A. This could be caused by a restricted turbocharger oil drain.
 - B. This is normal on some models.
 - C. This could be caused by a restricted fuel system.
 - D. Incorrect charge air cooler clamps are installed.
21. The bearings in the turbo have excessive wear. All of the following could cause this EXCEPT:
- A. Dirty engine oil
 - B. Poor air filtration
 - C. Dirt on the compressor wheel
 - D. An exhaust leak
22. The head of piston #4 of an inline 6-cylinder diesel engine is eroded. The other pistons are not worn. Technician A says the cause could be a restricted oil filter. Technician B says the cause could be a worn exhaust cam lobe. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
23. Which of the following is true regarding ULSD (ultra-low sulfur diesel) fuel?
- A. Ultra-low sulfur diesel has 15 ppm sulfur.
 - B. Ultra-low sulfur diesel has 150 ppm sulfur.
 - C. Ultra-low sulfur diesel has 250 ppm sulfur.
 - D. Ultra-low sulfur diesel has 350 ppm sulfur.

24. While diagnosing a rough-running engine, the cylinder power balance test reveals no power from cylinder #1. All of the following could be the cause EXCEPT:
- A. Fuel transfer pump
 - B. Worn compression rings on piston #1
 - C. Faulty injector
 - D. Leaking exhaust valve on cylinder #1
25. A turbocharger has been replaced because of pumping oil into the air intake piping. Technician A says the charge air cooler must also be replaced. Technician B says the diesel particulate filter must also be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
26. An engine with an in-line (pump-line nozzle) runs on cylinders #1, #2 and #3. However, cylinders #4, #5 and #6 are very weak, with cylinder #6 providing no power at all. Which of the following is the most likely cause?
- A. Missing bleed orifice
 - B. Faulty hand priming pump
 - C. Restricted fuel return line
 - D. Faulty nozzles
27. An oil pressure regulator is stuck in the open position. Technician A says this would result in higher than normal oil pressure at idle. Technician B says this would result in lower than normal oil pressure when at operating temperature. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
28. Lower than normal turbo boost pressure can be caused by all of the following EXCEPT:
- A. Restricted fuel filters
 - B. Restricted air filter
 - C. Restricted exhaust system
 - D. Restricted crankcase filter
29. The cooling system is being flushed on a diesel engine. The replacement coolant should be:
- A. Ethylene glycol + OAT
 - B. Propylene glycol
 - C. The coolant recommended by the OEM in the service literature
 - D. Any coolant labeled "Universal Diesel Engine Coolant"

30. Technician A says the acronym DOC stands for diesel oil combustion. Technician B says the DOC is located in the air intake system. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
31. Technician A says a depth micrometer is used to check for warpage of a block deck. Technician B says an outside micrometer is used to check for warpage of a block deck. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
32. Technician A says soot is controlled by the EGR system. Technician B says NO_x is controlled by the EGR system. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
33. A diesel engine has a leaking head gasket; after the gasket was replaced the engine will not start. The technician finds six bent pushrods when diagnosing the no-start condition. Which of the following is the most likely cause?
- A. The valves were adjusted incorrectly.
 - B. A head gasket that was too thick was installed.
 - C. The head is warped.
 - D. The block deck is warped.
34. Technician A says when installing roller-type cam followers, the bottom of the follower should be installed dry. Technician B says when installing non-roller cam followers, the bottom of the follower should be coated with pre-lube. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
35. The lobe lift on an in-block camshaft can be measured with the camshaft still in the block using which tool?
- A. Dial caliper
 - B. Dial indicator
 - C. Outside micrometer
 - D. Inside micrometer

36. A diesel engine is equipped with adjustable valve bridges (crossheads). Technician A says the valve clearance should be adjusted prior to adjusting the valve bridges (crossheads). Technician B says the valve bridges (crossheads) should be removed prior to adjusting the valve clearance. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



37. The test being performed above is:
- Intake restriction
 - Exhaust restriction
 - Turbo boost pressure
 - Charge air cooler pressure drop
38. Technician A says a PLN-E (pump-line-nozzle electronic fuel system) engine will have individual unit injectors. Technician B says a PLN-E engine will have a common rail. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
39. Camshaft end-play is greater than specification. Which of the following could be the cause?
- Worn camshaft drive gear
 - Worn camshaft drive belt
 - Worn camshaft thrust surface
 - Worn camshaft lobes
40. All of the following are methods to measure crankshaft end-play EXCEPT:
- Dial indicator on the rear of the crankshaft
 - Dial indicator on the front of the crankshaft
 - Feeler gauge at the thrust bearing
 - Feeler gauge at the harmonic balancer

41. A diesel engine has an active DTC P0103 Mass Airflow Sensor Voltage High. Which of the following could be the cause?
- A. Restricted air filter
 - B. Restricted fuel filter
 - C. Failed exhaust temperature sensor
 - D. Failed mass airflow sensor
42. Which of the following tools would be LEAST LIKELY to be used to test an APP (accelerator pedal position) sensor?
- A. Voltmeter
 - B. Oscilloscope
 - C. Ammeter
 - D. Ohmmeter
43. A light-duty diesel engine is being reassembled. Which of the following is considered a normal main bearing clearance specification?
- A. 0.0001" – 0.0003"
 - B. 0.001" – 0.003"
 - C. 0.010" – 0.030"
 - D. 0.100" – 0.300"
44. A diesel engine has a low power complaint. Technician A says this could be caused by a faulty fuel heater. Technician B says this could be caused by a restricted fuel filter.
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
45. While checking rod bearing clearance using Plastigauge[®], the technician notices that it is crushed wider at one end of the journal than the other. Which of the following could be the cause?
- A. A barrel-shaped journal
 - B. A tapered journal
 - C. Incorrect main bearing selection
 - D. Incorrect crankshaft end-play
46. A technician is checking voltage drop on the battery cables. Which of the following indicates excessive voltage drop?
- A. 0.50 volts
 - B. 0.75 volts
 - C. 0.03 volts
 - D. 0.05 volts
47. The cylinder bore has 0.0001" (0.0025 mm) out of round. Technician A says the engine should be sleeved. Technician B says the engine can be reused. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

48. The 10th digit of the vehicle identification number (VIN) indicates:
- A. Model year
 - B. Engine size
 - C. Tire size
 - D. Chassis length
49. A common rail injector has been replaced. All of the following are true EXCEPT:
- A. The common rail fuel system must be bled before the engine will start.
 - B. The injector fuel trim number must be programmed into the ECM before the engine is started.
 - C. The injector rocker arm must be adjusted before the engine is started.
 - D. The injector fuel line must be installed using a torque wrench.
50. The oil pressure is low on an engine. The oil is overfull and smells like diesel fuel. All of the following could be the cause EXCEPT:
- A. Cracked fuel cooler
 - B. Cracked injector tip
 - C. Fuel injector o-ring
 - D. Damaged injector sleeve

PREPARATION EXAM 3

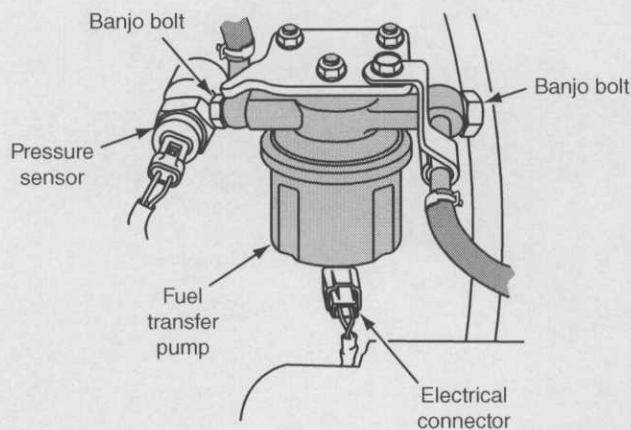
1. Technician A says the accelerator pedal position (APP) sensor is connected to the accelerator pedal. Technician B says the throttle position sensor can be located on the throttle body. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
2. Which of the following would be used to locate the source of an engine noise?
- A. Stethoscope
 - B. Oscilloscope
 - C. Refractometer
 - D. Hydrometer
3. Valve protrusion is lower than specification. Technician A says the valve may need to be replaced. Technician B says the valve seat may need to be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

4. The rear two cylinders on a V8 diesel engine show heavy erosion of the piston crowns. Technician A says a worn water pump impeller could be the cause. Technician B says a worn oil pump could be the cause. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

5. A turbocharger is passing oil into the exhaust. Which of the following is the most likely cause?
 - A. Plugged oil supply line to the turbocharger
 - B. Plugged oil return passage from the turbocharger
 - C. Restricted exhaust system
 - D. Restricted intake system

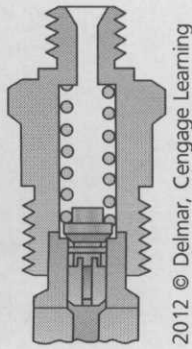
6. A viscous damper is being inspected. All of the following would be performed EXCEPT:
 - A. Lateral run out
 - B. Radial run out
 - C. Thickness
 - D. Height

7. A diesel engine is hard to start, especially in cold weather. Cranking speed is higher than normal. The most likely cause of the no-start condition is:
 - A. Low compression
 - B. High compression
 - C. Stuck open exhaust gas recirculation valve
 - D. Stuck closed exhaust gas recirculation valve



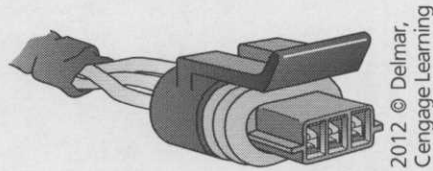
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8. Refer to the illustration above. Technician A says failure of this item can cause diesel fuel in the oil. Technician B says failure of this item can cause excessive black smoke. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

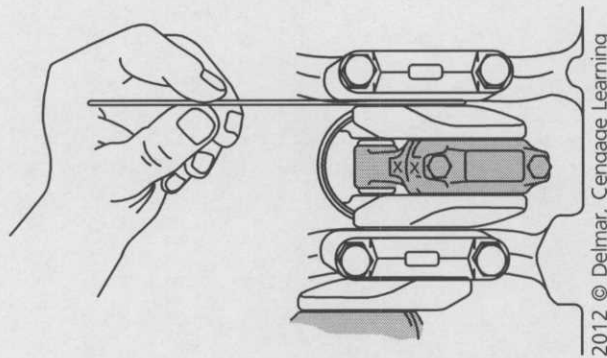


9. The delivery valve shown above is leaking at the seat. Which of the following is the most likely result?
- Engine smoke
 - Uncontrolled engine RPM
 - Slow acceleration
 - Slow deceleration
10. A diesel engine needs coolant added on a regular basis. There are no external coolant leaks. All of the following could be the cause EXCEPT:
- Leaking air-to-air charge air cooler
 - Leaking exhaust gas recirculation (EGR) cooler
 - Leaking injector sleeve
 - Loose head gasket
11. An in-frame engine overhaul is being performed. Technician A says the in-block camshaft bushings are installed by driving them in with a driver tool. Technician B says the rear most in-block camshaft bushing is installed last. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
12. Which of the following could cause block deck height to be lower than specification?
- Excessive milling of the head
 - Excessive milling of the block
 - Too little valve protrusion
 - Too little injector tip protrusion
13. While reassembling an engine, one piston does not come as high in the bore as the others. Which of the following is the most likely cause?
- Worn main bearing journal
 - Worn cylinder bore
 - A connecting rod that is shorter than specification
 - An undersized main bearing

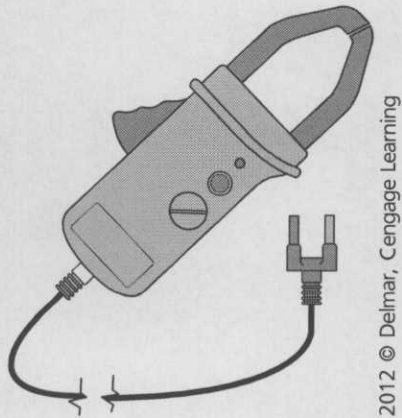
14. An air intake restriction test has been performed on a diesel engine with a low power concern. The test results show 15" H₂O during full-load operation. Which of the following is true concerning this test result?
- The air filter is restricted and needs to be replaced.
 - The air filter is perforated and needs to be replaced.
 - The air filter was installed incorrectly.
 - The air filter is performing correctly.



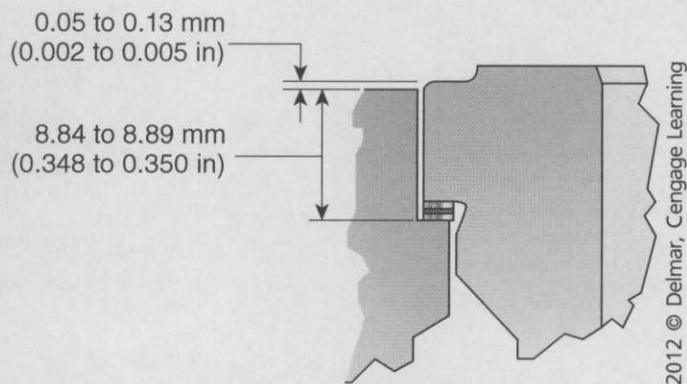
15. Technician A says when removing a terminal from the above connector it comes out the front. Technician B says when removing a terminal from the above connector it comes out the rear. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



16. The above measurement is less than specification. Which of the following is the LEAST LIKELY cause?
- Rod cap installed backward
 - Main cap installed backward
 - Incorrect bearing installed
 - Crank incorrectly machined
17. All of the following would be used to help isolate an engine vibration EXCEPT:
- A reed tachometer
 - A stethoscope
 - An ohmmeter
 - A chassis ear

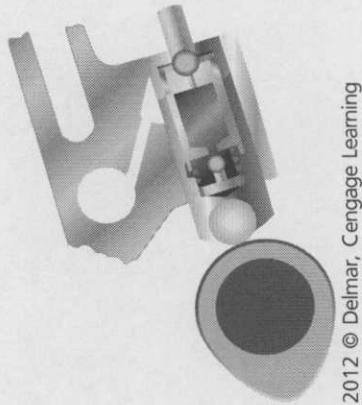


18. Technician A says the tool shown above is an ohmmeter. Technician B says the tool shown above measures amperage. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



19. The dimension shown above is:
- A. Liner protrusion
 - B. Liner recession
 - C. Count bore depth
 - D. Counterbore height
20. Technician A says air intake temperature can be used to control air intake heater on time. Technician B says coolant temperature can be used to control glow plug on time. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

21. Piston projection is lower than specification. Which of the following would be the most likely result?
- A. Piston-to-exhaust valve contact
 - B. Hard starting in cold weather
 - C. Hard starting in hot weather.
 - D. Piston-to-intake valve contact



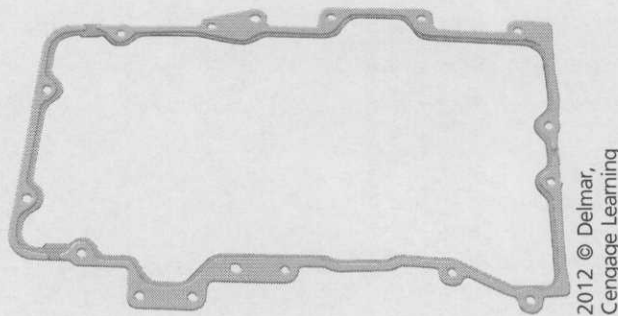
22. Technician A says the lifter shown above is a roller type. Technician B says the lifter shown above is a hydraulic type. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
23. Which oil would provide lubrication to the bearings first in cold weather?
- A. 0w30
 - B. 5w30
 - C. 10w30
 - D. 10w40
24. The ECM has an active trouble code P0046 indicating a Turbo/Super Charger Boost Control Solenoid Circuit Range/Performance problem. Technician A says the turbocharger should be replaced. Technician B says the solenoid valve should be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
25. The Service Throttle Soon lamp is illuminated on the dash panel. Technician A says this lamp indicates that the ECM has identified a fault in the throttle cable. Technician B says this lamp indicates that the ECM has identified a fault in the accelerator pedal position circuit. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

26. Technician A says mild detergent and water would be used to clean the internal passages in the charge air cooler. Technician B says oil in the charge air cooler can be caused by a restricted DPF. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
27. The function of the oil filter by-pass valve is to:
- A. Open when the oil filter is restricted.
 - B. Close when the oil filter is restricted.
 - C. Open when the oil is too thin.
 - D. Open when the oil is overheated.
28. Turbocharger boost pressure is lower than specification. Which of the following is the most likely cause?
- A. Restricted exhaust system
 - B. Restricted fuel filter
 - C. Missing crankcase filter
 - D. Failed turbocharger
29. A diesel engine will not communicate with a scan tool. Technician A says the ignition must be on. Technician B says the engine must be running. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
30. All of the following are true concerning injector sleeves EXCEPT:
- A. The sleeve must be replaced every time the injector is removed.
 - B. Copper sleeves should be reamed after installation.
 - C. The sleeve is sealed at both top and bottom.
 - D. A leaking sleeve can cause combustion gases in the coolant.
31. Excess exhaust back pressure may result in all of the following EXCEPT:
- A. Lower engine power
 - B. Higher exhaust temperature
 - C. Higher intake restriction readings
 - D. Poor combustion
32. A HEUI (hydraulic electronic unit injector) equipped diesel engine runs roughly. The injectors have passed a click test (solenoid test). Technician A says the ECM should be replaced. Technician B says the engine speed sensor should be inspected. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

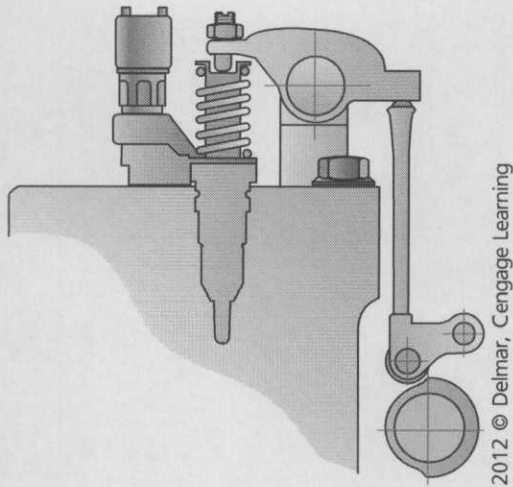
33. Which tool would be used to measure crankcase pressure?
- A. Mercury manometer
 - B. Water manometer
 - C. Refractometer
 - D. Hydrometer
34. Technician A says a voltmeter could be used to measure the resistance of a shutoff solenoid. Technician B says an ammeter could be used to measure the resistance of a shutoff solenoid. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
35. The gear-driven water pump is noisy and needs to be replaced. Technician A says the coolant should be drained prior to disassembly. Technician B says the oil should be drained prior to disassembly. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
36. Compression rings have worn out (deep vertical scratches) in a diesel engine in less than 50,000 miles. Which of the following is the most likely cause?
- A. Leaking cooling system
 - B. Dirt in the fuel system
 - C. Leaking intake air system
 - D. Dirt in the lubrication system
37. During reassembly of a V8 diesel engine, the technician finds excessive play in the timing chain. Technician A says the cause could be that the deck surface was ground excessively. Technician B says the cause could be that too much material was removed from the main bearing bores. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
38. Piston ring side clearance is measured with a/an:
- A. Inside micrometer
 - B. Outside micrometer
 - C. Feeler gauge
 - D. Dial indicator

39. A diesel engine that has a blue smoke concern also has oil in the air intake piping. Which of the following is the most likely cause?
- A. Restricted exhaust
 - B. Restricted fuel return
 - C. Dirty fuel filters
 - D. Worn turbocharger shaft seals
40. Technician A says cooling system test strips can be used to check the concentration of additives in diesel engine coolant. Technician B says cooling system test strips can be used to check the freeze protection of diesel engine coolant. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
41. As soon as the engine is started, there are bubbles in the coolant. The most likely cause of this concern is:
- A. Cracked oil cooler
 - B. Restricted radiator
 - C. Leaking radiator cap
 - D. Cracked cylinder head
42. A diesel engine with a common rail fuel system runs rough. However, the engine is making the correct amount of power. Which of the following is the most likely cause of the rough-running condition?
- A. Worn camshaft injector lobe
 - B. Worn camshaft valve lobe
 - C. Dirty injectors
 - D. Restricted fuel filter
43. All of the following are true regarding cylinder head removal EXCEPT:
- A. The engine oil must be drained prior to head removal.
 - B. The radiator must be drained prior to head removal
 - C. The head bolts should be removed in the reverse order of installation
 - D. The engine should be cold.
44. A diesel engine has a low power complaint. The fuel filter is removed and inspected. The filter is coated internally with a slimy film. Technician A says to replace the filter and return the vehicle to service. Technician B says to replace all the low pressure fuel system components. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

45. An engine is being repaired because of a blown head gasket. Technician A says this could be caused by an aftermarket program being installed in the engine ECM. Technician B says the use of an aftermarket air filter could be the cause. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
46. Technician A says an outside micrometer would be used to measure in-block camshaft end-play. Technician B says an inside micrometer would be used to measure in-block camshaft end-play. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
47. The low coolant level probe may be placed at any of the following locations EXCEPT:
- A. Lower radiator hose
 - B. Radiator top tank
 - C. Unpressurized coolant reservoir tank
 - D. Pressurized coolant reservoir tank
48. Technician A says diesel exhaust fluid (DEF) is used to control oxides of nitrogen (NO_x) emissions. Technician B says diesel exhaust fluid (DEF) is mixed with the diesel fuel in the diesel fuel tank. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



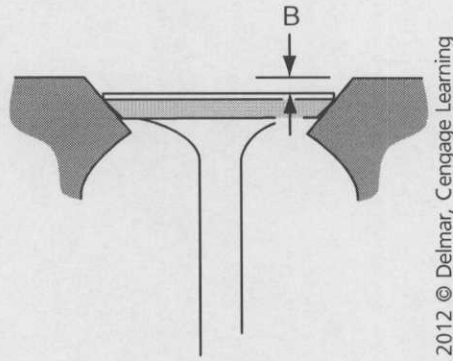
49. Technician A says the gasket shown above should be installed using gasket adhesive. Technician B says the gasket should be installed using a thin coating of oil. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



50. Technician A says the adjustment screw in the picture above is used to adjust the variable valve actuator. Technician B says the adjustment screw in the picture above is used to adjust injector height. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

PREPARATION EXAM 4

1. A diesel-powered vehicle has had two head gaskets replaced in the past 15,000 miles. Technician A says the electronic control module (ECM) should be checked for any diagnostic trouble codes. Technician B says the electronic control module (ECM) should be checked for VELCRO[®] straps. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

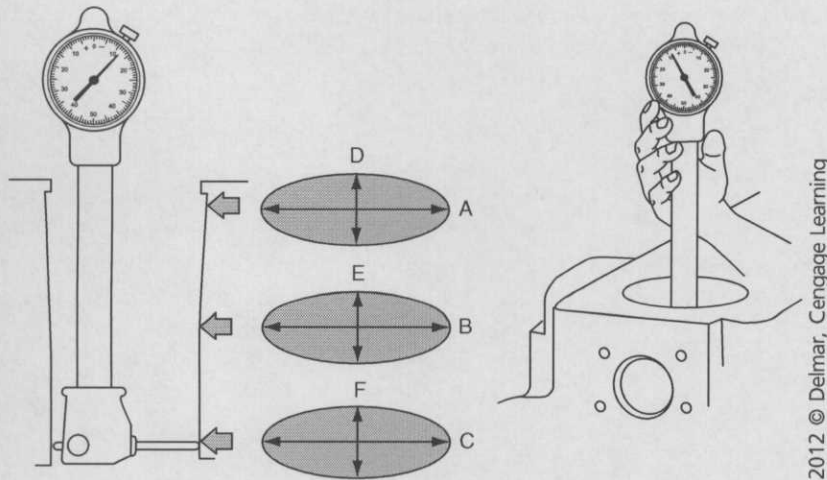


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2. The measurement pictured above is greater than specification. Technician A says this may cause low compression. Technician B says this may cause a coolant leak. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

3. A piston has heavy diagonal wear across the skirt. Technician A says the cause could be a main bearing bore out of alignment. Technician B says the cause could be a tapered main bearing journal. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

4. A hydraulic electronic unit injector (HEUI) diesel engine fails to start. The tachometer indicates RPM while cranking. Which of the following is LEAST LIKELY to be the cause?
 - A. Restricted fuel flow
 - B. Faulty engine position sensor
 - C. Low fuel level
 - D. Faulty high-pressure oil pump



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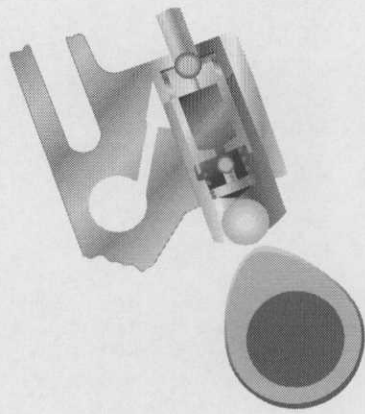
5. Results from the above measurements are as follows:

- A. 3.2303 inches
- B. 3.2302 inches
- C. 3.2302 inches
- D. 3.2305 inches
- E. 3.2303 inches
- F. 3.2302 inches

Which of the following is the best recommendation?

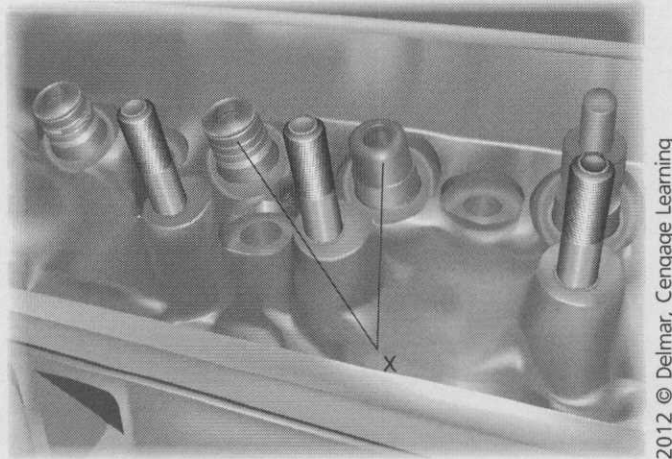
- A. The cylinder is out of round and should be bored or the block replaced.
 - B. The cylinder is tapered and should be bored or the block replaced.
 - C. The cylinder should be bored and sleeved.
 - D. The cylinder should be honed and reused.
6. When testing the coolant temperature sensor circuit, the scan tool displays coolant temperature to be 180 degrees F. An infrared temperature gun indicates the coolant temperature at the sensor to be 178 degrees F. Technician A says the temperature sensor is faulty and should be replaced. Technician B says the ECM is most likely faulty and should be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
7. Technician A says submerging the fuel return hose in a container of fuel will help determine if a fuel system has a suction side leak. Technician B says submerging the fuel return hose in a container of fuel will help locate which cylinder is misfiring on a diesel engine. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

8. A diesel engine has low power and excessive exhaust back pressure when measured after the turbocharger. All of the following could be the cause EXCEPT:
- A. Restricted air intake
 - B. Restricted diesel particulate filter (DPF)
 - C. Collapsed exhaust pipe
 - D. Plugged diesel oxidation catalyst (DOC)
9. An engine has an oil leak. Technician A says fluorescent dye can be used to locate the source of the leak. Technician B says smoke can be used to locate the source of the leak. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



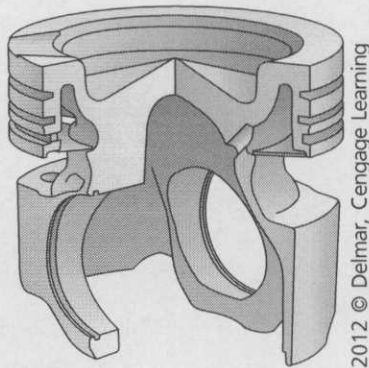
10. Technician A says the valve should be adjusted when the lifter is on the base circle, as illustrated. Technician B says the valve will be open when the lifter is on the base circle, as illustrated. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
11. Technician A says the intake air heater would be located in the charge air cooler. Technician B says the intake air heater will require a separate fuel injector. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

12. A diesel engine has run out of fuel. Technician A says the DTCs must be erased before the engine will restart. Technician B says ether should be used to prime the fuel system. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
13. A rebuilt diesel engine has developed a knock after 5,000 miles of operation. Oil pressure is normal. Which of the following is the most likely cause?
- A. Misdirected piston cooling nozzle
 - B. Incorrectly positioned EGR valve gasket
 - C. Incorrectly torqued rod bearings
 - D. Improperly positioned head gasket
14. While diagnosing a rough-running engine, the cylinder power balance test reveals low power on cylinder #2 and #3. All other cylinders pass the test. Which of the following would be the most likely cause?
- A. Worn rings
 - B. Weak valve springs
 - C. Broken valve springs
 - D. Leaking head gasket
15. A passage plug is left out of the crankshaft during engine reassembly. This will most likely result in:
- A. Higher than normal oil pressure.
 - B. Lower than normal oil pressure.
 - C. An external oil leak.
 - D. Excessive main bearing clearance.
16. Technician A says during an on-vehicle diesel particulate filter (DPF) regeneration, soot is removed. Technician B says during an on-vehicle diesel particulate filter (DPF) regeneration, ash is removed. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
17. After extended idling, a diesel engine accelerates itself to 1500 rpms, and the sound of the turbocharger changes. After a period of time the engine drops back to 600 rpms, and the sound from the turbocharger goes back to normal. Which of the following is the most likely cause?
- A. The APP (accelerator pedal position) sensor is faulty.
 - B. The TPS (throttle position sensor) is faulty.
 - C. The engine is acting normally.
 - D. The VGT (variable geometry turbocharger) sensor circuit is malfunctioning.



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18. Technician A says the items identified by the “X” in the picture above are injector seals. Technician B says the items identified by the “X” in the picture above can be replaced with the cylinder head still on the engine. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



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19. All of the following are true concerning the above piston EXCEPT:
- It is a two-piece piston.
 - It is sometimes called a trunk type.
 - It is sometimes called a MONOTHERM[®].
 - It is typically made of an aluminum alloy construction.
20. A normally operating light-duty diesel engine has suddenly lost all oil pressure according to the oil pressure gauge in the dash. All of the following could be the cause EXCEPT:
- A stuck shut oil filter by-pass
 - Lack of oil in the oil pan
 - A faulty oil pressure gauge
 - A faulty oil pressure gauge sending unit

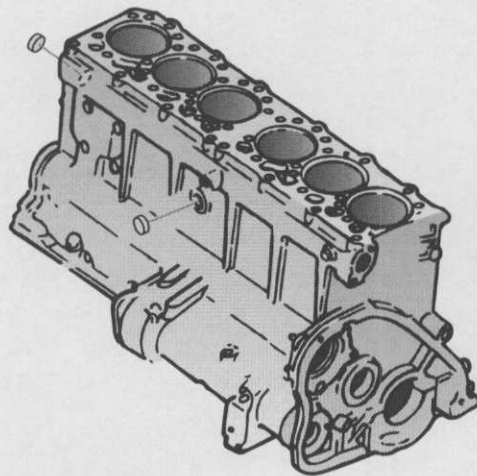
21. Which of the following would most likely be used to measure intake manifold pressure?
- A. Water manometer
 - B. Pressure gauge (Hg)
 - C. Vacuum gauge
 - D. Pressure gauge (H₂O)
22. Technician A says when installing a new injector, oil can be used to lubricate the o-rings. Technician B says when installing a new injector, anti-seize can be used to lubricate the o-rings. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
23. Peak boost pressure from a variable geometry turbocharger (VGT) is produced when:
- A. The waste gate is fully open.
 - B. The swinging vanes are fully open.
 - C. The swinging vanes are fully closed.
 - D. The waste gate is fully closed.
24. Which tool would most likely be used to check camshaft end-play when the camshaft is installed in the block?
- A. Feeler gauge
 - B. Dial indicator
 - C. Outside micrometer
 - D. Inside micrometer
25. A 2010 model year vehicle will use which of the following for the vehicle identification number (VIN) code?
- A. A
 - B. B
 - C. 10
 - D. Zero
26. Technician A says that a possible cause of an above-normal engine temperature is a faulty fan motor control module. Technician B says that plugged radiator fins may cause overheating. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

27. A customer has a low oil pressure concern on a vehicle with a data bus dash. The oil pressure is tested to be normal with a master gauge. A scan tool connected to the vehicle shows normal oil pressure. Which of the following is the most likely problem?
- A. Oil pressure sending unit
 - B. Oil pressure gauge
 - C. Data bus failure
 - D. Low oil level

Cylinder	#1	#2	#3	#4
Thrust diameter	3.656"	3.656"	3.656"	3.657"
Nonthrust diameter	3.651"	3.652"	3.650"	3.651"
Out of round	.005"	.004"	.006"	.006"

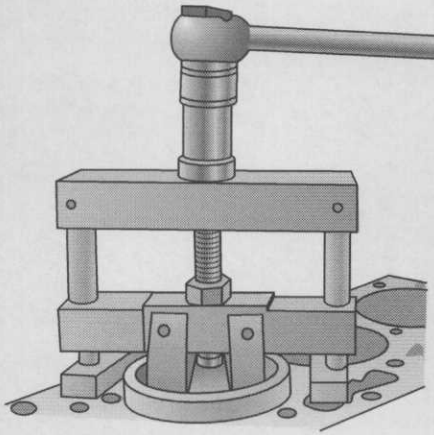
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28. The measurements above indicate that:
- A. All the cylinders are within out of round specifications.
 - B. Cylinders #1 and #2 are within out of round specifications.
 - C. Cylinder #1 is within out of round specifications.
 - D. All the cylinders exceed out of round specifications.



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29. Technician A says the items pictured above are oil gallery plugs. Technician B says the items pictured above should be replaced annually. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

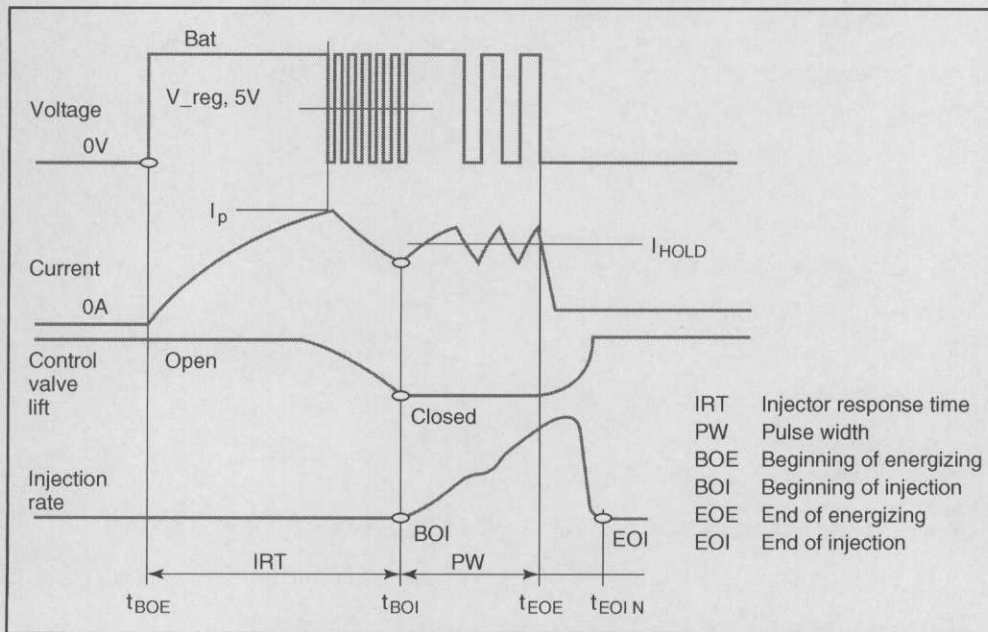


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30. What is the technician doing in the illustration above?
- Installing a liner
 - Installing an EGR cooler
 - Removing an EGR valve
 - Removing a liner
31. The fuel filter life monitor needs to be reset. Technician A says this can be done on some vehicles using the accelerator and brake pedals. Technician B says this can be done on some vehicles with the steering wheel mounted controls. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
32. A diesel engine has had repetitive head gasket failures. Technician A says failure of the wastegate to open could be the cause. Technician B says failure of the EGR to close could be the cause. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
33. Technician A says a clogged breather vent on a fuel tank can cause the fuel to gel. Technician B says a clogged breather vent on a fuel tank can cause the engine to have low power. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
34. Technician A says injector tip protrusion is measured using a feeler gauge. Technician B says injector tip protrusion is measured with the cylinder head removed. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

35. Piston rings are being installed on a piston. Technician A says to spiral the compression rings on the piston starting with the top compression ring. Technician B says incorrectly installing the rings could result in an overloaded crankcase ventilation system. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
36. The low coolant level sensor light is illuminated on the dash. All of the following could be the cause EXCEPT:
- A. Excessively high coolant level
 - B. Faulty engine ECM
 - C. Faulty low coolant level probe
 - D. Faulty instrument cluster
37. The cylinder head has been removed. Which of the following would be the most likely way to clean it before disassembly?
- A. Bead blaster
 - B. Steam cleaner
 - C. Air-powered grinder and Scotch-Brite™ pads
 - D. Tumble cleaner
38. The timing chain has been replaced on a light-duty diesel engine equipped with a common rail fuel system. Now the engine will not start. All of the following could be the cause EXCEPT:
- A. The high-pressure pump is out of time.
 - B. The fuel system has lost prime.
 - C. The camshaft is out of time.
 - D. The glow plug system was not reconnected.
39. Technician A says key-off battery drain can be measured with an oscilloscope. Technician B says key-off battery drain can be measured with an ammeter. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
40. A vehicle has an active DTC. Technician A says electrical connector terminals should be inspected during the diagnostic process. Technician B says electrical connector locks should be inspected during the diagnostic process. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

41. A diesel engine will not start. All of the following could be the cause EXCEPT:
- A. Faulty camshaft position sensor
 - B. Low fuel level
 - C. Faulty engine speed sensor
 - D. Faulty boost pressure sensor
42. Which tool would be used to measure piston projection?
- A. Dial indicator
 - B. Dial caliper
 - C. Outside micrometer
 - D. Inside micrometer
43. Technician A says valve clearance should be adjusted on a light-duty diesel engine with the engine running at 1000 rpm. Technician B says the valve clearance should be checked on a light-duty diesel engine with the engine at operating temperature. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



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44. The information above was collected, while cranking, from a diesel engine that will not start. Which of the following is the most likely cause of the no-start condition?
- A. The ECM is not turning the injectors on.
 - B. The engine position sensor is not sending a signal.
 - C. The engine is out of diesel fuel.
 - D. An overfilled engine oil crankcase.

