

Chapter 41

Gasoline Injection Fundamentals



Name _____

Date _____

Instructor _____

Score _____

Objective: After studying this chapter, you will be able to explain the construction, operation, and classifications of modern gasoline injection systems.

Gasoline Injection Fundamentals

1. A gasoline injection system uses _____ from an electric _____ or mechanical fuel pump to spray fuel into the engine's intake manifold or its combustion chambers.

2. Name the five subsystems of all electronic fuel injection systems.

3. At sea level, the atmosphere exerts _____ psi of pressure _____ on everything.

4. Define *vacuum*.

5. What is the function of the engine throttle valve?

6. When the engine throttle valve is _____, atmospheric pressure pushes more air into the intake manifold.

7. When the accelerator is released and the throttle valve is closed, the engine returns to _____.

8. *True or False?* Throttle valves are not used on diesel engines.

9. What systems move the engine throttle valves electronically instead of using conventional mechanical linkage from the accelerator pedal?

10. What feeds an electric signal to the ECM that corresponds to pedal position?

11. The ECM sends an amplified control current to a servo _____ motor _____ that opens and closes the engine throttle valve.

12. Define *engine throttle actuator*.

13. What is used in many throttle body assemblies to return the engine to idle even if the engine throttle actuator fails?

14. Older fuel injection systems use either _____ fuel injection or _____ fuel injection.

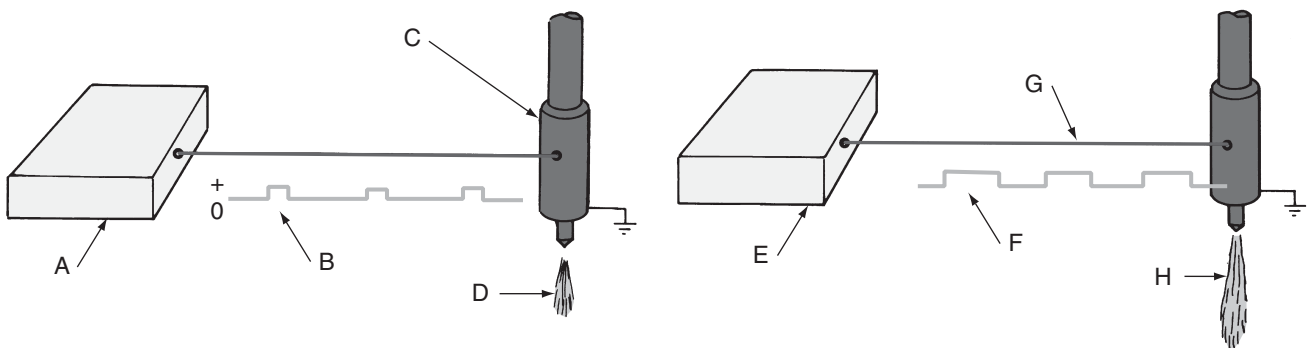
15. A timed injection system sprays fuel into the engine during the _____ or _____ strokes, in relation to piston and valve action.

16. The injector pulse _____ indicates the amount of time each injector is energized and kept open.

17. If the engine is accelerated for passing speeds, the ECM will (lengthen, shrink) _____ the injector pulse width to richen the air-fuel mixture for more power.

18. If the engine temperature sensor signals the ECM that the engine is very cold, injector pulse width will be (decreased, increased) _____ to spray more fuel to help start the cold engine.

19. Identify the operations and components of the illustration showing how pulse width controls injector output.



- | | |
|-----------|-----------|
| (A) _____ | (E) _____ |
| (B) _____ | (F) _____ |
| (C) _____ | (G) _____ |
| (D) _____ | (H) _____ |

Name _____

20. A(n) _____ connects the sensors to the input of the ECM and connects the output of the ECM to the fuel injectors.

Direct and Indirect Injection

21. A(n) _____ injection system sprays fuel into the engine intake manifold.
22. A(n) _____ injection system forces fuel into the engine combustion chambers.
23. A(n) _____ was the first electronic fuel injection system used on passenger cars.
24. Define *multiport injection system*.

25. How are new direct fuel injection systems different from old DFI systems?

For questions 26–28, match the following terms and identifying phrases.

- | | |
|--|----------------------------|
| _____ 26. Uses a slightly richer air-fuel mixture. | (A) Stratified charge mode |
| _____ 27. Ultra-lean burn mode. | (B) Stoichiometric mode |
| _____ 28. Produces lowest emissions of all DEFI systems. | (C) Full power charge mode |

Electronic Fuel Injector Types

29. What are the two common types of electronic fuel injectors?

30. Name four components of a solenoid fuel injector.

31. A solenoid fuel injector used in a multiport system is usually press-fit into the _____ in the intake manifold.

32. A piezo fuel injector uses a crystalline ceramic material _____ instead of a(n) _____ to open the injector valve.

33. Current flow through the piezo crystal in one direction _____ causes the atoms in the crystal to (attract, repel) _____ each other, physically (expanding, contracting) _____ the crystal.

