JONES & BARTLETT LEARNING

CDX Automotive

FIRST EDITION REVISED

FUNDAMENTALS OF

Automotive Technology

Principles and Practice

We support ASE program certification through

NATEF Improving Programs Through Certification

STUDENT WORKBOOK

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CDX Automotive

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Principles and Practice

STUDENT WORKBOOK

First Edition Revised

JONES & BARTLETT
LEARNING

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CHAPTER 1

Careers in Automotive Technology

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Chapter Review

The following activities have been designed to help you refresh your knowledge of this chapter. Your instructor may require you to complete some or all of these activities as a regular part of your training program. You are encouraged to complete any activity that your instructor does not assign as a way to enhance your learning.

Matching

Match the following terms with the correct description or example.

A. Automotive Service Excellence (ASE)
B. Brake technician
C. Drivability technician
D. Heavy line technician
E. Lube technician
F. Service consultant/advisor
G. Shop foreman

_____ **1.** Specializes in major engine, transmission, and differential overhaul and repair.
_____ **2.** Carries out scheduled maintenance activities.
_____ **3.** Supervisor who oversees the work of technicians and staff.
_____ **4.** An independent, nonprofit organization dedicated to the improvement of vehicle repair through the testing and certification of automotive professionals.
_____ **5.** Specializes in working on vehicle brake systems.
_____ **6.** Diagnoses and identifies mechanical and electrical faults that affect vehicle performance and emissions.
_____ **7.** A service worker who works with both customers and technicians.

Multiple Choice

Read each item carefully, and then select the best response.

_____ **1.** Who is generally acknowledged to have invented the modern automobile around 1885?
A. Henry Ford
B. Karl Benz
C. Armand Peugeot
D. Charles Rolls

_____ **2.** Who is a repair shop's first point of contact for customers seeking vehicle repairs?
A. Shop foreman
B. Service consultant/advisor
C. Drivability technician
D. Service manager

_____ **3.** What type of technician might specialize in particular vehicle systems, such as engines, transmissions, or final drives?
- **A.** Shop foreman
- **B.** Light line technician
- **C.** Drivability technician
- **D.** Heavy line technician

_____ **4.** What type of technician diagnoses and repairs faults, replaces or overhauls brake systems, and tests the components of disc, drum, and power brake systems used on all types of vehicles?
- **A.** Light line technician
- **B.** Heavy line technician
- **C.** Brake technician
- **D.** Drivability technician

_____ **5.** What type of technician works with computer-controlled engine management systems to service, identify, and repair faults on electronically controlled vehicle systems such as fuel injection, ignition, antilock braking, cruise control, and automatic transmissions?
- **A.** Electrical technician
- **B.** Heavy line technician
- **C.** Shop foreman
- **D.** Service manager

_____ **6.** What type of technician regularly uses meters, oscilloscopes, circuit wiring diagrams, and solder equipment?
- **A.** Light line technicians
- **B.** Transmission specialist
- **C.** Electrical technicians
- **D.** Heavy line technicians

_____ **7.** Which of the following is a key skill of a service manager?
- **A.** Communicating
- **B.** Motivating
- **C.** Creating positive work environments
- **D.** All of the above

_____ **8.** What types of shops are usually independent and focus on one type of service, such as transmission service, electrical system repair, or emission system diagnosis?
- **A.** Dealerships
- **B.** Specialty shops
- **C.** Franchises
- **D.** Fleet shops

_____ **9.** Which of the following programs receives access to new vehicle technology as well as manufacturer service information to help prepare students for working on today's vehicles and technology?
- **A.** National Automotive Technicians Education Foundation
- **B.** Automotive Service Excellence
- **C.** Automotive Youth Educational Systems
- **D.** Advanced Engine Performance certification

_____ **10.** Technicians who handle refrigerants or work on AC systems are required to have what?
- **A.** Environmental Protection Agency Section 609 certification
- **B.** ASE Advanced Engine Performance certification
- **C.** NATEF refrigerant certification
- **D.** AYES R134a certification

True/False

If you believe the statement to be more true than false, write the letter "T" in the space provided. If you believe the statement to be more false than true, write the letter "F".