45. A dual-mass flywheel has failed. The customer requested that the replacement flywheel be of a single-mass design. What should the technician do?
- A. Tell the customer that this would be a non-factory repair, and therefore cannot be performed.
 - B. Research to see if a replacement single-mass flywheel has been approved for this power train.
 - C. Ask the customer to bring in the flywheel they want installed.
 - D. Ask the customer to take the vehicle elsewhere.
46. The cooling system hoses collapse on a diesel engine when the vehicle sets overnight. Technician A says a restricted radiator could be the cause. Technician B says a restricted oil cooler could be the cause. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
47. Which of the following is the purpose of the EGR valve pressure differential sensor?
- A. To measure ash buildup in the DPF.
 - B. Determine the DEF injection quantity.
 - C. Determine the nitrous oxide emission levels.
 - D. Measure EGR flow.
48. Technician A says that prior to removing high-pressure fuel lines the engine should be thoroughly cleaned. Technician B says to spray the line with electronics cleaner, loosen slightly with a wrench, then spray the line again with electronics cleaner. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
49. The air inlet restriction test should be performed:
- A. At idle
 - B. Under load
 - C. With the engine cold
 - D. During the first two minutes of operation
50. Which of the following is true concerning changing the oil filter?
- A. The new oil filter should be tightened two complete turns with an oil filter wrench after the gasket contacts the base.
 - B. The new oil filter should be tightened three complete turns with an oil filter wrench after the gasket contacts the base.
 - C. The used oil filter should be hot-drained prior to disposal.
 - D. The new oil filter should be filled with transmission fluid prior to installation.

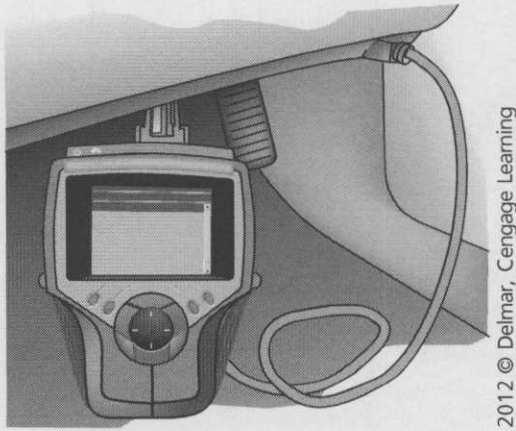
PREPARATION EXAM 5

1. Which of the following should be used to clean a cylinder block after honing?
 - A. Cleaning solvent
 - B. Hot Soapy water
 - C. Engine oil
 - D. Parts washer

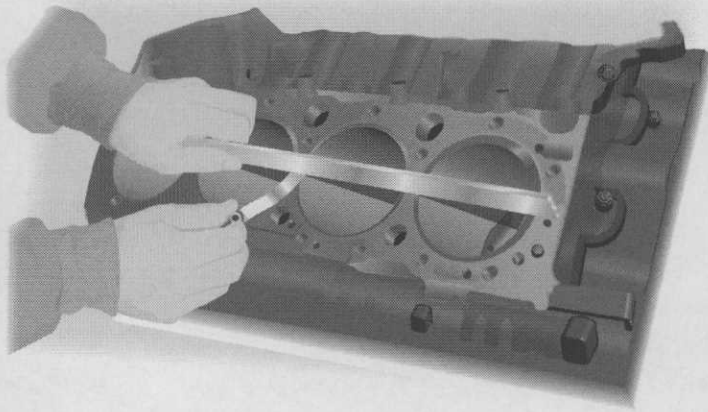
2. A diesel engine blows excessive white smoke and has an internal coolant leak. Technician A says the head gasket may be leaking. Technician B says the EGR cooler may be leaking. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

3. The cab-mounted PTO switch will raise and lower the engine RPM correctly. However, the remote PTO switch will not. Technician A says incorrect ECM programming could be the cause. Technician B says a faulty cab-mounted PTO switch could be the cause. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

4. Technician A says that most 2007 model diesel engines require CJ-4 oil. Technician B says using the incorrect oil in a 2007 model engine can result in frequent DPF regenerations. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



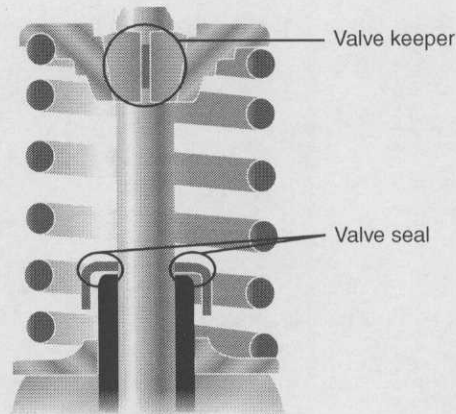
5. The scan tool shown above will not communicate with the engine. Which of the following is the LEAST LIKELY cause?
- A. Loose pins in the diagnostic link connector (DLC)
 - B. The ignition key is turned on.
 - C. A shorted data bus
 - D. A faulty scan tool
6. Technician A says cast iron blocks can be checked for cracks using the magnetic particle method. Technician B says aluminum cylinder heads can be checked for cracks using the magnetic particle method. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
7. Which of the following could cause a worn crankshaft thrust surface?
- A. Excessive air intake restriction
 - B. Excessive turbocharger boost pressure
 - C. A seized transmission slip yoke
 - D. A defective torque convertor
8. A diagnostic trouble code for an intermittent misfire is being diagnosed. The freeze frame data for the misfire indicates 0 rpm when the misfire occurred. Which of the following is the most likely cause of the code?
- A. Coolant temperature sensor
 - B. Camshaft position sensor
 - C. Boost pressure sensor
 - D. Variable geometry turbocharger (VGT) vane position sensor



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9. The technician is able to insert a 0.010" feeler gauge while doing the check shown above. Which of the following is true?
- This is within specification.
 - The cylinder head should be machined.
 - The cylinder block should be machined.
 - This would cause engine oil in the fuel.
10. Technician A says a valve bridge (crosshead) strengthens the valve guides. Technician B says the function of a valve bridge (crosshead) is to open two valves simultaneously. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
11. On a diesel engine equipped with a common rail fuel system, the fuel rail pressure sensor shows 12,500 psi fuel pressure for key on and the engine off. Which of the following is true?
- This is a normal reading on a cold engine.
 - This is a normal reading on a hot engine.
 - This reading is higher than normal for key on and the engine off.
 - This reading indicates the high-pressure pump is malfunctioning.
12. While driving at night, a diesel engine starts to misfire. The driver also remarks that the headlights are dim. Which of the following could be the cause?
- Low charging system output
 - High charging system output
 - Low starter current draw
 - High starter current draw
13. An electronic unit injector has been replaced. All of the following are true EXCEPT:
- The fuel system must be bled to restart the engine.
 - The fuel will need to be removed from the top of the piston before the new injector is installed.
 - The injector rocker arm must be adjusted before the engine is started.
 - The injector electrical connector should be disconnected when the engine is started.

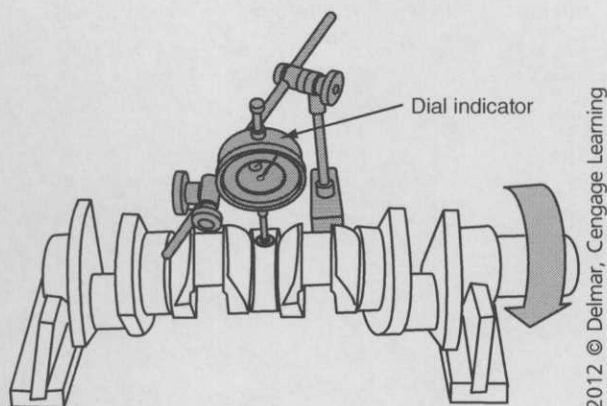
14. The after treatment diesel particulate filter is leaking at the V-band clamp. Which of the following would be the correct repair?
- Replace the V-band clamp
 - Replace the seal
 - Replace the after treatment diesel particulate filter
 - Replace the variable geometry turbocharger
15. A vehicle has been in the shop for multiple “hard starting when cold” customer concerns. All of the following could be the cause EXCEPT:
- The glow plugs are inoperative.
 - The air heater is inoperative.
 - The customer needs to be reminded of correct starting procedures.
 - The charge air cooler hose is restricted.



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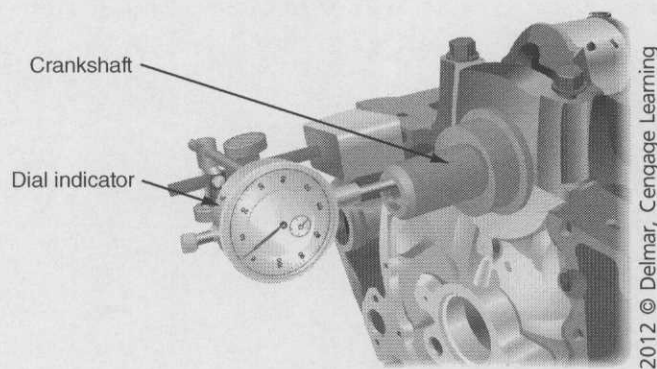
16. Refer to the illustration above. Technician A says that when reassembling the cylinder head, the valve seal is installed before the valve spring. Technician B says the valve keepers are installed before the valve spring. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
17. An engine has a vibration that is evident at 1000 rpm, 1600 rpm, and 2200 rpm. Which of the following is the most likely cause?
- Alternator
 - Water pump
 - Piston
 - Vibration damper
18. A V8 diesel engine piston has the word “front” stamped on it. Technician A says the word “front” goes on the right bank of cylinders. Technician B says the word “front” goes toward the front of the engine block. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

19. The engine oil cooler has an internal leak. Which of the following can be the result?
- Oil in the coolant
 - External oil leak
 - External coolant leak
 - Restricted diesel particulate filter
20. The valve springs are tested for tension and results are below specification. Technician A says the springs can be shimmed. Technician B says the springs should be replaced. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
21. The diesel fuel in a diesel engine is oily. Which of the following could be the cause?
- Leaking high-pressure oil pump
 - Leaking injector o-rings
 - Faulty injection pressure regulator
 - Faulty injection pressure actuation valve
22. The transmission overheats on a vehicle that also has a non-functioning cruise control concern. Which of the following could be the cause?
- Brake light switch
 - Torque convertor solenoid
 - Cruise control fuse
 - Transmission cooler
23. A freshly overhauled engine has lower than normal oil pressure, especially at hot idle. Which of the following could be the cause?
- Incorrect ring end gap
 - Incorrect bearing clearance
 - Incorrect piston-to-cylinder clearance
 - Incorrect valve adjustment

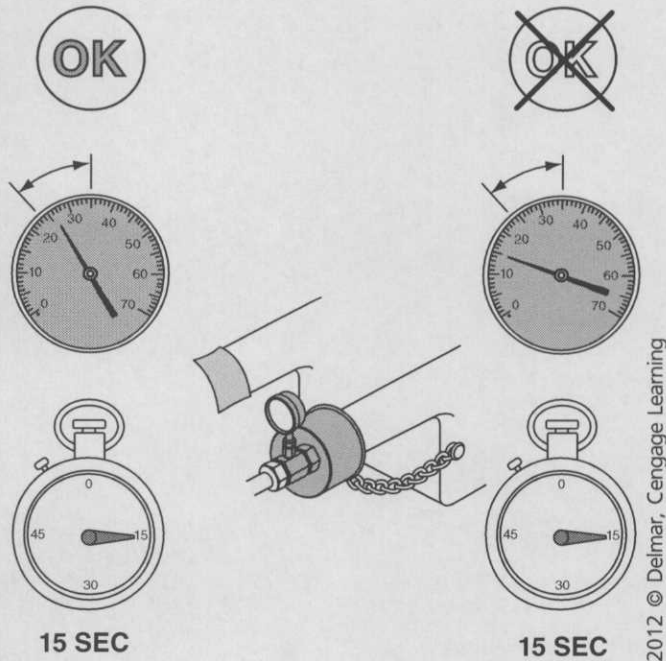


24. Which reading below would indicate an acceptable measurement for the test shown above?
- 0.0005"
 - 0.0050"
 - 0.0500"
 - 0.5000"

25. Which of the following is LEAST LIKELY to occur during a diesel particulate filter regeneration?
- A. Fuel is sprayed into the exhaust.
 - B. Exhaust temperatures will drop.
 - C. The engine will have reduced horsepower.
 - D. The idle speed will be raised.
26. An in-frame engine overhaul is being performed. The in-block camshaft bushings are removed by:
- A. Driving them out with a driver tool.
 - B. Shoving them out with a hydraulic press.
 - C. Shoving them out with an arbor press.
 - D. Shoving them out with a pusher screw.

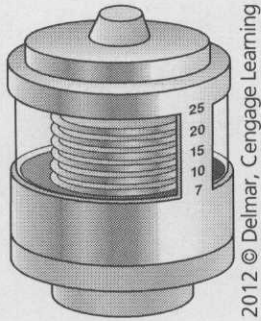


27. Technician A says that in the illustration shown above, the technician is measuring crankshaft end-play. Technician B says if the measurement shown above is greater than specification, the engine may have low power. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



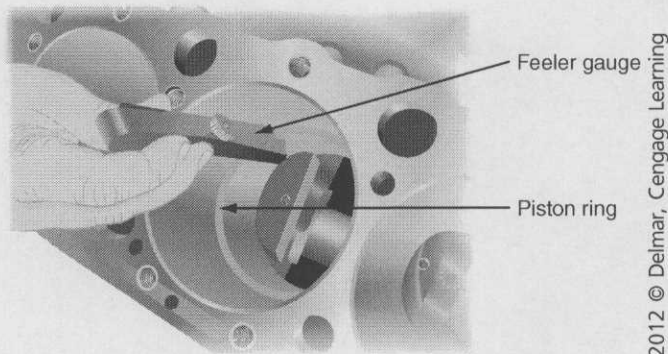
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28. The test performed above will indicate:
- Charge air cooler leaks.
 - Charge air cooler external restrictions.
 - Charge air cooler internal restrictions.
 - Charge air cooler flow rate.
29. The pins are loose at the sensor connector. Technician A says this could cause an incorrect idle RPM. Technician B says this could cause the ECM to set a DTC. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
30. Which of the following would cause excessive gallery pressure on a PLN-E (pump-line-nozzle electronic) fuel system pump?
- Stuck open fuel regulator
 - Stuck closed fuel regulator
 - Dirty injection nozzles
 - Incorrect injection pump timing
31. The injector harness under the valve cover on a HEUI engine is damaged. Which of the following is the most likely repair?
- Replace the harness
 - Replace the damaged connector
 - Replace the injector
 - Replace the glow plugs



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32. When the vehicle came in for service, the indicator reading above was observed. This indicates:
- A. The air filter is still serviceable.
 - B. The air filter is leaking.
 - C. There is a leak in the air intake piping.
 - D. There is an exhaust restriction.
33. The fuel heater is stuck on. This could result in:
- A. Increased power
 - B. Decreased power
 - C. Engine overheating
 - D. Increased turbo boost pressure



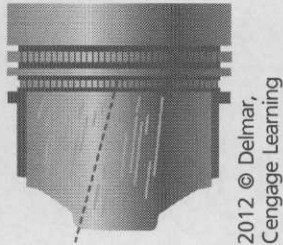
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34. The measurement above is greater than specification. This could result in:
- A. Piston seizure
 - B. Ring breakage
 - C. Increased crankcase pressure
 - D. Decreased oil pressure
35. A diesel fuel filter is being replaced. Which of the following is the correct procedure?
- A. Install the filter dry.
 - B. Fill the filter with diesel fuel, then install.
 - C. Fill the filter with fuel system cleaner, then install.
 - D. Fill the filter with $\frac{1}{2}$ diesel fuel and $\frac{1}{2}$ fuel system cleaner, then install.

36. The air entering the engine from the after cooler is too hot. Which of the following could be the cause?
- A. Leaking injector
 - B. Leaking after cooler
 - C. Clogged radiator
 - D. Tight turbocharger bearings
37. A high-pressure injection line is seeping. The fitting has been torqued to the correct specification. Which of the following should be done to correct the leak?
- A. Remove the line and inspect.
 - B. Replace the line.
 - C. Increase the torque on the line 10% and retest.
 - D. Increase the torque on the line 20% and retest
38. A diesel engine will not start. There is no voltage at the fuel shutoff solenoid when checked with the key on and the engine off (KOEO). Technician A says the wire could be shorted. Technician B says the solenoid could be open. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
39. Technician A says when the diesel engine is first put under load, the ECM should command the turbocharger vanes to close to raise turbo boost pressure. Technician B says when the diesel engine coolant temperature drops below a preset threshold, the ECM should command the turbochargers vanes to close to raise engine temperature. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
40. A diesel engine equipped with an air intake grid heater blows excessive white smoke when cold. Otherwise, the engine runs well and produces good power. Which of the following is the most likely cause?
- A. Low compression due to worn rings
 - B. Low fuel supply pressure
 - C. An open air intake heater
 - D. A high exhaust back pressure
41. A rebuilt vehicle has a DTC for the diesel particulate filter (DPF). Which of the following could be the cause?
- A. Rod bearing clearances are less than specified.
 - B. The DPF pressure sensor hoses were incorrectly installed.
 - C. A piston cooling nozzle was left out during reassembly.
 - D. A core plug was left out during reassembly.

42. A weather pack engine harness connector has a damaged pin. Technician A says the harness must be replaced. Technician B says that in some cases a damaged pin can be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
43. A piston ring has a dot imprinted on one side. Which of the following is true?
- A. The dot should always face down.
 - B. The dot should always face up.
 - C. The ring is to be used only on engines equipped with EGR valves.
 - D. The ring is to be used only on engines equipped with a diesel particulate filter.
44. All of the following are true for DEF EXCEPT:
- A. It is used to control NO_x emissions.
 - B. It is injected into the exhaust stream.
 - C. It contains urea.
 - D. It cannot be allowed to freeze.
45. Which of the following indicates a need to check fuel supply pressure?
- A. Smoke on acceleration.
 - B. Smoke on start up.
 - C. Low turbocharger boost pressure.
 - D. Excessive turbocharger boost pressure.
46. Which of the following would be used to measure oil pump drive gear backlash?
- A. Plastigauge[®]
 - B. Dial indicator
 - C. Torque wrench
 - D. Angle gauge
47. There is diesel fuel in the oil of a diesel engine. Which of the following could be the cause?
- A. Restricted fuel return line.
 - B. Restricted fuel supply line.
 - C. Leaking fuel filter.
 - D. Leaking injector o-ring.
48. A driver complains of poor fuel economy. Which of the following is the most likely cause?
- A. The fan clutch is not operating.
 - B. The fan clutch is stuck on.
 - C. The tires are overinflated.
 - D. Restricted fuel filters.

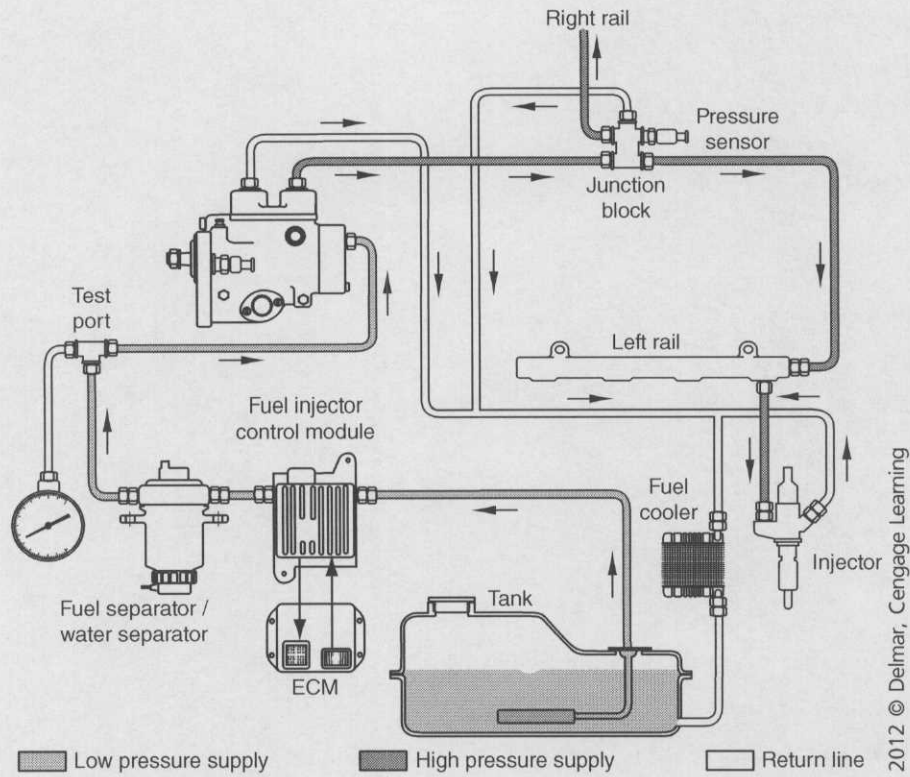
49. A surface comparator is used to:
- A. Measure surface warpage.
 - B. Compare the deck to the head.
 - C. Measure surface finish.
 - D. Measure head thickness.



50. The piston wear pattern shown above indicates:
- A. A bent crankshaft
 - B. A bent connecting rod
 - C. An out of round cylinder bore
 - D. A tapered cylinder bore

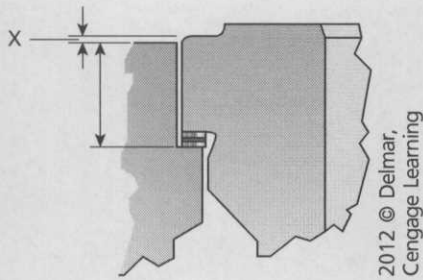
PREPARATION EXAM 6

1. An engine has had a major bearing failure. Besides replacing the failed parts, what else should be replaced?
- A. Engine oil cooler
 - B. Transmission oil cooler
 - C. Fuel cooler
 - D. ECM

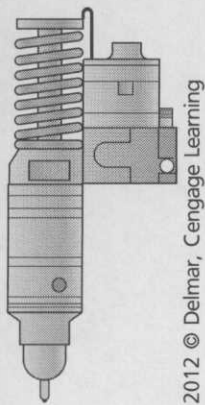


2. The technician is performing a fuel supply test at the test port as indicated above. The gauge is reading a vacuum that is higher than specification. Which of the following could be the problem?
 - A. Restricted fuel cooler
 - B. Stuck open pressure limiting valve
 - C. Stuck closed pressure limiting valve
 - D. Restricted fuel filter/water separator

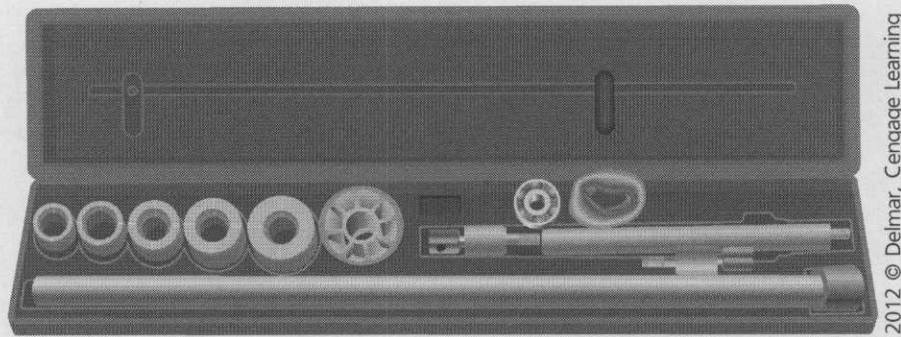
3. Which of the following is used with fluorescent dye?
 - A. Black light
 - B. Blue light
 - C. Red light
 - D. Yellow light



4. The dimension indicated by the "X" shown above is less than specified. This would be corrected by:
- Cutting the counter bore.
 - Increasing the shim thickness.
 - Decreasing the shim thickness.
 - Cutting the liner flange.



5. The injector pictured above is a:
- EUI
 - HEUI
 - Common rail
 - PLN-E
6. What is the function of the crankcase breather?
- Provide clean air for the DOC
 - Measure engine blow-by
 - Filter crankcase vapors
 - Filter the engine oil
7. Technician A says piston-to-cylinder wall clearance can be measured with a feeler gauge. Technician B says piston-to-cylinder wall clearance can be measured with a depth micrometer. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



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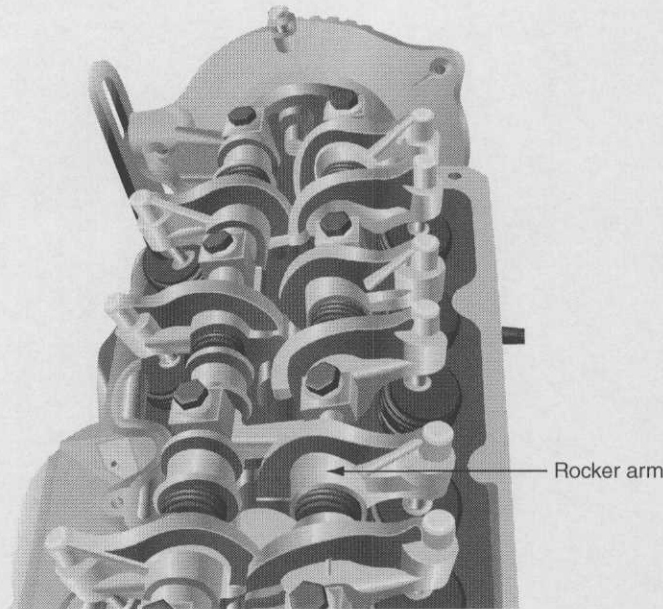
8. All of the following is true concerning using the tool shown above EXCEPT:
- It is used to remove cam bearings.
 - It is used to install cam bearings.
 - It is used to install main bearings.
 - The oil hole on the bearing must be aligned.
9. The turbocharger wastegate is stuck open on a diesel engine. Which of the following would be the most likely result?
- Poor acceleration
 - Hard starting
 - Excessive exhaust restriction
 - Excessive air inlet restriction
10. An ECM-controlled fan clutch is on all the time. Technician A says a faulty A\C high side pressure sensor could cause this. Technician B says a coolant temperature sensor could cause this. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
11. A vehicle has returned from the body shop after being repaired. After the repairs, the vehicle started, died and will not restart. Which of the following could be the cause?
- The engine ECM needs the accident information downloaded.
 - The anti-theft module needs to be reprogrammed.
 - The diesel particulate filter needs to be regenerated.
 - The variable geometry turbocharger needs to relearn its position.

12. A noise is coming from the accessory drive on the front of the engine. Technician A says the serpentine belt can be removed to help locate the source of the noise. Technician B says a laser can be used to help locate the source of the noise. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



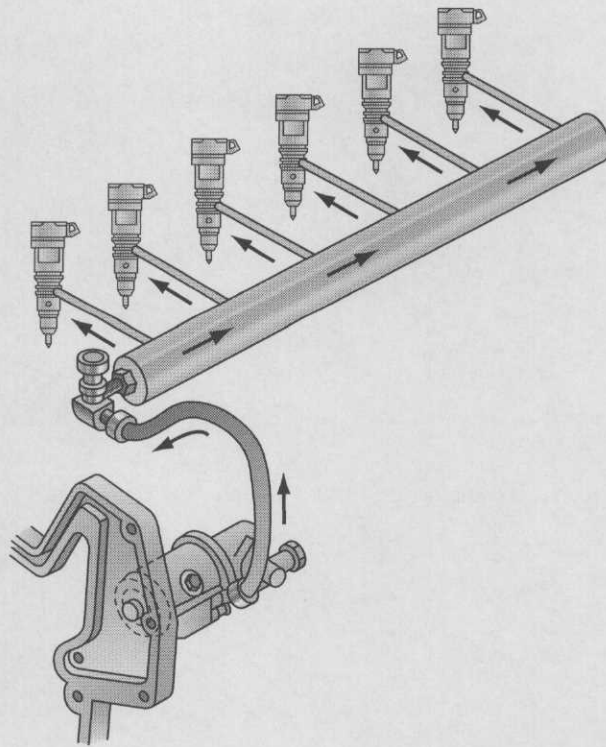
13. All of the following statements are true about the above illustration EXCEPT:
- A. The skirt will separate from the head.
 - B. The skirt is steel.
 - C. The piston pin is full-floating.
 - D. It is referred to as an articulating piston.
14. All of the following is true about the vehicle identification number (VIN) EXCEPT:
- A. The 8th digit is the engine code.
 - B. The 10th digit is the year.
 - C. The engine code is always a number.
 - D. The year code is a number or letter.
15. The fuel injection pump is being replaced on a PLN-E (pump-line-nozzle electronic) fuel system. Which of the following is true?
- A. The pump must be timed to the engine.
 - B. The injectors will also be replaced because they are a matched set.
 - C. The inactive (history) codes must be erased before the engine will start.
 - D. The engine's camshaft position sensor must be replaced because they are a matched set.

16. A cylinder head is to be removed from a cam in-block diesel engine. Which of the following must be done prior to head removal?
- A. Remove the timing chain
 - B. Remove the cam
 - C. Remove the coolant
 - D. Remove the oil pan



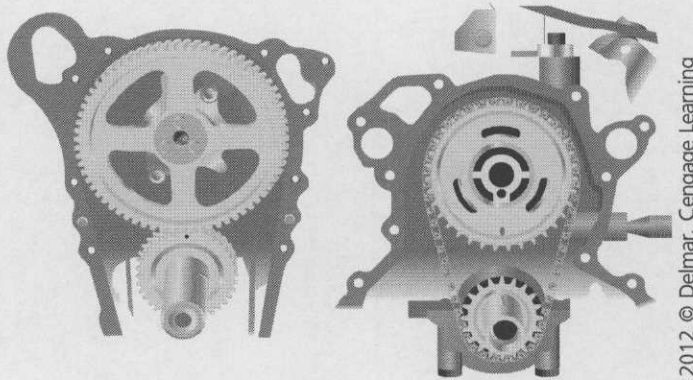
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17. The engine shown above:
- A. Is an overhead cam engine.
 - B. Is a cam in-block engine.
 - C. Has two rocker arms per cylinder.
 - D. Must be torqued from the outside in.

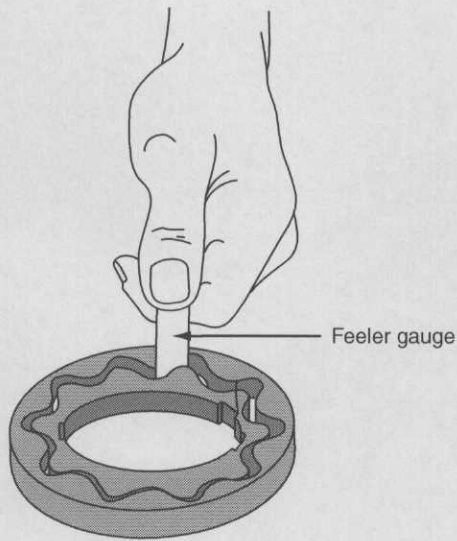


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18. An engine equipped with the fuel system shown above will not start. The scan tool displays an injector control pressure sensor value of 0 psi with key on and the engine off and 75 psi when cranking at 200 rpm. Which of the following is the most likely cause of the no start condition?
- Low fuel level
 - Low injection actuation pressure
 - A faulty injector control pressure sensor
 - A faulty engine position sensor
19. All of the following are true concerning piston pin installation EXCEPT:
- Semi-floating designs will use snap rings.
 - Semi-floating designs can be assembled with heat.
 - Semi-floating designs can be assembled with a press.
 - Full-floating designs will use snap rings.
20. A fleet of light-duty delivery trucks have repeated water-in-fuel problems. The bulk tanks have been tested and do not contain water. Technician A says the trucks should be refueled at the end of each day. Technician B says the trucks should be fueled at the beginning of each day. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



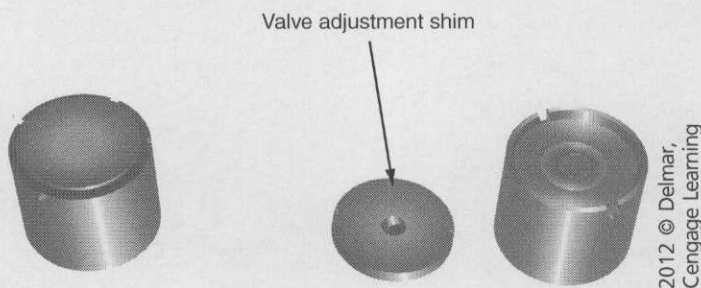
21. The gear train shown above has been assembled out of time. Which of the following would be the LEAST LIKELY result?
- A. The engine will not rotate.
 - B. The engine will have low power.
 - C. Turbo boost pressure will be excessive.
 - D. Incorrect injection timing.
22. The exhaust after treatment system is performing an active regeneration more often than normal. Technician A says a leaking fuel injector can cause this. Technician B says a leaking exhaust pipe downstream of the DPF (diesel particulate filter) can cause this. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B
23. The instrument panel on a customer's vehicle displays Exhaust System Regeneration in Process. Which of the following should the customer do?
- A. Bring the vehicle to the dealer for service as soon as possible.
 - B. Immediately stop the vehicle and let it idle until the message disappears.
 - C. Continue driving the vehicle.
 - D. Stop the vehicle immediately and have it towed to the dealer for service.
24. All of the following tools could be used to measure the cylinder walls for wear EXCEPT:
- A. Dial bore gauge
 - B. Depth micrometer
 - C. Inside micrometer
 - D. Snap gauge



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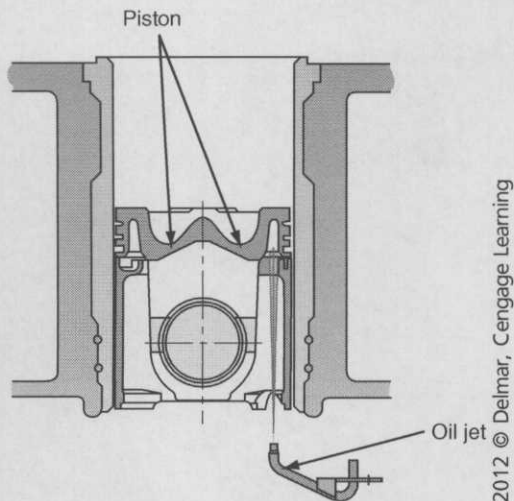
25. The oil pump measurement above is called:
- A. Inner to outer rotor clearance
 - B. Outer rotor to pump body
 - C. Inner rotor to pump body
 - D. Inner rotor to drive gear
26. An electronically controlled diesel engine runs poorly. It has eight active codes and 10 inactive codes. All the codes were set at the same ECM time. Which of the following is the most likely cause?
- A. Worn crankshaft thrust washer
 - B. Worn camshaft thrust washer
 - C. Poor electrical supply connections
 - D. Faulty ECM
27. When using coolant test strips, the engine should be:
- A. At operating temperature
 - B. Running at high idle
 - C. Running at low idle
 - D. Cool

32. The diesel oxidation catalyst (DOC) is located:
- A. Before the diesel particulate filter (DPF).
 - B. After the diesel particulate filter (DPF).
 - C. In parallel with the diesel particulate filter (DPF).
 - D. In parallel with the turbocharger.
33. There are air bubbles flowing in the return fuel flow. Which of the following is the most likely cause?
- A. Leaks in the return fuel line
 - B. Leaks in the suction side fuel line
 - C. Restricted fuel filter
 - D. Restricted fuel cooler
34. All of the following are true concerning crankcase pressure measurements EXCEPT:
- A. It is measured at the exhaust manifold.
 - B. A special restrictor orifice may be needed to perform the test.
 - C. It is measured at the dipstick tube.
 - D. The pressure will change depending on engine wear.
35. All the glow plugs in a diesel engine are burnt out. Which of the following could be the cause?
- A. Operating the vehicle with a low battery
 - B. A shorted glow plug relay
 - C. An open glow plug relay
 - D. A shorted coolant temperature sensor
36. A rear main seal is leaking on a diesel engine. Which of the following is the most likely cause?
- A. Restricted crankcase ventilation system
 - B. Restricted oil filter
 - C. Excessive main bearing clearance
 - D. Excessive rod bearing clearance
37. A diesel engine has a DTC P0103 Mass Airflow Sensor Voltage High. The technician wiggles the sensor wiring harness while observing the mass airflow sensor voltage with the scan tool. The sensor voltage changes. Technician A says the cause may be a faulty scan tool. Technician B says the cause may be a faulty ECM. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

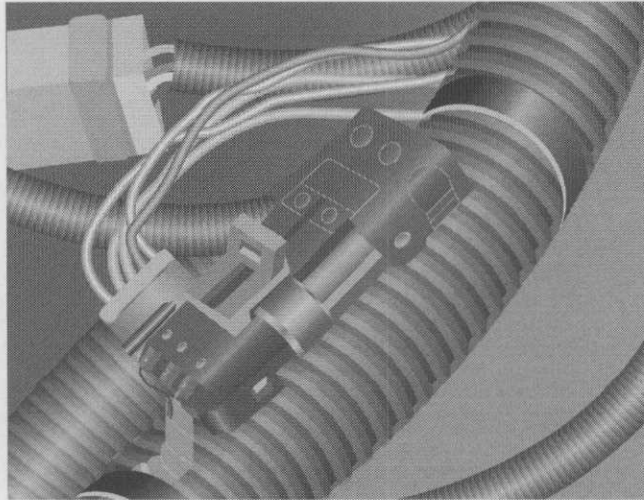


38. The valve adjustment is too tight on an engine that uses the above cam follower mechanism. All of the following are true EXCEPT:
- A thicker shim should be installed.
 - The valve will open earlier than normal due to the decreased clearance.
 - The valve will close later than normal due to the decreased clearance.
 - A thinner shim should be installed.
39. An engine is slow to warm and operates at a lower temperature than normal. Which of the following could be the cause?
- A restricted charge air cooler
 - A restricted radiator
 - A stuck open thermostat
 - A stuck closed thermostat
40. A common rail fuel system high-pressure pump has been replaced. Which of the following is true?
- The pump must be timed to the engine.
 - The pump serial number must be programmed into the ECM.
 - All inactive (history) codes will need to be removed for the engine to start.
 - The fuel filters should be installed and filled using the hand primer pump.
41. While repairing a leaking head gasket, the technician notices an electrical splice connector in the wiring harness at the turbo boost pressure sensor. Technician A says this could indicate vehicle tampering and possibly void the warranty. Technician B says the repair history of the vehicle should be researched. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B
42. Which tool is used to measure exhaust back pressure on an engine equipped with a DPF (diesel particulate filter)?
- Water manometer
 - Mercury manometer
 - Vacuum gauge
 - 20–100 psi pressure gauge

43. A freshly overhauled diesel engine is hard to start when cold and blows white smoke until fully warmed. All of the following could be the cause EXCEPT:
- A. Incorrect injection pump timing
 - B. Incorrect pistons were installed
 - C. Incorrect head gasket
 - D. Incorrect valve seals

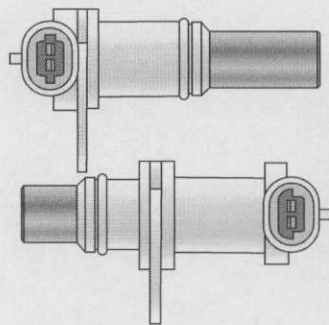


44. If the oil jet shown above was aimed incorrectly, the most likely result would be:
- A. Low oil pressure
 - B. High oil pressure
 - C. Increased piston temperature
 - D. Increased coolant temperature
45. Which of the following would be the best tool to use to help find a high-pressure fuel line leak on a PLN-E (pump-line-nozzle electronic) engine?
- A. A piece of cardboard
 - B. The technician's hand
 - C. A black light
 - D. Dye tracer



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46. The electrical connector shown above is a:
- A. Weather pack
 - B. Metri-Pack
 - C. Deutsch
 - D. Amp
47. Worn camshaft bearings can cause:
- A. High oil pressure
 - B. Low oil pressure
 - C. Retarded cam timing
 - D. Advanced cam timing



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48. An engine equipped with the sensors shown above will not start. There is zero RPM indicated on the scan tool while the engine is cranking. Technician A says these sensors can be checked using an ohmmeter. Technician B says these sensors can be checked using an AC voltmeter. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

49. A diesel engine has low power. The technician notices the engine has a new turbocharger and new fuel filters. The engine has several small oil leaks. Which of the following is the most likely cause of the low power concern?
- A. Worn piston rings
 - B. Late injection timing
 - C. Advanced injection timing
 - D. Worn injectors
50. Technician A says threaded holes can be repaired by using a thread insert. Technician B says threaded studs can be repaired using a thread insert. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer Keys and Explanations

INTRODUCTION

Included in this section are the answer keys for each preparation exam, followed by individual, detailed answer explanations and a reference identifying the designated task area being assessed by each specific question. This additional reference information may prove useful if you need to refer back to the task list located in Section 4 of this book for additional support.