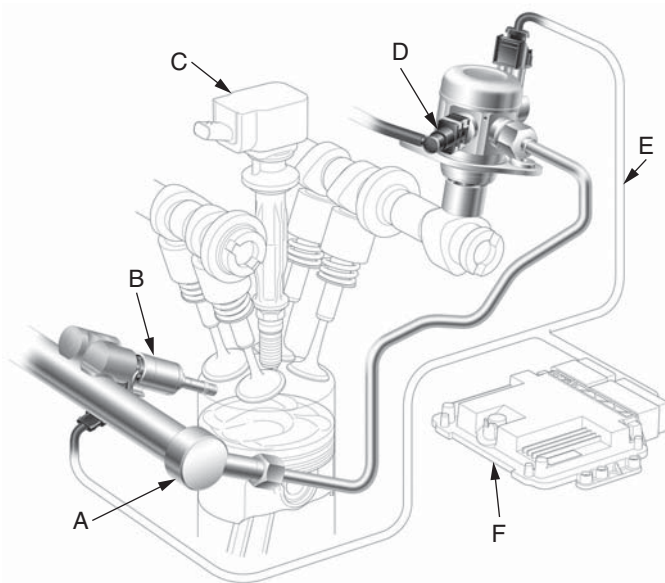
34. *True or False?* The needle valve, armature, and return spring in solenoid-operated injectors are smaller and lighter than those used in piezo fuel injectors.

Fuel Pressure Regulator

35. What is the function of an EFI system's fuel pressure regulator?

36. What does a DEFI fuel pressure regulator use to bypass excess fuel pressure back to the low pressure side of the system?

37. Identify the parts of the fuel delivery subsystem.



- (A) _____
- (B) _____
- (C) _____
- (D) _____
- (E) _____
- (F) _____

Name _____

38. To increase fuel pressure, the ECM sends a longer duty cycle and more _____ to the electromagnet to force a small relief valve closed.
39. *True or False?* Since a DEFI fuel pressure regulator is normally open, any loss of electric power to or from the ECM or injector amplifier will close the fuel pressure relief valve to reduce fuel pressure.
40. An EFI fuel pressure regulator uses _____, not the ECM, to control lower fuel pressure in multiport fuel injection systems.

Fuel Rail

41. Define *fuel rail*.

- _____ 42. Low-pressure EFI systems operate on less than _____ psi. A high-pressure fuel injection system with an engine-driven fuel pump can produce over _____ psi.
- (A) 10, 1000
- (B) 15, 2000
- (C) 20, 1000
- (D) 25, 250
43. A DEFI _____ is needed to increase the voltage and current signal sent from the ECM to operate the high-pressure direct injectors.

Fuel Control Sensors

44. Name five sensors used to help control the operation of a gasoline injection system.

45. What is the function of an EFI oxygen sensor?

46. Why do vehicles with OBD II use two oxygen sensors for each catalytic converter?

47. The (primary, secondary) _____ oxygen sensor is mounted downstream in the exhaust system.

48. The (primary, secondary) _____ oxygen sensor is used to monitor the oxygen in the exhaust gases as it leaves the engine.

49. How are the numbers for oxygen sensor positions in vehicles assigned?

50. When in (open, closed) _____ loop, the electronic fuel injection system does not use engine exhaust gas content as a main indicator of the air-fuel mixture.

51. (Open, Closed) loop _____ means that the computer is using information from the oxygen sensor and the other sensors.

52. Zirconia, titania, and planar sensors are considered _____ band sensors.

53. The surface of the zirconia oxygen sensor is coated in _____, which helps the sensor maintain a high operating temperature.

_____ 54. The ECM compares the voltage produced by the zirconia oxygen sensor to a reference voltage of approximately _____ mV.
(A) 250
(B) 400
(C) 450
(D) 500

55. If the engine's air-fuel mixture is too (lean, rich) _____, there will be a smaller difference in oxygen content between the sensor's surfaces.

56. Is the planar zirconia oxygen sensor more or less resistant to contamination and vibration than a conventional zirconia sensor?

_____ 57. A lean burn oxygen sensor measures the oxygen content in the exhaust of lean-burn engines at ratios as lean as _____:1.
(A) 10
(B) 15
(C) 17
(D) 23

58. The titania sensor is _____ than a zirconia oxygen sensor.

Name _____

59. Explain an advantage of a titania oxygen sensor.

60. Define *wide band oxygen sensor*.

61. A wide band oxygen sensor uses internal voltage signals _____ to produce a small _____ that represents oxygen content.

62. A rich mixture will produce (low, high) _____ voltage and a lean mixture will produce (low, high) _____ voltage.

_____ 63. When the free oxygen or free fuel has been neutralized, the voltage feedback signal drops to about _____ mV (same as V_{ref}) and no pump current is supplied to the pump cell.

- (A) 300
- (B) 400
- (C) 450
- (D) 500

64. Off-road race cars are often retrofitted with one or two _____ wide band oxygen sensors to better tune the race engines for high _____.

65. What is the function of the manifold absolute pressure (MAP) sensor?

66. Manifold pressure is an excellent indicator of _____.

67. Define *throttle position sensor*.

68. A(n) _____ sensor monitors the operating temperature _____ of the engine.

69. A(n) _____ sensor is used in many EFI systems to measure the amount of outside air entering the engine.

70. Explain the purpose of an intake air temperature sensor.

71. A(n) _____ is used to detect engine speed. _____

72. A fuel pressure sensor is often used in _____ fuel injection systems. _____

Engine Idle Speed Control

73. An idle air control is a solenoid- or servo motor-operated _____ valve. _____