

# Four-Stroke Engine Overview

-Student Notes

*Directions:*

Fill in the blanks.

## ***Four-Stroke Engine Operation Segment***

### **1. Four-Stroke Engines**

- Convert \_\_\_\_\_ energy to mechanical energy
  - energy contained in gasoline is turned into \_\_\_\_\_ power

### **2. Four-Stroke Engine Ignition**

1. Begins when the air/fuel mixture is ignited inside an enclosed cylinder which drives a piston connected to a crankshaft
2. The crankshaft then converts the \_\_\_\_\_ movement on the piston to rotary motion, using a journal which is offset to the crankshaft centerline
3. Next, fuel is mixed with air in the \_\_\_\_\_
  - or in some engines, the fuel injection system

### **3. Four-Stroke Engine Ignition**

4. The incoming air/fuel mixture and exhaust gases are controlled by valves which are put into action by a \_\_\_\_\_, which are driven through a gear set powered by the crankshaft
5. Finally, ignition of the air/fuel mixture is provided by a \_\_\_\_\_ connected to the engine's ignition system and is standardized to provide ignition at the proper time

### **4. Four-Stroke Cycle of Operation**

- Requires four strokes of the of the \_\_\_\_\_ inside the cylinder
  - which involves two full rotations of the crankshaft
- Includes the following events:
  - \_\_\_\_\_
  - compression stroke
  - power (combustion) stroke
  - exhaust stroke

Four-Stroke Fact: Strokes are the up-down movements of the piston.

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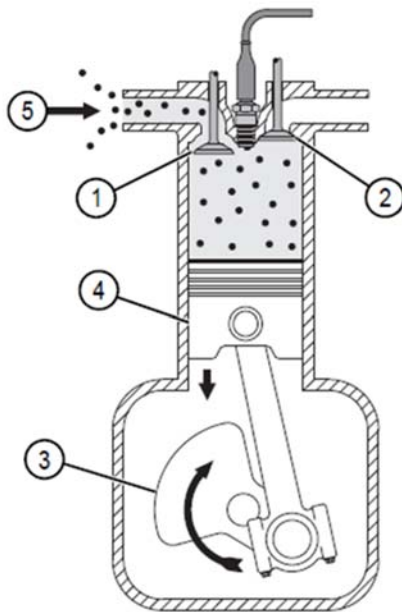
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## 5. Intake Stroke

- Is the process of obtaining fuel and air required for combustion
  - begins with the intake valve open and exhaust valve closed
  - as the \_\_\_\_\_ turns, the piston moves downward, allowing air/fuel mixture to flow into the cylinder
  - as the piston approaches the bottom of the \_\_\_\_\_ (known as bottom dead center, or BDC), the crankshaft continues to rotate, driving the camshaft and closing the intake valve

## 6. Intake Stroke

1. Intake Valve
2. \_\_\_\_\_
3. Crankshaft
4. \_\_\_\_\_
5. Air/Fuel Mixture



## 7. Compression Stroke

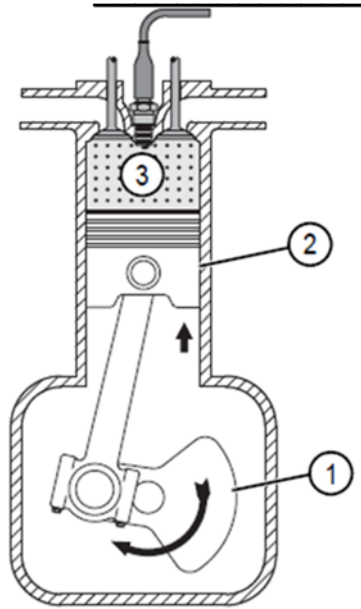
- Is when the air/fuel mixture becomes compressed in the cylinder
  - as the crankshaft \_\_\_\_\_, the piston starts to travel upward, compressing the air/fuel mixture
  - both the intake and exhaust \_\_\_\_\_ remain closed during this stage