PREPARATION EXAM 1—ANSWER KEY

- | | | |
|-------|-------|-------|
| 1. B | 21. D | 41. B |
| 2. A | 22. D | 42. C |
| 3. D | 23. B | 43. D |
| 4. C | 24. B | 44. D |
| 5. C | 25. C | 45. B |
| 6. B | 26. A | 46. B |
| 7. A | 27. B | 47. D |
| 8. C | 28. A | 48. D |
| 9. D | 29. C | 49. B |
| 10. B | 30. B | 50. B |
| 11. A | 31. A | |
| 12. D | 32. B | |
| 13. D | 33. B | |
| 14. C | 34. D | |
| 15. D | 35. C | |
| 16. A | 36. A | |
| 17. B | 37. D | |
| 18. B | 38. B | |
| 19. A | 39. C | |
| 20. D | 40. D | |

PREPARATION EXAM 1—EXPLANATIONS

1. A diesel engine blows excessive white smoke on a cold start. Which of the following could be the cause?
- A. The air intake grid heater staying on too long.
 - B. The air intake grid heater not staying on long enough.
 - C. The glow plugs staying on too long.
 - D. The glow plugs have too little resistance.



TASK A.9
PAGES 17-18

Answer A is incorrect. A grid heater that stays on too long will not cause white smoke.

Answer B is correct. A grid heater that does not stay on long enough or that does not come on at all will cause white smoke.

Answer C is incorrect. Glow plugs staying on too long will not cause white smoke.

Answer D is incorrect. Glow plugs should have very low resistance. They are electrical heaters. They fail when they have too much resistance.

2. Technician A says piston ring side clearance is measured with a feeler gauge. Technician B says piston ring side clearance is measured with a dial indicator. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK C.13
PAGES 30-31

Answer A is correct. Only Technician A is correct. Ring side clearance is the distance between the ring and land. A feeler gauge is the correct tool.

Answer B is incorrect. A dial indicator cannot effectively measure this type of clearance. Dial indicators work best at measuring motion.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

3. Technician A says the pressure in the low-pressure fuel supply circuit should be checked every time the fuel filters are replaced. Technician B says the pressure in the low-pressure fuel supply circuit should be checked every time the air filter is replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK F.4
PAGE 44

Answer A is incorrect. Fuel pressure should be checked when there is a low power concern. There would be no need to make this check every time the filters are changed.

Answer B is incorrect. Fuel pressure should be checked when there is a low power concern. Air filter restriction would have no connection with low fuel pressure.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



TASK E.10
PAGES 40–41

4. The acronym DPF stands for:
- Diesel pulsation fixture
 - Direct particle filter
 - Diesel particulate filter
 - Direct premium fluid

Answer A is incorrect. DPF stands for diesel particulate filter. This filter is installed in the exhaust stream.

Answer B is incorrect. DPF stands for diesel particulate filter. This filter catches the soot in the exhaust.

Answer C is correct. DPF stands for diesel particulate filter. The soot captured in the filter can be burned off in a regeneration procedure that is performed on the vehicle.

Answer D is incorrect. DPF stands for diesel particulate filter. Eventually this filter will fill with ash and will need to be removed.



TASK A.1
PAGE 14

5. A customer has a low power concern. All of the following could cause the problem EXCEPT:
- Fuel filter
 - Air filter
 - Over-fueling
 - Injection timing

Answer A is incorrect. A dirty fuel filter can cause low power because fuel flow is reduced.

Answer B is incorrect. A dirty air filter can cause low power because air flow is reduced.

Answer C is correct. Over-fueling will result in increased power and smoke.

Answer D is incorrect. Injection timing can affect power because the power stroke will be less effective.



TASK F.12
PAGE 50

6. The engine ECM has several unrelated and unrecognized DTCs. A technical service bulletin instructs the technician to re-flash the ECM. Technician A says that during the re-flash, a battery charger should be connected to the vehicle battery and set on the boost setting. Technician B says the scan tool used for the re-flash should be connected to an auxiliary power supply to ensure voltage to the scan tool is not interrupted. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Setting the battery charger on boost could cause an over voltage situation, which would shut down the ECM during the re-flash process. The battery should be connected to a battery maintainer instead.

Answer B is correct. Only Technician B is correct. It is important to maintain correct voltage to the scan tool during this process. If the scan tool voltage drops below minimum, the scan tool can shut down and corrupt the file.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

7. The coolant in a light-duty diesel engine smells like diesel fuel. Technician A says this could be caused by a leaking injector tube. Technician B says this could be caused by a leaking intake manifold. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. A leaking injector tube can allow diesel fuel to pass into the coolant. This condition will often cause the coolant recovery bottle to overflow.

Answer B is incorrect. A leaking intake manifold can result in a whistling sound from the engine under boost conditions. There should be no fuel in the intake manifold.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

8. Which of the following would be the most likely procedure for checking an engine oil cooler for a leak?
- A. Pressurize the oil cooler and let it set overnight.
 - B. Pressurize the oil cooler and submerge in cold water.
 - C. Pressurize the oil cooler and submerge in hot water.
 - D. Apply vacuum to the cooler and submerge in hot water.

Answer A is incorrect. This method may indicate a leak; however, a technician would not know where the leak is.

Answer B is incorrect. Cold water will not expand the cooler, thus it may not find the leak.

Answer C is correct. This method will expand the cooler, which will help identify a leak.

Answer D is incorrect. Water would be drawn into the cooler, and a leaking area would not be identified.

9. The cylinder bore has 0.0001" (0.0025 mm) taper. Technician A says to replace the engine block. Technician B says to bore the engine block. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. This is an acceptable amount of taper for reuse. The block does not need to be replaced.

Answer B is incorrect. This is an acceptable amount of taper for reuse. The block does not need to be bored. Specifications will vary; some manufacturers recommended boring the block if taper exceeds 0.003" (0.0762 mm).

Answer C is incorrect. Neither Technician is correct. This is an acceptable amount of taper for reuse.

Answer D is correct. Neither Technician is correct.



TASK B.5
PAGE 23



TASK D.4
PAGE 33



TASK C.3
PAGE 26

TASK B.1
PAGE 21

10. The valve cover gasket is leaking on a diesel engine. Technician A says to replace the gasket. Technician B says to check the valve cover mounting bolts for the correct torque. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Most diesel engines now have a rubber gasket. If these gaskets leak, tightening the valve cover to the correct torque will often fix the problem. Old engines with cork gaskets may not reseal and will need the gasket replaced.

Answer B is correct. Only Technician B is correct. Check the torque first. Rubber gaskets will usually reseal.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct. The valve cover assembly does not usually need replacing in order to stop the valve cover gasket leak.

TASK A.15
PAGE 20

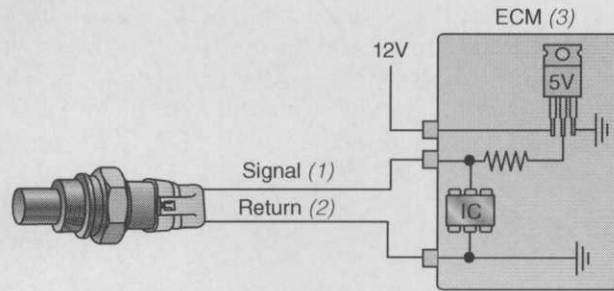
11. A diesel engine has become increasingly harder to start the first start on a cool morning. Technician A says the problem could be low current draw on the glow plug circuit. Technician B says the problem could be a jumped timing chain. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. A glow plug circuit drawing less than normal amperage indicates one or more glow plugs are inoperative. This could cause hard starting, especially on the cool mornings.

Answer B is incorrect. When a timing chain jumps on a diesel engine, the valves hit the piston and catastrophic engine damage occurs.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



CODE	REASON	EFFECT
Fault code : 154 PID : P105 SPN : 105 FMI : 4/4 Lamp : Amber SRT :	Intake manifold air temperature sensor circuit - Voltage below normal or shorted to low source. Low signal voltage detected at intake manifold air temperature circuit.	Possible white smoke. Fan will stay ON if controlled by ECM. No engine protection for intake manifold temperature.

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12. An engine has fault code 154 as shown above. If the sensor is disconnected and the engine started, fault code 153, Intake Manifold Temperature Sensor Circuit – Voltage Above Normal, becomes active. What is the most likely cause of fault code 154?

- A. Shorted intake manifold temperature sensor wiring harness
- B. Open intake manifold sensor harness
- C. Open intake manifold sensor
- D. Shorted intake manifold sensor

Answer A is incorrect. If the harness were shorted, code 154 would have stayed active.

Answer B is incorrect. If the harness were open, the original fault code would have been 153.

Answer C is incorrect. If the sensor were open, the original code would have been 153.

Answer D is correct. The shorted sensor set code 154; when the sensor is disconnected, fault code 153 indicated that the harness is not shorted and the short is in the sensor.

13. A diesel engine fails to reach operating temperature. All of the following could be the cause EXCEPT:

- A. Leaking internal thermostat housing seal
- B. Stuck open thermostat
- C. Radiator fan that operates continually
- D. Externally restricted charge air cooler

Answer A is incorrect. A leaking internal thermostat housing seal would cause an internal leak, and coolant could circulate through the radiator while cold, resulting in an engine that would not reach operating temperature.

Answer B is incorrect. A stuck open thermostat would allow coolant to circulate to the radiator before the engine reached operating temperature. This would result in a cold-running engine.

Answer C is incorrect. An engine cooling fan that operates continually can cause an engine to run cool and fail to reach operating temperature.

Answer D is correct. A restricted charge air cooler would result in high air inlet temperatures. This can cause engine overheating.





TASK E.4
PAGES 38–39

14. Technician A says an inactive trouble code P0046 Turbo/Super Charger Boost Control Solenoid Circuit Range/Performance trouble code can be cleared with a scan tool. Technician B says an inactive trouble code P0046 Turbo/Super Charger Boost Control Solenoid Circuit Range/Performance will clear itself after the appropriate number of drive cycles if no failures are reported by this or any other emission-related diagnostic. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. Inactive trouble codes can be cleared using a scan tool; this is useful for a technician when trying to ensure that the code does not reappear. Also if the appropriate number of drive cycles has occurred the ECM will clear the inactive trouble code.

Answer D is incorrect. Both Technicians are correct.



TASK F.15
PAGE 52

15. The cruise control will not work on a vehicle that also has an airbag warning light illuminated on the dash. Which of the following is the most likely cause?
- A faulty cruise control switch
 - A blown accessory fuse
 - Damaged air bag acceleration sensor
 - Damaged clock spring

Answer A is incorrect. A faulty cruise control switch would have no effect on the air bag system.

Answer B is incorrect. It is very unlikely that the same fuse would power both the cruise control and the air bag systems.

Answer C is incorrect. A damaged air bag acceleration sensor would not cause a cruise control malfunction.

Answer D is correct. Both cruise control and air bag systems can pass through the clock spring mounted in the steering column.



TASK A.14
PAGE 20

16. The oil in a diesel engine is tar-like and black. Maintenance records indicate the engine has been serviced regularly. The most likely cause of this condition is:
- Coolant in the oil
 - Diesel fuel in the oil
 - Engine overheating
 - Engine overcooling

Answer A is correct. When coolant slowly leaks into the oil, over time the oil will become a thick tar-like substance.

Answer B is incorrect. Diesel fuel in the oil will make the oil thin.

Answer C is incorrect. Engine overheating can cause the oil to become black and have a burnt odor, but will not cause the oil to become tar-like.

Answer D is incorrect. An engine running too cool can cause the oil to become contaminated with condensation. However, that will not cause a tar-like consistency.

17. A cylinder head is being reinstalled on an engine. Technician A says some manufacturers recommend coating the gasket with anaerobic sealant. Technician B says to install the gasket dry. Who is correct?

A. A only
 B. B only
 C. Both A and B
 D. Neither A nor B

Answer A is incorrect. It is not recommended to coat a head gasket with any type of sealant; sealant on a head gasket will usually cause it to leak. The gasket should be installed dry.

Answer B is correct. Only Technician B is correct. The gasket should be installed dry. The head gasket is designed to seal without the use of any sealants.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

18. During reassembly, the technician finds the piston ring side clearance is greater than specification. Which of the following should be done?

A. Replace the piston rings
 B. Replace the pistons
 C. Bore the cylinder oversized
 D. Knurl the pistons

Answer A is incorrect. If this problem was found during reassembly, new piston rings are already used.

Answer B is correct. The pistons are worn and should be replaced.

Answer C is incorrect. Boring the cylinder will not change ring side clearance.

Answer D is incorrect. Knurling the pistons will not change ring side clearance.

19. A diesel engine stalls going down the road and will not restart. All of the following could be the cause EXCEPT:

A. Faulty air inlet heater
 B. Restricted fuel filter
 C. Failed camshaft sensor
 D. Failed crankshaft position sensor

Answer A is correct. A failed air inlet heater will not cause the engine to die going down the road. It will cause hard starting.

Answer B is incorrect. A restricted fuel filter will starve the engine for fuel and can cause the engine to stall and not restart.

Answer C is incorrect. A failed camshaft position sensor could cause the engine to die going down the road and prevent the engine from restarting due to the fact that the ECM would not know when to fire the injector.

Answer D is incorrect. A failed crankshaft position sensor can cause the engine to stall because the ECM can no longer calculate engine RPM. Depending on the ECM programming, the engine may continue to run with a failed crankshaft position sensor but fail to restart after the engine is shut off.



TASK B.7
 PAGES 23-24



TASK C.13
 PAGES 30-31



TASK F.13
 PAGES 50-51

TASK D.7
PAGE 34

20. The water pump drive pulley serpentine grooves are damaged. Technician A says the grooves can be repaired using a special comb. Technician B says the grooves can be repaired using heat. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. The grooves are not repaired; the pulley is replaced. The grooves are hardened steel. A comb can be used to straighten radiator fins.

Answer B is incorrect. The grooves are not repaired; the pulley is replaced. There is no procedure provided to straighten the grooves using heat. Heat will occasionally be used to remove stuck components.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.

TASK C.8
PAGE 29

21. An engine is being assembled, and the crankshaft end-play is greater than specification. Technician A says the crankshaft rod journal could be out of round. Technician B says the crankshaft rod journal could be tapered. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. A crankshaft rod journal out of round would not change end-play. It would cause bearing wear.

Answer B is incorrect. A tapered crankshaft rod journal would not change end-play. It would cause bearing wear.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. End-play is controlled by the clearance between the thrust surface on the crankshaft and the thrust bearing. Excessive crankshaft end-play is normally caused by excessive wear on the thrust surface of the crankshaft or a worn thrust bearing.

TASK E.11
PAGES 41-42

22. When reinstalling an EGR valve on a diesel engine, the gasket should be coated with:
- A. Aerobic sealant
 - B. Anaerobic sealant
 - C. Anti-seize
 - D. Nothing; it should be installed dry.

Answer A is incorrect. Sealant should not be used on this gasket; it should be installed dry.

Answer B is incorrect. Sealant should not be used on this gasket; it should be installed dry.

Answer C is incorrect. Anti-seize is not used; the gasket should be installed dry.

Answer D is correct. The gasket should be installed dry.

23. The 8th digit of the vehicle identification number (VIN) indicates:

- A. Model year
- B. Engine size
- C. Tire size
- D. Chassis model

Answer A is incorrect. The model year is the 10th digit.

Answer B is correct. The engine size is the 8th digit.

Answer C is incorrect. The tire size does not have a specific digit.

Answer D is incorrect. The chassis model is not the 8th digit.

24. A common rail diesel engine will not start. There is no RPM indicated on the tachometer or scan tool while cranking. Which of the following is the most likely cause?

- A. Restricted fuel flow
- B. Faulty engine position sensor
- C. Low fuel level
- D. Stuck closed exhaust gas recirculation valve

Answer A is incorrect. Restricted fuel flow will not prevent the tachometer from working.

Answer B is correct. If there is a no-start and no RPM is indicated on the dash or scan tool, the most likely cause is a failed engine position sensor.

Answer C is incorrect. Low fuel level will not affect the tachometer.

Answer D is incorrect. A stuck closed exhaust gas recirculation valve will not cause a no-start, and will not affect the engine RPM signal.

25. Which of the following would be the most normal piston-to-cylinder wall clearance specification for a diesel engine with a 4-inch bore?

- A. 0.0001" – 0.0003"
- B. 0.001" – 0.003"
- C. 0.008" – 0.015"
- D. 0.100" – 0.300"

Answer A is incorrect. A clearance this small will result in piston seizure.

Answer B is incorrect. A clearance this small will result in piston seizure.

Answer C is correct. This is a normal clearance.

Answer D is incorrect. This will result in a knock.



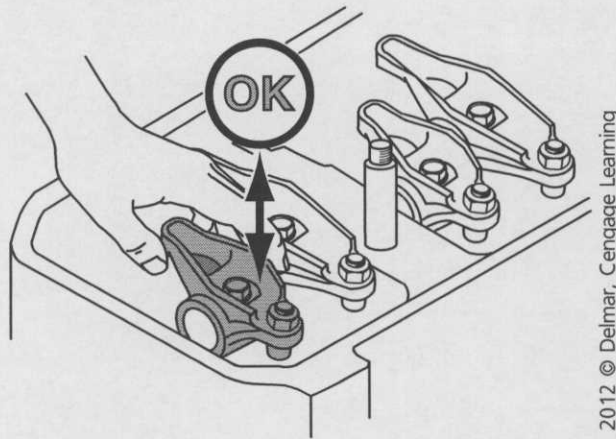
TASK A.2
PAGES 14–15



TASK F.7
PAGE 45



TASK C.11
PAGE 30



TASK B.9
PAGES 24-25

26. The technician is preparing to adjust the valves. The crankshaft is at TDC and both rockers on Cylinder #1 are loose, as illustrated above. This means that:
- This cylinder can be adjusted.
 - The companion cylinder can be adjusted.
 - The crankshaft needs to be rotated 90 degrees.
 - The crankshaft needs to be rotated 180 degrees.

Answer A is correct. Cylinder #1 can have both valves adjusted.

Answer B is incorrect. The companion cylinder will be finishing the exhaust stroke and beginning the intake stroke, so the valves on that cylinder cannot be adjusted.

Answer C is incorrect. The crankshaft does not need to be turned. Valves are adjusted when the valves are loose.

Answer D is incorrect. The crankshaft does not need to be turned. Valves are adjusted when on the base circle of the camshaft lobe. The engine is in the correct location to adjust the valves.



TASK E.6
PAGE 39

27. Technician A says when testing the air-to-air charge air cooler, it should be heated. Technician B says a viscous vibration damper should be heated during inspection. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. An air-to-air charge air cooler should be pressurized when tested, not heated.

Answer B is correct. Only Technician B is correct. A viscous damper should be heated during inspection to check for leaks.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

28. An engine has low oil pressure. This is most noticeable at a hot idle. Which of the following is the most likely cause?

A. Worn main bearings
B. Worn piston rings
C. Worn valve guides
D. Worn timing chain

Answer A is correct. Worn bearings are the normal cause of low oil pressure at idle.

Answer B is incorrect. Worn piston rings will cause low compression.

Answer C is incorrect. Worn valve guides can cause oil consumption.

Answer D is incorrect. A worn timing chain will cause noise and incorrect valve timing.

29. A high-pressure injection line is leaking on a diesel engine. The line has been torqued to specification. Which of the following should the technician do?

A. Replace the line.
B. Tighten the line.
C. Remove and inspect the line.
D. Replace the line and matching fitting.

Answer A is incorrect. The line should be removed and inspected.

Answer B is incorrect. If the line has been torqued to specification, tightening the line will over torque and damage it.

Answer C is correct. The line should be removed and inspected.

Answer D is incorrect. The line and fitting should not be replaced until they are inspected to determine the cause of the leak.

30. The DPF differential pressure sensor shows higher than normal differential pressure. Technician A says a leaking hose on the inlet of the DPF differential pressure sensor could be the cause. Technician B says the DPF could be plugged. Who is correct?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

Answer A is incorrect. A leaking hose on the sensor inlet would indicate low DPF restriction.

Answer B is correct. Only Technician B is correct. A plugged DPF will cause higher than normal differential pressure and set a diagnostic trouble code.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct. A plugged DPF would result in a high restriction reading.



TASK D.1
PAGE 32



TASK F.5
PAGE 44



TASK A.4
PAGES 15-16



TASK D.13
PAGE 37

31. A diesel engine is overheating. The technician can force the fan to operate with the scan tool, but the fan will not engage normally when the engine reaches the appropriate temperature. All of the following could be the cause EXCEPT:
- Faulty fan motor
 - Faulty coolant temperature sensor
 - Corrupt ECM programming
 - High resistance in the wires leading to the coolant temperature sensor.

Answer A is correct. If the fan motor was faulty it would not operate by using the scan tool. Answer B is incorrect. If the fan will operate by the scan tool but not when the engine is hot, the problem could be a coolant temperature sensor that is not registering the correct temperature.

Answer C is incorrect. If the fan will operate with the scan tool, it is possible that the ECM has a problem with programming. The technician should check the service literature to see if there is a method to correct this problem.

Answer D is incorrect. If there was high resistance in the wires to the coolant temperature sensor, the ECM would interpret this as a cool-running engine. It would not know the engine was at normal operating temperature and would not turn the fan on.



TASK E.4
PAGES 38-39

32. The timing belt has been replaced on a light-duty 4-cylinder diesel engine. The engine runs OK, but now there is a vibration. Technician A says the VGT turbocharger is out of balance. Technician B says the balance shaft is out of time. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. A turbocharger that is out of balance will wear the turbocharger shaft bearings and will eventually destroy itself. Changing the timing belt would not affect turbocharger balance.

Answer B is correct. Only Technician B is correct. The out of time balance shaft would cause this and very likely could have happened while the timing belt was being replaced.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK F.2
PAGE 43

33. The ECM mounting plate has fuel passing through it. Which of the following is true of this design?
- The fuel is cooled by the ECM.
 - The ECM is cooled by the fuel.
 - The fuel is conditioned by the ECM.
 - The ECM is grounded by the fuel.

Answer A is incorrect. The fuel is warmed by the ECM.

Answer B is correct. The ECM is cooled by the fuel.

Answer C is incorrect. The fuel passing through the plate cools the ECM.

Answer D is incorrect. The ECM does not receive its ground from the fuel.

34. All exhaust valve pushrods on an engine are bent. Which of the following is most likely the cause?

- A. The engine was operated for a long time under a very light load.
- B. The engine was operated for a long time under a very heavy load.
- C. The engine was idled for a long time in cold weather.
- D. The engine was allowed to exceed maximum governed RPM.

Answer A is incorrect. Light loads will not bend pushrods.

Answer B is incorrect. Heavy loads will not bend pushrods.

Answer C is incorrect. Idling will not bend pushrods.

Answer D is correct. Exceeding maximum governed RPM will bend pushrods.

35. An engine is being checked for a coolant leak. All of the following could be used to help locate the source of the leak EXCEPT:

- A. Black light
- B. Pressure tester
- C. Vacuum gauge
- D. Coolant dye

Answer A is incorrect. A black light could be used.

Answer B is incorrect. A pressure tester could be used.

Answer C is correct. A vacuum gauge is not used to locate pressure leaks.

Answer D is incorrect. Coolant dye can be used to help locate a leak.

36. Valve protrusion is lower than specification. This could result in:

- A. Hard starting
- B. Increased valve lash
- C. Decreased valve stem height
- D. Decreased valve spring installed height

Answer A is correct. Valve protrusion lower than specification can result in low compression and hard starting of a diesel engine.

Answer B is incorrect. Valve protrusion lower than specification could result in decreased valve lash because the valve would protrude farther through the valve guide.

Answer C is incorrect. Valve stem height would increase.

Answer D is incorrect. Valve spring installed height would increase.

37. Which bearing wear pattern would indicate a bent crankshaft?

- A. Worn lower main bearings.
- B. Worn upper rod bearings.
- C. Both halves of the rod bearing worn excessively.
- D. Both halves of the main bearing worn excessively.

Answer A is incorrect. Worn lower main bearings can be an indication of engine lugging.

Answer B is incorrect. Worn upper rod bearings can be an indication of engine lugging.

Answer C is incorrect. Both halves of the rod bearing worn excessively can indicate an out of round rod journal.

Answer D is correct. Both halves of the main bearing worn excessively is an indication of a bent crankshaft.



TASK B.8
PAGE 24



TASK A.5
PAGE 16



TASK B.4
PAGES 22-23



TASK C.12
PAGE 30



TASK E.1
PAGE 37

38. All of the following could cause face-plugging of the diesel oxidation catalyst (DOC) EXCEPT:

- A. Leaking turbocharger seals
- B. Leaking charge air cooler seals
- C. After treatment injector nozzle leakage
- D. Worn piston rings

Answer A is incorrect. Leaking turbocharger seals will allow excess oil to enter the DOC and cause face plugging.

Answer B is correct. Leaking charge air cooler seals will cause low turbo boost pressure, but will not cause the DOC to be face-plugged.

Answer C is incorrect. A leaking after treatment injector will cause DOC face-plugging.

Answer D is incorrect. Worn piston rings will cause DOC face-plugging because it allows excess oil into the exhaust stream.



TASK F.9
PAGE 47

39. A diesel engine equipped with a PLN-E (pump-line-nozzle electronic) system has had repeated injection pump failures. Technician A says the transfer (lift) pump should be checked. Technician B says the vehicle should be checked for aftermarket modifications. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. Low transfer pump pressure and volume can cause the injector pump to overheat and fail. Also aftermarket performance programmers deliver more fuel to the engine, which results in insufficient fuel in the injection pump for lubrication and cooling.

Answer D is incorrect. Both Technicians are correct.



TASK E.7
PAGES
39-40

40. Which of the following is the correct method to remove ash from the DPF (diesel particulate filter)?

- A. Perform a stationary regeneration.
- B. Perform a rolling regeneration.
- C. Ash cannot be removed; the DPF must be replaced.
- D. Remove the DPF and clean on a bench machine.

Answer A is incorrect. Ash cannot be cleaned from the DPF with a stationary regeneration. Ash is removed with an off-the-vehicle bench cleaning procedure.

Answer B is incorrect. A rolling regeneration is one that occurs while the vehicle is moving down the road. Ash cannot be cleaned from the DPF during a rolling regeneration. This type of regeneration removes soot, not ash.

Answer C is incorrect. Ash can be cleaned from a DPF.

Answer D is correct. Ash is cleaned from a DPF by removing the DPF from the vehicle and cleaning with a bench machine.

41. Fuel filter inlet restriction is being measured on an engine. The specification is 6–10 in Hg. The test results are 1 in Hg. Which of the following is indicated?

- A. The fuel filter is restricted.
- B. There may be a suction side air leak.
- C. The fuel filter is serviceable.
- D. There may be a restriction in the fuel cooler.

Answer A is incorrect. A restricted fuel filter would have a reading above 10 in Hg.

Answer B is correct. 1 in Hg is too low; this can indicate a suction side air leak.

Answer C is incorrect. The condition of the fuel filter is not really known because of the high possibility of an air leak.

Answer D is incorrect. It is very unlikely that a fuel cooler restriction would cause a lower than normal fuel inlet restriction reading.

42. When the cylinder head bolts are inspected, they are found to be pitted. Which of the following should be done?

- A. Primer the bolts
- B. Paint the bolts
- C. Replace the bolts
- D. Replace the head

Answer A is incorrect. The bolts should be replaced. Priming the bolts will not renew their strength.

Answer B is incorrect. The bolts should be replaced. Painting the bolts will not renew their strength.

Answer C is correct. The bolts should be replaced. Bolts that are pitted are weakened and can break when being installed.

Answer D is incorrect. The head does not have to be replaced because the bolts are pitted. The head is not damaged by pitted bolts.

43. A cam in-block diesel engine has excessive cam bearing clearance. This would result in:

- A. Retarded camshaft timing
- B. Advanced camshaft timing
- C. Excessive oil pressure
- D. Low oil pressure

Answer A is incorrect. Camshaft timing is not affected by cam bearing clearance. Therefore, the camshaft would not be retarded.

Answer B is incorrect. Camshaft bearing clearance causes low oil pressure; it does not affect advanced camshaft timing.

Answer C is incorrect. Oil pressure would be low, not high.

Answer D is correct. Oil pressure would be low. Excessive bearing clearance reduces restriction.



TASK F.3
PAGE 43



TASK B.2
PAGES 21–22



TASK C.4
PAGES 26–27



TASK E.13
PAGE 42

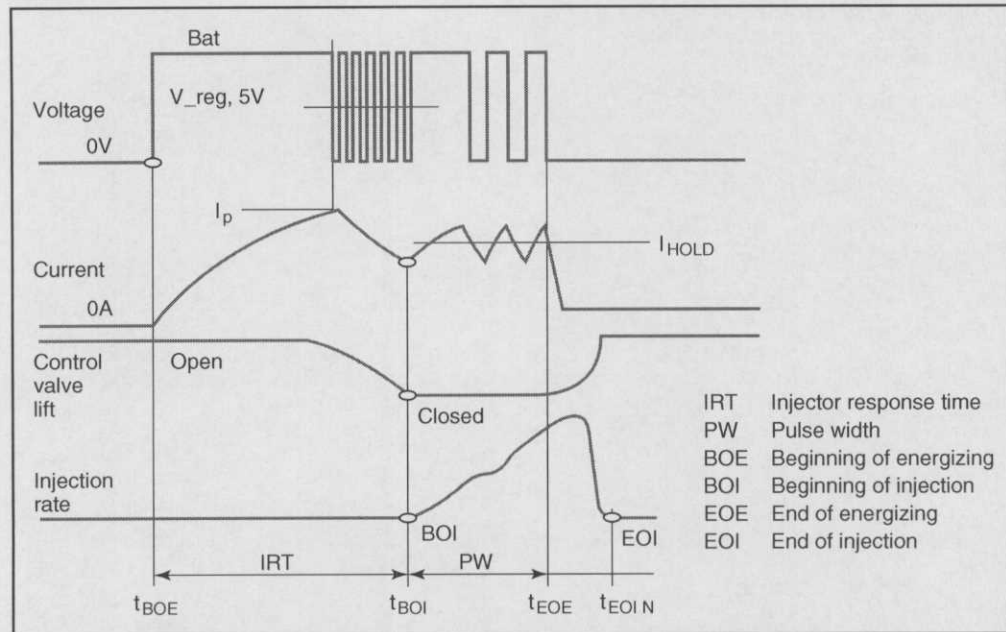
44. A diesel engine has oil leaks from the front crankshaft seal and the flywheel housing area. Which of the following is the most likely cause?
- A. The vibration damper is out of round.
 - B. The rear main seal was installed incorrectly.
 - C. The flywheel housing was not properly torqued.
 - D. The engine has excessive crankcase pressure.

Answer A is incorrect. An out of round vibration damper may cause engine noise, but it would not cause leaks at both ends of the engine.

Answer B is incorrect. An incorrectly installed rear main seal would not cause leaks at both ends of the engine.

Answer C is incorrect. A flywheel housing that is not properly torqued would not cause leaks at both ends of the engine.

Answer D is correct. Excessive crankcase pressure can cause leaks at multiple places on the engine.



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TASK F.10
PAGES
47-48

45. An engine with the fuel system shown above has low power. Fuel pressure is checked on the outlet side of the secondary fuel filter, and the results are as follows:
 Actual 78 psi
 Specification 70–90 psi
 Which of the following could be the cause of the low power concern?
- A. High fuel pressure
 - B. Restricted air filter
 - C. Restricted primary fuel filter
 - D. Restricted secondary fuel filter

Answer A is incorrect. High fuel pressure is not indicated by the test results.

Answer B is correct. The low power concern could be caused by a restricted air filter.

Answer C is incorrect. The fuel pressure is within specification; the fuel filters are not restricted.

Answer D is incorrect. The fuel pressure is within specification; the fuel filters are not restricted.

46. A diesel particulate filter (DPF) will not reach the correct temperature during a regeneration. Which of the following could be the cause?

- A. Insufficient air flow to the DPF.
- B. Insufficient fuel flow from the after treatment injector.
- C. Excessive fuel flow from the after treatment injector.
- D. Excessive air flow to the DPF.

Answer A is incorrect. Fuel is used to increase temperatures.

Answer B is correct. Insufficient fuel flow will cause a failure to reach the appropriate temperature in the DPF.

Answer C is incorrect. Excessive fuel flow from the after treatment injector will result in DPF overheating.

Answer D is incorrect. Fuel flow is used to increase temperatures.

47. An engine oil pick-up tube is cracked. Which of the following would be the most likely result?

- A. Excessive oil pressure
- B. External oil leak
- C. Internal oil leak
- D. Low oil pressure

Answer A is incorrect. A crack in the suction tube would allow air into the oil stream, resulting in low oil pressure, not excessive oil pressure.

Answer B is incorrect. Air would enter the oil stream since the tube is on the suction side of the pump.

Answer C is incorrect. Air would enter, and oil would not leak.

Answer D is correct. There would be low oil pressure due to oil aeration.

48. A diesel engine air filter has failed, split and separated in the center. Which of the following could be the cause?

- A. Too much turbo boost
- B. Too little turbo boost.
- C. Incorrect exhaust back pressure
- D. Incorrect filter installed

Answer A is incorrect. Excessive boost pressure will not cause an air filter to split.

Answer B is incorrect. Too little boost pressure will not cause the air filter to split.

Answer C is incorrect. Exhaust back pressure either too high or too low will not cause the air filter to split.

Answer D is correct. Many light-duty diesel engine vehicles use the same air cleaner housing as their gasoline engine counterparts. However, the air filter element itself is different. The air filter element for the diesel will have more support to withstand the variations in air pressure found in the diesel engine air intake.



TASK E.10
PAGES 40-41



TASK D.2
PAGE 32



TASK E.1
PAGE 37



TASK E.11
PAGES
41-42

49. Which of the following would most likely be used to test an EGR cooler for internal leaks?
- A. Feeler gauge
 - B. Pressure Test Kit
 - C. Flow meter
 - D. Dial caliper

Answer A is incorrect. A feeler gauge is not used to check for internal leaks; it may be used to check flange straightness.

Answer B is correct. The charge air cooler is pressure tested with a pressure test kit to locate leaks.

Answer C is incorrect. Although the cooler needs to be checked for restriction, technicians do not normally use a flow meter to check the cubic feet per minute (CFM) through the cooler. A visual inspection is the common method of testing.

Answer D is incorrect. A dial caliper would not be used to check the cooler.



TASK A.12
PAGE
19

50. While diagnosing a rough-running engine, the cylinder power balance test reveals low power on cylinder # 4. All other cylinders pass the test. The technician measures the resistance of the injector solenoid on cylinder #4 and finds it is within specification. Which of the following could be the cause of the low power on cylinder #4?

- A. Low compression on cylinder #3
- B. Low compression on cylinder #4
- C. Water in the fuel
- D. Restricted fuel filter

Answer A is incorrect. Low compression on cylinder #3 would cause low power on cylinder #3.

Answer B is correct. Low compression on cylinder #4 could cause low power on cylinder #4.

Answer C is incorrect. Water in the fuel would affect more than one cylinder.

Answer D is incorrect. A restricted fuel filter would affect more than one cylinder.

PREPARATION EXAM 2—ANSWER KEY

- | | | |
|-------|-------|-------|
| 1. C | 21. D | 41. D |
| 2. C | 22. B | 42. C |
| 3. B | 23. A | 43. B |
| 4. A | 24. A | 44. C |
| 5. C | 25. D | 45. B |
| 6. A | 26. A | 46. B |
| 7. C | 27. B | 47. B |
| 8. D | 28. D | 48. A |
| 9. D | 29. C | 49. C |
| 10. A | 30. D | 50. A |
| 11. A | 31. D | |
| 12. A | 32. B | |
| 13. C | 33. A | |
| 14. D | 34. B | |
| 15. B | 35. B | |
| 16. B | 36. D | |
| 17. A | 37. B | |
| 18. B | 38. D | |
| 19. A | 39. C | |
| 20. C | 40. D | |

PREPARATION EXAM 2—EXPLANATIONS

- The electronic control module (ECM)–driven OEM dash-mounted temperature gauge indicates an overheating engine. When a scan tool is connected, the technician finds no diagnostic trouble codes, and the engine temperature shown on the scan tool is normal. The temperature is verified with an infrared thermometer as the actual engine temperature. Which of the following is the most likely cause?
 - The engine temperature sensor is faulty.
 - The engine ECM is faulty.
 - The dash-mounted gauge is faulty.
 - The instrument panel control module is faulty.

Answer A is incorrect. If the engine temperature sensor is faulty, the engine temperature shown on the scan tool would also indicate an overheat condition.

Answer B is incorrect. The coolant temperature is verified to match the sensor reading. There is no reason to believe that the ECM is faulty.

