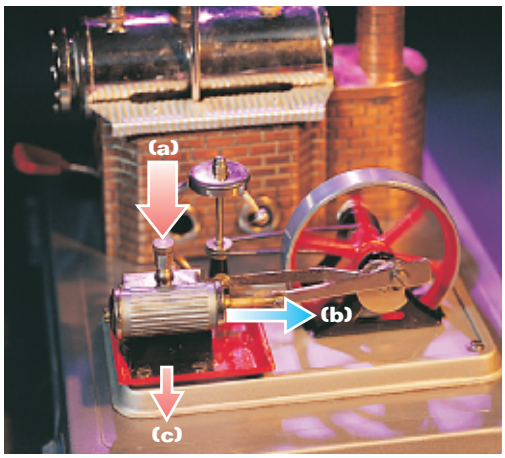

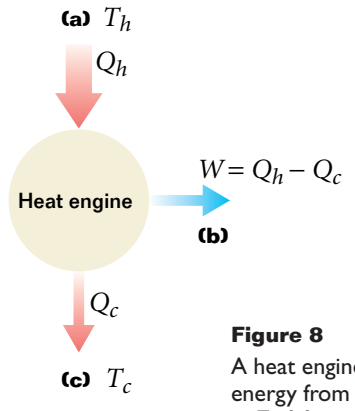

Figure 8
A heat engine is able to do work **(b)** by transferring energy from a high-temperature substance (the boiler) at T_h **(a)** to a substance at a lower temperature (the air surrounding the engine) at T_c **(c).**

Heat engines use heat to do work

A heat engine is a device that uses heat to do mechanical work. A heat engine is similar to a water wheel, which uses a difference in potential energy to do work. A water wheel uses the energy of water falling from one level above Earth's surface to another. The change in potential energy increases the water's kinetic energy so that the water can do work on one side of the wheel and thus turn it.

Instead of using the difference in potential energy to do work, heat engines do work by transferring energy from a high-temperature substance to a lower-temperature substance, as indicated for the steam engine shown in **Figure 8.** For each complete cycle of the heat engine, the net work done will equal the difference between the energy transferred as heat from a high-temperature substance to the engine (Q_h) and the energy transferred as heat from the engine to a lower-temperature substance (Q_c).

$$W_{net} = Q_h - Q_c$$

The larger the difference between the energy transferred as heat into the engine and out of the engine, the more work the engine can do in each cycle.

The internal-combustion engine found in most vehicles is an example of a heat engine. Internal-combustion engines burn fuel within a closed chamber (the cylinder). The potential energy of the chemical bonds in the reactant gases is converted to kinetic energy of the particle products of the reaction. These gaseous products push against a piston and thus do work on the environment (in this case, a crankshaft that transforms the linear motion of the piston to the rotational motion of the axle and wheels).

Although the basic operation of any internal-combustion engine resembles that of an ideal cyclic heat engine, certain steps do not fit the idealized model. When gas is taken in or removed from the cylinder, matter enters or leaves the system so that the matter in the system is not isolated. No heat engine operates perfectly. Only part of the available internal energy leaves the engine as work done on the environment; most of the energy is removed as heat.