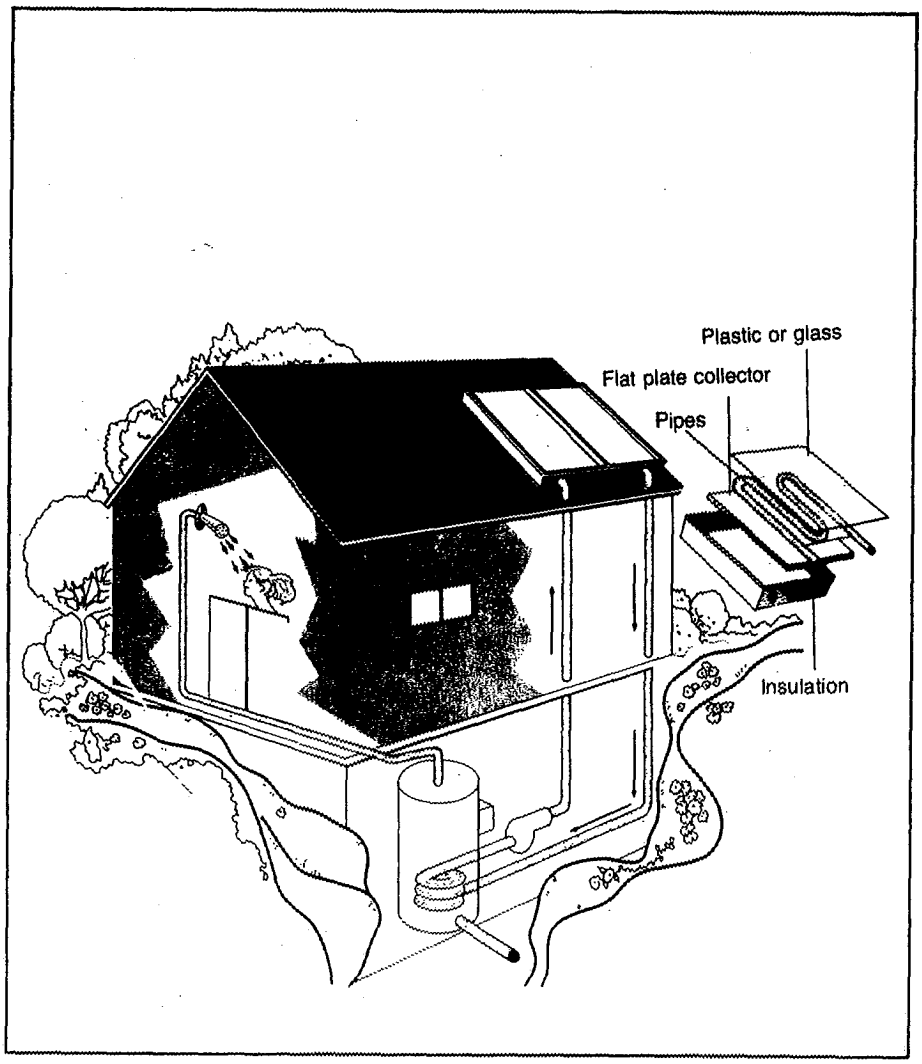
Applications of Conduction, Convection, and Radiation

Solar Water Heaters Solar water heating systems in homes are one of the most promising ways to use solar energy directly. Early models were based on a principle known as **thermosiphoning**. A hot water storage tank was mounted near the peak of the roof, above a solar collector. Pipes connected the tank to the solar collector located on the south side of the building.

The solar collector included flat panels painted black to absorb the radiant energy from the sun. The absorbed radiant energy was transferred by conduction to water flowing through the collector. As the water warmed up it rose upward to the tank (due to convection currents), displacing colder water downward to the solar collector. All three methods of heat transfer played key roles in the thermosiphoning process.



Modern solar collectors have the same basic components: a collector, a storage tank, and pipes joining the two (Fig. 10-29). However, modern solar collectors have several additional components. There is a method of protecting the circulating fluid from freezing, and a back-up heating element in the tank to supplement the energy from the sun on cloudy days. Because a pump helps move the water around the circuit, the storage tank can be kept in the basement beneath the collector. Also, electronic controls ensure that the pump runs only when the temperature inside the collector is high enough. In addition, the solar collector is insulated along the sides and back to minimize heat loss to the outside. The side next to the sun is covered with plastic or glass to create a miniature greenhouse. The transparent covering lets in the short wavelength rays from the hot sun, but reflects back inside the longer wavelength infrared rays emitted by the cooler black surface.

Thermography Heat transfer also plays a key role in diagnosing areas of the body infected by diseases such as arthritis and cancer. Diseased areas are usually warmer than the surrounding tissue. Hence, more energy is conducted to the surface of the skin from these areas. A warmer surface radiates more infrared radiation than a cooler surface. Pictures called **thermographs**, taken using film sensitive to heat, pinpoint the hot spots. Tumors as small as 1 cm in diameter can be detected. The process of taking photographs of the body with infrared radiation is called **thermography**. This technique is also used to pinpoint areas in buildings needing more insulation.

Section Review

1. Define conduction. How does it happen?
2. **a)** List and describe the four factors that affect heat transfer by conduction.
   b) Compare the thermal conductivity values of metals and non-metals. (See Table 10-3.)
   c) A slab of styrofoam insulation has dimensions of 1.2 m $\times$ 2.4 m and is 5.0 cm thick. It is used to seal an opening when the inside and outside temperatures are 20°C and 0°C respectively. How much heat escapes through the slab in one day? (See Table 10-3.)
3. **a)** What is the relationship between thermal resistance and thermal conductivity?
   b) Calculate the thermal resistance of a piece of animal fat 1.0 cm thick. (Refer to Table 10-3.)
4. **a)** State two differences between conduction and convection.
   b) What conditions are needed before convection can take place?
5. **a)** Define radiation.
   b) What factors affect the radiant energy emitted by an object?
   c) Compare an ideal emitter and an ideal absorber.
   d) Why do we tend to wear dark-coloured clothes in winter and light-coloured clothes in summer?
6. **a)** What are the main parts of a solar water heater system?
   b) On which side of the house is the solar collector placed
   i) in Canada? **ii)** in Australia?
7. **a)** What is the principle of operation of thermography?
   b) Describe two uses of thermographs.