Answer C is correct. The most likely cause is a faulty dash gauge.

Answer D is incorrect. There are no other problems with the instrument panel; most likely the control module is functioning correctly.



TASK F.15
PAGE 52



TASK C.4
PAGES 26–27

2. The two outside camshaft bushings as well as the center camshaft bushing show excessive wear. The other bushings show normal wear. Which of the following is the most likely cause?
- A. Insufficient oil flow to the center bearing
 - B. Insufficient oil flow to the outside bearings
 - C. A bent camshaft
 - D. A bent crankshaft

Answer A is incorrect. Insufficient oil flow to the center bearing would not damage the outer bearing.

Answer B is incorrect. Insufficient oil flow to the outside bearings would not damage the center bearing.

Answer C is correct. A bent camshaft will wear the center and outer bearings the most.

Answer D is incorrect. A bent crankshaft would not cause camshaft bushing wear.



TASK A.13
PAGE 19

3. Which tool is preferred by diesel engine manufacturers to measure freeze point of the coolant?
- A. Hydrometer
 - B. Refractometer
 - C. Mercury manometer
 - D. Water manometer

Answer A is incorrect. A hydrometer is not the preferred tool to measure diesel engine coolant freeze point. The supplemental coolant additives used in diesel engines can cause the hydrometer to read incorrectly.

Answer B is correct. The refractometer is the preferred tool to measure coolant freeze point.

Answer C is incorrect. A mercury manometer is used to measure pressure or vacuum.

Answer D is incorrect. A water manometer is used to measure pressure or vacuum.



TASK B.4
PAGES 22–23

4. Technician A says valve protrusion can be measured with a depth micrometer. Technician B says valve protrusion can be measured with a dial bore gauge. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. A depth micrometer will measure the height or recession of an item; therefore, it can be used to measure valve protrusion.

Answer B is incorrect. A dial bore gauge is used to measure the inside diameter of a round object. It cannot be used to measure valve protrusion.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

5. Technician A says a laser can be used to check accessory drive belt alignment. Technician B says a straightedge can be used to check accessory drive belt alignment. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians describe proper methods to check drive belt alignment.

Answer D is incorrect. Both Technicians are correct.

6. A diesel engine will start, run and then die. If the fuel system is primed, the engine will again start, run and die. Which of the following is the most likely cause?
- An air leak on the suction side of the fuel system.
 - A restriction on the return side of the fuel system.
 - A restricted exhaust.
 - A restricted intake.

Answer A is correct. This is a typical air in fuel system scenario.

Answer B is incorrect. A restriction on the return side will usually not cause this condition; however, it can lead to pump overheating and failure.

Answer C is incorrect. A restricted exhaust could cause a no-start; however, it would not be necessary to prime the fuel system to make the engine start.

Answer D is incorrect. A restricted intake could possibly cause a no-start; however, priming the fuel system would not make the engine start.

7. Ring end gap is measured using a/an:
- Inside micrometer
 - Outside micrometer
 - Feeler gauge
 - Dial indicator

Answer A is incorrect. An inside micrometer cannot be used to measure ring end gap.

Answer B is incorrect. An outside micrometer cannot be used to measure ring end gap.

Answer C is correct. A feeler gauge is used to measure ring end gap.

Answer D is incorrect. A dial indicator cannot be used to measure ring end gap.

8. After setting overnight, a diesel engine has a slow cranking speed concern. After the first start of the day, there are no other concerns. Which of the following is the most likely cause of the concern?
- Charging voltage is higher than normal.
 - Starter current draw is lower than normal.
 - Charging amperage is lower than normal.
 - Excessive key-off battery drain.

Answer A is incorrect. High-charging system voltage would not cause the battery to be low for the first start of the day.

Answer B is incorrect. Low starter current draw would be a concern at times other than just the first start of the day.

Answer C is incorrect. Low-charging system amperage would cause a concern other than just the first start of the day.

Answer D is correct. Excessive key-off drain is indicated.



TASK D.7
PAGE 34



TASK F.3
PAGE 43



TASK C.13
PAGES 30-31



TASK A.17
PAGE 21



TASK E.1
PAGE 37

15. Technician A says a mercury manometer could be used to measure air intake restriction. Technician B says a water manometer could be used to measure air intake restriction. Who is correct?

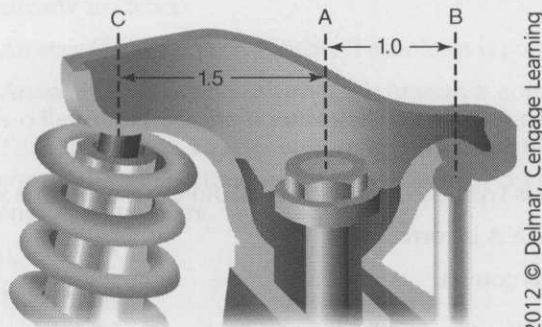
- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. A mercury manometer would not be sensitive enough for this test.

Answer B is correct. Only Technician B is correct. A water manometer is the correct tool. Typical specifications are 20–25 inches of water.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



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TASK B.8
PAGE 24

16. Technician A says the rocker arm shown above is an injector rocker. Technician B says the rocker arm shown above is non-adjustable. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. This is a valve rocker arm. The rocker arm is positioned above the valve stem and the valve spring assembly.

Answer B is correct. Only Technician B is correct. This is a non-adjustable rocker arm.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK A.6
PAGE 16

17. An engine has an intermittent low power concern. There are no active diagnostic trouble codes. There is an inactive trouble code for low boost pressure sensor voltage. Technician A says a poor electrical connection on the boost pressure sensor could be the cause. Technician B says a leaking radiator could be the cause. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is correct. Only Technician A is correct. A poor electrical connection could be the cause.

Answer B is incorrect. A leaking radiator would not cause this concern.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

18. A technician is installing a software calibration update for the ECM. Which of the following is LEAST LIKELY to be performed?
- Installing a battery maintainer on the vehicle battery
 - Rewiring the ECM data link connector
 - Downloading the calibration update file from the factory website
 - Driving the vehicle after repairs



TASK F.12
PAGE 50

Answer A is incorrect. A battery maintainer is installed on the vehicle battery during this procedure to ensure battery voltage does not fall too low and corrupt the file.

Answer B is correct. It would not be necessary to rewire the data link connector during a calibration update.

Answer C is incorrect. The file will need to be downloaded from the factory website.

Answer D is incorrect. The vehicle will need to be driven after repairs.

19. Technician A says that a faulty intake manifold pressure sensor can cause low power. Technician B says that after installing Plastigauge®, the crankshaft should be rotated one full turn. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



TASK E.5
PAGE 39

Answer A is correct. Only Technician A is correct. A faulty intake manifold pressure sensor can incorrectly report the turbocharger boost pressure, and this could result in insufficient fuel delivery.

Answer B is incorrect. The crankshaft should not be turned after installing Plastigauge®.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

20. A small amount of oil is present where the charge air cooler hose seals against the charge air cooler pipe. Which statement is incorrect?
- This could be caused by a restricted turbocharger oil drain.
 - This is normal on some models.
 - This could be caused by a restricted fuel system.
 - Incorrect charge air cooler clamps are installed.



TASK D.5
PAGE 33

Answer A is incorrect. A restricted turbocharger can cause the turbocharger to leak oil.

Answer B is incorrect. On some models, the oil vapors accumulate in a low area of the piping and will cause this condition.

Answer C is correct. A restricted fuel system will not cause this complaint.

Answer D is incorrect. Some manufacturers have released different hose clamps to help eliminate this condition.



TASK E.4
PAGES 38-39

21. The bearings in the turbo have excessive wear. All of the following could cause this EXCEPT:
- Dirty engine oil
 - Poor air filtration
 - Dirt on the compressor wheel
 - An exhaust leak

Answer A is incorrect. Dirty oil will cause excessive bearing wear in the turbocharger.

Answer B is incorrect. Dirt coming in with the incoming air will work its way past the compression rings and into the oil. Technicians can find this with an oil sample sent to a lab. This dirt will cause contaminated oil and bearing wear.

Answer C is incorrect. Contamination of turbocharger wheels will cause an imbalance and rapid bearing wear.

Answer D is correct. An exhaust leak will not cause bearing wear.



TASK E.8,
C.10
PAGES 40,
29-30

22. The head of piston #4 of an inline 6-cylinder diesel engine is eroded. The other pistons are not worn. Technician A says the cause could be a restricted oil filter. Technician B says the cause could be a worn exhaust cam lobe. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. A restricted oil filter would cause the bypass valve to open and dirty oil to be circulated to the bearings.

Answer B is correct. Only Technician B is correct. A worn exhaust lobe would result in trapped exhaust gases and excessively high piston temperatures. The result is a piston with a "moon crater" look.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK A.10
PAGE 18

23. Which of the following is true regarding ULSD (ultra-low sulfur diesel) fuel?
- Ultra-low sulfur diesel has 15 ppm sulfur.
 - Ultra-low sulfur diesel has 150 ppm sulfur.
 - Ultra-low sulfur diesel has 250 ppm sulfur.
 - Ultra-low sulfur diesel has 350 ppm sulfur.

Answer A is correct. The maximum level of sulfur in ULSD is 15 ppm per government mandated specifications.

Answer B is incorrect. The maximum level of sulfur in ULSD is 15 ppm. The sulfur content was reduced to help lower diesel engine emissions.

Answer C is incorrect. The maximum level of sulfur in ULSD is 15 ppm. This is a government regulation to help lower exhaust emissions.

Answer D is incorrect. The maximum level of sulfur in ULSD is 15 ppm. The previous level of sulfur was mandated to be a maximum of 500 ppm.

24. While diagnosing a rough-running engine, the cylinder power balance test reveals no power from cylinder #1. All of the following could be the cause EXCEPT:
- A. Fuel transfer pump
 - B. Worn compression rings on piston #1
 - C. Faulty injector
 - D. Leaking exhaust valve on cylinder #1

TASK A.12
PAGE 19

Answer A is correct. A faulty fuel transfer pump usually would affect all cylinders, but it may affect some cylinders more than others. When this is the case, it will affect the cylinders farthest away, such as cylinders #7 and #8 on a V8 diesel engine.

Answer B is incorrect. Worn compression rings will cause low compression and a misfire, which will result in low power and a rough-running engine.

Answer C is incorrect. A faulty injector could cause no power contribution during a power balance test.

Answer D is incorrect. A leaking exhaust valve causes low compression and a rough-running engine.

25. A turbocharger has been replaced because of pumping oil into the air intake piping. Technician A says the charge air cooler must also be replaced. Technician B says the diesel particulate filter must also be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

TASK E.6
PAGE 39

Answer A is incorrect. The charge air cooler should be cleaned. It would not have to be replaced.

Answer B is incorrect. The diesel particulate filter must be checked for contamination and plugging to determine if replacement is necessary.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. The charge air cooler can normally be cleaned of the oil contamination.

26. An engine with an in-line (pumpline nozzle) runs on cylinders #1, #2 and #3. However, cylinders #4, #5 and #6 are very weak, with cylinder #6 providing no power at all. Which of the following is the most likely cause?
- A. Missing bleed orifice
 - B. Faulty hand priming pump
 - C. Restricted fuel return line
 - D. Faulty nozzles

TASK F.4
PAGE 44

Answer A is correct. If the bleed orifice is missing, the fuel will not be contained in the fuel injection pump. The last three cylinders will not have sufficient gallery pressure.

Answer B is incorrect. A faulty hand priming pump would make priming difficult.

Answer C is incorrect. A restricted fuel return line will cause overheated fuel and low power.

Answer D is incorrect. Faulty nozzles will cause smoke.



TASK D.3
PAGE 33

27. An oil pressure regulator is stuck in the open position. Technician A says this would result in higher than normal oil pressure at idle. Technician B says this would result in lower than normal oil pressure when at operating temperature. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. A stuck open oil pressure regulator would decrease oil pressure because it would allow oil to bypass and return to the suction side of the oil pump or to the oil pan. Restriction is needed to create pressure.

Answer B is correct. Only Technician B is correct. A stuck open oil pressure regulator would decrease oil pressure because it would allow oil to circulate back to the suction side of the oil pump or directly back to the oil pan, which would reduce restriction. The problem would be most noticeable at hot idle when the flow is low and the oil is thin.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK E.2
PAGE 38

28. Lower than normal turbo boost pressure can be caused by all of the following EXCEPT:
- Restricted fuel filters
 - Restricted air filter
 - Restricted exhaust system
 - Restricted crankcase filter

Answer A is incorrect. Restricted fuel filters reduce exhaust heat and cause slow turbocharger RPM, resulting in low boost pressure.

Answer B is incorrect. Restricted air filters reduce air flow resulting in low boost pressure.

Answer C is incorrect. Restricted exhaust systems reduce exhaust flow and cause slow turbocharger RPM, resulting in low boost pressure.

Answer D is correct. A restricted crankcase filter can cause high crankcase pressure and engine leaks, but it would not affect turbo boost.



TASK D.10
PAGES 35-36

29. The cooling system is being flushed on a diesel engine. The replacement coolant should be:
- Ethylene glycol + OAT.
 - Propylene glycol.
 - The coolant recommended by the OEM in the service literature.
 - Any coolant labeled "Universal Diesel Engine Coolant".

Answer A is incorrect. Not all manufacturers recommend ethylene glycol + OAT.

Answer B is incorrect. Not all manufacturers recommend propylene glycol.

Answer C is correct. Always use only the recommended coolant. Using the incorrect coolant can cause the cooling system to become sludged. Additionally, the incorrect coolant can attack the metal and seals in the cooling system; this will result in premature failure.

Answer D is incorrect. Although universal coolants can be purchased, their use may void the engine warranty and cause damage. The technician should use only OEM-approved coolants.

30. Technician A says the acronym DOC stands for diesel oil combustion. Technician B says the DOC is located in the air intake system. Who is correct?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

Answer A is incorrect. DOC stands for diesel oxidation catalyst.

Answer B is incorrect. The DOC is located in the exhaust stream to reduce exhaust emissions by trapping soot.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



TASK E.10
PAGES 40-41

31. Technician A says a depth micrometer is used to check for warpage of a block deck. Technician B says an outside micrometer is used to check for warpage of a block deck. Who is correct?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

Answer A is incorrect. A depth micrometer can be used to measure depth, such as a liner counter bore, but it would not be effective at measuring the slight difference measured during a check for block deck warpage.

Answer B is incorrect. An outside micrometer is used to measure the diameter of an object. A straightedge is commonly used to check block deck warpage.

Answer C is incorrect. Neither Technician is correct. A straightedge is commonly used to check block deck warpage.

Answer D is correct. Neither Technician is correct.



TASK B.2
PAGES 21-22

32. Technician A says soot is controlled by the EGR system. Technician B says NO_x is controlled by the EGR system. Who is correct?

A. A only
B. B only
C. Both A and B
D. Neither A nor B

Answer A is incorrect. The EGR system controls NO_x emissions. Soot is trapped in the DPF.

Answer B is correct. Only Technician B is correct. The EGR system controls NO_x emissions by lowering combustion chamber temperatures.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK E.12
PAGE 42



TASK B.7
PAGES
23–24

33. A diesel engine has a leaking head gasket; after the gasket was replaced the engine will not start. The technician finds six bent pushrods when diagnosing the no-start condition. Which of the following is the most likely cause?
- The valves were adjusted incorrectly.
 - A head gasket that was too thick was installed.
 - The head is warped.
 - The block deck is warped.

Answer A is correct. If the valves were adjusted incorrectly, it could cause the pistons to contact the valves and bend the pushrods.

Answer B is incorrect. A head gasket that was too thick would cause low compression, not bent pushrods.

Answer C is incorrect. A warped head would not cause bent pushrods.

Answer D is incorrect. A warped deck would not cause bent pushrods.



TASK A.9,
B.9 PAGES
17–18, 24–25

34. Technician A says when installing roller-type cam followers, the bottom of the follower should be installed dry. Technician B says when installing non-roller cam followers, the bottom of the follower should be coated with pre-lube. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Roller-type lifters should be coated with pre-lube during installation to ensure adequate lubrication at startup.

Answer B is correct. Only Technician B is correct. Non-roller lifters should be coated with pre-lube during assembly to ensure adequate lubrication at startup.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK E.3, C.5
PAGES
38, 27

35. The lobe lift on an in-block camshaft can be measured with the camshaft still in the block using which tool?
- Dial caliper
 - Dial indicator
 - Outside micrometer
 - Inside micrometer

Answer A is incorrect. A dial caliper would not be useful for this check.

Answer B is correct. A dial indicator could be used to check the lobe lift.

Answer C is incorrect. An outside micrometer cannot be used to check the lobe lift with the camshaft in the block.

Answer D is incorrect. An inside micrometer would not be useful to measure lobe lift.

36. A diesel engine is equipped with adjustable valve bridges (crossheads). Technician A says the valve clearance should be adjusted prior to adjusting the valve bridges (crossheads). Technician B says the valve bridges (crossheads) should be removed prior to adjusting the valve clearance. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



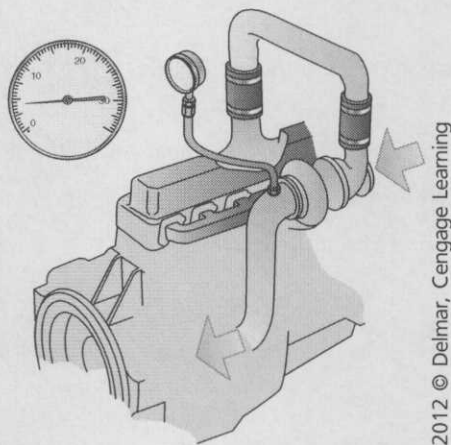
TASK B.6
PAGE 23

Answer A is incorrect. The valve bridges (crossheads) should be adjusted prior to the valve clearance.

Answer B is incorrect. The valve bridges (crossheads) do not need to be removed prior to adjusting the valves.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



37. The test being performed above is:
- A. Intake restriction
 - B. Exhaust restriction
 - C. Turbo boost pressure
 - D. Charge air cooler pressure drop



TASK E.7
PAGES
39-40

Answer A is incorrect. An intake restriction test is performed between the air cleaner and turbocharger inlet.

Answer B is correct. This is an exhaust restriction test.

Answer C is incorrect. A turbo boost pressure test is performed on the clean air side of the turbo.

Answer D is incorrect. A charge air cooler pressure drop test is performed across the charge air cooler.



TASK F.9
PAGE 47

38. Technician A says a PLN-E (pump-line-nozzle electronic fuel system) engine will have individual unit injectors. Technician B says a PLN-E engine will have a common rail. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. An EUI (electronic unit injector) system has individual unit injectors.

Answer B is incorrect. A common rail fuel system has a common rail.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



TASK B.10
PAGE 25

39. Camshaft end-play is greater than specification. Which of the following could be the cause?
- Worn camshaft drive gear
 - Worn camshaft drive belt
 - Worn camshaft thrust surface
 - Worn camshaft lobes

Answer A is incorrect. The camshaft drive gear does not control end-play.

Answer B is incorrect. The camshaft drive belt does not control end-play.

Answer C is correct. Worn camshaft thrust surfaces would cause excessive end-play.

Answer D is incorrect. Camshaft lobes do not control end-play.



TASK C.8
PAGE 29

40. All of the following are methods to measure crankshaft end-play EXCEPT:
- Dial indicator on the rear of the crankshaft.
 - Dial indicator on the front of the crankshaft.
 - Feeler gauge at the thrust bearing.
 - Feeler gauge at the harmonic balancer.

Answer A is incorrect. A dial indicator on the rear of the crankshaft can be used to measure crankshaft end-play. Another method would be to use a feeler gauge.

Answer B is incorrect. A dial indicator on the front of the crankshaft can be used to measure crankshaft end-play. Another method would be to use a feeler gauge.

Answer C is incorrect. A feeler gauge installed between the thrust bearing and crankshaft can be used to measure the amount of end-play.

Answer D is correct. A feeler gauge at the harmonic balancer would not be in the correct location to measure the movement of the crankshaft end-play.



TASK E.5
PAGE 39

41. A diesel engine has an active DTC P0103 Mass Airflow Sensor Voltage High. Which of the following could be the cause?
- Restricted air filter.
 - Restricted fuel filter.
 - Failed exhaust temperature sensor.
 - Failed mass airflow sensor.

Answer A is incorrect. When a DTC Mass Airflow Sensor Voltage High indicates higher than normal airflow, this would not be caused by a restricted air filter.

Answer B is incorrect. When a DTC Mass Airflow Sensor Voltage High indicates higher than normal airflow, this would not be caused by a restricted fuel filter.

Answer C is incorrect. A failed exhaust temperature sensor would not cause this code.

Answer D is correct. A failed sensor could cause this code.

42. Which of the following tools would be LEAST LIKELY to be used to test an APP (accelerator pedal position) sensor?
- A. Voltmeter.
 - B. Oscilloscope.
 - C. Ammeter.
 - D. Ohmmeter.



TASK C.8,
F.6 PAGES
29, 44-45

Answer A is incorrect. A voltmeter is a good choice to check an APP.

Answer B is incorrect. An oscilloscope can be used to test an APP.

Answer C is correct. An ammeter would not be useful to check an APP.

Answer D is incorrect. An ohmmeter can be used to test an APP.

43. A light-duty diesel engine is being reassembled. Which of the following is considered a normal main bearing clearance specification?
- A. 0.0001" – 0.0003"
 - B. 0.001" – 0.003"
 - C. 0.010" – 0.030"
 - D. 0.100" – 0.300"



TASK C.7
PAGE 28

Answer A is incorrect. This is too tight and will result in a seized engine.

Answer B is correct. This is a normal bearing specification.

Answer C is incorrect. This is excessive bearing clearance and will result in low oil pressure and an engine knock.

Answer D is incorrect. This is excessive bearing clearance and will result in low oil pressure and an engine knock.

44. A diesel engine has a low power complaint. Technician A says this could be caused by a faulty fuel heater. Technician B says this could be caused by a restricted fuel filter.
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK F.2
PAGE 43

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. A faulty fuel heater can cause fuel gelling; however, it can also cause fuel to overheat. Either will result in low power.

A restricted fuel filter will reduce fuel flow and create a low power concern.

Answer D is incorrect. Both Technicians are correct.

TASK C.8
PAGE 29

45. While checking rod bearing clearance using Plastigauge[®], the technician notices that it is crushed wider at one end of the journal than the other. Which of the following could be the cause?
- A. A barrel-shaped journal.
 - B. A tapered journal.
 - C. Incorrect main bearing selection.
 - D. Incorrect crankshaft end-play.

Answer A is incorrect. A barrel-shaped journal will cause the Plastigauge[®] to be wider in the center than at the ends.

Answer B is correct. This is an indication of a tapered journal.

Answer C is incorrect. Installation of the wrong main bearings would not cause tapered clearances on the rod bearings.

Answer D is incorrect. Incorrect crankshaft end-play would not cause tapered rod bearing oil clearances.

TASK F.14
PAGES 51-52

46. A technician is checking voltage drop on the battery cables. Which of the following indicates excessive voltage drop?
- A. 0.50 volts
 - B. 0.75 volts
 - C. 0.03 volts
 - D. 0.05 volts

Answer A is incorrect. The voltage drop specification for battery cables is 0.5 volts while cranking.

Answer B is correct. 0.75 volts would exceed the specification.

Answer C is incorrect. 0.03 volts is within specification.

Answer D is incorrect. 0.05 volts is within specification.

TASK C.3
PAGE 26

47. The cylinder bore has 0.0001" (0.0025 mm) out of round. Technician A says the engine should be sleeved. Technician B says the engine can be reused. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. This is an acceptable amount of out of round for reuse. There is no reason for sleeving the engine.

Answer B is correct. Only Technician B is correct. This is an acceptable amount of out of round for reuse. Typical out of round specifications are 0.001" (0.0254 mm).

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

48. The 10th digit of the vehicle identification number (VIN) indicates:

- A. Model year
- B. Engine size
- C. Tire size
- D. Chassis length

Answer A is correct. The 10th digit indicates the model year.

Answer B is incorrect. The engine size is indicated by the 8th digit.

Answer C is incorrect. The tire size does not have a specific digit.

Answer D is incorrect. The chassis length does not have a specific digit.

49. A common rail injector has been replaced. All of the following are true EXCEPT:

- A. The common rail fuel system must be bled before the engine will start.
- B. The injector fuel trim number must be programmed into the ECM before the engine is started.
- C. The injector rocker arm must be adjusted before the engine is started.
- D. The injector fuel line must be installed using a torque wrench.

Answer A is incorrect. The fuel system will need the air bled before the engine will start.

Answer B is incorrect. The injector fuel trim number must be programmed into the ECM. This improves the smoothness of idle.

Answer C is correct. A common rail injector is not camshaft operated.

Answer D is incorrect. The injector has a high-pressure fuel line, and it must be installed using a torque wrench.

50. The oil pressure is low on an engine. The oil is overfull and smells like diesel fuel. All of the following could be the cause EXCEPT:

- A. Cracked fuel cooler
- B. Cracked injector tip
- C. Fuel injector o-ring
- D. Damaged injector sleeve

Answer A is correct. The fuel cooler does not come into contact with the engine oil.

Answer B is incorrect. A cracked injector tip can allow fuel to flow directly into the combustion chamber, past the rings and into the oil.

Answer C is incorrect. A leaking injector o-ring can allow fuel into the oil.

Answer D is incorrect. A damaged injector sleeve can allow fuel to flow directly into the combustion chamber and wash the cylinder walls down, diluting the oil.



TASK A.2
PAGES 14-15



TASK F.7
PAGE 45



TASK D.1
PAGE 32

PREPARATION EXAM 3—ANSWER KEY

1. C	21. B	41. D
2. A	22. C	42. C
3. C	23. A	43. A
4. A	24. D	44. D
5. B	25. B	45. A
6. D	26. A	46. D
7. A	27. A	47. A
8. D	28. B	48. A
9. A	29. A	49. D
10. A	30. A	50. B
11. A	31. C	
12. B	32. D	
13. C	33. B	
14. D	34. D	
15. A	35. A	
16. B	36. C	
17. C	37. B	
18. B	38. C	
19. A	39. D	
20. C	40. C	

PREPARATION EXAM 3—EXPLANATIONS



TASK F.13
PAGES
50-51

- Technician A says the accelerator pedal position (APP) sensor is connected to the accelerator pedal. Technician B says the throttle position sensor can be located on the throttle body. Who is correct?
 - A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. The accelerator pedal position sensor tells the ECM the position of the accelerator and is connected to the accelerator pedal. The sensor is often at the accelerator pedal inside the vehicle. The throttle position sensor is located at the throttle body. This sensor tells the position of the throttle plate. Throttle plates are now used on some diesel engines to help control airflow for exhaust gas recirculation.

Answer D is incorrect. Both Technicians are correct.

2. Which of the following would be used to locate the source of an engine noise?
- A. Stethoscope
 - B. Oscilloscope
 - C. Refractometer
 - D. Hydrometer

Answer A is correct. A stethoscope can be used to locate noises.

Answer B is incorrect. An oscilloscope measures voltage.

Answer C is incorrect. A refractometer does not locate vibrations.

Answer D is incorrect. A hydrometer does not locate vibrations.

3. Valve protrusion is lower than specification. Technician A says the valve may need to be replaced. Technician B says the valve seat may need to be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. When the valve does not protrude far enough, the valve or valve seat may need to be replaced. The source of the problem is that too much material has been removed from the valve seat or valve face.

Answer D is incorrect. Both Technicians are correct.

4. The rear two cylinders on a V8 diesel engine show heavy erosion of the piston crowns. Technician A says a worn water pump impeller could be the cause. Technician B says a worn oil pump could be the cause. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. A worn water pump impeller will cause low coolant flow. The cylinders farthest away from the water pump will be most affected by the lack of coolant circulation.

Answer B is incorrect. A worn oil pump will cause low oil pressure. The low oil pressure will likely show in the valve train area first because that is farthest away from the oil pump.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK A.7
PAGE 17



TASK B.4
PAGES
22-23



TASK E.6,
C.10
PAGES 39,
29-30

TASK D.5
PAGE 33

5. A turbocharger is passing oil into the exhaust. Which of the following is the most likely cause?
- A. Plugged oil supply line to the turbocharger.
 - B. Plugged oil return passage from the turbocharger.
 - C. Restricted exhaust system.
 - D. Restricted intake system.

Answer A is incorrect. A restricted oil supply line would not cause oil to pass into the exhaust stream.

Answer B is correct. A restricted drain line could cause oil to back up in the turbocharger, resulting in turbocharger shaft seal leakage.

Answer C is incorrect. A restricted exhaust system would not cause oil to pass from the turbocharger into the exhaust stream.

Answer D is incorrect. A restricted air intake system may cause the oil to be pulled past the seals into the air intake; however, it would not cause oil to pass into the exhaust system.

TASK C.14
PAGE 31

6. A viscous damper is being inspected. All of the following would be performed EXCEPT:
- A. Lateral run out.
 - B. Radial run out.
 - C. Thickness.
 - D. Height.

Answer A is incorrect. Lateral run out is checked.

Answer B is incorrect. Radial run out is checked.

Answer C is incorrect. Thickness is checked.

Answer D is correct. Height is not checked. However, diameter may be checked to determine correct application.

TASK A.15
PAGE 20

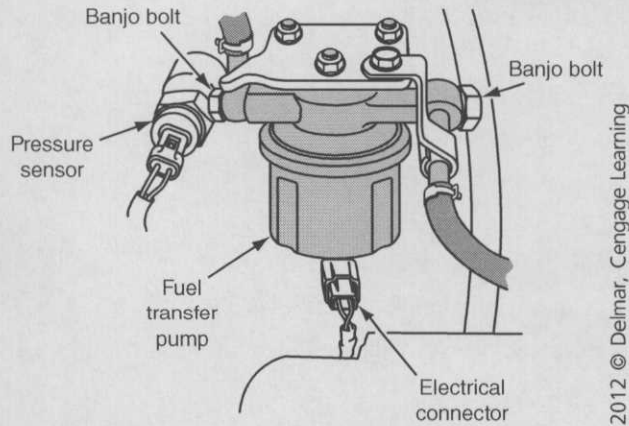
7. A diesel engine is hard to start, especially in cold weather. Cranking speed is higher than normal. The most likely cause of the no-start condition is:
- A. Low compression.
 - B. High compression.
 - C. Stuck open exhaust gas recirculation valve.
 - D. Stuck closed exhaust gas recirculation valve.

Answer A is correct. This is very common with a low compression engine.

Answer B is incorrect. Diesel engines have high compression.

Answer C is incorrect. A stuck open EGR valve will not cause this condition.

Answer D is incorrect. A stuck closed EGR valve will not cause this condition.



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8. Refer to the illustration above. Technician A says failure of this item can cause diesel fuel in the oil. Technician B says failure of this item can cause excessive black smoke. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

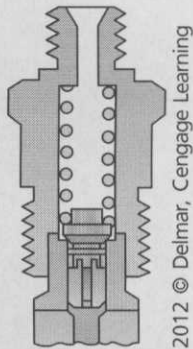


Answer A is incorrect. This is an electrically operated fuel transfer pump. It cannot put fuel in the oil.

Answer B is incorrect. This pump will either work or starve the engine for fuel; it will not cause black smoke.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



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9. The delivery valve shown above is leaking at the seat. Which of the following is the most likely result?
- A. Engine smoke
 - B. Uncontrolled engine RPM
 - C. Slow acceleration
 - D. Slow deceleration



Answer A is correct. Internally leaking delivery valves allow the nozzles to drip and cause engine smoke.

Answer B is incorrect. The delivery valve does not affect engine RPM.

Answer C is incorrect. The delivery valve will not affect acceleration.

Answer D is incorrect. The delivery valve will not affect deceleration.



TASK E.11
PAGES
41-42

10. A diesel engine needs coolant added on a regular basis. There are no external coolant leaks. All of the following could be the cause EXCEPT:
- Leaking air-to-air charge air cooler.
 - Leaking exhaust gas recirculation (EGR) cooler.
 - Leaking injector sleeve.
 - Loose head gasket.

Answer A is correct. The air-to-air charge cooler is not connected to the cooling system.

Answer B is incorrect. The EGR cooler will let coolant escape into the exhaust.

Answer C is incorrect. A leaking injector sleeve can allow coolant into the combustion chamber.

Answer D is incorrect. A leaking head gasket can allow coolant into the combustion chamber.



TASK C.4
PAGES 26-27

11. An in-frame engine overhaul is being performed. Technician A says the in-block camshaft bushings are installed by driving them in with a driver tool. Technician B says the rear most in-block camshaft bushing is installed last. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. In-block camshaft bushings are installed with a driver tool and a hammer.

Answer B is incorrect. These bearings are installed starting from the rear and working toward the front.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK C.2,
B.2 PAGES
26, 21-22

12. Which of the following could cause block deck height to be lower than specification?
- Excessive milling of the head.
 - Excessive milling of the block.
 - Too little valve protrusion.
 - Too little injector tip protrusion.

Answer A is incorrect. Milling the head does not change block deck height.

Answer B is correct. Excessive milling of the block will cause block deck height to be below specification.

Answer C is incorrect. Valve protrusion does not change deck height.

Answer D is incorrect. Injector tip protrusion does not change deck height.

13. While reassembling an engine, one piston does not come as high in the bore as the others. Which of the following is the most likely cause?

- A. Worn main bearing journal.
- B. Worn cylinder bore.
- C. A connecting rod that is shorter than specification.
- D. An undersized main bearing.

Answer A is incorrect. A worn main bearing journal will not affect piston projection.

Answer B is incorrect. A worn cylinder bore will not affect piston projection.

Answer C is correct. A short connecting rod will affect piston compression. Connecting rods can become shorter than normal by being bent or when the connecting rod has been reconditioned and too much material was removed.

Answer D is incorrect. An undersized main bearing will not affect piston projection.

14. An air intake restriction test has been performed on a diesel engine with a low power concern. The test results show 15" H₂O during full-load operation. Which of the following is true concerning this test result?

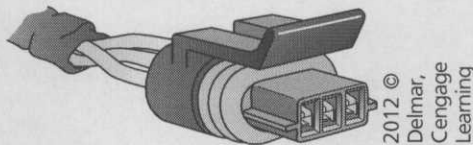
- A. The air filter is restricted and needs to be replaced.
- B. The air filter is perforated and needs to be replaced.
- C. The air filter was installed incorrectly.
- D. The air filter is performing correctly.

Answer A is incorrect. The typical test specification that indicates the filter needs to be replaced is 20" – 25" H₂O.

Answer B is incorrect. If the filter was perforated, the test results would have been very low.

Answer C is incorrect. This test result does not indicate an incorrectly installed filter. An incorrectly installed filter usually results in a leaking air filter and a low restriction during this test.

Answer D is correct. The test passed, and the air intake system seems to be working correctly.



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15. Technician A says when removing a terminal from the above connector it comes out the front. Technician B says when removing a terminal from the above connector it comes out the rear. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is correct. Only Technician A is correct. This is a metri-pack connector, and the terminal removes from the front.

Answer B is incorrect. This is a metri-pack connector, and the terminal removes from the front.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



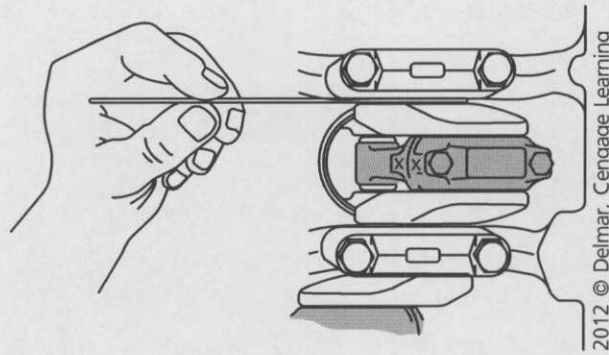
TASK C.12
PAGE 30



TASK E.1
PAGE 37



TASK F.11
PAGES
49–50



TASK C.13
PAGES 30-31

16. The above measurement is less than specification. Which of the following is the LEAST LIKELY cause?
- Rod cap installed backward
 - Main cap installed backward
 - Incorrect bearing installed
 - Crank incorrectly machined

Answer A is incorrect. A rod cap installed backward can cause rod side clearance to be less than specified.

Answer B is correct. A main cap installed backward will not cause the connecting rod side clearance to be less than specified.

Answer C is incorrect. If the wrong bearing (wider than factory) was installed, connecting rod side clearance would be less than specification.

Answer D is incorrect. A crankshaft that did not have the correct fillet radius ground could cause incorrect rod side clearance.



TASK A.8
PAGE 17

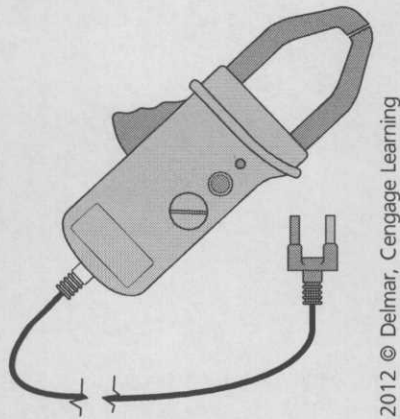
17. All of the following would be used to help isolate an engine vibration EXCEPT:
- A reed tachometer
 - A stethoscope
 - An ohmmeter
 - A chassis ear

Answer A is incorrect. A reed tachometer can be used to determine the vibration frequency.

Answer B is incorrect. A stethoscope can be used to isolate the area of vibration.

Answer C is correct. An ohmmeter would not be useful in locating a vibration.

Answer D is incorrect. A chassis ear can be used to help locate the source of a vibration.



18. Technician A says the tool shown above is an ohmmeter. Technician B says the tool shown above measures amperage. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



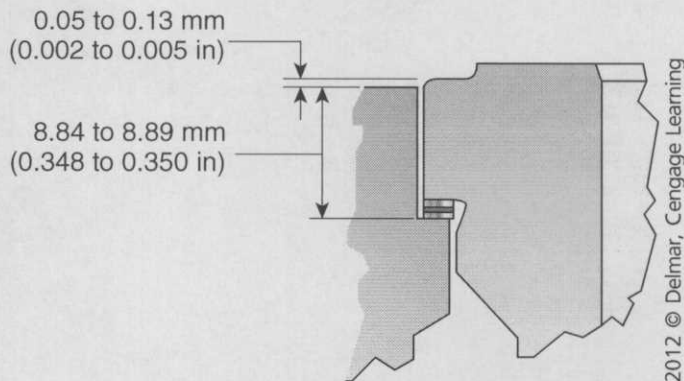
TASK A.16
PAGE 20

Answer A is incorrect. This is not an ohmmeter. It is an amp clamp.

