Directions:
Fill in the blanks.

**Engine Components Segment**

1. **Four-Stroke Engines**   
   - Are composed of many components, including:
     - piston
     - __________________
     - wrist pin or piston pin
     - connecting rod
     - crankshaft
     - __________________
     - lifters
     - valves

2. **Four-Stroke Engine**
   1. ____________
   2. Piston Rings
   3. Wrist Pin/Piston Pin
   4. Wrist Pin/Piston Pin Retaining Clip
   5. Connecting Rod
   6. Crankshaft
   7. ____________
3. Four-Stroke Engine

4. Piston
   • Travels within the ________ of the cylinder
   • Transfers combustion energy to the ________

Four-Stroke Fact: The cylinder wall and the piston expand at different rates, so enough clearance must be provided between them.

5. Piston Rings
   • Are installed on the piston to form a ________ between the piston and the cylinder wall
   • Are typically made of high-grade cast iron and steel
   • Have the following functions:
     – provide a seal to hold the ________ in
     – retain as much oil as possible in the crankcase
     – transfer heat from the piston to the cylinder walls

6. Piston Rings
   • Include three ________ types:
     – compression ring
     – scraper/wiper ring
     – ____________ control ring
7. Compression Ring
- Is installed in the top _____________ on the piston
- Provides the seal for the cylinder by expanding out against the cylinder wall
  - the compression pressure will flow in behind the compression ring to increase _____________ against the cylinder wall
- Is typically made of cast iron

8. Scraper/Wiper Ring
- Is located between the compression ring and the oil ring
- Is used to further _____________ the combustion chamber and wipe the cylinder wall clean of excess _____________

9. Oil Control Ring
- Is located in the groove closest to the crankcase
  - toward the bottom
- Wipes excess oil from the cylinder wall and _____________ the oil back to the crankcase
  - the oil goes back to the crankcase through _____________ machined in the ring and the piston ring groove

10. Wrist Pin/Piston Pin
- Attaches the piston to the upper end of the connecting rod
- Allows the piston to _____________ on the end of the connecting rod
  - while the other end of the connecting rod is following the stroke of the crankshaft
- Can be pressed in or held in place by a _____________ retaining clip at each end

11. Connecting Rod
- Connects the _____________ to the crankshaft
  - the small end is attached to the piston with the wrist pin
  - the large end is usually split across the _____________ of its opening to allow for assembly onto the crankshaft

Four-Stroke Fact: The reciprocating movement of the piston in the cylinder is converted to the rotational movement of the crankshaft
12. Connecting Rod
• Connects the piston to the crankshaft
  – the lower half of the large end is the connecting rod ___________ and is bolted to the upper half after placing it around the connecting rod ___________ on the crankshaft

Four-Stroke Fact: The connecting rod and its connecting rod cap are manufactured as a unit and must always be kept together.

13. Crankshaft
• Converts the reciprocating movement of the piston into a ___________ movement, creating torque which powers the machine the engine is attached to
• Has a mechanical link, usually _____________, to the camshaft and mechanical governor

Four-Stroke Fact: The distance from the centerline of the crankshaft to the centerline of the connecting rod journal, multiplied by two, determines the stroke of the engine.

14. Camshaft
• Is at half speed of the crankshaft, usually through direct gear contact
• Will have a _____________ to open each intake and exhaust valve
• Determines the timing when _____________ open and close in relation to each other

15. Lifters
• Are also known as tappets
• Are located on the camshaft lobes
  – as the camshaft rotates, the lifter follows the profile of the camshaft lobe and moves the _____________ up and down to move the rocker arm
• Include two types
  – _____________
  – mechanical
16. Hydraulic Lifters
- Have multiple parts and are usually replaced as a _____________
  - through the use of a spring, inner and outer cylinders, and engine oil, the hydraulic lifter will be maintenance free
- Allow for constant _____________ between the cam, lifter, pushrod, rocker arm and valve

17. Mechanical Lifters
- Are solid, without moving parts
  - these lifters typically require some _____________ regularly as components wear
    - the most common form of adjustment is at the _____________
- Are typically made of solid metal

18. Valves
- Are components which allow the air/fuel mixture in and exhaust out
- Are made of heat _____________ materials
  - the exhaust valve is usually made from a separate alloy metal
- Include the use of valve seats
  - valve seats are inserted into the _____________ for the valves to seal and transfer heat
  - valve seats are grounded to an angle which mates with the valve face, so a tight seal is created when the valve is closed

Engine Cooling Segment
1. Air-Cooled Engines
- Generate heat which is _____________ directly into the air
- Rely on the circulation of air to cool hot engine components
  - heat must be _____________ from the engine to prevent permanent damage
2. Air-Cooled Engines

2. Air

• Is brought in through an air intake screen by fins on the ___________ and distributed through a shroud and then across the fins on the cylinder(s)
  – metal fins covering the outside of the cylinders are used to increase the ___________ air can act on
  – the air movement across the cooling fin draws away excess heat

Four-Stroke Fact: In all combustion engines, a great percentage of the heat generated escapes though the exhaust.