_____ **1.** Today's vehicles are assembled on high-volume production lines, with robots used for many of the assembly processes, including welding seams.

_____ **2.** Heavy line technicians diagnose and replace the mechanical and electrical components of motor vehicles, such as gaskets, belts, hoses, timing belts, water pumps, radiators, alternators, and starters.

_____ **3.** Drivability technicians perform wheel alignments and wheel balancing, and they diagnose and replace faulty steering system components.

_____ **4.** In larger shops, roles may be assigned to separate electrical and drivability technicians, whereas in smaller shops, one technician could perform both roles.

_____ **5.** Electrical technicians test and replace faulty charging system components, starter motors, and related items such as batteries.

_____ **6.** Light line technicians use electronic test equipment, scan tools, pressure transducers, exhaust gas analyzers, lab scopes, meters, and circuit wiring diagrams to locate electrical, fuel, and emission systems faults.

_____ **7.** A service manager's job is to oversee technicians' work in order to ensure that customers receive quality repair work.

_____ **8.** Because dealership technicians are working on the latest vehicles, they are right at the cutting edge of technology.

_____ **9.** The automotive service industry in the United States is generally not subject to licensure requirements.

_____ **10.** The Automotive Youth Educational Systems (AYES) is an independent, nonprofit organization dedicated to the improvement of vehicle repair through the testing and certification of automotive professionals.

Fill in the Blank

Read each item carefully, and then complete the statement by filling in the missing word(s).

1. Henry Ford applied two concepts that helped make the Model T affordable for the masses, _____ and the _____ _____.

2. A(n) _____ _____ changes oil and filters and carries out lubrication, fluid inspection, fluid service, and tire rotations.

3. A(n) _____ _____ diagnoses, repairs, and services steering system components and suspension systems on all types of vehicles.

4. A(n) _____ _____ diagnoses, replaces, maintains, identifies faults with, and repairs electrical wiring and computer-based equipment in vehicles.

5. Electrical technicians use meters, oscilloscopes, test instruments, and circuit wiring diagrams to diagnose _____ _____.

6. A(n) _____ _____ works with computer-controlled engine management systems to service, identify, and repair faults on electronically controlled vehicle systems such as fuel injection, ignition, and automatic transmissions.

7. A(n) _____ _____ may also work on the other components of the drivetrain, including the drive shafts and differentials.

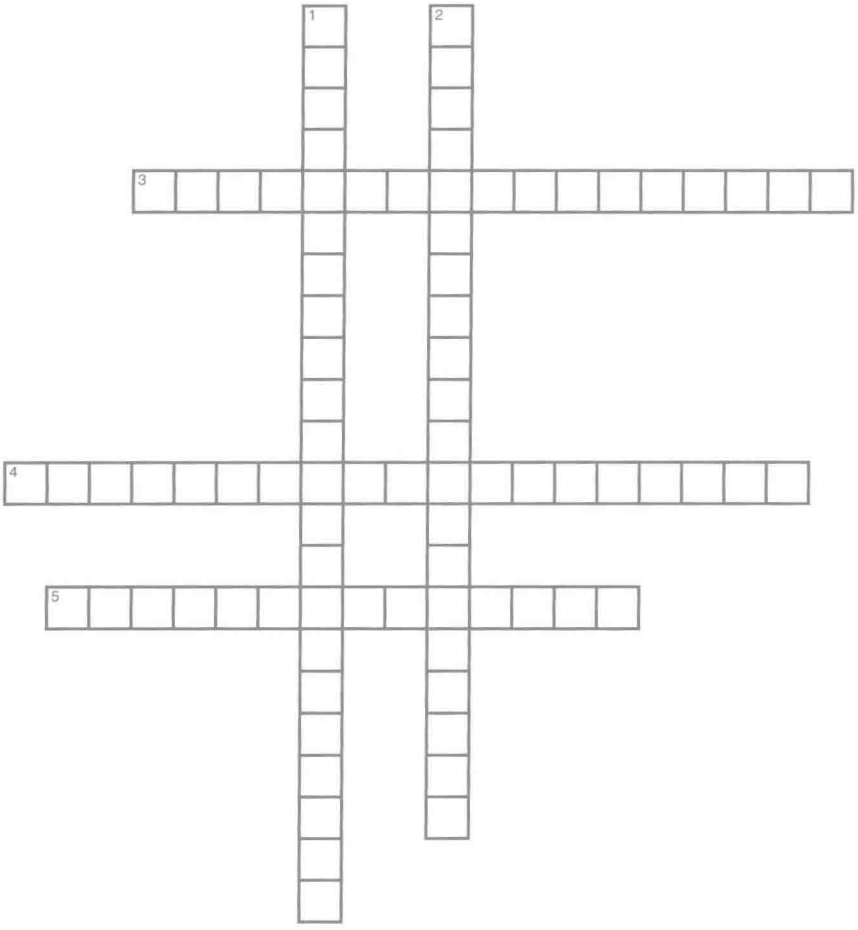
8. A(n) _____ _____ oversees the work of all types of technicians and staff, communicates with customers and external suppliers, and handles the various administrative duties involved with operating a business.