Answer B is correct. Only Technician B is correct. This is an amp clamp. It measures the magnetic field generated around the wire as current is flowing. It then converts that reading into a millivolt signal and sends that signal to the DMM.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



19. The dimension shown above is:
- A. Liner protrusion
 - B. Liner recession
 - C. Count bore depth
 - D. Counter bore height



TASK C.13
PAGES 30-31

Answer A is correct. Liner protrusion is shown.

Answer B is incorrect. Liner recession would show the liner below the block.

Answer C is incorrect. Counter bore depth is measured with the liner removed.

Answer D is incorrect. Liner protrusion is shown.

TASK E.9
PAGE 40

20. Technician A says air intake temperature can be used to control air intake heater on time. Technician B says coolant temperature can be used to control glow plug on time. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. Air intake temperature and coolant temperature are both used by manufacturers to determine how long cold start devices should be energized.

Answer D is incorrect. Both Technicians are correct.

TASK E.9, C.7
PAGE 40, 28

21. Piston projection is lower than specification. Which of the following would be the most likely result?

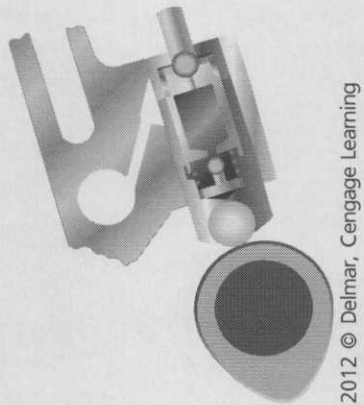
- A. Piston-to-exhaust valve contact.
- B. Hard starting in cold weather.
- C. Hard starting in hot weather.
- D. Piston-to-intake valve contact.

Answer A is incorrect. Pistons that do not come up high enough in the bore will not cause piston-to-valve contact.

Answer B is correct. Pistons that do not come up high enough will cause low compression and hard starting. This will be most evident in cold weather. This hard-start condition would act similar to an engine that has a glow plug failure.

Answer C is incorrect. Pistons that do not come up high enough will cause low compression and hard starting. This will be most evident in cold weather, not hot weather.

Answer D is incorrect. Pistons that do not come up high enough in the bore will not cause piston-to-valve contact.



22. Technician A says the lifter shown above is a roller type. Technician B says the lifter shown above is a hydraulic type. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. This is a roller hydraulic lifter. Notice the roller on the bottom. Some lifters have a slightly convex bottom; they are generally referred to as flat tappet or non-roller lifter.

Answer D is incorrect. Both Technicians are correct.

23. Which oil would provide lubrication to the bearings first in cold weather?
- 0w30
 - 5w30
 - 10w30
 - 10w40

Answer A is correct. 0w30 is thinnest when cold.

Answer B is incorrect. 5w30 is thicker than 0w30 when cold.

Answer C is incorrect. 10w30 is thicker than 0w30 when cold.

Answer D is incorrect. 10w40 is thicker than 0w30 when cold.

24. The ECM has an active trouble code P0046 indicating a Turbo/Super Charger Boost Control Solenoid Circuit Range/Performance problem. Technician A says the turbocharger should be replaced. Technician B says the solenoid valve should be replaced. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Neither Technician is correct.

Answer B is incorrect. Neither Technician is correct.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. The technician will need to troubleshoot the active fault code. A solenoid valve, sticking turbocharger vanes, turbocharger vane position sensor, ECM or wiring harness failure could all be the cause of this code.



TASK B.9
PAGES 24–25



TASK D.1
PAGE 32



TASK E.4
PAGES 38–39



TASK F.6
PAGES
44-45

25. The "Service Throttle Soon" lamp is illuminated on the dash panel. Technician A says this lamp indicates that the ECM has identified a fault in the throttle cable. Technician B says this lamp indicates that the ECM has identified a fault in the accelerator pedal position circuit. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. The lamp does not illuminate for a throttle cable concern. A diesel engine with an illuminated "Service Throttle Soon" lamp is a drive-by-wire system and will not normally have a throttle cable.

Answer B is correct. Only Technician B is correct. The lamp is illuminated when the ECM recognizes a fault in the APP sensor, usually meaning that the sensor is sending conflicting information.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK E.6
PAGE 39

26. Technician A says mild detergent and water would be used to clean the internal passages in the charge air cooler. Technician B says oil in the charge air cooler can be caused by a restricted DPF. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. A mild soap solution can be used to clean the interior of the cooler; the cooler will usually need to be cleaned after a turbocharger failure.

Answer B is incorrect. A restricted DPF will cause low power but not oil in the charge air cooler.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK D.3
PAGE 33

27. The function of the oil filter by-pass valve is to:
- A. Open when the oil filter is restricted.
 - B. Close when the oil filter is restricted.
 - C. Open when the oil is too thin.
 - D. Open when the oil is overheated.

Answer A is correct. The oil by-pass valve opens when the pressure differential across the filter exceeds specification. This can be caused by a plugged oil filter due to dirt or due to thick oil, such as during a cold start.

Answer B is incorrect. The valve should open during restriction.

Answer C is incorrect. The valve should open when the oil is thick.

Answer D is incorrect. The valve should open when the oil is cold and thick.

28. Turbocharger boost pressure is lower than specification. Which of the following is the most likely cause?
- A. Restricted exhaust system
 - B. Restricted fuel filter
 - C. Missing crankcase filter
 - D. Failed turbocharger

Answer A is incorrect. A restricted exhaust system could cause low boost pressure; however, it is not the most likely cause.

Answer B is correct. It takes heat to make turbo boost pressure. The most common cause of low boost pressure is insufficient fuel—a restricted fuel filter.

Answer C is incorrect. A missing crankcase filter would not cause low boost pressure.

Answer D is incorrect. A failed turbocharger may cause low boost; however, it is not the most likely cause.

29. A diesel engine will not communicate with a scan tool. Technician A says the ignition must be on. Technician B says the engine must be running. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. The ignition switch must be on for communication.

Answer B is incorrect. The engine does not need to be running to communicate with the scan tool.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

30. All of the following are true concerning injector sleeves EXCEPT:
- A. The sleeve must be replaced every time the injector is removed.
 - B. Copper sleeves should be reamed after installation.
 - C. The sleeve is sealed at both top and bottom.
 - D. A leaking sleeve can cause combustion gases in the coolant.

Answer A is correct. The sleeve is replaced when it is leaking, not every time the injector is removed.

Answer B is incorrect. Copper sleeves may need to be reamed after they are installed to create a clean injector seating surface.

Answer C is incorrect. The sleeve is sealed at the top and bottom to prevent leaks.

Answer D is incorrect. Since the sleeve seals the combustion chamber, a leaking sleeve can allow combustion chamber gases to enter into the cooling system. They can allow fuel and coolant to mix on some engines also.



TASK E.2
PAGE 38



TASK A.4
PAGES 15-16



TASK B.5
PAGE 23

TASK E.7
PAGES 39–40

31. Excess exhaust back pressure may result in all of the following EXCEPT:
- A. Lower engine power
 - B. Higher exhaust temperature
 - C. Higher intake restriction readings
 - D. Poor combustion

Answer A is incorrect. High exhaust back pressure will result in low engine power.

Answer B is incorrect. High exhaust back pressure will cause higher exhaust temperature.

Answer C is correct. High exhaust back pressure will cause lower engine power, higher exhaust temperature and poor combustion, but it should not cause higher air intake restriction readings.

Answer D is incorrect. High exhaust back pressure will cause poor combustion.

TASK F.8
PAGES 45–47

32. A HEUI (hydraulic electronic unit injector) equipped diesel engine runs roughly. The injectors have passed a click test (solenoid test). Technician A says the ECM should be replaced. Technician B says the engine speed sensor should be inspected. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. There is no reason to replace the ECM.

Answer B is incorrect. There is no reason to replace the engine speed sensor.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. The technician should perform a cylinder power balance test next to help locate any low-performing cylinders.

TASK A.11
PAGES 18–19

33. Which tool would be used to measure crankcase pressure?
- A. Mercury manometer
 - B. Water manometer
 - C. Refractometer
 - D. Hydrometer

Answer A is incorrect. A mercury manometer measures too high of a pressure to be useful for this test.

Answer B is correct. A water manometer is the correct tool.

Answer C is incorrect. A refractometer does not measure pressure. A refractometer is used to test coolant.

Answer D is incorrect. A hydrometer does not measure pressure. A hydrometer is used to test coolant.

34. Technician A says a voltmeter could be used to measure the resistance of a shutoff solenoid. Technician B says an ammeter could be used to measure the resistance of a shutoff solenoid. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. A voltmeter cannot measure resistance. It measures voltage.

Answer B is incorrect. An ammeter cannot measure resistance. It measures amperage.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. An ohmmeter would be used to measure resistance.

35. The gear-driven water pump is noisy and needs to be replaced. Technician A says the coolant should be drained prior to disassembly. Technician B says the oil should be drained prior to disassembly. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. The coolant must be drained prior to removing the water pump. Failure to do so will cause the coolant to create a huge mess when the pump is removed.

Answer B is incorrect. It is not necessary to drain the oil when replacing the water pump. The water pump will not leak oil during the replacement process.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

36. Compression rings have worn out (deep vertical scratches) in a diesel engine in less than 50,000 miles. Which of the following is the most likely cause?
- A. Leaking cooling system
 - B. Dirt in the fuel system
 - C. Leaking intake air system
 - D. Dirt in the lubrication system

Answer A is incorrect. A leaking cooling system will not cause scratched rings.

Answer B is incorrect. Dirt in the fuel system will wear out injection components.

Answer C is correct. Dirt in the incoming air will cause scratches on the rings.

Answer D is incorrect. Dirt in the oil will cause bearing wear.



TASK F.14
PAGES 51-52



TASK D.11
PAGE 36



TASK E.3, C.3
PAGES 38, 26



TASK C.9
PAGE 29

37. During reassembly of a V8 diesel engine, the technician finds excessive play in the timing chain. Technician A says the cause could be that the deck surface was ground excessively. Technician B says the cause could be that too much material was removed from the main bearing bores. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. If the deck was ground excessively, the pistons would protrude too far.

Answer B is correct. Only Technician B is correct. If the line bore was ground excessively, the crankshaft would move too far up in the block, thus moving the cam and crank closer together. This would result in a loose timing chain.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK C.13
PAGES 30-31

38. Piston ring side clearance is measured with a/an:
- Inside micrometer
 - Outside micrometer
 - Feeler gauge
 - Dial indicator

Answer A is incorrect. An inside micrometer cannot be used to measure ring side clearance.

Answer B is incorrect. An outside micrometer cannot be used to measure ring side clearance.

Answer C is correct. A feeler gauge is used to measure ring side clearance.

Answer D is incorrect. A dial indicator cannot be used to measure ring side clearance.



TASK E.6
PAGE 39

39. A diesel engine that has a blue smoke concern also has oil in the air intake piping. Which of the following is the most likely cause?
- Restricted exhaust
 - Restricted fuel return
 - Dirty fuel filters
 - Worn turbocharger shaft seals

Answer A is incorrect. Restricted exhaust would not cause oil in the air intake piping.

Answer B is incorrect. A restricted return fuel system would not cause oil in the air intake piping.

Answer C is incorrect. Dirty fuel filters would not cause oil in the air intake piping.

Answer D is correct. Worn turbocharger seals would cause oil in the air intake piping and would cause blue smoke.

40. Technician A says cooling system test strips can be used to check the concentration of additives in diesel engine coolant. Technician B says cooling system test strips can be used to check the freeze protection of diesel engine coolant. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK A.13
PAGE 19

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. New cooling system test strips will check the additive package as well as the freeze protection of coolant.

Answer D is incorrect. Both Technicians are correct.

41. As soon as the engine is started, there are bubbles in the coolant. The most likely cause of this concern is:
- A. Cracked oil cooler
 - B. Restricted radiator
 - C. Leaking radiator cap
 - D. Cracked cylinder head



TASK B.3
PAGE 22

Answer A is incorrect. A cracked oil cooler will allow oil and coolant to mix. It will not cause bubbles in the coolant.

Answer B is incorrect. A restricted radiator can cause an overheated engine.

Answer C is incorrect. A leaking radiator cap will not cause bubbles in the coolant as soon as the engine is started.

Answer D is correct. A cracked cylinder head will allow compression gases into the coolant, which will cause bubbles when the engine is started.

42. A diesel engine with a common rail fuel system runs rough. However, the engine is making the correct amount of power. Which of the following is the most likely cause of the rough-running condition?
- A. Worn camshaft injector lobe
 - B. Worn camshaft valve lobe
 - C. Dirty injectors
 - D. Restricted fuel filter



TASK F.7
PAGE 45

Answer A is incorrect. A common rail fuel system does not use a camshaft injector lobe.

Answer B is incorrect. If the camshaft valve lobe was worn, there would be low power from the engine.

Answer C is correct. Dirty or leaking injectors can cause a rough idle and will not greatly affect horsepower.

Answer D is incorrect. A restricted fuel filter would cause a low power concern.



TASK B.1
PAGE 21

43. All of the following are true regarding cylinder head removal EXCEPT:
- The engine oil must be drained prior to head removal.
 - The radiator must be drained prior to head removal.
 - The head bolts should be removed in the reverse order of installation.
 - The engine should be cold.

Answer A is correct. The oil does not need to be drained prior to head removal. However, if the head has been removed, it is likely the technician will change the oil and filter during the procedure.

Answer B is incorrect. The radiator and cooling system must be drained; otherwise, coolant will enter the crankcase when the head is removed.

Answer C is incorrect. Head bolts are removed in reverse order to equally remove the clamping load.

Answer D is incorrect. The engine should be cold (room temperature); removing a warm cylinder head can cause it to warp.



TASK F.1
PAGE 42

44. A diesel engine has a low power complaint. The fuel filter is removed and inspected. The filter is coated internally with a slimy film. Technician A says to replace the filter and return the vehicle to service. Technician B says to replace all the low pressure fuel system components. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. The fuel system is contaminated with bacteria, so it must be cleaned.

Answer B is incorrect. The bacteria growing in the fuel system must be destroyed. This can be done with a biocide treatment. All the components of the low pressure system do not need to be replaced; they need to be cleaned with the biocide treatment.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



TASK A.1
PAGE 14

45. An engine is being repaired because of a blown head gasket. Technician A says this could be caused by an aftermarket program being installed in the engine ECM. Technician B says the use of an aftermarket air filter could be the cause. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. Programs that increase engine horsepower and torque increase the combustion chamber pressure; this can cause the head gasket to blow.

Answer B is incorrect. An aftermarket air filter can cause dirty air to enter the engine, which will cause premature wear of the rings and cylinder walls; however, this will not cause a blown head gasket.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

46. Technician A says an outside micrometer would be used to measure in-block camshaft end-play. Technician B says an inside micrometer would be used to measure in-block camshaft end-play. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. An outside micrometer is used to measure outside diameters. A dial indicator is used to measure in-block camshaft end-play.

Answer B is incorrect. An inside micrometer is used to measure inside diameters. A dial indicator is used to measure in-block camshaft end-play.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither technician is correct.

47. The low coolant level probe may be placed at any of the following locations EXCEPT:
- A. Lower radiator hose
 - B. Radiator top tank
 - C. Unpressurized coolant reservoir tank
 - D. Pressurized coolant reservoir tank

Answer A is correct. The probe is usually located in the reservoir. The lower radiator hose would be so low in the system that the engine would be ruined before the sensor detected a problem.

Answer B is incorrect. The probe is usually located in the reservoir tank, or in the radiator top tank.

Answer C is incorrect. The probe is usually located in the reservoir tank, or in the radiator top tank.

Answer D is incorrect. The probe is usually located in the reservoir tank; this is high enough in the system to signal a problem before the engine is damaged.

48. Technician A says diesel exhaust fluid (DEF) is used to control oxides of nitrogen (NO_x) emissions. Technician B says diesel exhaust fluid (DEF) is mixed with the diesel fuel in the diesel fuel tank. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. DEF is injected into the exhaust stream to reduce the NO_x emissions from a diesel engine.

Answer B is incorrect. DEF should NEVER be mixed in with the fuel. This will cause immediate fuel system damage.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



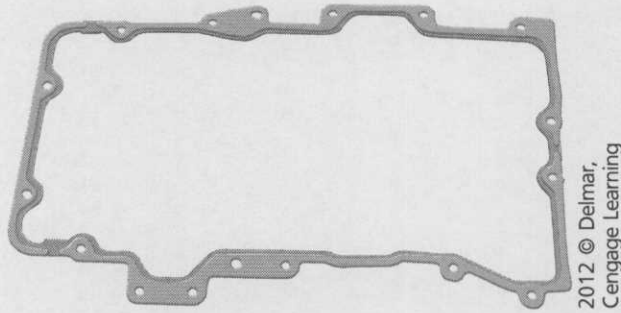
TASK C.5,
B.10
PAGES 27, 25



TASK D.8
PAGES 34-35



TASK E.10
PAGES 40-41



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TASK B.7
PAGES 23-24

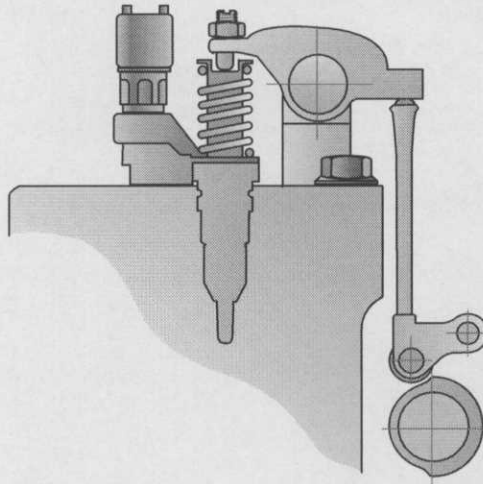
49. Technician A says the gasket shown above should be installed using gasket adhesive. Technician B says the gasket should be installed using a thin coating of oil. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. The gasket should be installed dry. It is a rubber embossed reusable gasket. Gasket adhesive is sometimes used on older cork gaskets.

Answer B is incorrect. The gasket should be installed dry. A thin coating of oil could cause the gasket to slip out of place during installation and leak.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



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TASK F.10
PAGES
47-49

50. Technician A says the adjustment screw in the picture above is used to adjust the variable valve actuator. Technician B says the adjustment screw in the picture above is used to adjust injector height. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. This is the injector height adjustment screw. This engine is not equipped with a variable valve actuator.

Answer B is correct. Only Technician B is correct. This is the injector height adjustment screw. This screw will change the initial setting of the injector height.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

PREPARATION EXAM 4—ANSWER KEY

- | | | |
|-------|-------|-------|
| 1. C | 21. B | 41. D |
| 2. A | 22. A | 42. A |
| 3. D | 23. C | 43. D |
| 4. B | 24. B | 44. C |
| 5. D | 25. A | 45. B |
| 6. D | 26. C | 46. D |
| 7. A | 27. B | 47. D |
| 8. A | 28. D | 48. C |
| 9. C | 29. D | 49. B |
| 10. A | 30. D | 50. C |
| 11. D | 31. C | |
| 12. D | 32. A | |
| 13. A | 33. B | |
| 14. D | 34. B | |
| 15. B | 35. B | |
| 16. A | 36. A | |
| 17. C | 37. B | |
| 18. B | 38. A | |
| 19. A | 39. B | |
| 20. A | 40. C | |

PREPARATION EXAM 4—EXPLANATIONS

1. A diesel-powered vehicle has had two head gaskets replaced in the past 15,000 miles. Technician A says the electronic control module (ECM) should be checked for any diagnostic trouble codes. Technician B says the electronic control module (ECM) should be checked for VELCRO® straps. Who is correct?
 - A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

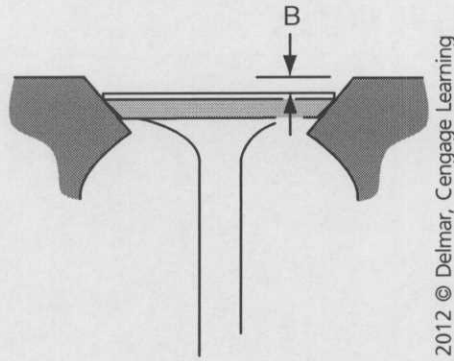
Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. When repetitive failures have occurred, the underlying problem needs to be found. Diagnostic trouble codes should be checked. Also VELCRO® straps around the ECM or the wiring harness can indicate that the customer is using an aftermarket engine controller. This could be the cause of the head gasket failure.

Answer D is incorrect. Both Technicians are correct.



TASK A.3
PAGE 15



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TASK B.4
PAGES 22–23

2. The measurement pictured above is greater than specification. Technician A says this may cause low compression. Technician B says this may cause a coolant leak. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. If valve recession is greater than specification compression pressure will be lower than specification. This will result in low power on that cylinder, and if all cylinders have this condition, it will result in an engine that is hard to start when cold.

Answer B is incorrect. Valve recession will not cause a coolant leak.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

TASK C.10
PAGES 29–30

3. A piston has heavy diagonal wear across the skirt. Technician A says the cause could be a main bearing bore out of alignment. Technician B says the cause could be a tapered main bearing journal. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Main bearing bore alignment problems will be evidenced by main bearing wear.

Answer B is incorrect. A tapered main journal will be indicated by main bearing wear.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. A twisted connecting rod will cause the piston to develop a diagonal wear pattern across the skirt.

4. A hydraulic electronic unit injector (HEUI) diesel engine fails to start. The tachometer indicates RPM while cranking. Which of the following is LEAST LIKELY to be the cause?
- A. Restricted fuel flow
 - B. Faulty engine position sensor
 - C. Low fuel level
 - D. Faulty high-pressure oil pump

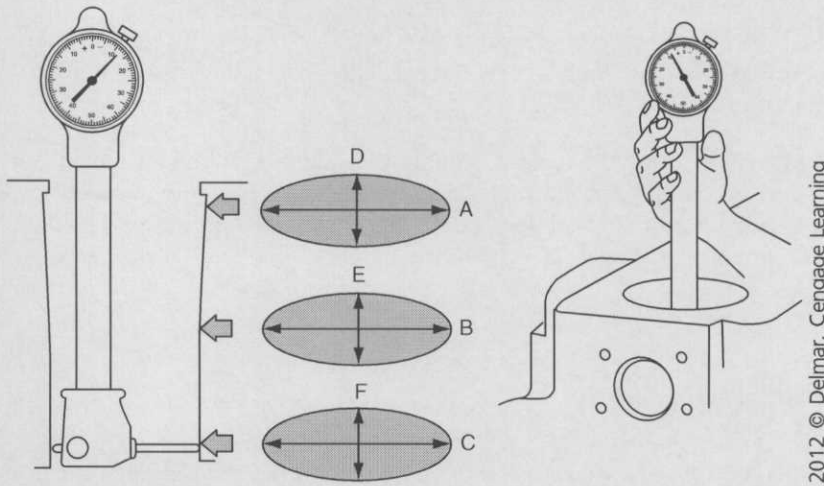


Answer A is incorrect. Restricted fuel flow can cause a no-start condition.

Answer B is correct. While a failed engine position sensor could cause a no-start condition, the tachometer would not indicate RPM. Therefore, this is the answer that would be LEAST LIKELY to cause this condition.

Answer C is incorrect. Low fuel level can cause a no-start condition.

Answer D is incorrect. A faulty high-pressure pump can cause a no-start condition.



5. Results from the above measurements are as follows:
- A. 3.2303 inches
 - B. 3.2302 inches
 - C. 3.2302 inches
 - D. 3.2305 inches
 - E. 3.2303 inches
 - F. 3.2302 inches



Which of the following is the best recommendation?

- A. The cylinder is out of round and should be bored or the block replaced.
- B. The cylinder is tapered and should be bored or the block replaced.
- C. The cylinder should be bored and sleeved.
- D. The cylinder should be honed and reused.

Answer A is incorrect. The measurement indicates 0.0002 out of round. This is within normal wear limits.

Answer B is incorrect. The measurements indicate 0.0003 taper. This is within normal wear limits.

Answer C is incorrect. The measurements do not indicate that the cylinder should be sleeved.

Answer D is correct. The cylinder should be honed, cleaned and returned to service.



TASK F.13
PAGES 50-51

6. When testing the coolant temperature sensor circuit, the scan tool displays coolant temperature to be 180 degrees F. An infrared temperature gun indicates the coolant temperature at the sensor to be 178 degrees F. Technician A says the temperature sensor is faulty and should be replaced. Technician B says the ECM is most likely faulty and should be replaced. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. The two readings are very close. There is most likely no problem indicated.

Answer B is incorrect. There is no indication that the ECM is faulty. The two readings are very close.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. The two readings are very close, so there is no problem indicated.



TASK F.3
PAGE 43

7. Technician A says submerging the fuel return hose in a container of fuel will help determine if a fuel system has a suction side leak. Technician B says submerging the fuel return hose in a container of fuel will help locate which cylinder is misfiring on a diesel engine. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. Air bubbles will indicate a suction side leak.

Answer B is incorrect. This will not isolate individual cylinders.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK E.8
PAGE 40

8. A diesel engine has low power and excessive exhaust back pressure when measured after the turbocharger. All of the following could be the cause EXCEPT:
- Restricted air intake
 - Restricted diesel particulate filter (DPF)
 - Collapsed exhaust pipe
 - Plugged diesel oxidation catalyst (DOC)

Answer A is correct. A restricted air intake can cause low power, but it will not cause excessive exhaust back pressure because the restriction is on the intake side.

Answer B is incorrect. A restricted diesel particulate filter could cause low power and excessive exhaust back pressure.

Answer C is incorrect. A collapsed exhaust pipe could cause high pressure and low power because it restricts air flow.

Answer D is incorrect. A plugged diesel exhaust catalyst will cause high exhaust back pressure and low power because it restricts air flow in the exhaust.

9. An engine has an oil leak. Technician A says fluorescent dye can be used to locate the source of the leak. Technician B says smoke can be used to locate the source of the leak. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



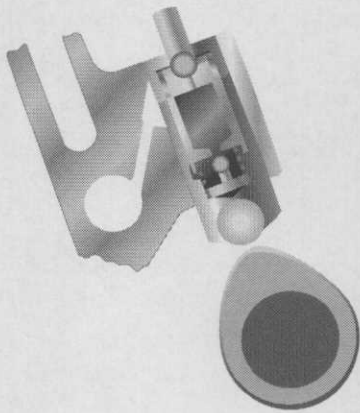
TASK A.5
PAGE 16

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. Fluorescent dye is a good method to locate engine oil leaks. A smoke generator can also be used to fill the crankcase with smoke and see where the smoke exits.

Answer D is incorrect. Both Technicians are correct.



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10. Technician A says the valve should be adjusted when the lifter is on the base circle, as illustrated. Technician B says the valve will be open when the lifter is on the base circle, as illustrated. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B



TASK B.9
PAGES 24-25

Answer A is correct. Only Technician A is correct. Valves are adjusted when the lifter is on the base circle.

Answer B is incorrect. The valve is closed when the lifter is on the base circle.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK E.9
PAGE 40

11. Technician A says the intake air heater would be located in the charge air cooler. Technician B says the intake air heater will require a separate fuel injector. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. The air heater is located in the intake manifold. Heating the air in the cooler will not aid in cold starting.

Answer B is incorrect. The heater is electrically operated; it does not require a fuel injector.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. The air heater is located in the intake manifold.



TASK F.3
PAGE 43

12. A diesel engine has run out of fuel. Technician A says the DTCs must be erased before the engine will restart. Technician B says ether should be used to prime the fuel system. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Running a diesel engine low on fuel can possibly set a low fuel pressure DTC on some engines; however, this code does not need to be erased for the engine to restart.

Answer B is incorrect. Ether should not be used to prime the fuel system; engine damage is the usual result of this method of fuel system bleeding.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



TASK E.11
PAGES 41–42

13. A rebuilt diesel engine has developed a knock after 5,000 miles of operation. Oil pressure is normal. Which of the following is the most likely cause?
- Misdirected piston cooling nozzle
 - Incorrectly positioned EGR valve gasket
 - Incorrectly torqued rod bearings
 - Improperly positioned head gasket

Answer A is correct. An improperly installed piston cooling nozzle would allow a piston to overheat and cause this type of concern.

Answer B is incorrect. An incorrectly installed EGR valve gasket would result in an exhaust leak; it would not cause a knock 5,000 miles after an overhaul.

Answer C is incorrect. A rod bearing failure would most likely result in abnormal oil pressure.

Answer D is incorrect. An improperly installed head gasket would most likely show up prior to 5,000 miles of operation; it would likely cause a leak, not a knock.

14. While diagnosing a rough-running engine, the cylinder power balance test reveals low power on cylinder #2 and #3. All other cylinders pass the test. Which of the following would be the most likely cause?

- A. Worn rings
- B. Weak valve springs
- C. Broken valve springs
- D. Leaking head gasket

Answer A is incorrect. Worn rings are not usually isolated to two cylinders.

Answer B is incorrect. It would be very uncommon to find weak valve springs on two adjacent cylinders and all the other cylinders be OK.

Answer C is incorrect. It would be very uncommon to find broken valve springs on two adjacent cylinders and all the other cylinders be OK. Broken valve springs result in knocking noises because of piston/valve contact, or popping noises because of the combustion chamber not being sealed at the correct times.

Answer D is correct. When two adjacent cylinders have low power, a leaking head gasket is suspect. A compression test or cylinder leakage test should be run to verify the leaking gasket.

15. A passage plug is left out of the crankshaft during engine reassembly. This will most likely result in:

- A. Higher than normal oil pressure.
- B. Lower than normal oil pressure.
- C. An external oil leak.
- D. Excessive main bearing clearance.

Answer A is incorrect. A missing oil plug will not cause an increase in restriction; therefore, it will not cause an increase in oil pressure.

Answer B is correct. A missing oil plug will result in an internal oil leak and lower oil pressure.

Answer C is incorrect. A missing oil plug will cause an internal oil leak into the oil pan.

Answer D is incorrect. A missing oil plug will not change main bearing clearance.

16. Technician A says during an on-vehicle diesel particulate filter (DPF) regeneration, soot is removed. Technician B says during an on-vehicle diesel particulate filter (DPF) regeneration, ash is removed. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is correct. Only Technician A is correct. Soot is removed from the DPF during a regeneration.

Answer B is incorrect. The DPF must be removed and the ash removed using a cleaning machine.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK A.12
PAGE 19



TASK C.6
PAGE 27



TASK E.10
PAGES 40-41



TASK F.6
PAGES 44–45

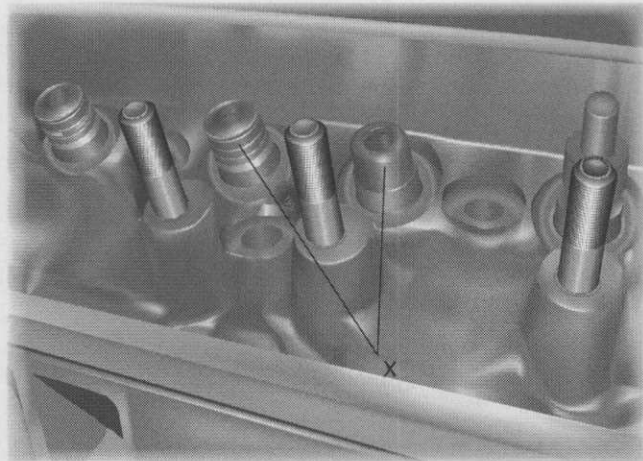
17. After extended idling, a diesel engine accelerates itself to 1500 rpms, and the sound of the turbocharger changes. After a period of time the engine drops back to 600 rpms, and the sound from the turbocharger goes back to normal. Which of the following is the most likely cause?
- The APP (accelerator pedal position) sensor is faulty.
 - The TPS (throttle position sensor) is faulty.
 - The engine is acting normally.
 - The VGT (variable geometry turbocharger) sensor circuit is malfunctioning.

Answer A is incorrect. This is a normal operating mode for a late model diesel engine; as it cools down, it will start this procedure to increase coolant temperature.

Answer B is incorrect. This is a normal operating mode for a late model diesel engine; as it cools down, it will start this procedure to increase coolant temperature.

Answer C is correct. The ECM is programmed to do this to maintain proper operating temperature.

Answer D is incorrect. The noise from the turbocharger changed because the ECM commanded the turbocharger vanes to close to help warm the engine.



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TASK B.7
PAGES 23–24

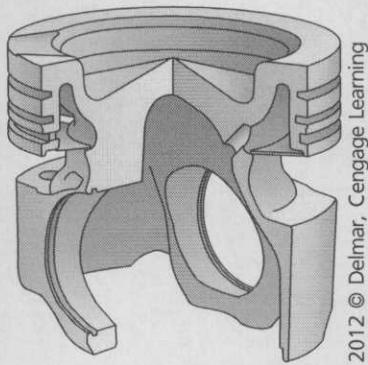
18. Technician A says the items identified by the “X” in the picture above are injector seals. Technician B says the items identified by the “X” in the picture above can be replaced with the cylinder head still on the engine. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. The items identified above are valve guide seals.

Answer B is correct. Only Technician B is correct. Valve guide seals can be replaced with the head still installed on the engine, as long as some system is used to keep the valve from falling into the cylinder.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



19. All of the following are true concerning the above piston EXCEPT:
- A. It is a two-piece piston.
 - B. It is sometimes called a trunk type.
 - C. It is sometimes called a monotherm[®].
 - D. It is typically made of an aluminum alloy construction.

Answer A is correct. This is a single piece piston.

Answer B is incorrect. This is called a trunk-type piston. A two-piece piston can be called an articulating piston.

Answer C is incorrect. This is a monotherm piston. A two-piece piston can be called a crosshead piston.

Answer D is incorrect. This piston is constructed of aluminum alloy.

20. A normally operating light-duty diesel engine has suddenly lost all oil pressure according to the oil pressure gauge in the dash. All of the following could be the cause EXCEPT:
- A. A stuck shut oil filter by-pass.
 - B. Lack of oil in the oil pan.
 - C. A faulty oil pressure gauge.
 - D. A faulty oil pressure gauge sending unit.

Answer A is correct. The oil filter by-pass valve, also known as the pressure differential valve, opens to by-pass a restricted oil filter. This valve is normally shut.

Answer B is incorrect. Lack of oil in the oil pan would cause sudden oil pressure loss and resulting indication on the dash.

Answer C is incorrect. A faulty gauge could be the problem; the engine could possibly still have oil pressure.

Answer D is incorrect. A faulty oil pressure gauge sending unit could cause the gauge to fall to zero. The engine could possibly still have oil pressure.

21. Which of the following would most likely be used to measure intake manifold pressure?
- A. Water manometer
 - B. Pressure gauge (Hg)
 - C. Vacuum gauge
 - D. Pressure gauge (H₂O)

Answer A is incorrect. A water manometer would not be capable of measuring a pressure as high as intake manifold pressure.

Answer B is correct. The most likely tool would be a pressure gauge (Hg).

Answer C is incorrect. A vacuum gauge does not measure pressure.

Answer D is incorrect. A pressure gauge calibrated to inches of water would not be capable of reading the pressures generated in the intake manifold.



TASK C.12
PAGE 30



TASK D.3
PAGE 33



TASK E.2
PAGE 38



TASK F.10
PAGES
47-49

22. Technician A says when installing a new injector, oil can be used to lubricate the o-rings. Technician B says when installing a new injector, anti-seize can be used to lubricate the o-rings. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. Oil is sometimes specified by the manufacture as the proper lubricant for new injector o-rings.

Answer B is incorrect. Anti-seize is not specified as a lubricant for new injector o-rings. The fine particles in anti-seize will contaminate the fuel system.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK E.4
PAGES
38-39

23. Peak boost pressure from a variable geometry turbocharger (VGT) is produced when:
- The waste gate is fully open.
 - The swinging vanes are fully open.
 - The swinging vanes are fully closed.
 - The waste gate is fully closed.

Answer A is incorrect. A VGT does not use a waste gate.

Answer B is incorrect. When the vanes are fully open, boost pressure will be low.

Answer C is correct. When the vanes are fully closed, the VGT will be making maximum boost for that operating condition.

Answer D is incorrect. A VGT does not have a waste gate.



TASK C.5
PAGE 27

24. Which tool would most likely be used to check camshaft end-play when the camshaft is installed in the block?
- Feeler gauge
 - Dial indicator
 - Outside micrometer
 - Inside micrometer

Answer A is incorrect. A feeler gauge could be used to measure camshaft end-play on some engines; however, when choosing from the options on this question, it is not the most likely tool.

Answer B is correct. A dial indicator is most often used to check camshaft end-play.

Answer C is incorrect. An outside micrometer is used to measure the bearing journal and lobe diameter, but it would not be used to measure end-play.

Answer D is incorrect. An inside micrometer can be used to measure the inside diameter of the camshaft bearings, but it would not be used to measure camshaft end-play.

25. A 2010 model year vehicle will use which of the following for the vehicle identification number (VIN) code?
- A. A
 - B. B
 - C. 10
 - D. Zero



TASK A.2
PAGES 14-15

Answer A is correct. A indicates 2010.

Answer B is incorrect. B indicates 2011.

Answer C is incorrect. There is not a two-digit number for the year code.

Answer D is incorrect. There is not a zero used for the year code.

26. Technician A says that a possible cause of an above-normal engine temperature is a faulty fan motor control module. Technician B says that plugged radiator fins may cause overheating. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK A.13
PAGE 19

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. A faulty fan motor control module can cause above-normal engine temperatures or overheating. The fan motor, if stuck in a low speed, will be unable to pull enough air through the radiator, causing overheating. The engine ECM is monitoring coolant temperature, oil temperature and air inlet temperature and sends a signal to the fan motor module to vary the speed of the fan motor. Radiators should be cleaned externally using a low-pressure hose, detergent and a soft nylon bristle brush. Never use a high-pressure washer because this will almost certainly result in damaging the cooling fins.

Answer D is incorrect. Both Technicians are correct.

27. A customer has a low oil pressure concern on a vehicle with a data bus dash. The oil pressure is tested to be normal with a master gauge. A scan tool connected to the vehicle shows normal oil pressure. Which of the following is the most likely problem?
- A. Oil pressure sending unit
 - B. Oil pressure gauge
 - C. Data bus failure
 - D. Low oil level



TASK D.1
PAGE 32

Answer A is incorrect. If the oil pressure sending unit was faulty, the oil pressure on the scan tool would read low.

Answer B is correct. If the ECM says the oil pressure is normal, then the gauge is most likely displaying incorrectly. This gauge may be serviced separately, or the whole instrument panel display may need to be replaced.

Answer C is incorrect. If the data bus failed, the other gauges on the instrument panel would not display properly.

Answer D is incorrect. If a low oil level was the cause, the oil pressure would be low on the scan tool.

