

# Automotive Engines Theory and Servicing

Ninth Edition

## Automotive Engines

### Theory and Servicing

Ninth Edition

James D. Halderman



## Chapter 10

### Gasoline Engine Operation, Parts, and Specifications

ALWAYS LEARNING

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved

PEARSON

---

---

---

---

---

---

---

---

## OBJECTIVES (1 OF 2)

**10.1** Discuss engine construction, purpose and function of an engine, and energy and power of an engine.

**10.2** Explain engine parts and systems.

**10.3** Explain four-stroke cycle operation.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved

PEARSON

---

---

---

---

---

---

---

---

## OBJECTIVES (2 OF 2)

**10.4** Discuss engine classification and construction.

**10.5** Explain engine measurement.

**10.6** Discuss compression ratio, torque, and horsepower.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved

PEARSON

---

---

---

---

---

---

---

---

## PURPOSE AND FUNCTION

- The purpose and function of an engine is to convert the heat energy of burning fuel into mechanical energy.
- In a typical vehicle, mechanical energy is then used to perform the following:
  - Propel the vehicle
  - Power the air-conditioning system and power steering
  - Produce electrical power for use throughout the vehicle

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENERGY AND POWER (1 OF 2)

- Engines use energy to produce power.
- The chemical energy in fuel is converted to heat energy by the burning of the fuel at a controlled rate.
  - This process is called combustion.
  - If engine combustion occurs within the power chamber, the engine is called an internal combustion engine.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENERGY AND POWER (2 OF 2)

- The pressure developed within the combustion chamber is applied to the head of a piston to produce a usable mechanical force, which is then converted into useful mechanical power.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENGINE CONSTRUCTION OVERVIEW

- Block
- Rotating Assembly
- Cylinder Heads



**FIGURE 10-1** The rotating assembly for a V-8 engine that has eight pistons and connecting rods and one crankshaft.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENGINE PARTS AND SYSTEMS (1 OF 2)

- Intake and Exhaust Manifolds
- Cooling System
- Lubrication System

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENGINE PARTS AND SYSTEMS (2 OF 2)

- Fuel System and Ignition System
  - Spark plugs
  - Sensor(s)
  - Ignition coils
  - Ignition control module (ICM)
  - Associated wiring

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

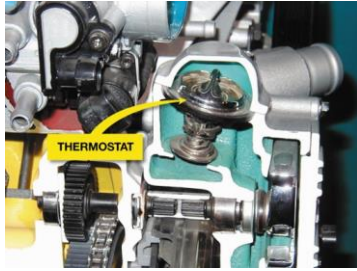
---

---

---

---

**FIGURE 10-3** The coolant temperature is controlled by the thermostat, which opens and allows coolant to flow to the radiator when the temperature reaches the rating temperature of the thermostat.



Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## FOUR-STROKE CYCLE OPERATION

- Principles
- Operation
  - Intake stroke
  - Compression stroke
  - Power stroke
  - Exhaust stroke
- The 720-degree Cycle

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

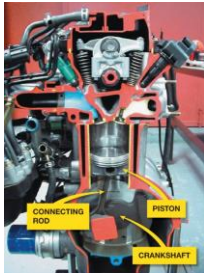
---

---

---

---

**FIGURE 10-6** Cutaway of an engine showing the cylinder, piston, connecting rod, and crankshaft.



Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENGINE CLASSIFICATION AND CONSTRUCTION (1 OF 3)

- Engines are classified by several characteristics, including:
  - Number of strokes
  - Cylinder arrangement
  - Longitudinal and transverse mounting
  - Valve and camshaft number and location

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENGINE CLASSIFICATION AND CONSTRUCTION (2 OF 3)

- Type of fuel
- Cooling method
- Type of induction pressure

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

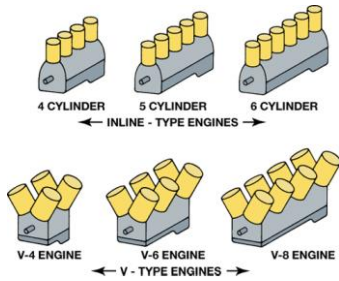
---

---

---

---

FIGURE 10-7 Automotive engine cylinder arrangements.



Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

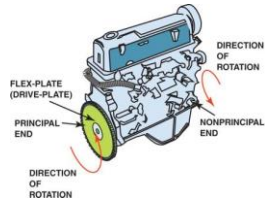
---

---

---

## ENGINE CLASSIFICATION AND CONSTRUCTION (3 OF 3)

- Engine Rotation Direction



**FIGURE 10-15** Inline 4-cylinder engine showing principal and nonprincipal ends. Normal direction of rotation is clockwise (CW) as viewed from the front or accessory belt (nonprincipal) end.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

## ENGINE MEASUREMENT

- Bore
- Stroke
- Displacement
- Conversion
- Calculating Cubic Inch Displacement
- Engine Size Conversion

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

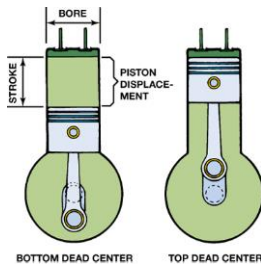
---

---

---

---

**FIGURE 10-16** The bore and stroke of pistons are used to calculate an engine's displacement.



Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

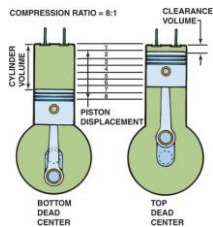
---

---

---

## COMPRESSION RATIO (1 OF 2)

- Compression ratio (CR) is the ratio of the difference in the cylinder volume when the piston is at the bottom of the stroke to the volume in the cylinder above the piston when the piston is at the top of the stroke.



**FIGURE 10-18** Compression ratio is the ratio of the total cylinder volume (when the piston is at the bottom of its stroke) to the clearance volume (when the piston is at the top of its stroke).

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

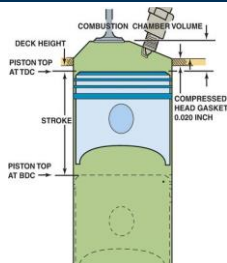
---

---

---

## COMPRESSION RATIO (2 OF 2)

- Calculating Compression Ratio
- Changing Compression Ratio
  - Head gasket thickness
  - Increasing the cylinder size



**FIGURE 10-19** Combustion chamber volume is the volume above the piston with the piston is at top dead center.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

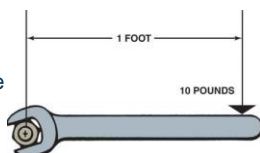
---

---

---

## TORQUE AND HORSEPOWER

- Definition of Torque
- Definition of Power
- Horsepower and Altitude



**FIGURE 10-20** Torque is a twisting force equal to the distance from the pivot point times the force applied expressed in units called pound-feet (lb-ft) or newton-meters (N-m).

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved.

PEARSON

---

---

---

---

---

---

---

---

---

---

## SUMMARY (1 OF 2)

- The four strokes of the four-stroke cycle are intake, compression, power, and exhaust.
- Engines are classified by number and arrangement of cylinders and by number and location of valves and camshafts.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved

PEARSON

---

---

---

---

---

---

---

---

## SUMMARY (2 OF 2)

- Most engines rotate clockwise as viewed from the front (accessory) end of the engine.
- Engine size is called displacement and represents the volume displaced by all of the pistons.

Copyright © 2018, 2015, 2011 Pearson Education, Inc. All Rights Reserved

PEARSON

---

---

---

---

---

---

---

---