9. _____ are affiliated with a specific vehicle manufacturer.

10. To earn _____ _____, technicians are required to pass one or more ASE certification tests and have 2 years of qualifying work experience as a technician.

Crossword Puzzle

Use the clues to complete the puzzle.



Across

3. A technician who specializes in working on vehicle suspension and steering systems.

4. A technician who diagnoses and replaces the mechanical and electrical components of motor vehicles.

5. The shop supervisor who is responsible for the management of the service department.

Down

1. A technician who diagnoses, overhauls, and repairs transmissions.

2. A technician who diagnoses, replaces, maintains, identifies fault with, and repairs electrical wiring and computer-based equipment in vehicles.

ASE-Type Questions

Read each item carefully, and then select the best response.

_____ **1.** Tech A says that newer vehicles require less maintenance compared to older vehicles. Tech B says that service intervals for an older vehicle can be extended if new oils are used. Who is correct?

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

_____ **2.** Tech A says that Henry Ford is credited with the invention of the automobile. Tech B says that Carl Benz is credited with the invention of the automobile. Who is correct?

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

_____ **3.** Tech A says that the production of vehicles today requires a mix of robotic and human assembly to be profitable. Tech B says that most parts on a car are preassembled before they reach the assembly line for higher assembly numbers per day. Who is correct?

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

_____ **4.** Tech A says that the automotive industry is highly technical and only a certain few people will find jobs. Tech B says the automotive industry is wide open with job opportunities for almost every level of skill. Who is correct?

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

_____ **5.** Tech A says that a technician can specialize in different areas based on his or her interest and ability. Tech B says that when a technician specializes in a certain area, he or she will only work on certain vehicle models. Who is correct?

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

_____ **6.** Tech A says that the foreman is the frontline contact for customer relations. Tech B says that the service consultant is the frontline contact for customer relations. Who is correct?

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

_____ **7.** Tech A says that dealership technicians generally have access to manufacturers' training to help prepare them as technicians. Tech B says that an independent shop works on a wide variety of equipment that requires a broad skill level in technicians. Who is correct?

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

_____ **8.** Tech A says that AYES certifies technicians. Tech B says that ASE certifications can help get you a job. Who is correct?

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

_____ **9.** Tech A says that the maintenance requirements of a vehicle have not changed since the creation of the automobile. Tech B says that manufacturers are predicting 25,000-mile (40,000-km) intervals. Who is correct?