Cylinder	#1	#2	#3	#4
Thrust diameter	3.656"	3.656"	3.656"	3.657"
Nonthrust diameter	3.651"	3.652"	3.650"	3.651"
Out of round	.005"	.004"	.006"	.006"

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Cengage LearningTASK C.13
PAGES 30-31

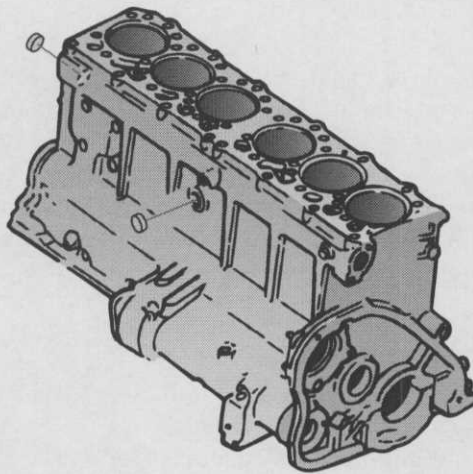
28. The measurements above indicate that:
- All the cylinders are within out of round specifications.
 - Cylinders #1 and #2 are within out of round specifications.
 - Cylinder #1 is within out of round specifications.
 - All the cylinders exceed out of round specifications.

Answer A is incorrect. Typical out of round specifications are less than 0.001". All of these measurements exceed that specification.

Answer B is incorrect. Typical out of round specifications are less than 0.001". All the cylinders exceed out of round specifications.

Answer C is incorrect. Typical out of round specifications are less than 0.001". Cylinder #1 measurements exceed these specifications.

Answer D is correct. Typical out of round specifications are less than 0.001".



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TASK B.3
PAGE 22

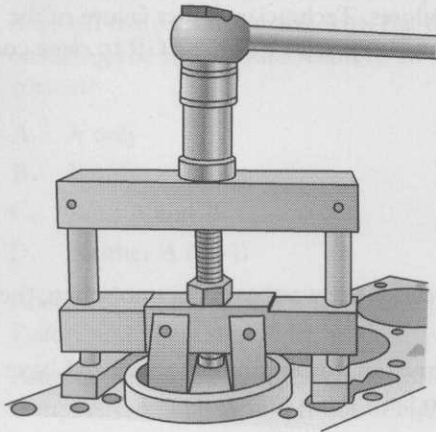
29. Technician A says the items pictured above are oil gallery plugs. Technician B says the items pictured above should be replaced annually. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Oil gallery plugs are smaller and most times will be threaded. These are coolant plugs.

Answer B is incorrect. These plugs are replaced only when leaking.

Answer C is incorrect. Neither Technician is correct. These are coolant core plugs, sometimes referred to as freeze out plugs.

Answer D is correct. Neither Technician is correct.



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30. What is the technician doing in the illustration above?
- A. Installing a liner
 - B. Installing an EGR cooler
 - C. Removing an EGR valve
 - D. Removing a liner

Answer A is incorrect. A cylinder liner is being removed.

Answer B is incorrect. This is not an EGR cooler.

Answer C is incorrect. This is not an EGR valve.

Answer D is correct. A cylinder liner is being removed.

31. The fuel filter life monitor needs to be reset. Technician A says this can be done on some vehicles using the accelerator and brake pedals. Technician B says this can be done on some vehicles with the steering wheel mounted controls. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct. The pedals can be used to trigger a reset. However, Technician B is also correct.

Answer B is incorrect. Technician A is also correct. The monitor can be reset using the steering wheel controls. However, Technician A is also correct.

Answer C is correct. Both Technicians are correct.

Answer D is incorrect. Both Technicians are correct.



TASK E.11,
C.2 PAGES
41-42, 26



TASK F.2
PAGE 43



TASK E.5, C.9
PAGES 39, 29

38. The timing chain has been replaced on a light-duty diesel engine equipped with a common rail fuel system. Now the engine will not start. All of the following could be the cause EXCEPT:
- The high-pressure pump is out of time.
 - The fuel system has lost prime.
 - The camshaft is out of time.
 - The glow plug system was not reconnected.

Answer A is correct. The high-pressure pump does not need to be timed on a common rail fuel system.

Answer B is incorrect. It is likely that the fuel system had to be opened to gain access to the timing chain; therefore, the fuel system could have lost prime.

Answer C is incorrect. If the camshaft was installed out of time, the engine may not start.

Answer D is incorrect. It is likely that the glow plug system had to be disconnected to gain access to the timing chain; therefore, an open glow plug system could be the cause.



TASK A.16
PAGE 20

39. Technician A says key-off battery drain can be measured with an oscilloscope. Technician B says key-off battery drain can be measured with an ammeter. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. An oscilloscope is used to measure voltage, not amperage.

Answer B is correct. Only Technician B is correct. An ammeter would be used to measure key-off battery drain.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK F.11
PAGES 49-50

40. A vehicle has an active DTC. Technician A says electrical connector terminals should be inspected during the diagnostic process. Technician B says electrical connector locks should be inspected during the diagnostic process. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. The electrical connector locks and terminals should both be inspected during the diagnostic process.

Answer D is incorrect. Both Technicians are correct.

41. A diesel engine will not start. All of the following could be the cause EXCEPT:

- A. Faulty camshaft position sensor.
- B. Low fuel level.
- C. Faulty engine speed sensor.
- D. Faulty boost pressure sensor.

Answer A is incorrect. A faulty cam position sensor could cause a no-start condition because the engine would not know cylinder position.

Answer B is incorrect. A low fuel level can cause a no-start condition. This should be checked first.

Answer C is incorrect. The engine speed sensor can cause a no-start condition; however, the fuel level should be checked first.

Answer D is correct. A boost pressure sensor can cause low horsepower, but it will not cause a no-start condition. The engine can operate without a boost pressure signal.

42. Which tool would be used to measure piston projection?

- A. Dial indicator
- B. Dial caliper
- C. Outside micrometer
- D. Inside micrometer

Answer A is correct. A dial indicator is the most common tool used to measure piston projection.

Answer B is incorrect. A dial caliper would not be used to measure piston projection.

Answer C is incorrect. An outside micrometer could not be used to measure piston projection.

Answer D is incorrect. An inside micrometer cannot be used to measure piston projection.

43. Technician A says valve clearance should be adjusted on a light-duty diesel engine with the engine running at 1000 rpm. Technician B says the valve clearance should be checked on a light-duty diesel engine with the engine at operating temperature. Who is correct?

- A. A only.
- B. B only.
- C. Both A and B.
- D. Neither A nor B.

Answer A is incorrect. Valves are adjusted with the engine off. Engine damage will occur if the technician attempts to adjust the valves with the engine running.

Answer B is incorrect. Valves should be adjusted with the engine cold for consistent results.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



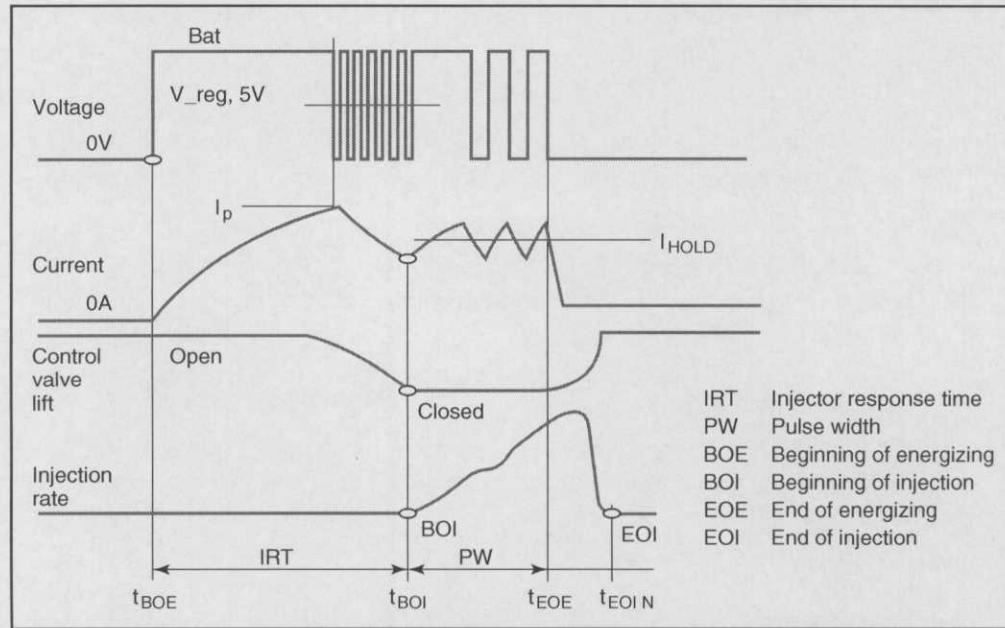
TASK A.15
PAGE 20



TASK C.7
PAGE 28



TASK A.9,
B.9 PAGES
17-18, 24-25



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TASK F.14
PAGES 51-52

44. The information above was collected, while cranking, from a diesel engine that will not start. Which of the following is the most likely cause of the no-start condition?

- A. The ECM is not turning the injectors on.
- B. The engine position sensor is not sending a signal.
- C. The engine is out of diesel fuel.
- D. An overfilled engine oil crankcase.

Answer A is incorrect. The graph shows that the injectors are being turned on.

Answer B is incorrect. The engine position sensor is sending a signal, or the ECM would not have energized the injectors.

Answer C is correct. The ECM is operating the injectors; the engine could simply be out of fuel.

Answer D is incorrect. There is no reason to believe the crankcase is overfull.



TASK C.15
PAGES 31-32

45. A dual-mass flywheel has failed. The customer requested that the replacement flywheel be of a single-mass design. What should the technician do?

- A. Tell the customer that this would be a non-factory repair, and therefore cannot be performed.
- B. Research to see if a replacement single-mass flywheel has been approved for this power train.
- C. Ask the customer to bring in the flywheel they want installed.
- D. Ask the customer to take the vehicle elsewhere.

Answer A is incorrect. Some engine manufacturers have specified replacement single-mass flywheels due to high failure rates of dual-mass flywheels.

Answer B is correct. The technician should research to see if a single-mass flywheel is available.

Answer C is incorrect. It is not good policy to tell customers to get their own parts.

Answer D is incorrect. The customer request is legitimate and should be researched.

46. The cooling system hoses collapse on a diesel engine when the vehicle sets overnight. Technician A says a restricted radiator could be the cause. Technician B says a restricted oil cooler could be the cause. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK D.12
PAGE 36

Answer A is incorrect. A restricted radiator will cause engine overheating, not a vacuum in the cooling system.

Answer B is incorrect. A restricted oil cooler can cause engine oil temperatures to be elevated, but it will not cause a vacuum in the cooling system.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct. The most likely cause is a faulty radiator cap.

47. Which of the following is the purpose of the EGR valve pressure differential sensor?
- A. To measure ash buildup in the DPF.
 - B. Determine the DEF injection quantity.
 - C. Determine the nitrous oxide emission levels.
 - D. Measure EGR flow.



TASK E.11
PAGES 41-42

Answer A is incorrect. Ash buildup is in the exhaust after treatment system, not in the EGR system.

Answer B is incorrect. DEF injection quantity is calculated based upon the NOx sensor.

Answer C is incorrect. NOx levels are measured with NOx sensors.

Answer D is correct. EGR flow is measured and determined by the EGR pressure differential sensor.

48. Technician A says that prior to removing high-pressure fuel lines the engine should be thoroughly cleaned. Technician B says to spray the line with electronics cleaner, loosen slightly with a wrench, then spray the line again with electronics cleaner. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK F.5
PAGE 44

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. Both Technicians are using good fuel system cleaning practices.

Answer D is incorrect. Both Technicians are correct.

TASK E.1
PAGE 37

49. The air inlet restriction test should be performed:
- A. At idle
 - B. Under load
 - C. With the engine cold
 - D. During the first two minutes of operation

Answer A is incorrect. The test should be performed under load. When the engine is under load, exhaust temperature will be high and turbo boost should be high; therefore, a large volume of air will be flowing through the air intake system and restrictions will be more evident.

Answer B is correct. The test should be performed under load; this is when the air intake system will have the greatest flow.

Answer C is incorrect. The test should be performed at operating temperature.

Answer D is incorrect. The test should be performed at operating temperature.

TASK D.6
PAGE 34

50. Which of the following is true concerning changing the oil filter?
- A. The new oil filter should be tightened two complete turns with an oil filter wrench after the gasket contacts the base.
 - B. The new oil filter should be tightened three complete turns with an oil filter wrench after the gasket contacts the base.
 - C. The used oil filter should be hot-drained prior to disposal.
 - D. The new oil filter should be filled with transmission fluid prior to installation.

Answer A is incorrect. The new filter is typically tightened $\frac{3}{4}$ of a turn after the gasket contacts the base.

Answer B is incorrect. The new filter is typically tightened $\frac{3}{4}$ of a turn after the gasket contacts the base.

Answer C is correct. The used oil filter should be hot drained prior to disposal. Some shops will crush the filter prior to disposal.

Answer D is incorrect. The new oil filter should only be filled with engine oil, and then only if recommended by the engine manufacturer.

PREPARATION EXAM 5—ANSWER KEY

- | | | |
|-------|-------|-------|
| 1. B | 21. B | 41. B |
| 2. C | 22. A | 42. B |
| 3. A | 23. B | 43. B |
| 4. C | 24. A | 44. D |
| 5. B | 25. B | 45. C |
| 6. A | 26. A | 46. B |
| 7. D | 27. A | 47. D |
| 8. B | 28. A | 48. B |
| 9. C | 29. C | 49. C |
| 10. B | 30. B | 50. B |
| 11. C | 31. A | |
| 12. A | 32. A | |
| 13. D | 33. B | |
| 14. B | 34. C | |
| 15. D | 35. A | |
| 16. A | 36. C | |
| 17. D | 37. A | |
| 18. B | 38. B | |
| 19. A | 39. C | |
| 20. B | 40. C | |

PREPARATION EXAM 5—EXPLANATIONS

- Which of the following should be used to clean a cylinder block after honing?
 - Cleaning solvent
 - Hot Soapy water
 - Engine oil
 - Parts washer

Answer A is incorrect. Cleaning solvent will not remove the fine metal particles.

Answer B is correct. Hot soapy water will float the fine metal particles away from the block.

Answer C is incorrect. Engine oil will not clean the metal particles from the block.

Answer D is incorrect. A parts washer will not effectively remove the fine metal particles created during the honing process.



TASK C.3
PAGE 26



TASK E.11
PAGES 41–42

2. A diesel engine blows excessive white smoke and has an internal coolant leak. Technician A says the head gasket may be leaking. Technician B says the EGR cooler may be leaking. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. A leaking head gasket and a leaking EGR cooler can both allow coolant into the exhaust stream, as well as an internal coolant leak.

Answer D is incorrect. Both Technicians are correct.



TASK F.6
PAGES 44–45

3. The cab-mounted PTO switch will raise and lower the engine RPM correctly. However, the remote PTO switch will not. Technician A says incorrect ECM programming could be the cause. Technician B says a faulty cab-mounted PTO switch could be the cause. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. Only Technician A is correct. Some ECMs must be programmed to recognize that the vehicle has a remote-mount PTO switch.

Answer B is incorrect. The cab-mounted PTO switch and the remote-mounted PTO switch are usually two separate circuits to the ECM; therefore, it is very unlikely that a cab-mounted PTO switch would cause a remote-mounted PTO switch to not function.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK D.6
PAGE 34

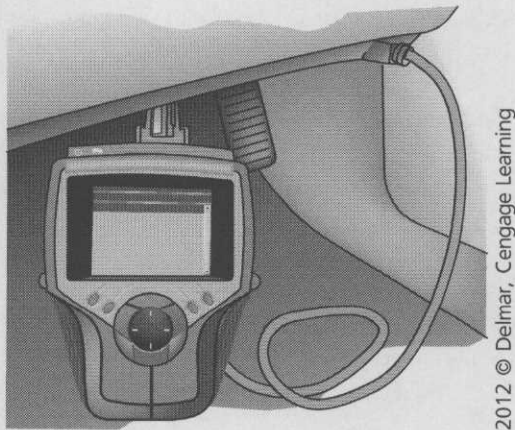
4. Technician A says that most 2007 model diesel engines require CJ-4 oil. Technician B says using the incorrect oil in a 2007 model engine can result in frequent DPF regenerations. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. CJ-4 oil is required for 2007 diesel engines. Using the incorrect oil, such as a CH or CI, will result in higher pollutants in the exhaust stream and more frequent DPF regenerations.

Answer D is incorrect. Both Technicians are correct.



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5. The scan tool shown above will not communicate with the engine. Which of the following is the LEAST LIKELY cause?

A. Loose pins in the diagnostic link connector (DLC).
 B. The ignition key is turned on.
 C. A shorted data bus.
 D. A faulty scan tool.

Answer A is incorrect. Loose pins in the diagnostic link connector could result in no communication.

Answer B is correct. The ignition key should be on.

Answer C is incorrect. A shorted data bus would cause a no-communications condition.

Answer D is incorrect. A faulty scan tool may not be able to communicate with the engine.

6. Technician A says cast iron blocks can be checked for cracks using the magnetic particle method. Technician B says aluminum cylinder heads can be checked for cracks using the magnetic particle method. Who is correct?

A. A only
 B. B only
 C. Both A and B
 D. Neither A nor B

Answer A is correct. Only Technician A is correct. Magnetic particle inspection can be used on cast iron blocks.

Answer B is incorrect. Magnetic particle inspection cannot be used on aluminum.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

7. Which of the following could cause a worn crankshaft thrust surface?

A. Excessive air intake restriction.
 B. Excessive turbocharger boost pressure.
 C. A seized transmission slip yoke.
 D. A defective torque convertor.

Answer A is incorrect. Excessive air intake restriction can cause low power, but would not wear the crankshaft thrust surface excessively.

Answer B is incorrect. Excessive turbocharger boost pressure will cause turbocharger damage and leaks at the charge air cooler hoses, but it will not cause a worn crankshaft thrust surface.

Answer C is incorrect. A seized transmission slip yoke can cause wear to the differential drive pinion bearing due to the thrust load it generates; however, that thrust load would not be transmitted to the engine crankshaft.

Answer D is correct. A defective (ballooning) torque converter can expand and put excessive pressure on the end of the crankshaft, which will wear the crankshaft thrust surface and thrust bearing.



TASK F.13
 PAGES 50-51



TASK B.2
 PAGES 21-22



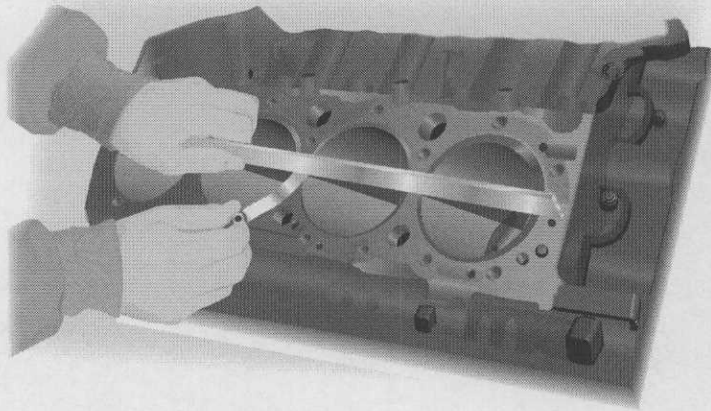
TASK E.1
 PAGE 37



TASK A.4
PAGES 15-16

8. A diagnostic trouble code for an intermittent misfire is being diagnosed. The freeze frame data for the misfire indicates 0 rpm when the misfire occurred. Which of the following is the most likely cause of the code?
- Coolant temperature sensor.
 - Camshaft position sensor.
 - Boost pressure sensor.
 - Variable geometry turbocharger (VGT) vane position sensor.

Answer A is incorrect. The coolant temperature sensor would not cause 0 rpm to be indicated.
Answer B is correct. A camshaft position sensor failure could cause 0 rpm to be indicated.
 Answer C is incorrect. The boost pressure sensor would not cause 0 rpm to be indicated.
 Answer D is incorrect. The VGT would not cause 0 rpm to be indicated.



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TASK C.2
PAGE 26

9. The technician is able to insert a 0.010" feeler gauge while doing the check shown above. Which of the following is true?
- This is within specification.
 - The cylinder head should be machined.
 - The cylinder block should be machined.
 - This would cause engine oil in the fuel.

Answer A is incorrect. 0.010" is greater than specification.
 Answer B is incorrect. This is a block, not a head.
Answer C is correct. The block must be machined.
 Answer D is incorrect. This would not cause engine oil to enter the fuel.



TASK B.6
PAGE 23

10. Technician A says a valve bridge (crosshead) strengthens the valve guides. Technician B says the function of a valve bridge (crosshead) is to open two valves simultaneously. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. A valve bridge opens two valves simultaneously with one rocker arm. It does not provide additional strength to the system.

Answer B is correct. Only Technician B is correct. A valve bridge opens two valves simultaneously with one rocker arm. Otherwise two rocker arms would be needed.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

11. On a diesel engine equipped with a common rail fuel system, the fuel rail pressure sensor shows 12,500 psi fuel pressure for key on and the engine off. Which of the following is true?
- A. This is a normal reading on a cold engine.
 - B. This is a normal reading on a hot engine.
 - C. This reading is higher than normal for key on and the engine off.
 - D. This reading indicates the high-pressure pump is malfunctioning.

Answer A is incorrect. A normal reading for key on and the engine off is 160–200 psi.

Answer B is incorrect. A normal reading for key on and the engine off is 160–200 psi.

Answer C is correct. This reading is abnormally high.

Answer D is incorrect. This reading indicates a failure in the fuel pressure sensor circuit, not the fuel pump.

12. While driving at night, a diesel engine starts to misfire. The driver also remarks that the headlights are dim. Which of the following could be the cause?
- A. Low charging system output
 - B. High charging system output
 - C. Low starter current draw
 - D. High starter current draw

Answer A is correct. Low charging system output could cause battery voltage to drop low enough to cause a misfire.

Answer B is incorrect. High charging system output would not cause the lights to be dim.

Answer C is incorrect. Starter current draw would not cause this condition.

Answer D is incorrect. Starter current draw would not cause this condition.

13. An electronic unit injector has been replaced. All of the following are true EXCEPT:
- A. The fuel system must be bled to restart the engine.
 - B. The fuel will need to be removed from the top of the piston before the new injector is installed.
 - C. The injector rocker arm must be adjusted before the engine is started.
 - D. The injector electrical connector should be disconnected when the engine is started.

Answer A is incorrect. The fuel system will have air in it and will need to be bled.

Answer B is incorrect. Removing the old injector will allow fuel to drain onto the top of the piston; this fuel can cause hydraulic lock if not removed.

Answer C is incorrect. An electronic unit injector is camshaft-operated and must be adjusted prior to starting the engine.

Answer D is correct. The injector electrical connection must be connected prior to starting. Otherwise, the injector will not inject fuel.



TASK F.7
PAGE 45



TASK A.17
PAGE 21



TASK F.10
PAGES 47–49



TASK E.8
PAGE 40

14. The after treatment diesel particulate filter is leaking at the V-band clamp. Which of the following would be the correct repair?
- Replace the V-band clamp
 - Replace the seal
 - Replace the after treatment diesel particulate filter
 - Replace the variable geometry turbocharger

Answer A is incorrect. The V-band clamp should be replaced only if it has failed.

Answer B is correct. There is a seal between the sections of the after treatment diesel particulate filter that can be replaced.

Answer C is incorrect. The seal can be replaced separately.

Answer D is incorrect. The turbocharger did not cause this leak.



TASK A.1
PAGE 14

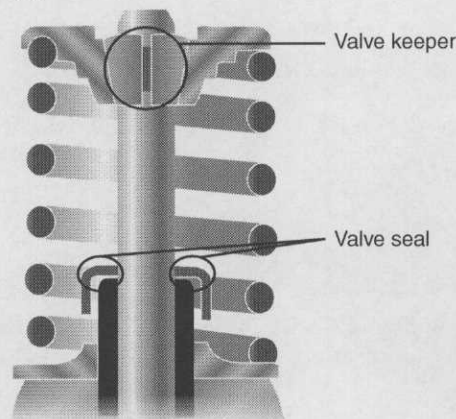
15. A vehicle has been in the shop for multiple “hard starting when cold” customer concerns. All of the following could be the cause EXCEPT:
- The glow plugs are inoperative.
 - The air heater is inoperative.
 - The customer needs to be reminded of correct starting procedures.
 - The charge air cooler hose is restricted.

Answer A is incorrect. Faulty glow plugs could cause hard starting when cold.

Answer B is incorrect. A faulty air intake heater could cause hard starting when cold.

Answer C is incorrect. The customer may not be waiting before trying to start the vehicle.

Answer D is correct. A restricted charge air cooler hose would cause low power, not hard starting, when cold.



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TASK B.7
PAGES 23–24

16. Refer to the illustration above. Technician A says that when reassembling the cylinder head, the valve seal is installed before the valve spring. Technician B says the valve keepers are installed before the valve spring. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. The valve seal is installed before the valve spring.

Answer B is incorrect. The valve keepers are installed after the spring.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

17. An engine has a vibration that is evident at 1000 rpm, 1600 rpm, and 2200 rpm. Which of the following is the most likely cause?

- A. Alternator
- B. Water pump
- C. Piston
- D. Vibration damper

Answer A is incorrect. Alternators typically do not cause vibration; however, when they do, it is usually not engine RPM-specific.

Answer B is incorrect. Water pumps typically do not cause vibration; however, when they do, they are usually not RPM-specific.

Answer C is incorrect. Incorrect piston weight can cause vibration; however, that vibration is not usually RPM-specific.

Answer D is correct. A vibration that is RPM-specific and comes and goes at specific RPMs is most likely caused by a faulty vibration damper.

18. A V8 diesel engine piston has the word “front” stamped on it. Technician A says the word “front” goes on the right bank of cylinders. Technician B says the word “front” goes toward the front of the engine block. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. The cylinder bank is not indicated. The word “front” should go toward the front of the engine. This correctly positions the major thrust side of the piston.

Answer B is correct. Only Technician B is correct. The word “front” goes toward the front of the engine.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

19. The engine oil cooler has an internal leak. Which of the following can be the result?

- A. Oil in the coolant
- B. External oil leak
- C. External coolant leak
- D. Restricted diesel particulate filter

Answer A is correct. This would allow oil in the coolant.

Answer B is incorrect. The leak is internal, not external.

Answer C is incorrect. The leak is internal, not external.

Answer D is incorrect. Oil in the coolant would not restrict the DPF. The DPF is restricted when there is an excessive soot load in the exhaust stream.



TASK C.14
PAGE 31



TASK C.10
PAGE 29



TASK D.4
PAGE 33

TASK B.4
PAGES 22-23

20. The valve springs are tested for tension and results are below specification. Technician A says the springs can be shimmed. Technician B says the springs should be replaced. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. Shimming a spring is done to correct installed height, not to correct for weakness.

Answer B is correct. Only Technician B is correct. The spring should be replaced.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.

TASK A.10
PAGE 18

21. The diesel fuel in a diesel engine is oily. Which of the following could be the cause?

- A. Leaking high-pressure oil pump.
- B. Leaking injector o-rings.
- C. Faulty injection pressure regulator.
- D. Faulty injection pressure actuation valve.

Answer A is incorrect. A leaking high-pressure oil pump would cause an external oil leak.

Answer B is correct. Leaking injector o-rings can allow oil to enter the return fuel stream.

Answer C is incorrect. A faulty injection pressure regulator will not cause oil in the diesel fuel.

Answer D is incorrect. A faulty injection pressure actuation valve cannot cause the oil to get into the fuel.

TASK F.15
PAGE 52

22. The transmission overheats on a vehicle that also has a non-functioning cruise control concern. Which of the following could be the cause?

- A. Brake light switch
- B. Torque convertor solenoid
- C. Cruise control fuse
- D. Transmission cooler

Answer A is correct. The brake light switch will keep the cruise control from engaging as well as keep the torque convertor clutch from locking up.

Answer B is incorrect. A faulty torque convertor solenoid can cause the transmission to overheat, but it would not affect the cruise control.

Answer C is incorrect. The cruise control fuse would not cause the transmission to overheat.

Answer D is incorrect. The transmission cooler would cause the transmission to overheat, but it would not cause the cruise control not to function.

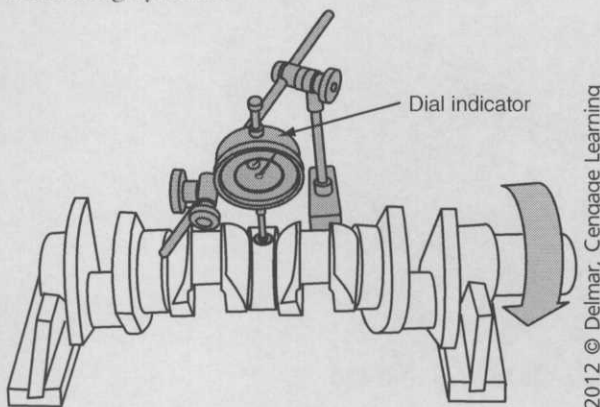
23. A freshly overhauled engine has lower than normal oil pressure, especially at hot idle. Which of the following could be the cause?
- Incorrect ring end gap
 - Incorrect bearing clearance
 - Incorrect piston-to-cylinder clearance
 - Incorrect valve adjustment

Answer A is incorrect. Incorrect ring end gap will cause high crankcase pressure or cylinder wall scuffing.

Answer B is correct. If an engine is reassembled with too much bearing clearance, oil pressure will be lower than normal. This will be most noticeable at hot idle because the oil is thin and oil pump speed is low.

Answer C is incorrect. Incorrect piston-to-cylinder wall clearance will cause a knocking noise or engine seizure.

Answer D is incorrect. An incorrect valve adjustment will cause low power, burnt valves, or a misfiring cylinder.



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24. Which reading below would indicate an acceptable measurement for the test shown above?
- 0.0005"
 - 0.0050"
 - 0.0500"
 - 0.5000"

Answer A is correct. The measurement indicates crankshaft run out. The normal maximum reading is less than 0.001".

Answer B is incorrect. 0.0050" would be too much run out.

Answer C is incorrect. 0.0500" would be too much run out.

Answer D is incorrect. 0.5000" would be too much run out.

25. Which of the following is LEAST LIKELY to occur during a diesel particulate filter regeneration?
- Fuel is sprayed into the exhaust.
 - Exhaust temperatures will drop.
 - The engine will have reduced horsepower.
 - The idle speed will be raised.

Answer A is incorrect. Fuel can be sprayed into the exhaust.

Answer B is correct. Exhaust temperature will increase, not decrease.

Answer C is incorrect. The engine may operate with decrease horsepower during the regeneration process.

Answer D is incorrect. The engine idle speed will be raised during certain portions of a regeneration event.



TASK C.7
PAGE 28



TASK C.6
PAGE 27



TASK E.10
PAGES 40-41



TASK C.4
PAGES
26-27

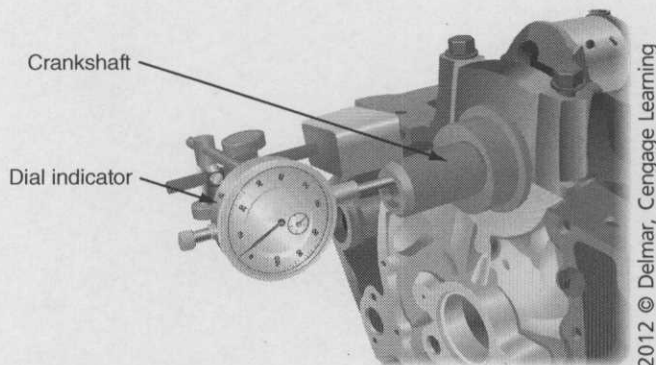
26. An in-frame engine overhaul is being performed. The in-block camshaft bushings are removed by:
- Driving them out with a driver tool.
 - Shoving them out with a hydraulic press.
 - Shoving them out with an arbor press.
 - Shoving them out with a pusher screw.

Answer A is correct. In-block camshaft bushings are removed with a driver tool and a hammer.

Answer B is incorrect. These bearings are not shoved out with a hydraulic press.

Answer C is incorrect. These bearings are not removed with an arbor press.

Answer D is incorrect. These bearings are not removed with a pusher screw.



TASK C.8
PAGE 29

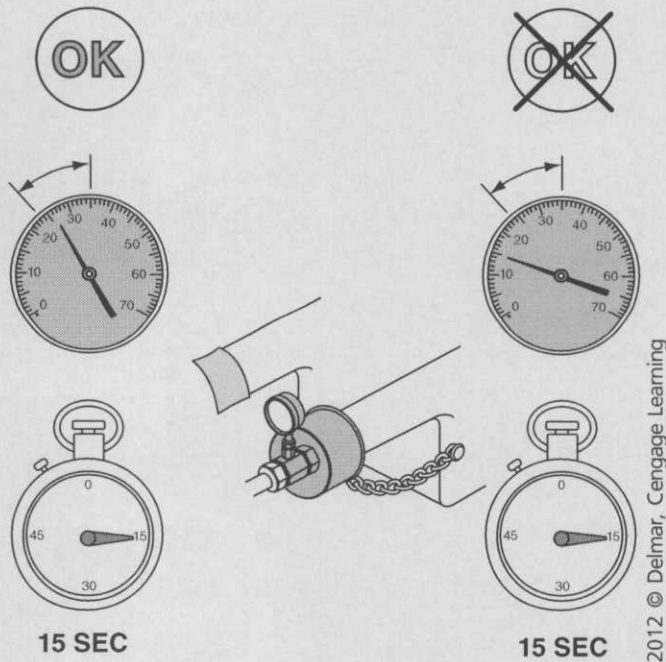
27. Technician A says that in the illustration shown above, the technician is measuring crankshaft end-play. Technician B says if the measurement shown above is greater than specification, the engine may have low power. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. The technician is measuring crankshaft end-play.

Answer B is incorrect. Crankshaft end-play greater than specification can cause noise that goes away when the clutch is depressed, but it would not cause low power.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



28. The test performed above will indicate:
- A. Charge air cooler leaks.
 - B. Charge air cooler external restrictions.
 - C. Charge air cooler internal restrictions.
 - D. Charge air cooler flow rate.

Answer A is correct. The test checks the charge air cooler for leaks. All coolers leak some, thus the specification of 7 pounds in 15 seconds is indicated.

Answer B is incorrect. External restrictions are determined by performing a temperature drop test while the engine is operating.

Answer C is incorrect. Charge air cooler internal restrictions are located using a pressure drop test while the engine is operating.

Answer D is incorrect. Charge air cooler flow rate is determined by performing a pressure drop test while the engine is operating.

29. The pins are loose at the engine coolant temperature sensor connector. Technician A says this could cause an incorrect idle RPM. Technician B says this could cause the ECM to set a DTC. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. A loose pin connection can result in increased resistance, which can cause the ECM to interpret a cold engine and increase idle RPM. A loose pin connection can cause the ECM to set a DTC.

Answer D is incorrect. Both Technicians are correct.



TASK E.6
PAGE 39



TASK F.11
PAGES
49-50



TASK F.9
PAGE 47

30. Which of the following would cause excessive gallery pressure on a PLN-E (pump-line-nozzle electronic) fuel system pump?

- A. Stuck open fuel regulator
- B. Stuck closed fuel regulator
- C. Dirty injection nozzles
- D. Incorrect injection pump timing

Answer A is incorrect. A stuck open fuel regulator would cause low pressure.

Answer B is correct. A stuck closed regulator would cause high pressure.

Answer C is incorrect. Dirty nozzles would not raise gallery pressure.

Answer D is incorrect. Injection pump timing would not affect gallery pressure.



TASK B.8
PAGE 24

31. The injector harness under the valve cover on a HEUI engine is damaged. Which of the following is the most likely repair?

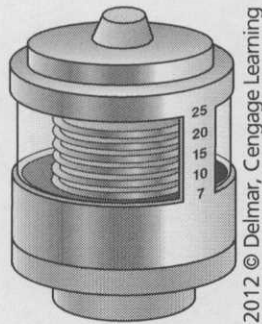
- A. Replace the harness
- B. Replace the damaged connector
- C. Replace the injector
- D. Replace the glow plugs

Answer A is correct. Normally wiring harnesses that are under the valve cover are replaced as a complete unit.

Answer B is incorrect. Normally connectors are not replaced on under valve cover wiring harness.

Answer C is incorrect. There is no cause for injector replacement.

Answer D is incorrect. There is no cause for glow plug replacement, unless it is open or shorted.



TASK E.1
PAGE 37

32. When the vehicle came in for service, the indicator reading above was observed. This indicates:

- A. The air filter is still serviceable.
- B. The air filter is leaking.
- C. There is a leak in the air intake piping.
- D. There is an exhaust restriction.

Answer A is correct. This reading was the highest reading taken under load. The filter shows some restriction but is still serviceable.

Answer B is incorrect. The air filter is showing restriction. It is not leaking.

Answer C is incorrect. If there were a leak in the air intake piping, the indicator would not show any restriction because there would not be any.

Answer D is incorrect. This indicator does not indicate exhaust restriction.

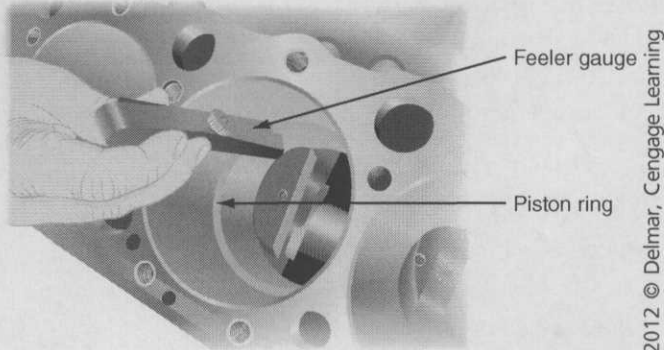
33. The fuel heater is stuck on. This could result in:
- A. Increased power
 - B. Decreased power
 - C. Engine overheating
 - D. Increased turbo boost pressure

Answer A is incorrect. The hot fuel will decrease power.

Answer B is correct. Hot fuel has less power.

Answer C is incorrect. Hot fuel will not cause the engine to overheat.

Answer D is incorrect. Hot fuel will not cause an increase in turbo boost pressure.



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34. The measurement above is greater than specification. This could result in:
- A. Piston seizure
 - B. Ring breakage
 - C. Increased crankcase pressure
 - D. Decreased oil pressure

Answer A is incorrect. The measurement being performed is ring end gap. If this measurement is beyond specification, it would not cause the piston to seize.

Answer B is incorrect. The measurement being performed is ring end gap. If this measurement was less than specification, it could cause the ring to break.

Answer C is correct. The measurement being performed is ring end gap. If this measurement is beyond specification, there would be increased blow-by and increased crankcase pressure.

Answer D is incorrect. The measurement being performed is ring end gap. This will not affect oil pressure.