3. Air

• Is brought in through an air intake screen by fins on the ___________ and distributed through a shroud and then across the fins on the cylinder(s)
  – metal fins covering the outside of the cylinders are used to increase the ___________ air can act on
  – the air movement across the cooling fin draws away excess heat

4. Heat Energy

• May find its way into the oil, which although primarily meant for ___________, also plays a role in heat dissipation
  – on an air-cooled engine, the addition of an ___________ may greatly help in the dissipation of heat

5. Engine Overheating

• May occur if any part of the air flow is restricted by ___________
• May also be caused by one or more of the following:
  – obstructions or blockage of air intake screen
  – obstructions on or in the flywheel fins
  – obstructions or damage to the ___________
  – obstructions or damage to the cylinder cooling fins
  – obstructions or damage to the external cooler
6. Liquid-Cooled Engines
• Utilize a _____________, coolant pump, thermostat, engine coolant passages, and the correct blend of coolant and water to regulate and dissipate _____________

Four-Stroke Fact: Coolant, commonly called antifreeze, is a mixture of ethylene of propylene glycol and water.

7. Liquid-Cooled Engine

8. Liquid-Cooled Engines
• Operate in the following manner:
  – coolant is circulated from the coolant pump to the cylinders, engine block, cylinder head, valves and _____________ chambers through a series of coolant passages
    • coolant exiting the engine flows through the thermostat housing
  – _____________ flows through a check valve opening in the thermostat, enabling a fast warm-up period
    • the check valve also acts as a vent to allow air to escape while filling the cooling system
    • before engine warm-up, the thermostat is closed
9. Liquid-Cooled Engines
- Operate in the following manner:
  - once the engine has reached full operating temperature, the thermostat will completely open, allowing maximum __________ through the upper radiator hose to the radiator top tank
  - coolant circulates through the radiator, dissipates heat and flows out the lower radiator __________ back to the coolant pump

10. Excessive Temperatures
- Will trigger the pressure cap to open to allow excess coolant to flow into the __________
  - when the coolant temperature drops, the pressure cap will close
  - as the coolant continues to cool, a vacuum will form in the radiator, opening a valve in the __________, allowing coolant to be siphoned from the expansion tank back into the radiator

11. Engine Coolant
- Will continue __________ throughout the system until the coolant temperature drops below the thermostat __________ rating, at which the thermostat begins to close and the sequence starts again
- Allows the engine to operate at an optimal temperature, facilitating clean, efficient operation

12. Engine Overheating
- May be caused by one or more of the following:
  - improper mixture of water and coolant/antifreeze
  - improper level of coolant
  - improper fan belt tension
  - internally __________
  - externally clogged cooling fins on radiator
  - thermostat opening slowly or not at all
  - collapsed hoses
  - faulty __________
  - blockage of water flow in the block or cylinder head
1. Pressure-Lubricated Engines
   - Typically utilize a wet sump _____________ system in which the oil pump is driven by the _____________

Four-Stroke Fact: Most systems include a pressure regulation system which maintains a working pressure.

2. Pressure Lubrication System
   - the rotation of the oil pump draws oil from the sump through the pickup _____________
     - the sump is the lowest part of the engine
   - the oil is pumped into passages in the engine block, which route the oil to the components requiring _____________
     - oil is routed to bearings, bushings, hydraulic lifters and rotating crankshaft assembly

3. Pressure-Lubricated Engines
   - Operate in the following manner:
     - the rotation of the oil pump draws oil from the sump through the pickup _____________
     - the sump is the lowest part of the engine
     - the oil is pumped into passages in the engine block, which route the oil to the components requiring _____________
     - oil is routed to bearings, bushings, hydraulic lifters and rotating crankshaft assembly

4. Oil Pressure Switch
   - Is situated in an engine block oil passage
   - Alerts the operator of a _____________ situation
     - the engine oil continues to a full-flow oil filter equipped with a bypass valve
     - if oil flow through the filter becomes _____________, the bypass valve opens to allow engine oil to continue to circulate through the engine
5. Splash Lubrication System
- Uses an ____________, attached to the connecting ____________ in a horizontal-crankshaft engine

Four-Stroke Fact: In a vertical-cranking model, the oil dipper will be attached to a crankshaft counterweight, or it will be a separate component driven by the cam gear.

6. Splash Lubrication

7. Splash Lubrication System
- Operates in the following manner:
  - with each ____________ of the crankshaft, the oil dipper reaches into the engine's oil supply like a small cup at the bottom of the crankcase, throwing ____________ onto the internal engine parts

8. Engine Oil
- Is used in the lubrication system to perform the following ____________ basic functions:
  - lubrication
  - sealing
  - ____________
  - cleaning
9. Choosing the Correct Oil
• Requires technicians to know how lubricating oils are rated
  – the oil should meet the manufacturer’s
    ______________recommendations and performance
    ______________

Viscosity- resistance to flow
Four-Stroke Fact: By law, a manufacturer cannot require users to run their oil. The manufacturer can only specify the specific oil quantity and grade.

10. Choosing the Correct Oil
• Can be accomplished with the help of the American
  ______________Institute (API) and Society of ______________Engineers
  (SAE) standards

11. API & SAE
• Are voluntary collaborations of the automotive and oil industries to ensure certain standards
• Place a symbol on oil containers which gives ______________consistent standards of information among oil brands and formulations
  – a container of engine oil bearing the API and SAE
    ______________conforms to the standards and specifications of each

12. API & SAE Symbols
• Contain information about the following:
  – ______________grade
  – oil performance classification
  – energy ______________rating

13. Oil Ratings
• Include API ratings which are expressed as C for compression ignition and S for ______________
  – also includes codes which indicate the use of the oil in a certain engine
• Include SAE ratings to ensure the standards of the oil’s viscosity
  – a ______________oil is commonly recommended
14. Crankcase Breather System

• Is required to maintain a net-negative _____________ in the crankcase
  – a net-negative (vacuum) is necessary to control oil consumption
  and manage crankcase vapor for _____________ concerns

Four-Stroke Fact: Modern engines incorporate a closed crankcase breather system.