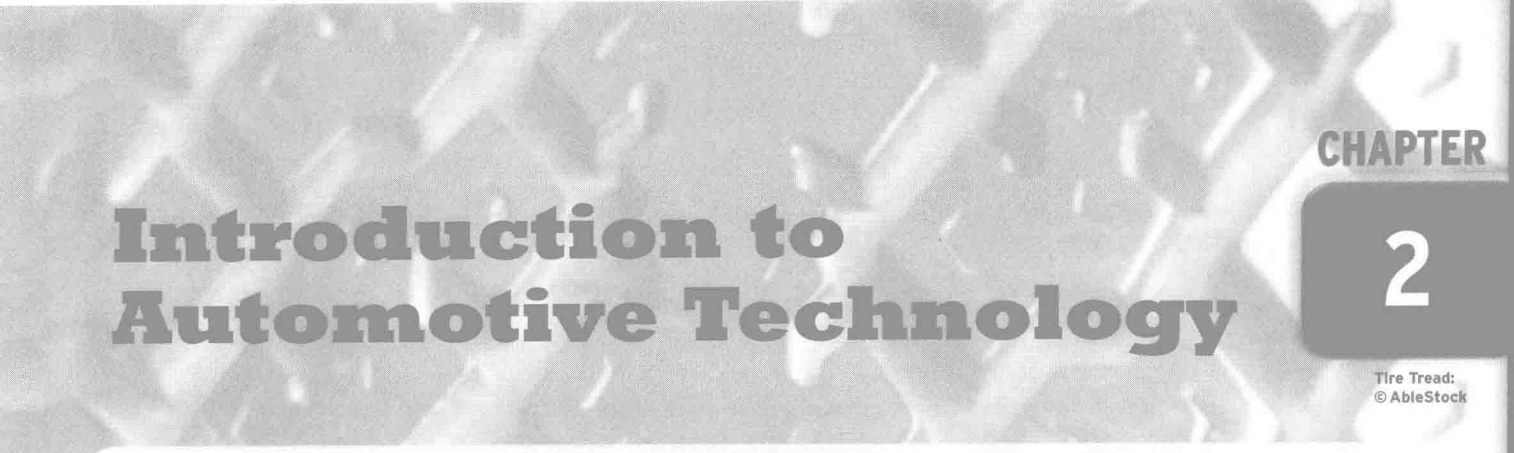
A. Tech A
B. Tech B
C. Both A and B
D. Neither A nor B

_____ **10.** Tech A says that a technician can progress to different jobs within the industry. Tech B says that carriers in the automotive industry include new car assembly lines. Who is correct?

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

CHAPTER 2

Introduction to Automotive Technology



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Chapter Review

The following activities have been designed to help you refresh your knowledge of this chapter. Your instructor may require you to complete some or all of these activities as a regular part of your training program. You are encouraged to complete any activity that your instructor does not assign as a way to enhance your learning.

Matching

Match the following terms with the correct description or example.

A. Differential gear set
B. Four-wheel drive
C. Horizontally opposed engine
D. In-line engine
E. Longitudinal
F. Piston engine
G. Rotary engine
H. Torque converter
I. Unibody design
J. V engine

_____ **1.** An engine in which the cylinders are arranged side by side in a single row.

_____ **2.** An internal combustion engine that uses cylindrical pistons moving back and forth in a cylinder to extract mechanical energy from chemical energy.

_____ **3.** A term used to describe an engine configuration that uses a single bank of cylinders staggered at a shallow 15-degree V.

_____ **4.** An engine that uses a triangular rotor turning in a housing instead of conventional pistons.

_____ **5.** A term used to describe the front-to-back engine orientation when mounted in the engine compartment.

_____ **6.** The arrangement of gears between two axles that allows each axle to spin at its own speed when the vehicle is going around a corner.

_____ **7.** A drive train layout in which the engine drive has either two wheels or four wheels depending on which mode is selected by the driver.

_____ **8.** A vehicle design that does not use a rigid frame to support the body. The body panels are designed to provide the strength for the vehicle.

_____ **9.** A device that is turned by the crankshaft and transmits torque to the input shaft of an automatic transmission.

_____ **10.** An engine with two banks of cylinders, 180 degrees apart, on opposite sides of the crankshaft. It is also called a flat engine or a boxer engine.

Multiple Choice

Read each item carefully, and then select the best response.

_____ **1.** Which vehicle design has an enclosed body with a maximum of four doors, and a trunk located in the rear of the vehicle accessible from a trunk lid?