35. A diesel fuel filter is being replaced. Which of the following is the correct procedure?
- A. Install the filter dry.
 - B. Fill the filter with diesel fuel, then install.
 - C. Fill the filter with fuel system cleaner, then install.
 - D. Fill the filter with 1/2 diesel fuel and 1/2 fuel system cleaner, then install.

Answer A is correct. The filter should be installed dry, then the fuel system is used to fill it. This is the best way to prevent dirt entering the system. There is no chance of introducing dirt into the fuel system when this method is used.

Answer B is incorrect. This can allow dirt into the fuel system.

Answer C is incorrect. This can allow dirt into the fuel system.

Answer D is incorrect. This can allow dirt into the fuel system.



TASK F.2
PAGE 43



TASK E.13
PAGE 42



TASK F.2
PAGE 43



TASK E.5,
A.12
PAGES 39, 19

36. The air entering the engine from the after cooler is too hot. Which of the following could be the cause?
- A. Leaking injector
 - B. Leaking after cooler
 - C. Clogged radiator
 - D. Tight turbocharger bearings

Answer A is incorrect. A leaking injector can cause fuel in the oil, or fuel dribbling into the combustion chamber.

Answer B is incorrect. A leaking after cooler will cause low turbo boost pressure.

Answer C is correct. A radiator that is clogged externally will cause insufficient airflow across the charge air cooler. This will cause the charge air cooler to do a poor job cooling the boost air.

Answer D is incorrect. Tight turbocharger bearings will cause low boost pressure.



TASK F.5
PAGE 44

37. A high-pressure injection line is seeping. The fitting has been torqued to the correct specification. Which of the following should be done to correct the leak?
- A. Remove the line and inspect.
 - B. Replace the line.
 - C. Increase the torque on the line 10% and retest.
 - D. Increase the torque on the line 20% and retest

Answer A is correct. The line needs to be removed and inspected.

Answer B is incorrect. The line should be inspected to determine if replacement is needed.

Answer C is incorrect. The torque specification should not be exceeded.

Answer D is incorrect. The torque specification should not be exceeded.



TASK A.15
PAGE 20

38. A diesel engine will not start. There is no voltage at the fuel shutoff solenoid when checked with the key on and the engine off (KOEO). Technician A says the wire could be shorted. Technician B says the solenoid could be open. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is correct. If the wire was shorted, it could prevent voltage from reaching the solenoid.

Answer B is incorrect. Only Technician A is correct. An open solenoid would not operate, but it would not prevent voltage from reaching the solenoid.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

39. Technician A says when the diesel engine is first put under load, the ECM should command the turbocharger vanes to close to raise turbo boost pressure. Technician B says when the diesel engine coolant temperature drops below a preset threshold, the ECM should command the turbochargers vanes to close to raise engine temperature. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. The ECM will command the vanes to close to speed up the turbocharger shaft, raising turbocharger boost pressure. It also does this to restrict the exhaust in order to raise engine temperature.

Answer D is incorrect. Both Technicians are correct.

40. A diesel engine equipped with an air intake grid heater blows excessive white smoke when cold. Otherwise, the engine runs well and produces good power. Which of the following is the most likely cause?
- A. Low compression due to worn rings
 - B. Low fuel supply pressure
 - C. An open air intake heater
 - D. A high exhaust back pressure

Answer A is incorrect. Low compression will cause low power.

Answer B is incorrect. Low fuel pressure will cause low power.

Answer C is correct. An open air intake heater would cause this condition.

Answer D is incorrect. High exhaust back pressure will cause low power.

41. A rebuilt vehicle has a DTC for the diesel particulate filter (DPF). Which of the following could be the cause?
- A. Rod bearing clearances are less than specified.
 - B. The DPF pressure sensor hoses were incorrectly installed.
 - C. A piston cooling nozzle was left out during reassembly.
 - D. A core plug was left out during reassembly.

Answer A is incorrect. Rod bearing clearances less than specified would cause higher than normal oil pressure.

Answer B is correct. The hoses that connect the DPF pressure sensor can easily be switched during reassembly; this could result in a DTC for the DPF.

Answer C is incorrect. If a piston cooling nozzle was left out during reassembly, an internal oil leak would be created and oil pressure would be less than specified.

Answer D is incorrect. If a core plug was left out, there would be a coolant leak.



TASK E.4
PAGES 38-39



TASK E.9
PAGE 40



TASK E.10
PAGES 40-41



TASK A.6
PAGES 16–17

42. A weather pack engine harness connector has a damaged pin. Technician A says the harness must be replaced. Technician B says that in some cases a damaged pin can be replaced. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

Answer A is incorrect. Normally, a damaged weather pack pin can be replaced.

Answer B is correct. Only Technician B is correct. Normally, a damaged weather pack pin can be replaced. Some electrical connectors, such as Metri-Pack, are usually replaced as a unit, and some under-valve cover harnesses are replaced as a complete unit.

Answer C is incorrect. Only Technician B is correct.

Answer D is incorrect. Technician B is correct.



TASK C.13,
E.10
PAGES
30–31,
40–41

43. A piston ring has a dot imprinted on one side. Which of the following is true?
- A. The dot should always face down.
 - B. The dot should always face up.
 - C. The ring is to be used only on engines equipped with EGR valves.
 - D. The ring is to be used only on engines equipped with a diesel particulate filter.

Answer A is incorrect. The dot always faces up.

Answer B is correct. The dot always faces up.

Answer C is incorrect. The dot always faces up. It has nothing to do with EGR.

Answer D is incorrect. The dot always faces up. It has nothing to do with diesel particulate filters.



TASK E.10
PAGES 40–41

44. All of the following are true for DEF EXCEPT:
- A. It is used to control NO_x emissions.
 - B. It is injected into the exhaust stream.
 - C. It contains urea.
 - D. It cannot be allowed to freeze.

Answer A is incorrect. DEF lowers NO_x emissions.

Answer B is incorrect. DEF is injected into the exhaust stream between the diesel particulate filter and the selective catalytic reduction catalyst.

Answer C is incorrect. DEF is 32% urea.

Answer D is correct. Freezing does not affect DEF.

45. Which of the following indicates a need to check fuel supply pressure?

- A. Smoke on acceleration
- B. Smoke on start up
- C. Low turbocharger boost pressure
- D. Excessive turbocharger boost pressure

Answer A is incorrect. Smoke on acceleration indicates a problem with the aneroid/air fuel control or the boost pressure sensor circuit.

Answer B is incorrect. Smoke on start up can indicate a problem with valve guide seals or valve guides. White smoke on start up can indicate low compression or a failure in the starting aids, such as glow plugs or air inlet heaters.

Answer C is correct. Low turbocharger boost pressure can be a direct result of low fuel delivery. This would indicate a need to check fuel pressure.

Answer D is incorrect. Excessive boost pressure indicates a failure in the wastegate circuit or in the variable geometry controls.

46. Which of the following would be used to measure oil pump drive gear backlash?

- A. Plastigauge[®]
- B. Dial indicator
- C. Torque wrench
- D. Angle gauge

Answer A is incorrect. Plastigauge[®] is used to check bearing clearance, not gear lash.

Answer B is correct. A dial indicator is used to measure gear backlash.

Answer C is incorrect. A torque wrench can be used to measure turning torque, but not backlash.

Answer D is incorrect. An angle gauge would not be used to measure backlash.

47. There is diesel fuel in the oil of a diesel engine. Which of the following could be the cause?

- A. Restricted fuel return line.
- B. Restricted fuel supply line.
- C. Leaking fuel filter.
- D. Leaking injector o-ring.

Answer A is incorrect. A restricted fuel return line will not cause fuel to enter the oil.

Answer B is incorrect. A restricted supply line will cause low power, but it will not cause fuel to enter the oil.

Answer C is incorrect. A leaking fuel filter will cause an external leak or allow air to enter the fuel, but it will not allow fuel to enter the oil.

Answer D is correct. A leaking injector o-ring could cause the fuel to enter the oil.



TASK F.4
PAGE 44



TASK D.2
PAGE 32



TASK A.14
PAGE 20



TASK D.13
PAGE 37

48. A driver complains of poor fuel economy. Which of the following is the most likely cause?
- The fan clutch is not operating.
 - The fan clutch is stuck on.
 - The tires are overinflated.
 - Restricted fuel filters.

Answer A is incorrect. A fan clutch that is not operating would not cause the engine to burn excess fuel.

Answer B is correct. A fan that was operating all the time could cause excess fuel consumption.

Answer C is incorrect. Overinflated tires would not increase fuel consumption.

Answer D is incorrect. Restricted fuel filters would not cause increased fuel consumption.



TASK B.3
PAGE 22

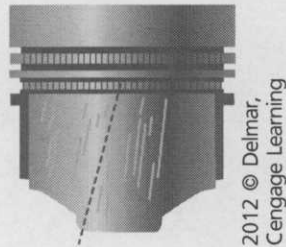
49. A surface comparator is used to:
- Measure surface warpage.
 - Compare the deck to the head.
 - Measure surface finish.
 - Measure head thickness.

Answer A is incorrect. A straightedge and feeler gauge are used to measure warpage.

Answer B is incorrect. A surface comparator visually measures the surface finish.

Answer C is correct. A surface comparator is used to measure the machined surface of a cylinder head and block deck.

Answer D is incorrect. Head thickness is measured with a micrometer.



TASK C.12
PAGE 30

50. The piston wear pattern shown above indicates:
- A bent crankshaft
 - A bent connecting rod
 - An out of round cylinder bore
 - A tapered cylinder bore

Answer A is incorrect. A diagonal wear pattern on a piston skirt is an indication of a bent connecting rod.

Answer B is correct. A diagonal wear pattern on a piston skirt is an indication of a bent connecting rod.

Answer C is incorrect. A diagonal wear pattern on a piston skirt is an indication of a bent connecting rod.

Answer D is incorrect. A diagonal wear pattern on a piston skirt is an indication of a bent connecting rod.

PREPARATION EXAM 6—ANSWER KEY

- | | | |
|-------|-------|-------|
| 1. A | 21. C | 41. C |
| 2. D | 22. A | 42. B |
| 3. A | 23. C | 43. D |
| 4. B | 24. B | 44. C |
| 5. A | 25. A | 45. A |
| 6. C | 26. C | 46. A |
| 7. A | 27. D | 47. B |
| 8. C | 28. B | 48. C |
| 9. A | 29. C | 49. A |
| 10. C | 30. A | 50. A |
| 11. B | 31. A | |
| 12. C | 32. A | |
| 13. B | 33. B | |
| 14. C | 34. A | |
| 15. A | 35. B | |
| 16. C | 36. A | |
| 17. A | 37. D | |
| 18. B | 38. A | |
| 19. A | 39. C | |
| 20. A | 40. D | |

PREPARATION EXAM 6—EXPLANATIONS

- An engine has had a major bearing failure. Besides replacing the failed parts, what else should be replaced?
 - Engine oil cooler
 - Transmission oil cooler
 - Fuel cooler
 - ECM

Answer A is correct. Bearing particles entered the oil cooler during the bearing failure, so there is no way to be sure all these particles are removed during oil cooler cleaning. If the oil cooler is reused, the danger of a particle leaving the oil cooler and entering the engine is too high to reuse the cooler.

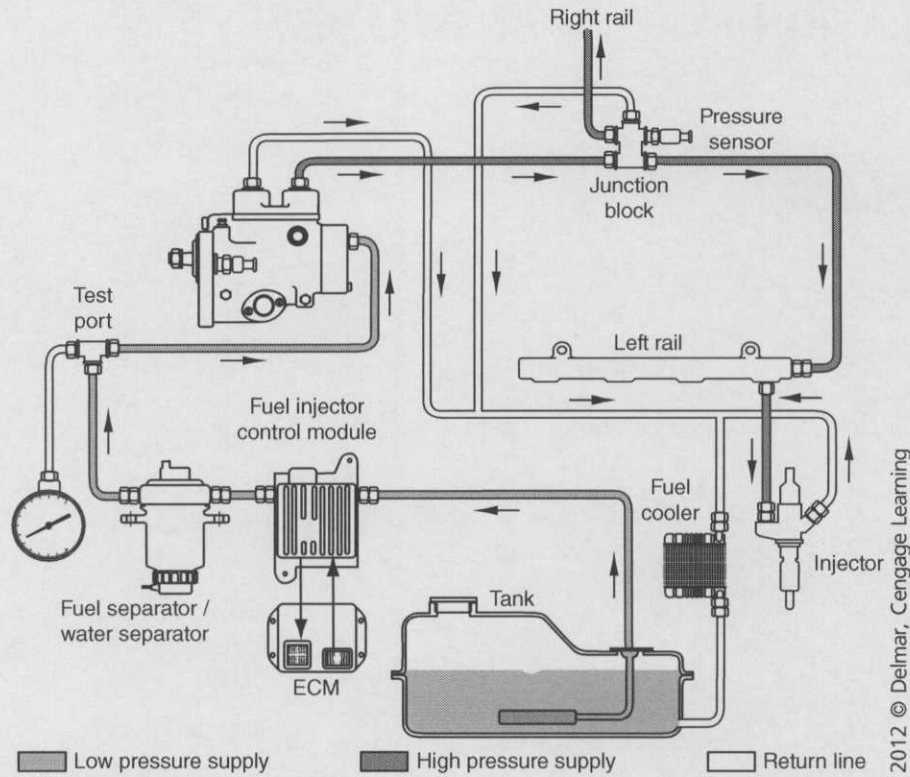
Answer B is incorrect. There is no need to replace the transmission oil cooler when the engine has a bearing failure.

Answer C is incorrect. The fuel cooler will not be contaminated when the engine has a bearing failure.

Answer D is incorrect. The ECM does not need to be replaced.



TASK D.4
PAGE 33



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TASK F.4
PAGE 44

2. The technician is performing a fuel supply test at the test port as indicated above. The gauge is reading a vacuum that is higher than specification. Which of the following could be the problem?
- A. Restricted fuel cooler
 - B. Stuck open pressure limiting valve
 - C. Stuck closed pressure limiting valve
 - D. Restricted fuel filter/water separator

Answer A is incorrect. A restricted fuel cooler would cause a high-drain system pressure.

Answer B is incorrect. A stuck open pressure limiting valve would cause low high side pressure.

Answer C is incorrect. A stuck closed pressure limiting valve would cause a higher than normal high side pressure.

Answer D is correct. A restricted fuel filter/water separator would cause a higher than normal vacuum on the suction side.



TASK A.5
PAGE 16

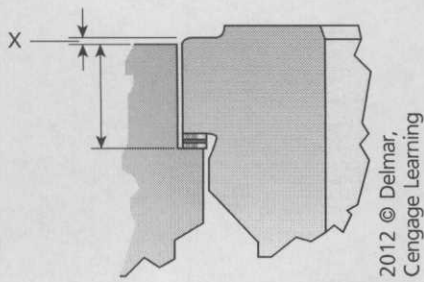
3. Which of the following is used with fluorescent dye?
- A. Black light
 - B. Blue light
 - C. Red light
 - D. Yellow light

Answer A is correct. A black light is used with fluorescent dye.

Answer B is incorrect. A blue light is not used.

Answer C is incorrect. A red light is not used.

Answer D is incorrect. The dye will show yellow under the black light.



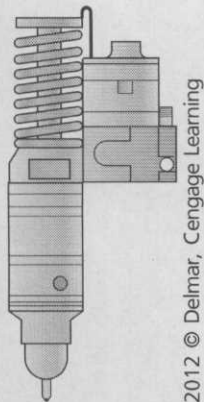
4. The dimension indicated by the “X” shown above is less than specified. This would be corrected by:
- Cutting the counter bore.
 - Increasing the shim thickness.
 - Decreasing the shim thickness.
 - Cutting the liner flange.

Answer A is incorrect. Cutting the counter bore would lower the liner even further.

Answer B is correct. Installing thicker shims would increase liner height.

Answer C is incorrect. Decreasing the shim thickness would lower the liner height.

Answer D is incorrect. Cutting the flange is not done, and if it was, it would lower the liner height.



5. The injector pictured above is a:
- EUI
 - HEUI
 - Common rail
 - PLN-E

Answer A is correct. This is a EUI injector.

Answer B is incorrect. A HEUI injector will not have a plunger tappet on the top.

Answer C is incorrect. A common rail injector will not have a plunger tappet on the top.

Answer D is incorrect. A PLN-E injector will not have a plunger tappet on top.



TASK C.13
PAGES 30-31



TASK F.10
PAGES 47-49



TASK E.13
PAGE 42

6. What is the function of the crankcase breather?
- Provide clean air for the DOC
 - Measure engine blow-by
 - Filter crankcase vapors
 - Filter the engine oil

Answer A is incorrect. The DOC does not get clean air from the crankcase breather.

Answer B is incorrect. The crankcase pressure sensor is designed to set a DTC when the crankcase filter is restricted.

Answer C is correct. The crankcase breather filters out the oil from the crankcase vapors.

Answer D is incorrect. The engine oil is filtered by the engine oil filter.



TASK C.11
PAGE 30

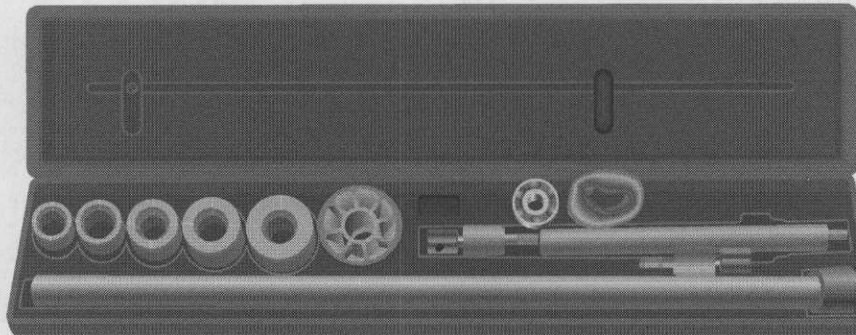
7. Technician A says piston-to-cylinder wall clearance can be measured with a feeler gauge. Technician B says piston-to-cylinder wall clearance can be measured with a depth micrometer. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. A feeler gauge can be inserted next to the piston to determine piston-to-cylinder wall clearance.

Answer B is incorrect. A depth micrometer cannot be used to measure piston-to-cylinder wall clearance.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



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TASK C.8,
C.4
PAGES 29,
26-27

8. All of the following is true concerning using the tool shown above EXCEPT:
- It is used to remove cam bearings.
 - It is used to install cam bearings.
 - It is used to install main bearings.
 - The oil hole on the bearing must be aligned.

Answer A is incorrect. The tool is used to remove cam bearings.

Answer B is incorrect. The tool is used to install cam bearings.

Answer C is correct. Main bearings are typically installed by hand, not with a tool.

Answer D is incorrect. When the bearing is installed on the installer sleeve, the technician must be sure to align the oil hole on the bearing with the oil hole in the block.

9. The turbocharger wastegate is stuck open on a diesel engine. Which of the following would be the most likely result?
- A. Poor acceleration
 - B. Hard starting
 - C. Excessive exhaust restriction
 - D. Excessive air inlet restriction



TASK E.4
PAGES 38-39

Answer A is correct. A stuck open wastegate will cause the turbo to be slow to spool up. This will cause poor acceleration.

Answer B is incorrect. This will not cause the engine to be hard to start.

Answer C is incorrect. This will not affect exhaust restriction.

Answer D is incorrect. This will not affect air inlet restriction.

10. An ECM-controlled fan clutch is on all the time. Technician A says a faulty A/C high side pressure sensor could cause this. Technician B says a coolant temperature sensor could cause this. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B



TASK D.13
PAGE 37

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. A faulty high side A/C pressure switch could cause the fan to run all the time. A coolant temperature sensor could also cause the fan to run all the time if the sensor was indicating to the ECM that the engine was hot.

Answer D is incorrect. Both Technicians are correct.

11. A vehicle has returned from the body shop after being repaired. After the repairs, the vehicle started, died and will not restart. Which of the following could be the cause?
- A. The engine ECM needs the accident information downloaded.
 - B. The anti-theft module needs to be reprogrammed.
 - C. The diesel particulate filter needs to be regenerated.
 - D. The variable geometry turbocharger needs to relearn its position.



TASK F.15
PAGE 52

Answer A is incorrect. Any information stored during the accident would not need to be downloaded for the engine to run.

Answer B is correct. If the anti-theft module was replaced or lost its memory during the repairs, it will need to be reprogrammed.

Answer C is incorrect. The diesel particulate filter would not cause this type of concern.

Answer D is incorrect. If the VGT needed to relearn, it would set a DTC, but it would not cause this type of concern.



TASK A.7
PAGE 17

12. A noise is coming from the accessory drive on the front of the engine. Technician A says the serpentine belt can be removed to help locate the source of the noise. Technician B says a laser can be used to help locate the source of the noise. Who is correct?

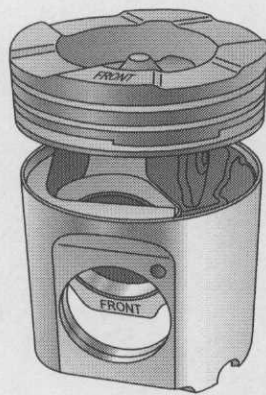
- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. The belt can be removed and the pulleys spun by hand. Also the belt alignment can be checked with a laser alignment tool.

Answer D is incorrect. Both Technicians are correct.



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TASK C.12
PAGE 30

13. All of the following statements are true about the above illustration EXCEPT:

- A. The skirt will separate from the head.
- B. The skirt is steel.
- C. The piston pin is full-floating.
- D. It is referred to as an articulating piston.

Answer A is incorrect. This is a two-piece piston; the skirt and head will separate.

Answer B is correct. The skirt is constructed of aluminum, and the head is steel.

Answer C is incorrect. Two-piece pistons are held together by the piston pin.

Answer D is incorrect. This is an articulating piston.

14. All of the following is true about the vehicle identification number (VIN) EXCEPT:

- A. The 8th digit is the engine code.
- B. The 10th digit is the year.
- C. The engine code is always a number.
- D. The year code is a number or letter.

Answer A is incorrect. The 8th digit is the engine code.

Answer B is incorrect. The 10th digit is the year.

Answer C is correct. The engine code can be a number or a letter.

Answer D is incorrect. The year code can be a number or a letter.

15. The fuel injection pump is being replaced on a PLN-E (pump-line-nozzle electronic) fuel system. Which of the following is true?

- A. The pump must be timed to the engine.
- B. The injectors will also be replaced because they are a matched set.
- C. The inactive (history) codes must be erased before the engine will start.
- D. The engine's camshaft position sensor must be replaced because they are a matched set.

Answer A is correct. The pump must be timed to the engine.

Answer B is incorrect. The injectors and pump are not a matched set.

Answer C is incorrect. The inactive codes will not prevent the engine from starting.

Answer D is incorrect. The engine's camshaft position sensor and injection pump are not a matched set.

16. A cylinder head is to be removed from a cam in-block diesel engine. Which of the following must be done prior to head removal?

- A. Remove the timing chain
- B. Remove the cam
- C. Remove the coolant
- D. Remove the oil pan

Answer A is incorrect. The timing chain does not need to be removed prior to removing the head.

Answer B is incorrect. The cam does not need to be removed prior to removing the head.

Answer C is correct. The coolant must be drained prior to removing the head.

Answer D is incorrect. The oil pan does not need to be removed prior to head removal.



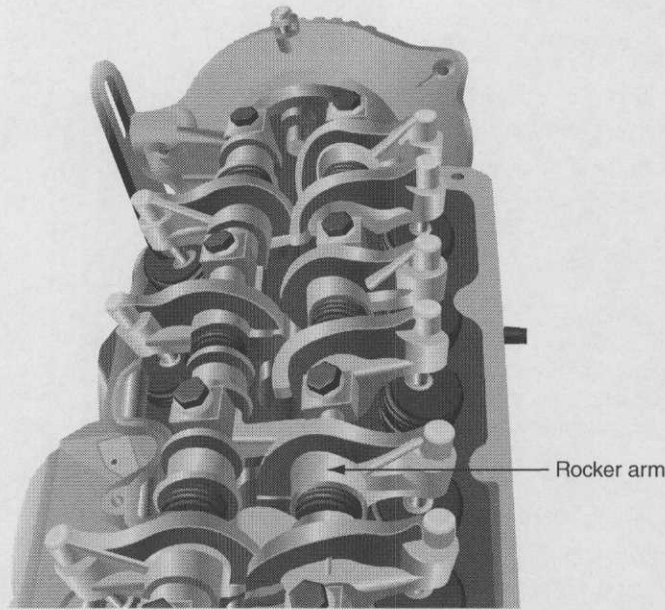
TASK A.2
PAGES 14-15



TASK F.9
PAGE 47



TASK B.1,
A.17
PAGES 21, 21



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TASK B.7
PAGES 23-24

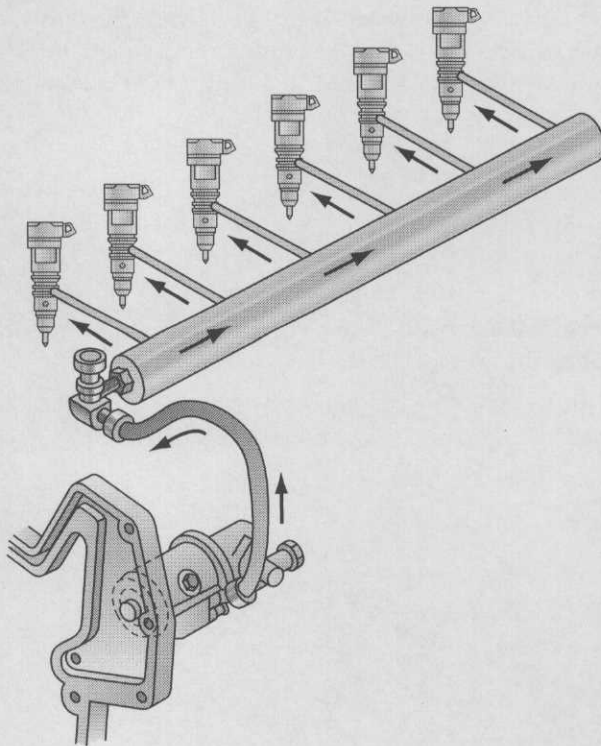
17. The engine shown above:
- A. Is an overhead cam engine.
 - B. Is a cam in-block engine.
 - C. Has two rocker arms per cylinder.
 - D. Must be torqued from the outside in.

Answer A is correct. This is an overhead cam engine.

Answer B is incorrect. This is an overhead cam engine.

Answer C is incorrect. This engine has three rocker arms per cylinder.

Answer D is incorrect. Cylinder heads are torqued from the inside out.



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18. An engine equipped with the fuel system shown above will not start. The scan tool displays an injector control pressure sensor value of 0 psi with key on and the engine off and 75 psi when cranking at 200 rpm. Which of the following is the most likely cause of the no start condition?
- Low fuel level
 - Low injection actuation pressure
 - A faulty injector control pressure sensor
 - A faulty engine position sensor

TASK A.15
PAGE 20

Answer A is incorrect. The injection actuation pressure is too low to operate the injectors.

Answer B is correct. Injection actuation pressure is too low for the engine to start.

Answer C is incorrect. The sensor is most likely working correctly; it reads 0 psi with key on and the engine off and a higher psi while cranking.

Answer D is incorrect. 200 rpm while cranking is a normal reading.

19. All of the following are true concerning piston pin installation EXCEPT:
- Semi-floating designs will use snap rings.
 - Semi-floating designs can be assembled with heat.
 - Semi-floating designs can be assembled with a press.
 - Full-floating designs will use snap rings.

TASK C.13
PAGES 30-31

Answer A is correct. Semi-floating designs do not need snap rings.

Answer B is incorrect. Semi-floating designs can be heated to increase the hole diameter to aid in installing the pin.

Answer C is incorrect. Semi-floating designs can be assembled with a press, but special fixtures must be used to prevent piston damage.

Answer D is incorrect. A full floating design will use snap rings, and a semi-floating will not.



TASK F.2,
B.4
PAGES 43,
22-23

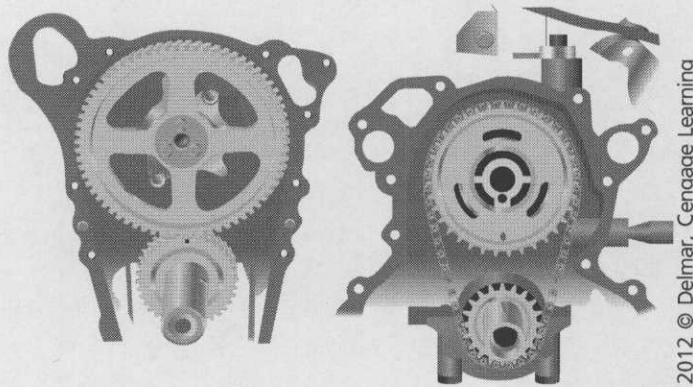
20. A fleet of light-duty delivery trucks have repeated water-in-fuel problems. The bulk tanks have been tested and do not contain water. Technician A says the trucks should be refueled at the end of each day. Technician B says the trucks should be fueled at the beginning of each day. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is correct. Only Technician A is correct. Refueling the trucks at the end of each day will help prevent condensation in the tanks while the trucks set overnight.

Answer B is incorrect. Refueling the trucks in the morning will allow water to collect in the tanks due to condensation. This may be the cause of the original concern.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



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TASK E.2,
C.9
PAGES
38, 29

21. The gear train shown above has been assembled out of time. Which of the following would be the LEAST LIKELY result?
- The engine will not rotate.
 - The engine will have low power.
 - Turbo boost pressure will be excessive.
 - Incorrect injection timing.

Answer A is incorrect. The engine may lock up with an out of time camshaft.

Answer B is incorrect. If the engine will start, it will likely have low power because the cam is out of time.

Answer C is correct. An out of time camshaft will not cause excessive boost pressure. It can cause poor performance and increased emissions.

Answer D is incorrect. If the injection pump is cam gear driven, it will most likely be out of time.

22. The exhaust after treatment system is performing an active regeneration more often than normal. Technician A says a leaking fuel injector can cause this. Technician B says a leaking exhaust pipe downstream of the DPF (diesel particulate filter) can cause this. Who is correct?
- A. A only
 - B. B only
 - C. Both A and B
 - D. Neither A nor B

TASK E.10
PAGE 40

Answer A is correct. Only Technician A is correct. A leaking injector can load up the DPF and require frequent active regeneration.

Answer B is incorrect. A leaking exhaust pipe downstream from the DPF will not cause restriction of the DPF.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.

23. The instrument panel on a customer's vehicle displays Exhaust System Regeneration in Process. Which of the following should the customer do?
- A. Bring the vehicle to the dealer for service as soon as possible.
 - B. Immediately stop the vehicle and let it idle until the message disappears.
 - C. Continue driving the vehicle.
 - D. Stop the vehicle immediately and have it towed to the dealer for service.

TASK E.8
PAGE 40

Answer A is incorrect. The vehicle does not need to be taken to the dealer.

Answer B is incorrect. This is a normal message; the customer should continue to drive the vehicle and let the process complete.

Answer C is correct. The customer should continue to drive the vehicle.

Answer D is incorrect. The vehicle does not need to be towed.

24. All of the following tools could be used to measure the cylinder walls for wear EXCEPT:
- A. Dial bore gauge
 - B. Depth micrometer
 - C. Inside micrometer
 - D. Snap gauge

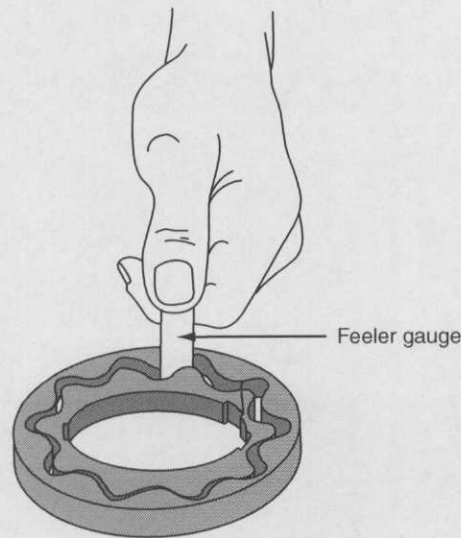
TASK C.3
PAGE 26

Answer A is incorrect. A dial bore gauge can be used to measure cylinder walls.

Answer B is correct. A depth micrometer cannot be used to measure cylinder walls.

Answer C is incorrect. An inside micrometer can be used to measure cylinder walls.

Answer D is incorrect. A snap gauge can be used to measure cylinder walls.



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TASK D.2
PAGE 32

25. The oil pump measurement above is called:

- A. Inner to outer rotor clearance
- B. Outer rotor to pump body
- C. Inner rotor to pump body
- D. Inner rotor to drive gear

Answer A is correct. This is the inner to outer rotor clearance check. If this clearance is greater than specification, low oil pressure will be the result. These rotors are usually replaced in a set.

Answer B is incorrect. Outer rotor to pump body would have the feeler gauge on the outside of the outer rotor.

Answer C is incorrect. Inner rotor to pump body is not a valid measurement.

Answer D is incorrect. Inner rotor to drive gear would have the feeler gauge on the inside of the inner rotor.

TASK F.11
PAGES
49-50

26. An electronically controlled diesel engine runs poorly. It has eight active codes and 10 inactive codes. All the codes were set at the same ECM time. Which of the following is the most likely cause?

- A. Worn crankshaft thrust washer
- B. Worn camshaft thrust washer
- C. Poor electrical supply connections
- D. Faulty ECM

Answer A is incorrect. A worn crankshaft thrust washer may set a code for a crankshaft position sensor, but it is very unlikely that it would set this many codes.

Answer B is incorrect. A worn camshaft thrust washer may set a camshaft position sensor code, but it is very unlikely that it would set this many codes.

Answer C is correct. Poor electrical connections can cause many codes to be set simultaneously.

Answer D is incorrect. The ECM may cause multiple codes to be set; however, it is not the most likely cause.

27. When using coolant test strips, the engine should be:

- A. At operating temperature
- B. Running at high idle
- C. Running at low idle
- D. Cool

Answer A is incorrect. It is not a safe practice to open the cooling system when it is at operating temperature.

Answer B is incorrect. The engine does not need to be running to check the coolant with test strips.

Answer C is incorrect. The engine does not need to be running to test the coolant with test strips.

Answer D is correct. The engine should be cool for safety.



TASK A.13
PAGE 19



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28. The measurement shown above is less than specified. Which of the following could be the cause?

- A. The connecting rod is worn.
- B. The connecting rod is installed incorrectly.
- C. The crankshaft is worn.
- D. The incorrect main bearings were selected.

Answer A is incorrect. A worn rod would cause the measurement to be excessive.

Answer B is correct. If the rod was installed backward, this could cause the measurement to be less than specified.

Answer C is incorrect. If the crankshaft was worn, the measurement would be greater than specified.

Answer D is incorrect. Main bearing selection will not affect rod side clearance.



TASK C.12
PAGE 30



TASK B.3
PAGE 22

29. The cooling passage core plug in a cylinder head is leaking. Which of the following is true?
- The head must be replaced.
 - The cooling system must be flushed.
 - The core plug must be replaced.
 - The injector sleeves must be inspected.

Answer A is incorrect. Core plugs are usually replaced without replacing the head.

Answer B is incorrect. The cooling system may be flushed if contaminated. However, it does not necessarily have to be flushed.

Answer C is correct. The core plug is replaced if leaking. It cannot be reused.

Answer D is incorrect. There is no reason to suspect the injector sleeves caused the core plug to leak.



TASK F.2
PAGE 43

30. The WIF (water in fuel) sensor may be found in any of the following EXCEPT:
- Fuel tank
 - Primary filter
 - Water separator
 - Fuel conditioner module

Answer A is correct. The WIF sensor is usually located in the primary fuel filter. It is not located in the fuel tank.

Answer B is incorrect. The WIF sensor can be located in the primary fuel filter.

Answer C is incorrect. The WIF sensor can be located in the water separator if the vehicle is so equipped.

Answer D is incorrect. The WIF sensor can be located in the fuel conditioner module, which may also contain the primary fuel filter.



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TASK C.13,
D.7
PAGES
30-31, 34

31. All of the following are true concerning the tool shown above EXCEPT:
- It is used to measure ring end gap.
 - It becomes wider when clearances are tighter.
 - It measures bearing clearance.
 - Color determines width.

Answer A is correct. This is Plastigauge[®], which is used to measure bearing clearance. It cannot be used to measure ring end gap.

Answer B is incorrect. This is Plastigauge[®]. It is compressed thinner, thus becoming wider when clearance is decreased.

Answer C is incorrect. This is Plastigauge[®], which is used to measure bearing clearance.

Answer D is incorrect. This is Plastigauge[®], which is used to measure bearing clearance. The color indicates which clearance range it should be used for.

32. The diesel oxidation catalyst (DOC) is located:
- A. Before the diesel particulate filter (DPF).
 - B. After the diesel particulate filter (DPF).
 - C. In parallel with the diesel particulate filter (DPF).
 - D. In parallel with the turbocharger.

Answer A is correct. The DOC is located before the DPF in the exhaust stream to heat the DPF.

Answer B is incorrect. The DPF is located after the DOC.

Answer C is incorrect. The DOC and DPF are in series.

Answer D is incorrect. The turbocharger and DOC are in series.

33. There are air bubbles flowing in the return fuel flow. Which of the following is the most likely cause?
- A. Leaks in the return fuel line
 - B. Leaks in the suction side fuel line
 - C. Restricted fuel filter
 - D. Restricted fuel cooler

Answer A is incorrect. Leaks in the return fuel line would cause a fuel leak, not air bubbles in the return fuel stream.

Answer B is correct. Air bubbles flowing in the return fuel line indicate suction side leaks.

Answer C is incorrect. A restricted fuel filter will cause reduced fuel flow, but it will not introduce air in the return fuel stream.

Answer D is incorrect. A restricted fuel cooler will cause hot fuel, which can cause low power.

34. All of the following are true concerning crankcase pressure measurements EXCEPT:
- A. It is measured at the exhaust manifold.
 - B. A special restrictor orifice may be needed to perform the test.
 - C. It is measured at the dipstick tube.
 - D. The pressure will change depending on engine wear.

Answer A is correct. Crankcase pressure is measured at the dipstick tube, or crankcase breather tube. Exhaust back pressure is measured at the exhaust manifold.

Answer B is incorrect. Crankcase pressure is measured at the dipstick tube, or crankcase breather tube. A special orifice may be needed to perform the measurement accurately. If needed, it will be listed in the service procedures.

Answer C is incorrect. Crankcase pressure is measured at the dipstick tube, or crankcase breather tube.

Answer D is incorrect. Crankcase pressure is measured at the dipstick tube, or crankcase breather tube. Worn compression rings and cylinder walls will cause the test results to be higher.



