24. Why is the liner of a thermos bottle silvered (Fig. 14–15), and why does it have a vacuum between its two walls?

FIGURE 14–15
Question 24.

25. Imagine you have a wall that is very well insulated—it has a very high thermal resistance, R_1. Now you place a window in the wall that has a relatively low R-value, R_2. What has happened to the overall R-value of the wall plus window, compared to R_1 and R_2? [*Hint*: The temperature *difference* across the wall is still the same everywhere.]

26. Heat loss occurs through windows by the following processes: (1) ventilation around edges; (2) through the frame, particularly if it is metal; (3) through the glass panes; and (4) radiation. (*a*) For the first three, what is (are) the mechanism(s): conduction, convection, or radiation? (*b*) Heavy curtains reduce which of these heat losses? Explain in detail.

27. A piece of wood lying in the Sun absorbs more heat than a piece of shiny metal. Yet the wood feels less hot than the metal when you pick it up. Explain.

28. The Earth cools off at night much more quickly when the weather is clear than when cloudy. Why?

29. An "emergency blanket" is a thin shiny (metal coated) plastic foil. Explain how it can help to keep an immobile person warm.

30. Explain why cities situated by the ocean tend to have less extreme temperatures than inland cities at the same latitude.

Problems

14–1 Heat as Energy Transfer

1. (I) How much heat (in joules) is required to raise the temperature of 30.0 kg of water from 15°C to 95°C?

2. (I) To what temperature will 7700 J of heat raise 3.0 kg of water that is initially at 10.0°C?

3. (II) An average active person consumes about 2500 Cal a day. (*a*) What is this in joules? (*b*) What is this in kilowatt-hours? (*c*) Your power company charges about a dime per kilowatt-hour. How much would your energy cost per day if you bought it from the power company? Could you feed yourself on this much money per day?

4. (II) A British thermal unit (Btu) is a unit of heat in the British system of units. One Btu is defined as the heat needed to raise 1 lb of water by 1 F°. Show that

$$1\ \text{Btu} = 0.252\ \text{kcal} = 1055\ \text{J}.$$

5. (II) A water heater can generate 32,000 kJ/h. How much water can it heat from 15°C to 50°C per hour?

6. (II) A small immersion heater is rated at 350 W. Estimate how long it will take to heat a cup of soup (assume this is 250 mL of water) from 20°C to 60°C.

7. (II) How many kilocalories are generated when the brakes are used to bring a 1200-kg car to rest from a speed of 95 km/h?

14–3 and 14–4 Specific Heat; Calorimetry

8. (I) An automobile cooling system holds 16 L of water. How much heat does it absorb if its temperature rises from 20°C to 90°C?

9. (I) What is the specific heat of a metal substance if 135 kJ of heat is needed to raise 5.1 kg of the metal from 18.0°C to 31.5°C?

10. (II) Samples of copper, aluminum, and water experience the same temperature rise when they absorb the same amount of heat. What is the ratio of their masses? [*Hint*: See Table 14–1.]

11. (II) A 35-g glass thermometer reads 21.6°C before it is placed in 135 mL of water. When the water and thermometer come to equilibrium, the thermometer reads 39.2°C. What was the original temperature of the water?

12. (II) What will be the equilibrium temperature when a 245-g block of copper at 285°C is placed in a 145-g aluminum calorimeter cup containing 825 g of water at 12.0°C?

13. (II) A hot iron horseshoe (mass = 0.40 kg), just forged (Fig. 14–16), is dropped into 1.35 L of water in a 0.30-kg iron pot initially at 20.0°C. If the final equilibrium temperature is 25.0°C, estimate the initial temperature of the hot horseshoe.

FIGURE 14–16
Problem 13.

14. (II) A 215-g sample of a substance is heated to 330°C and then plunged into a 105-g aluminum calorimeter cup containing 165 g of water and a 17-g glass thermometer at 12.5°C. The final temperature is 35.0°C. What is the specific heat of the substance? (Assume no water boils away.)

15. (II) How long does it take a 750-W coffeepot to bring to a boil 0.75 L of water initially at 8.0°C? Assume that the part of the pot which is heated with the water is made of 360 g of aluminum, and that no water boils away.

16. (II) Estimate the Calorie content of 75 g of candy from the following measurements. A 15-g sample of the candy is allowed to dry before putting it in a bomb calorimeter. The aluminum bomb has a mass of 0.725 kg and is placed in 2.00 kg of water contained in an aluminum calorimeter cup of mass 0.624 kg. The initial temperature of the mixture is 15.0°C, and its temperature after ignition is 53.5°C.