A. Coupe
B. Sedan
C. Hatchback
D. Station wagon

_____ **2.** Which type of vehicle acts like both a full-size van and a pickup in that it has a heavier-duty chassis so it can carry heavier loads?
- **A.** Sedan
- **B.** Hatchback
- **C.** Sport utility vehicle
- **D.** Minivan

_____ **3.** What type of chassis design was first used in aircraft and then spread to automobiles?
- **A.** Unibody
- **B.** Body on frame
- **C.** Dual shell
- **D.** Steel ladder

_____ **4.** In which type of drivetrain layout are all four wheels driven by the engine all of the time?
- **A.** Front-wheel drive
- **B.** Rear-wheel drive
- **C.** All-wheel drive
- **D.** Four-wheel drive

_____ **5.** All of the following criteria are used to define the drive train layout, *except*:
- **A.** Engine position
- **B.** Transmission type
- **C.** Engine orientation
- **D.** Type of drive

_____ **6.** Which of the following engine designs is the most powerful compared to its overall dimensions, but more complicated and expensive than the other engines?
- **A.** V8
- **B.** Flat 6
- **C.** W12
- **D.** In-line 4

_____ **7.** Which type of engine uses a single bank of cylinders, staggered at a shallow 15-degree V within the bank?
- **A.** Horizontally opposed
- **B.** W
- **C.** V
- **D.** VR

_____ **8.** Which type of axle uses the engine's torque to turn the wheels (drive the vehicle) and at the same time support the weight of the vehicle?
- **A.** Live axle
- **B.** Dead axle
- **C.** Transaxle
- **D.** Solid axle

_____ **9.** The twisting force applied to a shaft is known as what?
- **A.** Play
- **B.** Torque
- **C.** Collar
- **D.** Give

_____ **10.** What designation is used when measuring torque?
- **A.** Foot-pound
- **B.** Inch-pound
- **C.** Newton meter
- **D.** Any of the above

True/False

If you believe the statement to be more true than false, write the letter "T" in the space provided. If you believe the statement to be more false than true, write the letter "F".

_____ **1.** Reducing the number of doors to the passenger compartment makes the vehicle structure more rigid.

_____ **2.** In some vehicles, known as roadsters, the roof can be a series of folding steel or fiberglass panels.

_____ **3.** A station wagon has an extended roof that goes all the way to the rear of the vehicle. It is similar to a van but not as tall.

_____ **4.** Body-on-frame is the term used when a vehicle body is mounted on a rigid frame or chassis.

_____ **5.** Some high-performance racing cars today have no chassis at all.

_____ **6.** Mechanical energy can be converted into chemical energy in two primary ways: through the operation of an internal combustion engine or through the operation of an electric motor.

_____ **7.** The suspension system makes the connection between the steering wheel and the road wheels so the driver can point the vehicle in the intended direction of travel.

_____ **8.** A drive train is classified by type, cylinder arrangement, number of cylinders/rotors, and total engine displacement in cubic inches or liters.

_____ **9.** Multi-cylinder internal combustion automotive engines are produced in four common configurations.

_____ **10.** V engines have two banks of cylinders sitting side by side in a V arrangement sharing a common crankshaft.

_____ **11.** Horizontally opposed engines are very powerful for their size, but they do not use conventional pistons that slide back and forth inside a straight cylinder.

_____ **12.** The automatic transmission uses a torque converter instead of a clutch.

_____ **13.** Part-time 4WD means the vehicle is usually driven in two-wheel drive and switched to full-time when needed by engaging the transfer case.

_____ **14.** A transfer case locks the drive shafts together and directs torque through them to both axles.

_____ **15.** All transfer cases use a viscous coupling to split the drive between the front and rear wheels.

Fill in the Blank

Read each item carefully, and then complete the statement by filling in the missing word(s).

1. A(n)_____ has only two doors.

2. A(n)_____ is available in three-door and five-door designs.

3. A(n) _____ is an automobile that can convert from having an enclosed top to having an open top by means of a roof that can be removed, retracted, or folded away.

4. A(n) pickup, or _____, carries and tows cargo.

5. A(n) _____ _____ _____ can easily be used to carry out functions that would otherwise require several different vehicles.

6. A(n) _____ is an underlying supporting structure for vehicles—similar to the skeleton of a human—on which additional components are mounted.

7. The _____ design is constructed of a large number of steel sheet metal panels that are precisely formed in presses and spot-welded together into a structural unit.

8. Stored _____ energy is converted to mechanical energy to propel a vehicle down the road.

9. As the pistons move up and down, they rotate the crankshaft, turning the _____ or flex plate, which is bolted to the engine crankshaft.

10. The _____ system evens out the road shocks caused by irregular road surfaces.

11. Manufacturers mount engines in one of two orientations, _____ and _____, depending on which design best fits the vehicle and the rest of the drive train.