TASK E.10
PAGES
40-41



TASK F.3
PAGE 43



TASK A.11
PAGES 18-19



TASK E.9
PAGE 40

35. All the glow plugs in a diesel engine are burnt out. Which of the following could be the cause?
- Operating the vehicle with a low battery.
 - A shorted glow plug relay.
 - An open glow plug relay.
 - A shorted coolant temperature sensor.

Answer A is incorrect. Operating the vehicle with a discharged battery may prevent the engine from starting; however, it is very unlikely that this would burn out all the glow plugs.

Answer B is correct. Shorted contacts on a glow plug relay will keep the voltage applied to the glow plugs continuously. This will overheat the glow plugs and burn them out.

Answer C is incorrect. An open glow plug relay would not apply voltage to the glow plugs. The engine may not start; however, the glow plugs would not burn out because of this.

Answer D is incorrect. A shorted coolant temperature sensor would indicate a higher than normal engine temperature. This would not cause the ECM to keep the glow plugs on longer than normal.



TASK E.13,
C.1
PAGES 42,
25-26

36. A rear main seal is leaking on a diesel engine. Which of the following is the most likely cause?
- Restricted crankcase ventilation system
 - Restricted oil filter
 - Excessive main bearing clearance
 - Excessive rod bearing clearance

Answer A is correct. A restricted crankcase ventilation system could cause high crankcase pressure and cause the rear main seal to leak.

Answer B is incorrect. A restricted oil filter will cause the by-pass valve to open, but it would not cause the seal to leak.

Answer C is incorrect. Excessive main bearing clearance causes low oil pressure.

Answer D is incorrect. Excessive rod bearing clearance causes low oil pressure.



TASK E.5
PAGE 39

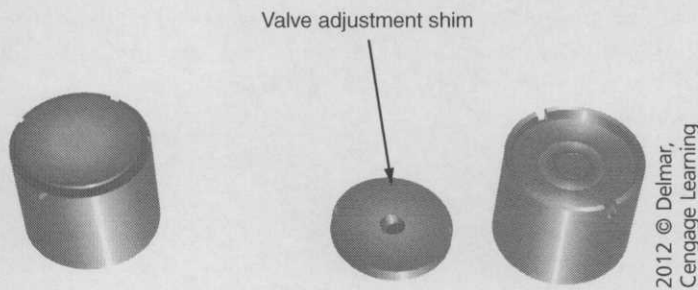
37. A diesel engine has a DTC P0103 Mass Airflow Sensor Voltage High. The technician wiggles the sensor wiring harness while observing the mass airflow sensor voltage with the scan tool. The sensor voltage changes. Technician A says the cause may be a faulty scan tool. Technician B says the cause may be a faulty ECM. Who is correct?
- A only
 - B only
 - Both A and B
 - Neither A nor B

Answer A is incorrect. If the voltage value changed while moving the wiring harness, the most likely cause is the wiring harness. If the voltage changed while moving the scan tool, then the problem may be the scan tool.

Answer B is incorrect. If the voltage value changed while moving the wiring harness, the cause is the wiring harness. If the ECM was faulty, the voltage may change while tapping lightly on the ECM.

Answer C is incorrect. Neither Technician is correct.

Answer D is correct. Neither Technician is correct.



38. The valve adjustment is too tight on an engine that uses the above cam follower mechanism. All of the following are true EXCEPT:
- A thicker shim should be installed.
 - The valve will open earlier than normal due to the decreased clearance.
 - The valve will close later than normal due to the decreased clearance.
 - A thinner shim should be installed.

Answer A is correct. Installing a thicker shim would tighten the clearance even more.

Answer B is incorrect. Decreased valve clearance allows the cam to make contact sooner, thus opening the valve sooner.

Answer C is incorrect. Decreased valve clearance causes the camshaft to travel farther prior to closing the valve.

Answer D is incorrect. A thinner shim should be installed. This will bring the clearance back into specification.

39. An engine is slow to warm and operates at a lower temperature than normal. Which of the following could be the cause?
- A restricted charge air cooler
 - A restricted radiator
 - A stuck open thermostat
 - A stuck closed thermostat

Answer A is incorrect. A restricted charge air cooler could cause overheating because there would be insufficient air flow across the radiator.

Answer B is incorrect. A restricted radiator would cause engine overheating.

Answer C is correct. A stuck open thermostat could cause the engine to fail to reach operating temperature.

Answer D is incorrect. A stuck closed thermostat would prevent the coolant from circulating to the radiator and would cause engine overheating.

40. A common rail fuel system high-pressure pump has been replaced. Which of the following is true?
- The pump must be timed to the engine.
 - The pump serial number must be programmed into the ECM.
 - All inactive (history) codes will need to be removed for the engine to start.
 - The fuel filters should be installed and filled using the hand primer pump.

Answer A is incorrect. The common rail pump is not timed to the engine.

Answer B is incorrect. The pump serial number does not need to be entered into the ECM.

Answer C is incorrect. Inactive (history) codes will not prevent the engine from starting.

Answer D is correct. The filters should be filled using the hand primer pump. Fuel should not be poured directly into the filters; this would allow unfiltered fuel to enter the fuel system.



TASK B.9
PAGES 24–25



TASK D.9
PAGE 35



TASK F.7
PAGE 45



TASK A.3
PAGE 15

41. While repairing a leaking head gasket, the technician notices an electrical splice connector in the wiring harness at the turbo boost pressure sensor. Technician A says this could indicate vehicle tampering and possibly void the warranty. Technician B says the repair history of the vehicle should be researched. Who is correct?

- A. A only
- B. B only
- C. Both A and B
- D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. Vehicle tampering could be the cause of the blown head gasket if there is evidence that the engine has been subjected to excessive turbo boost pressure. The repair history of the vehicle should be reviewed to see if similar failures have been repaired. This would be additional evidence of a possible tampering concern.

Answer D is incorrect. Both Technicians are correct.



TASK E.7
PAGES
39-40

42. Which tool is used to measure exhaust back pressure on an engine equipped with a DPF (diesel particulate filter)?

- A. Water manometer
- B. Mercury manometer
- C. Vacuum gauge
- D. 20–100 psi pressure gauge

Answer A is incorrect. The pressure is too great for a water manometer.

Answer B is correct. A mercury manometer is used.

Answer C is incorrect. There will be pressure, not vacuum, in the exhaust system.

Answer D is incorrect. The pressure will be too low for a 20–100 psi pressure gauge.



TASK A.9
PAGES 17-18

43. A freshly overhauled diesel engine is hard to start when cold and blows white smoke until fully warmed. All of the following could be the cause EXCEPT:

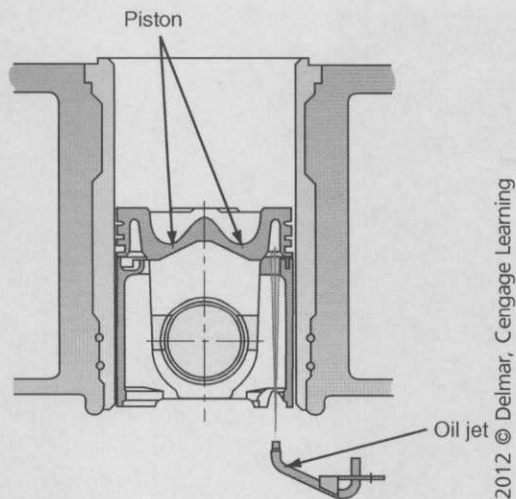
- A. Incorrect injection pump timing
- B. Incorrect pistons were installed
- C. Incorrect head gasket
- D. Incorrect valve seals

Answer A is incorrect. Incorrect pump timing can result in incomplete combustion, a hard to start engine and white smoke.

Answer B is incorrect. Incorrect pistons can cause lower compression and result in the conditions indicated.

Answer C is incorrect. An incorrect head gasket can cause lower than normal compression, which can cause white smoke and hard to start concerns.

Answer D is correct. Incorrect valve seals can cause blue smoke, but they would not cause white smoke or a hard to start concern.



44. If the oil jet shown above was aimed incorrectly, the most likely result would be:
- A. Low oil pressure
 - B. High oil pressure
 - C. Increased piston temperature
 - D. Increased coolant temperature



Answer A is incorrect. If the piston cooling jet is misdirected, the oil pressure would not be affected. If the jet was broken or missing, the oil pressure may be lower than normal.

Answer B is incorrect. If the piston cooling jet is misdirected, the oil pressure would not be affected. If the jet was broken or missing, the oil pressure may be lower than normal.

Answer C is correct. If the piston cooling jet was misdirected, the piston temperature would increase and could result in piston seizure, collapse or cylinder wall scoring.

Answer D is incorrect. The coolant temperature would not be affected if one piston cooling jet was misdirected.

45. Which of the following would be the best tool to use to help find a high-pressure fuel line leak on a PLN-E (pump-line-nozzle electronic) engine?
- A. A piece of cardboard
 - B. The technician's hand
 - C. A black light
 - D. Dye tracer

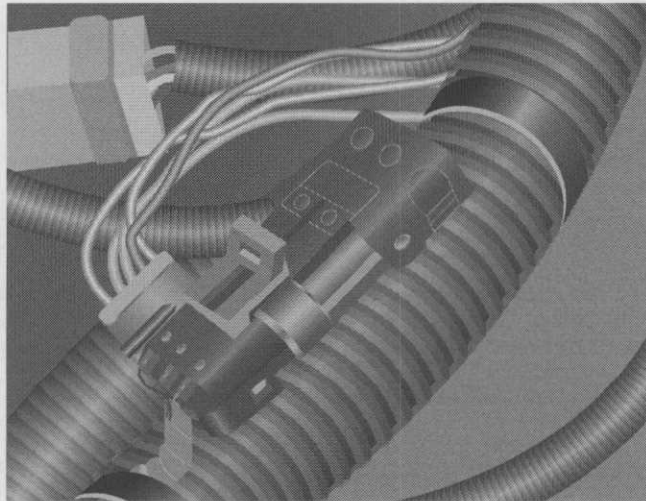


Answer A is correct. A piece of cardboard moved around the suspected leak area with the engine running will safely show the technician the source of the leak.

Answer B is incorrect. It is unsafe to put your hand in a suspected high-pressure leak area. The diesel fuel can penetrate the skin and cause blood poisoning.

Answer C is incorrect. A black light would not be used to find a high-pressure fuel leak.

Answer D is incorrect. Dye tracer would not be used to find a high-pressure fuel leak.



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TASK F.13
PAGES 50-51

46. The electrical connector shown above is a:
- A. Weather pack
 - B. Metri-Pack
 - C. Deutsch
 - D. Amp

Answer A is correct. This is a weather pack connector. It has a seal located between the two halves of the connector to protect the terminals from moisture corrosion.

Answer B is incorrect. This is a weather pack connector.

Answer C is incorrect. This is a weather pack connector.

Answer D is incorrect. This is a weather pack connector.

TASK B.10
PAGE 25

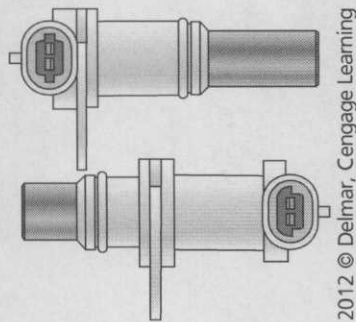
47. Worn camshaft bearings can cause:
- A. High oil pressure
 - B. Low oil pressure
 - C. Retarded cam timing
 - D. Advanced cam timing

Answer A is incorrect. Worn camshaft bearings will not cause high oil pressure.

Answer B is correct. Worn camshaft bearings will cause increased clearance and low oil pressure.

Answer C is incorrect. Worn camshaft bearings will not retard cam timing.

Answer D is incorrect. Worn camshaft bearings will not advance cam timing.



48. An engine equipped with the sensors shown above will not start. There is zero RPM indicated on the scan tool while the engine is cranking. Technician A says these sensors can be checked using an ohmmeter. Technician B says these sensors can be checked using an AC voltmeter. Who is correct?

A. A only
 B. B only
 C. Both A and B
 D. Neither A nor B

Answer A is incorrect. Technician B is also correct.

Answer B is incorrect. Technician A is also correct.

Answer C is correct. Both Technicians are correct. These sensors can be tested using an ohmmeter or checked for AC voltage generation while the engine is cranking.

Answer D is incorrect. Both Technicians are correct.

49. A diesel engine has low power. The technician notices the engine has a new turbocharger and new fuel filters. The engine has several small oil leaks. Which of the following is the most likely cause of the low power concern?

A. Worn piston rings
 B. Late injection timing
 C. Advanced injection timing
 D. Worn injectors

Answer A is correct. The engine has low power, and the turbocharger and fuel filters have been replaced. Most likely this engine has ingested a large amount of dirt. This is the reason for the turbocharger replacement. However, the rings were also subjected to the dirt and are worn. The oil leaks are from increased crankcase pressure due to worn compression rings.

Answer B is incorrect. Late injection timing would not account for the new parts and oil leaks.

Answer C is incorrect. Advanced injection timing would not account for the new parts and oil leaks.

Answer D is incorrect. Worn injectors would not account for the oil leaks or the new parts.

50. Technician A says threaded holes can be repaired by using a thread insert. Technician B says threaded studs can be repaired using a thread insert. Who is correct?

A. A only
 B. B only
 C. Both A and B
 D. Neither A nor B

Answer A is correct. Only Technician A is correct. A thread insert is used to repair threaded holes.

Answer B is incorrect. Studs are repaired by chasing the threads or stud replacement.

Answer C is incorrect. Only Technician A is correct.

Answer D is incorrect. Technician A is correct.



TASK F.15
 PAGE 52



TASK E.1
 PAGE 37



TASK B.2
 PAGES 21–22

PREPARATION EXAM ANSWER SHEET FORMS

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Glossary

Actuator A device that delivers motion in response to an electrical signal.

A/D Converter Abbreviation for analog-to-digital converter.

Additive An additive intended to improve a certain characteristic of the material or fluid.

Adsorber Catalyst An after-treatment device used in diesel and direct injection gasoline engines that uses a base metal oxide and a precious metal compound as a catalyst to transform NO_x to nitrogen gas and H₂O (water vapor).

Aftercooler A charge air cooling device, usually water cooled.

Air Compressor An engine-driven mechanism for supplying high-pressure air to the vehicle brake system.

Air Filter A device that minimizes the possibility of impurities entering the intake system.

Altitude Compensation System An altitude barometric switch and solenoid used to provide better drivability over 1,000 feet above sea level.

Ambient Temperature Temperature of the surrounding air. Normally, it is considered to be the temperature in the service area where testing is taking place.

Amp Acronym for ampere.

Ampere The unit for measuring electrical current.

Analog Signal A voltage signal that varies within a given range from high to low, including all points in between.

Analog-to-Digital Converter (A/D Converter) A device that converts analog voltage signals to a digital format; located in the ECM.

Analog Volt/Ohmmeter (AVOM) A test meter used for checking voltage and resistance. Analog meters should not be used on solid-state circuits.

Antifreeze A mixture added to water to lower its freezing point.

Armature The rotating component of a (1) starter or other motor or (2) generator.

Articulation Pivoting movement.

ASE Acronym for Automotive Service Excellence, a trademark of the National Institute for Automotive Service Excellence.

Atmospheric Pressure The weight of air at sea level; 14.696 pounds per square inch (psi) or 101.33 kilopascals (kPa).

Axis of Rotation The center line around which a gear or part revolves.

Battery Terminal A tapered post or threaded studs on top of the battery case for connecting the cables.

Bimetallic Two dissimilar metals joined together that have different bending characteristics when subjected to changes of temperature.

Blade Fuse A type of fuse having two flat male lugs for insertion in female box connectors.

Blower Fan A fan that pushes or blows air through a ventilation, heater or air-conditioning system.

Bobtailing A tractor running without a trailer.

Boss Outer race of a bearing.

Bottoming A condition that occurs when the teeth of one gear touch the lowest point between teeth of a mating gear.

British Thermal Unit (BTU) A measure of heat quantity equal to the amount of heat required to raise one pound of water by one degree F.

BTU Acronym for British thermal unit.

CAA Acronym for Clean Air Act.

Cartridge Fuse A type of fuse having a strip of low melting point metal enclosed in a glass tube. If an excessive current flows through the circuit, the fuse element melts at the narrow portion, opening the circuit and preventing damage.

Caster The angle formed between the kingpin axis and a vertical axis as viewed from the side of the vehicle. Caster is considered positive when the top of the kingpin axis is behind the vertical axis.

Cavitation A condition caused by bubble collapse.

C-EGR Cooled exhaust gas recirculation.

CFC Acronym for chlorofluorocarbon.

Charging System A system consisting of the battery, alternator, voltage regulator, associated wiring and the electrical loads of a vehicle. The purpose of the system is to recharge the battery whenever necessary and to provide the current required to power the electrical components.

Charging Circuit The alternator (or generator) and associated circuit used to keep the battery charged and power the vehicle electrical system when the engine is running.

Check Valve A valve that allows air to flow in one direction only.

Climbing A gear problem caused by excessive wear in gears, bearings and shafts whereby the gears move sufficiently apart to

cause the apex of the teeth on one gear to climb over the apex of another gear.

Clutch A device for connecting and disconnecting the engine from the transmission.

CO (Carbon Monoxide) A colorless, tasteless and odorless gas containing one carbon atom and one oxygen atom connected by a triple bond.

CO₂ (Carbon Dioxide) One carbon atom and two oxygen atoms. Carbon dioxide is considered a greenhouse gas because it allows visible light to pass but absorbs infrared light.

Coalescing Filter Media The filter media that removes the tiny oil particles from the engine crankcase blow-by gas. When used in the crankcase ventilation system the filter helps reduce engine emissions.

COE Acronym for cab-over-engine.

Coefficient of Friction A measurement of the amount of friction developed between two objects in physical contact when one of the objects is drawn across the other.

Coil Springs Spring steel spirals.

Common Rail A diesel fuel system that maintains a high fuel pressure regardless of engine speed. The system uses high-pressure fuel stored in a single or dual "common" rail that connects to every fuel injector on the engine via an injector line or tube.

Compression Applying pressure to a spring or fluid.

Compressor Mechanical device that increases pressure within a circuit.

Condensation The process by which gas (or vapor) changes to a liquid.

Conductor Any material that permits the electrical current to flow.

Coolant Liquid that circulates in an engine cooling system.

Coolant Heater A component used to aid engine starting and reduce the wear caused by cold starting.

Coolant Hydrometer A tester designed to measure coolant-specific gravity and determine antifreeze protection.

Cooling System System for circulating coolant.

Crankcase The housing within which the crankshaft rotates.

Cranking Circuit The starter circuit, including battery, relay (solenoid), ignition switch, neutral start switch (on vehicles with automatic transmission) and cables and wires.

Crosshead A device that allows a single rocker lever to depress two valves at a time. Sometimes referred to as a bridge.

Cycling (1) On-off action of the air conditioner compressor. (2) Repeated electrical cycling that can cause the positive plate material to break away from its grids and fall into the sediment base of the battery case.

Dampen To slow or reduce oscillations or movement.

Dampened Discs Discs that have dampening springs incorporated into the disc hub. When engine torque is transmitted to

the disc, the plate rotates on the hub, compressing the springs. This action absorbs the torsional vibration caused by today's low RPM-high torque engines.

Data Links Circuits through which computers communicate with other electronic devices, such as control panels, modules, sensors or other computers.

Deburring To remove sharp edges from a cut.

Deflection Bending or moving to a new position as the result of an external force.

Detergent Additive An additive that helps keep metal surfaces clean and prevents deposits. These additives suspend particles of carbon and oxidized oil in the oil.

DER Acronym for Department of Environmental Resources.

Diagnostic Flow Chart Charts that provide a systematic approach to the electrical system and component troubleshooting and repair. They are found in service manuals and are vehicle make and model specific.

Dial Caliper A measuring instrument capable of taking inside, outside, depth and step measurements.

Diesel Exhaust Fluid (DEF) A urea-based chemical that is 32.5 percent urea and 67.5 percent deionized water, designed specifically for use in selective catalyst reduction (SCR) systems on diesel engines to reduce NOx emissions.

Diesel Oxidation Catalyst (DOC) A flow-through device located in the exhaust system that consists of a canister containing a honeycomb-like structure. The substrate has a surface area that is coated with catalyst. This layer contains precious metals, usually either palladium or platinum. As the exhaust gases go through the catalyst, carbon monoxide and hydrocarbons (unburned fuel) are oxidized, thereby reducing harmful emissions, specifically particulate matter.

Diesel Particulate Filter (DPF) A flow-through device mounted in the exhaust stream of a diesel engine. It is designed to capture diesel particulate matter or soot from the exhaust gas of a diesel engine. The filter is cleaned on the engine through a regeneration process.

Digital Binary Signal A signal that has only two values, on and off.

Digital Volt/Ohmmeter (DVOM) A test meter recommended for use on solid-state circuits.

Diode Semiconductor device formed by joining P-type semiconductor material with N-type semiconductor material. A diode allows current to flow in one direction, but not in the opposite direction.

Dosing Injector The name of the injector used to inject DEF in the exhaust stream of a diesel engine equipped with selective catalyst reduction.

DOT Acronym for Department of Transportation.

Driven Gear A gear that is driven by a drive gear, by a shaft or by some other device.

Drive or Driving Gear A gear that drives another gear.

Driveline The propeller or driveshaft and universal joints that link the transmission output to the axle pinion gear shaft.

Driveline Angle The alignment of the transmission output shaft, driveshaft and rear axle pinion center line.

Drive Shaft Assembly of one or two universal joints connected to a shaft or tube used to transmit torque from the transmission to the differential.

Drive Train An assembly that includes all torque transmitting components from the rear of the engine to the wheels.

ECM Acronym for electronic control module.

ECU Acronym for electronic control unit.

Eddy Current Circular current produced inside a metal core in the armature of a starter motor. Eddy currents produce heat and are reduced by using a laminated core.

EGR (Exhaust Gas Recirculation) A system that diverts a small percentage of the exhaust gasses back into the cylinder. These gasses are inert, which results in lowering combustion temperatures and reducing NOx.

EGR Cooler An exhaust gas/engine coolant device that transfers heat from the exhaust gas to the engine coolant, allowing cooled EGR gases to flow to the combustion chamber.

EGR Valve A butterfly or poppet-type valve that controls EGR flow. The valve can be installed before or after the EGR cooler.

Electricity The movement of electrons from one location to another.

Electromotive Force (EMF) The force that moves electrons between atoms. This force is the pressure that exists between the positive and negative points. This force is measured in units called volts. Charge differential.

Electronically Erasable Programmable Memory (EEPROM) Computer memory that enables write-to functions.

Electrons Negatively charged particles orbiting every nucleus.

Engine Brake A hydraulically operated device that converts the engine into a power-absorbing mechanism.

Environmental Protection Agency (EPA) An agency of the United States government charged with the responsibilities of protecting the environment.

Exhaust After-Treatment Any technology or device that treats emissions in the exhaust stream as opposed to inside the combustion chamber.

Exhaust Brake A slide mechanism that restricts exhaust flow, causing exhaust backpressure to build up in the engine's cylinders. The exhaust brake actually transforms the engine into a power-absorbing air compressor driven by the wheels.

False Brinelling The polishing of a surface that is not damaged.

Fatigue Failures Progressive destruction of a shaft or gear teeth usually caused by overloading.

Fault Code A code that is recorded into the computer's memory.

Federal Motor Vehicle Safety Standard (FMVSS) A federal standard that specifies all vehicles in the United States must be assigned a vehicle identification number (VIN).

Fixed Value Resistor An electrical device designed to have only one resistance rating, which should not change, for controlling voltage.

Flammable Any material that will easily catch fire or explode.

Flare To spread gradually outward in a bell shape.

Foot-Pound A unit of measurement for torque. One foot-pound is the torque obtained by a force of one pound applied to a foot long wrench handle.

Fretting A result of vibration that the bearing outer race can pick up the machining pattern.

Fusible Link A term often used for an insulated fuse link.

Fuse Link A short length of smaller gauge wire installed in a conductor, usually close to the power source.

Gear A disc-like wheel with external or internal teeth that serves to transmit or change motion.

Gear Pitch The number of teeth per given unit of pitch diameter, an important factor in gear design and operation.

Ground The negatively charged side of a circuit. A ground can be a wire, the negative side of the battery, or the vehicle chassis.

Grounded Circuit A shorted circuit that causes current to return to the battery before it has reached its intended destination.

Harness and Harness Connectors The vehicle's electrical system wiring that provides a convenient starting point for tracking and testing circuits.

Hazardous Materials Any substance that is flammable, explosive, or is known to produce adverse health effects in people or the environment.

Heads-Up Display (HUD) A technology used in some vehicles that superimposes data on the driver's normal field of vision. The operator can view the information, which appears to "float" just above the hood at a range near the front of a vehicle. This allows the driver to monitor conditions such as road speed without interrupting his view of traffic.

Heater Control Valve A valve that controls the flow of coolant into the heater core from the engine.

Heat Exchanger A device used to transfer heat, such as a radiator or condenser.

Heavy-Duty Truck A truck that has a gross vehicle weight of 26,001 pounds or more.

High-Resistant Circuits Circuits that have an increase in circuit resistance with a corresponding decrease in current.

High-Strength Steel A low-alloy steel that is stronger than hot-rolled or cold-rolled sheet steels.

Hinged Pawl Switch The simplest type of switch; one that makes or breaks the current of a single conductor.

Hydrometer A tester designed to measure the specific gravity of a liquid.

Inboard Toward the center line of the vehicle.

In-Line Fuse A fuse that is in series with the circuit in a small plastic fuse holder, not in the fuse box or panel. It is used, when necessary, as a protection device for a portion of the circuit, even though the entire circuit may be protected by a fuse in the fuse box or panel.

Installation Templates Drawings supplied by some vehicle manufacturers to allow the technician to correctly install an accessory. The templates available can be used to check clearances or to ease installation.

Insulator A material, such as rubber or glass, that offers high resistance to electron flow.

Integrated Circuit A component containing diodes, transistors, resistors, capacitors and other electronic components mounted on a single piece of material and capable of performing numerous functions.

J1939 The standard set by the society of automotive engineers (SAE) used for communication and diagnostics among vehicle components.

Jacobs Engine Brake[®] A hydraulically operated engine brake that converts a power-producing diesel engine into a power-absorbing retarder.

Jumper Wire A wire used to temporarily by-pass a circuit or components for electrical testing. A jumper wire consists of a length of wire with an alligator clip at each end.

Jump Start The procedure used when it becomes necessary to use a boost battery to start a vehicle with a discharged battery.

Kinetic Energy Energy in motion.

Lateral Runout The wobble or side-to-side movement of a rotating wheel.

Laser Beam Alignment System A two- or four-wheel alignment system using wheel-mounted instruments to project a laser beam to measure toe, caster and camber.

Linkage A system of rods and levers used to transmit motion or force.

Low-Maintenance Battery A conventionally vented, lead/acid battery requiring normal periodic maintenance.

Magnetorque An electromagnetic clutch.

Maintenance-Free Battery A battery that does not require the addition of water during normal service life.

Maintenance Manual A publication containing routine maintenance procedures and intervals for vehicle components and systems.

National Automotive Technicians Education Foundation (NATEF) A foundation that certifies secondary and post-secondary automotive and heavy-duty truck training programs for accreditation by ASE.

National Institute for Automotive Service Excellence (ASE) A non-profit organization that has established certifica-

tion programs for automotive, heavy-duty truck, auto body repair, engine machine shop technicians, and parts specialists.

NIOSH Acronym for National Institute for Occupational Safety and Health.

NLGI Acronym for National Lubricating Grease Institute.

NHTSA Acronym for National Highway Traffic Safety Administration.

NO or Oxide of Nitrogen One nitrogen atom and one oxygen atom. Oxides of nitrogen are believed to react with oxygen in the air to create ozone.

NO₂ or Nitrous Dioxide One nitrogen atom and two oxygen atoms; the 2 stands for the number of oxygen atoms. NO₂ is linked to the production of acid rain.

NOx or Oxides of Nitrogen One nitrogen atom and three or more oxygen atoms; the x stands for the unknown number of oxygen atoms. NOx is easily formed in a combustion chamber due to the high temperature and high pressure present.

NOP (Nozzle Opening Pressure) The amount of pressure it takes to lift the needle off the seat in an injection nozzle tip. Also known as valve opening pressure (VOP).

OEM Acronym for original equipment manufacturer.

Off-Road Refers to unpaved, rough, or ungraded terrain on which a vehicle will operate. Any terrain not considered part of the highway system falls into this category.

Ohm A unit of electrical resistance.

Ohm's Law Basic law of electricity stating that in any electrical circuit, current, resistance and pressure work together in a mathematical relationship.

On-Road Refers to paved or smooth-graded surface on which a vehicle will operate; part of the public highway system.

Open Circuit An electrical circuit whose path has been interrupted or broken either accidentally (a broken wire) or intentionally (a switch turned off).

Oscillation Movement in either fore/aft or side-to-side direction about a pivot point.

OSHA Acronym for Occupational Safety and Health Administration.

Out of Round When an object or cylinder is no longer round. This deformation can be caused by wear, heat damage or distortion from mechanical stress. In the case of an engine cylinder bore, the result will be a failure of the piston rings to seal.

Output Driver Electronic switch that the computer uses to control the output circuit. Output drivers are located in the output ECM.

Oval Condition that occurs when a tube is egg shaped.

Overrunning Clutch A clutch mechanism that transmits power in one direction only.

Overspeed Governor A governor that shuts off fuel at a specific RPM.

Oxidation Inhibitor An additive used with lubricating oils to keep oil from oxidizing at high temperatures.

Oxide of Nitrogen (NO) One nitrogen atom and one oxygen atom.

Oxides of Nitrogen (NO_x) One nitrogen atom and an unknown number of oxygen atoms; the x stands for the unknown number of oxygen atoms.

Parallel Circuit An electrical circuit that provides two or more paths for current flow.

Parallel Joint Type A type of drive shaft installation whereby all companion flanges and/or yokes in the complete driveline are parallel to each other with the working angles of the joints of a given shaft being equal and opposite.

Parking Brake A mechanically applied brake used to prevent a parked vehicle's movement.

Particulate Matter The fine particles in diesel exhaust stream, sometimes referred to as soot.

Parts Requisition A form that is used to order new parts, on which the technician writes the part(s) needed along with the VIN.

Payload The weight of the cargo carried by a truck, not including the weight of the body.

Pitting Surface irregularities resulting from corrosion.

Polarity The state, either positive or negative, of charge differential.

Pole The number of input circuits made by an electrical switch.

Pounds per Square Inch (psi) A unit of measure for pressure.

Power A measure of work being done factored with time.

Power Flow The flow of power from the input shaft through one or more sets of gears.

Power Train The parts of a vehicle that transfer the torque of the engine to the wheels. The parts usually included are the flywheel, transmission, drive shaft and drive axles.

Pressure The force applied to a definite area measured in pounds per square inch (psi) or kilopascals (kPa).

Pressure Differential The difference in pressure between any two points of a system or a component.

Printed Circuit Board Electronic circuit board made of thin nonconductive material onto which conductive metal has been deposited. The metal is then etched by acid, leaving lines that form conductors for the circuits on the board. A printed circuit board can hold many complex circuits.

Programmable Read-Only Memory (PROM) Electronic component that contains program information specific to vehicle model calibrations.

P-Type Semiconductors Positively biased semiconductors.

Ram Air Air forced into the engine housing or passenger compartment by the forward motion of the vehicle.

Random Access Memory (RAM) Memory used during computer operation to store temporary information. The micro-computer can write, read and erase information from RAM. Electronically retained.

RCRA Acronym for Resource Conservation and Recovery Act.

Reactivity The characteristic of a material that enables it to react violently with air, heat, water or other materials.

Read-Only Memory (ROM) Memory used in microcomputers to store information permanently.

Recall Bulletin A bulletin pertaining to special situations that involve service work or replacement of components in connection with a recall notice.

Reference Voltage The voltage supplied to a sensor by the computer, which acts as baseline voltage, modified by the sensor to act as an input signal. Usually 5 VDC (volts of direct current).

Relay An electric switch that allows a small current to control a much larger one. It consists of a control circuit and a power circuit.

Reserve Capacity Rating The ability of a battery to sustain a minimum vehicle electrical load in the event of a charging system failure.

Resistance Opposition to current flow in an electrical circuit.

Resource Conservation and Recovery Act (RCRA) Law stating that after using hazardous material, it must be properly stored until an approved hazardous waste hauler arrives to take it to a disposal site.

Revolutions per Minute (RPM) The number of complete turns of a shaft in one minute.

Right to Know Law A law passed by the federal government and administered by the Occupational Safety and Health Administration (OSHA) requiring any company that uses or produces hazardous chemicals or substances to inform its employees, customers and vendors of any potential hazards that may exist in the workplace as a result of using the products.

Ring Gear The gear around the edge of a flywheel.

Rotary Oil Flow A condition caused by the centrifugal force applied to the fluid as the converter rotates around its axis.

Rotation A term used to describe a gear, shaft or other device when it is turning.

Rotor Rotating part of the alternator that provides the magnetic fields necessary to create a current flow. The rotating member of an assembly.

Runout Deviation or wobble of a shaft or wheel as it rotates. Measured with a dial indicator.

Selective Catalyst Reduction (SCR) An emission reduction strategy that injects a small amount of diesel exhaust fluid into the diesel exhaust stream to convert NO_x into nitrogen and water vapor.

Semiconductor Solid-state material used in diodes and transistors.

Sensing Voltage The voltage that allows the regulator to sense and monitor the battery voltage level.

Sensor An electronic device used to monitor conditions for computer control requirements. An input circuit device.

Series Circuit A circuit connected to a voltage source with only one path for electron flow.

Series/Parallel Circuit Circuit designed so that both series and parallel conditions exist within the same circuit.

Service Bulletin Publication that provides the latest service tips, field repairs, product improvements and related information of benefit to service personnel.

Service Manual A manual published by the manufacturer that contains service and repair information for all vehicle systems and components.

Short Circuit An undesirable connection between two worn or damaged wires. The short occurs when the insulation is worn between two adjacent wires and the metal in each wire contacts the other, or when wires are damaged or pinched.

Single-Axle Suspension A suspension with one axle.

Single Reduction Axle Any axle assembly that employs only one gear reduction through its differential carrier assembly.

Smart Device A device connected to and able to communicate on the J1939 data bus. Usually the controller for the EGR valve or the VGT.

Solenoid An electromagnet that is used to conduct electrical energy in mechanical movement.

Solid Wires Single-strand conductor.

Solvent A substance that dissolves other substances.

Soot A general term that refers to impure carbon particles resulting from the incomplete combustion of a hydrocarbon.

Spade Fuse Term used for blade fuse.

Spalling Surface fatigue that occurs when chips, scales or flakes of metal break off.

Specialty Service Shop A shop that specializes in areas such as engine rebuilding, transmission/axle overhauling, brake, air-conditioning/heating repairs and electrical/electronic work.

Specific Gravity The ratio of a liquid's mass to that of an equal volume of distilled water.

Spontaneous Combustion A reaction in which a combustible material self-ignites.

Stall Test Test performed when there is a malfunction in the vehicle's power package (engine and transmission) to determine which of the components is at fault.

Starter Circuit The circuit that carries the high current flow and supplies power for engine cranking.

Starter Motor Device that converts electrical energy from the battery into mechanical energy for cranking.

Starter Safety Switch Switch that prevents vehicles with automatic transmissions from being started in gear.

Static Balance Balance at rest, or still balance.

Stepped Resistor A resistor designed to have two or more fixed values, available by connecting wires to one of several taps.

Storage Battery A battery to provide a source of direct current electricity for both the electrical and electronic systems.

Stranded Wire Wire that is made up of a number of small solid wires, generally twisted together, to form a single conductor.

Sulfation Condition that occurs when sulfate is allowed to remain on the battery plates for a long time, causing two problems: (1) It lowers the specific gravity levels, increasing the danger of freezing at low temperatures. (2) In cold weather a sulfated battery may not have the reserve power needed to crank the engine.

Sulfur A naturally occurring element that is often used as fertilizer and has been linked to acid formation both inside engines and in the atmosphere.

Swage To reduce or taper.

Switch Device used to control on/off and direct the flow of current in a circuit. A switch can be under the control of the driver or can be self-operating through a condition of the circuit, the vehicle or the environment.

Tachometer Instrument that indicates shaft rotating speeds.

Throw (1) Offset of a crankshaft. (2) Number of output circuits of a switch.

Time Guide Used for computing compensation payable by the vehicle manufacturer for repairs or service work to vehicles under warranty.

Timing The phasing of events to produce action, such as ignition.

Torque Twisting force.

Torque Converter A device, similar to a fluid coupling, that transfers engine torque to the transmission input shaft and can multiply engine torque.

Toxicity A statement of how poisonous a substance is.

Tractor A motor vehicle that has a fifth wheel and is used for pulling a semitrailer.

Transistor Electronic device produced by joining three sections of semiconductor materials. Used as a switching device.

Tree Diagnosis Chart Chart used to provide a logical sequence for what should be inspected or tested when troubleshooting a repair problem.

ULSF (Ultra-Low Sulfur Fuel) On-highway diesel fuel that contains less than 15 parts per million by volume of sulfur. Mandated phase-in started in mid-2006. ULSF has been connected to seal shrinkage in some older diesel engines.

Urea A chemical compound used in diesel engines to reduce the NOx pollutants from combustion in the exhaust gases.

Urea is stored in a tank separate from the fuel tank on the vehicle.

Urea injection and control system A system and controls used to inject DEF into the exhaust stream of a diesel engine.

Vacuum Pressure values below atmospheric pressure.

Vehicle Retarder An engine or driveline brake.

VGT (Variable Geometry Turbocharger) Turbochargers that use a swinging vane or variable volute to constantly adjust the amount of airflow into the combustion chamber.

VGT Actuator An air-pressure or electrically operated, computer-controlled device that opens and closes the variable geometry turbocharger.

Viscosity Resistance to flow or fluid shear.

VOP Acronym for valve opening pressure. Caterpillar term for NOP.

Volt The unit of electromotive force.

Voltage-Generating Sensors Devices that produce their own voltage signal.

Voltage Limiter Device that provides protection by limiting voltage to the instrument panel gauges to approximately 5 volts.

Voltage Regulator Device that controls the current produced by the alternator and thus the voltage level in the charging circuit.

Watt Measure of electrical power.

Watt's Law A law of electricity used to calculate the power consumed in an electrical circuit, expressed in watts. It states that power equals voltage multiplied by current.

Windings (1) The three bundles of wires in the stator. (2) Coil of wire in a relay or similar device.

Work (1) Forcing a current through a resistance. (2) The product of a force.

Yield Strength The highest stress a material can stand without permanent deformation or damage, expressed in pounds per square inch (psi).

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