Cooling System

There will be two questions on the ASE P2 test that deal with cooling systems, parts and products.

The cooling system includes the radiator, radiator cap, coolant reservoir, fan (electric or mechanical), fan clutch (if equipped with a mechanical fan), water pump, thermostat, hoses, belts and antifreeze. Related parts include the coolant temperature sensor and fan relay.

The radiators in most late-model vehicles are aluminum with plastic end tanks. Most older vehicles have copper/brass radiators. Both types are vulnerable to internal corrosion caused by coolant neglect. Replacement radiators should have the same cooling capacity (or better) than the original and the same hose connections. Cooling capacity is determined by the thickness of the radiator, the number of fins and tubes and/or the design of the fins and tubes. Increased cooling capacity is recommended for towing and performance applications.

The water pump is the heart of the cooling system. It is belt-driven and consists of a plastic or stamped steel impeller mounted on a shaft inside a cast or stamped steel housing. The pump is usually mounted on the

front of the engine. On some overhead cam (OHC) engines the pump is mounted under the timing belt and requires considerable labor to replace. For this reason, you should recommend replacing the pump if the timing belt is being replaced for scheduled maintenance (recommended every 60,000 to 100,000 miles, depending on the application).

The service life of the water pump and timing belt is about the same, so changing both at the same time can save the vehicle owner money on future repairs. Water pumps don't last forever, and leaks around the pump shaft seal and bearing can quickly lead to overheating. Erosion of the blades on a plastic impeller or a loose impeller can also cause overheating. Any water pump that is leaking, making noise or has excessive shaft play should be replaced. Replacement options include remanufactured and new pumps.

The water pump may also be driven by a V-belt or a flat serpentine belt. The same belt may also drive other engine accessories. Belts deteriorate with age and should be replaced if frayed, cracked, glazed or oil-soaked. Replacement belt length and width must be the same as the original. On vehicles with serpentine belts, the automatic tensioner may also need to be replaced if it is sticking, making noise or cannot maintain proper belt tension. Belt idler pulleys should also be replaced if noisy, worn or sticking.

For temperature control, the cooling system requires a thermostat. It is usually located in a housing where the upper radiator hose connects to the engine. The thermostat does two things: First, it allows the engine to warm up quickly (which reduces cold emissions and fuel consumption) and second, it maintains a consistent operating temperature (also important for low emissions, good fuel economy and performance). The thermostat has a temperature-sensitive valve that remains closed and blocks the flow of coolant until the engine reaches 195 to 210 degrees F. It then opens and allows coolant to flow to the radiator. The thermostat continues to cycle open and shut so the engine can run within a certain temperature range. This is very important on late-model vehicles with computer engine controls because engine temperature affects the fuel feedback control loop, emissions, fuel economy and performance.

If the thermostat sticks shut, the engine will overheat. If it fails to close, the engine will be slow to warm-up and the heater may not put out much heat when the weather turns cold. Fuel economy, emissions and engine wear will also suffer. Under no circumstances should an engine run without a thermostat. Replacement thermostats should have the same rating as the original. A slightly hotter thermostat may be used during cold weather for increased heater output, but a colder thermostat should not be used on engines with computer controls. Other items that may be needed when changing a thermostat include a new thermostat housing and gasket or sealer.

To improve cooling, a fan is needed to pull air through the radiator when the vehicle is stopped or traveling at low speed. Older rear-wheel-drive vehicles may have a belt-driven fan with or without a clutch. The clutch allows some slippage and is used to reduce fan noise at high RPM and to improve fuel economy by reducing drag. Excessive slippage in the clutch, however, may reduce airflow and cause the engine to overheat at low speed. Most people don't know it, but the fluid inside a fan clutch breaks down over time, causing the clutch to slip more than it should. This can lead to overheating in a high-mileage vehicle. Most newer vehicles have one or two electric cooling fans mounted behind the radiator and a few have hydraulic fans driven by power steering fluid. Electric fans are powered through a relay and controlled by a coolant temperature switch or the engine computer. A failure of the fan motor, fan relay, coolant temperature switch or a wiring problem that prevents the fan from coming on can cause the engine to overheat.

The major hoses in the cooling system include the upper and lower radiator hoses (the lower one usually attaches to the water pump and the upper usually attaches to the thermostat housing), plus a pair of heater hoses (one inlet and one outlet) and various connecting hoses and bypass hoses depending on the application. Replacement hoses must be the same length and diameter as the original. New clamps should also be installed when hoses are replaced. Hoses should be replaced if leaking, cracked or bulging. Electro-chemical degradation due to coolant neglect can cause hoses to fail from the inside out.

The coolant is a mixture of ethylene glycol antifreeze and water (typically a 50/50 mix). This combination provides freezing protection down to -34 degrees and boilover protection up to 265 degrees F with a 15 PSI radiator cap. The condition of the coolant is just as important as the strength because corrosion can attack the system from within if the coolant is neglected. The recommended replacement interval for traditional "green" antifreeze is two years or 30,000 miles. For the newer extended- life coolants, the change interval can be as long as five years or 150,000 miles. Most long-life coolants use organic acid technology (OAT) additives that are different from those used in standard antifreeze. Long-life coolants may contain special dyes to distinguish them from ordinary antifreeze, such as the orange dye in General Motor's Dex-Cool coolant. Other manufacturers use different colors. If the cooling system is low, it should be topped off with the same type of antifreeze as the original. Even so, the type of coolant can't always be identified by its color, so most long-life antifreeze now uses a "universal" chemistry that is compatible with all types of coolants and makes and models of vehicles. ◉