12. In a piston engine, the way engine cylinders are arranged is called the engine _____.

13. _____ _____ engines are sometimes referred to as "flat" engines and are commonly found in 4- and 6-cylinder configurations.

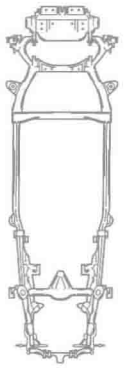
14. Axles come in two configurations: _____ axle and _____ axle.

15. A vehicle with a manual transmission uses a _____ to engage and disengage the engine from the transmission.

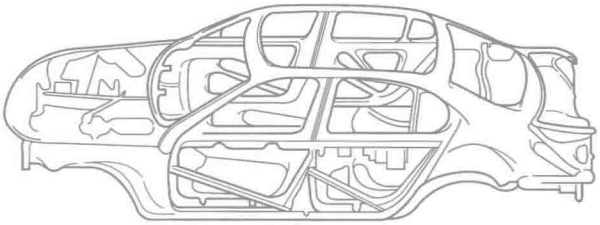
Labeling

Label the following images with the correct terms.

1. Chassis, engines, and axles:



A



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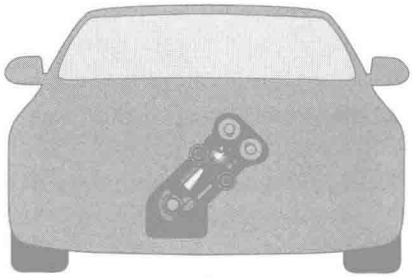

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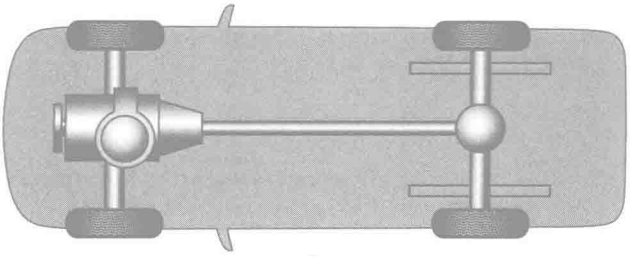

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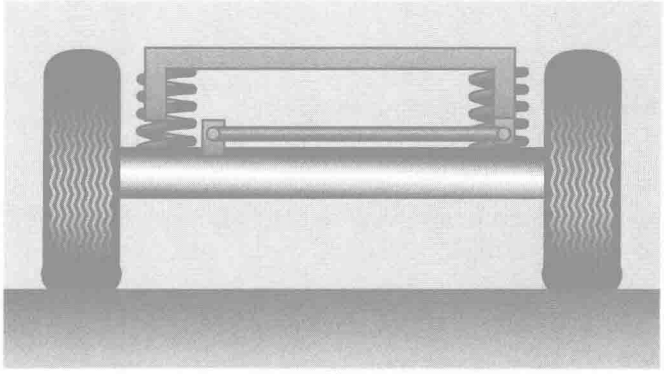