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## 8. Compression Stroke

1. \_\_\_\_\_
2. Piston
3. Air/Fuel \_\_\_\_\_



## 9. Power (Combustion) Stroke

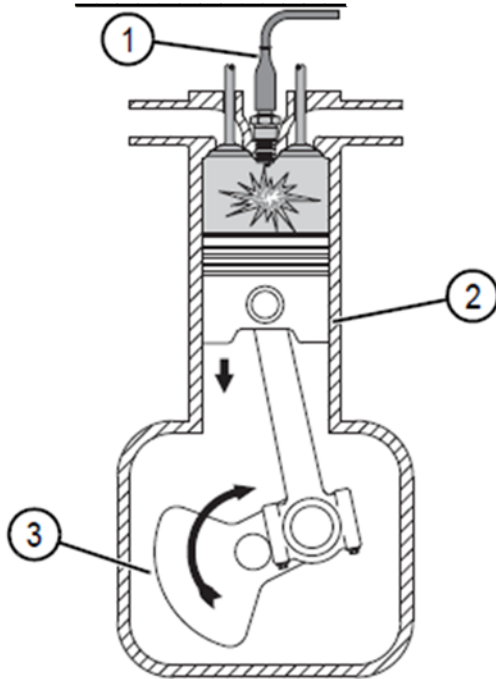
- Is when the compressed air/fuel \_\_\_\_\_ is ignited by a spark plug
  - as the piston reaches the top of the cylinder (known as the top dead center, or TDC), the spark plug fires, igniting the compressed air/fuel mixture
  - the intake and exhaust valves remain closed
  - the \_\_\_\_\_ combustion gases force the piston downward in the cylinder
  - this reciprocating (downward) motion transfers to the crankshaft, where it converts to rotary motion

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## 10. Power (Combustion) Stroke

1. \_\_\_\_\_
2. Piston
3. \_\_\_\_\_



## 11. Exhaust Stroke

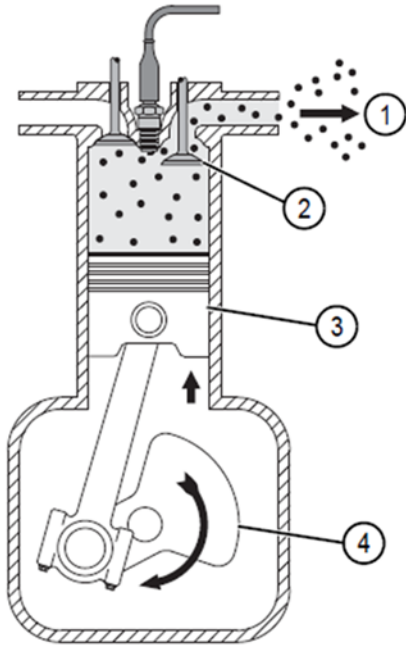
- Is the process of releasing the spent air/fuel mixture
  - as the piston approaches the bottom of its travel (bottom dead center, or BDC) within the cylinder, the camshaft opens the exhaust valve in order to release the exhaust \_\_\_\_\_
  - as the crankshaft rotates, the piston is driven up and forces the \_\_\_\_\_ gases from the cylinder

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## 12. Exhaust Stroke

1. Exhaust Gases
2. \_\_\_\_\_
3. Piston
4. \_\_\_\_\_



## ***Combustion Segment***

### **1. Normal Combustion**

- Is when the spark plug ignites the \_\_\_\_\_ mixture inside the combustion chamber at a specific moment toward the end of the \_\_\_\_\_
  - the burning air/fuel mixture creates a controlled combustion wave consisting of rapidly expanding heat and gases which force the piston down in the cylinder to create rotational energy of the crankshaft

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## 2. Abnormal Combustion

- May be caused by one or more of the following:
  - pre-ignition
  - \_\_\_\_\_
  - improper ignition timing
  - lean air/fuel mixtures
  - using low-quality fuel
  - engine overload

Four-Stroke Fact: \_\_\_\_\_ and detonation are very closely associated and are often interchanged; however, they are caused by different factors.

## 3. Pre-Ignition

- Occurs when the air/fuel mixture is ignited before the \_\_\_\_\_ fires
- Is caused by another ignition source
  - for example, a glowing \_\_\_\_\_ on a spark plug
- May advance to detonation

## 4. Detonation

- Is an uncontrolled and spontaneous \_\_\_\_\_ of the air/fuel mixture caused by high cylinder temperatures and pressures
  - ignition timing which has advanced too far can also lead to \_\_\_\_\_, which causes combustion pressures to rise too quickly

## 5. Detonation

- Creates multiple combustion waves, and when combined with the main combustion wave produced by the spark plug, create very high and very sharp \_\_\_\_\_ which makes the engine components resonate
  - this condition is known as a combustion \_\_\_\_\_, or more commonly known as ping

Resonate – produce a loud sound

## 6. Detonation

- Must be corrected
  - if the cause of \_\_\_\_\_ is not corrected, the high pressure spikes can cause fracture damage to the valves, spark plug, piston and \_\_\_\_\_ over time

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## 7. Improper Ignition Timing

- Refers to the incorrect \_\_\_\_\_ of spark plug ignition during the compression stroke
  - resulting in poor \_\_\_\_\_ performance

## 8. Lean Air/Fuel Mixture

- Has too little fuel, or not enough air, in the mix for proper \_\_\_\_\_
  - the correct \_\_\_\_\_ will combust with minimum detonation

## 9. Using Low-Quality Fuel

- May leave excessive carbon residue in the combustion \_\_\_\_\_ which can lead to \_\_\_\_\_ combustion

## 10. Engine Overload

- Is when an engine exceeds its maximum \_\_\_\_\_
  - at which point the \_\_\_\_\_ begins to overheat and cause abnormal combustion