E

A. _____

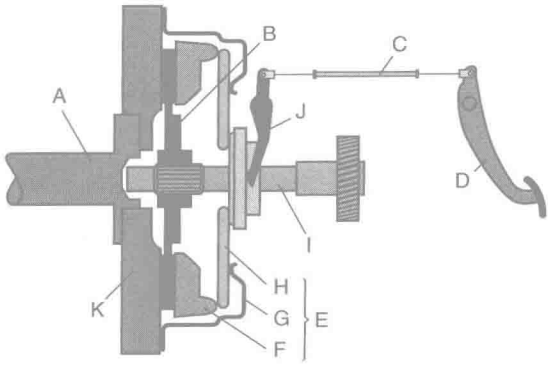
B. _____

C. _____

D. _____

E. _____

2. Manual transmission clutch:



A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

G. _____

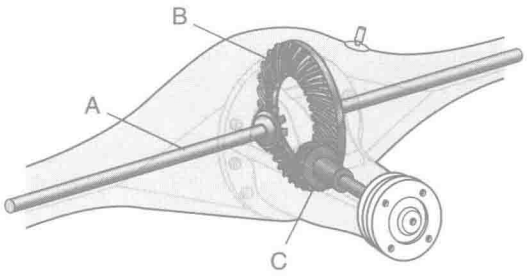
H. _____

I. _____

J. _____

K. _____

3. Final drive assembly:



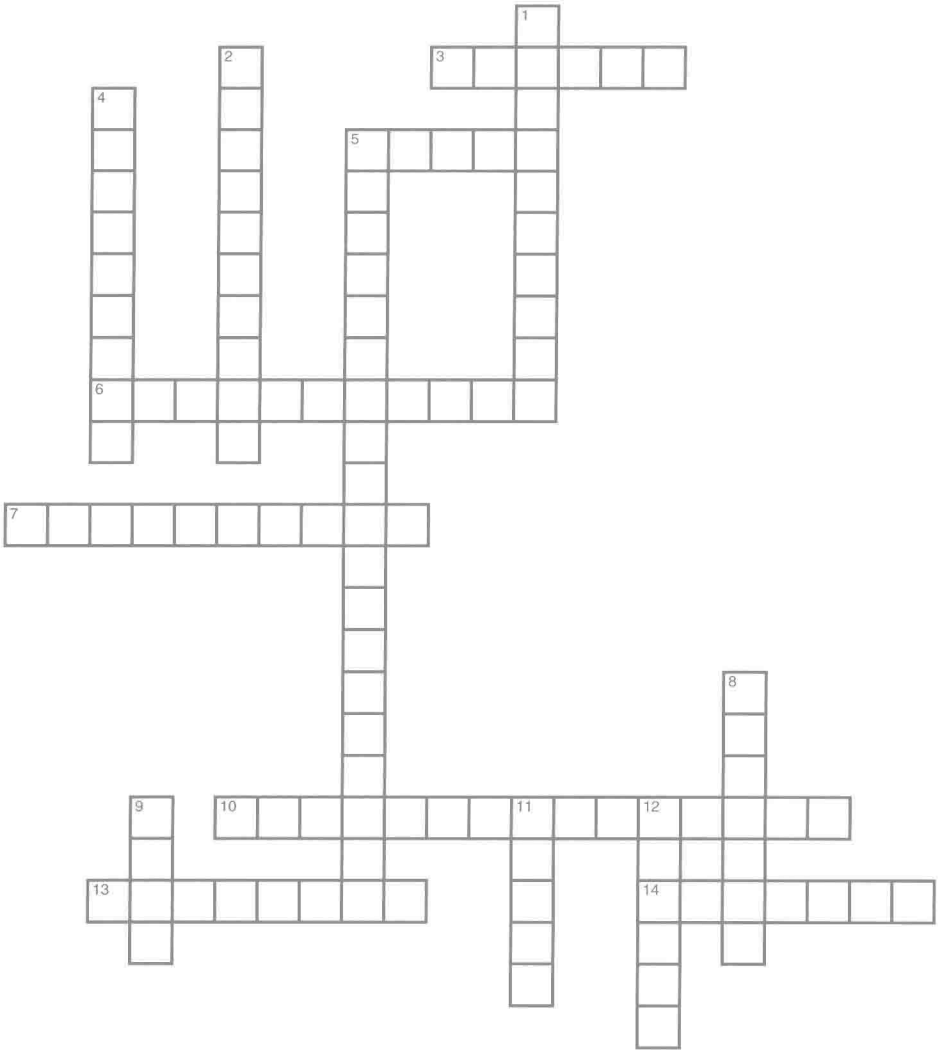
A. _____

B. _____

C. _____

Crossword Puzzle

Use the clues to complete the puzzle.



Across

3. Twisting force.

5. A vehicle configuration that has an enclosed body, with a maximum of four doors to allow access to the passenger compartment.

6. A vehicle that converts from having an enclosed top to having an open top by a roof that can be removed, retracted, or folded away.

7. A term used to identify the engine, transmission/transaxle, differential, axles, and wheels.

10. A device that acts like a limited slip clutch.

13. The heavy disc bolted to the rear of the crankshaft that smooths out the power pulses and stores energy from the power stroke for use in keeping the crankshaft rotating through the other three strokes.

14. The main support frame in a vehicle. It includes the running gear, such as suspension, the engine, and the drive train.