

56. A house has well-insulated walls 17.5 cm thick (assume conductivity of air) and area 410 m^2 , a roof of wood 6.5 cm thick and area 280 m^2 , and uncovered windows 0.65 cm thick and total area 33 m^2 . (a) Assuming that heat is lost only by conduction, calculate the rate at which heat must be supplied to this house to maintain its inside temperature at 23°C if the outside temperature is -10°C . (b) If the house is initially at 10°C , estimate how much heat must be supplied to raise the temperature to 23°C within 30 min. Assume that only the air needs to be heated and that its volume is 750 m^3 . (c) If natural gas costs $\$0.080$ per kilogram and its heat of combustion is $5.4 \times 10^7 \text{ J/kg}$, how much is the monthly cost to maintain the house as in part (a) for 24 h each day, assuming 90% of the heat produced is used to heat the house? Take the specific heat of air to be $0.24 \text{ kcal/kg}\cdot^\circ\text{C}$.
57. A 15-g lead bullet traveling at 220 m/s passes through a thin wall and emerges at a speed of 160 m/s. If the bullet absorbs 50% of the heat generated, (a) what will be the temperature rise of the bullet? (b) If the bullet's initial temperature was 20°C , will any of the bullet melt, and if so, how much?
58. A leaf of area 40 cm^2 and mass $4.5 \times 10^{-4} \text{ kg}$ directly faces the Sun on a clear day. The leaf has an emissivity of 0.85 and a specific heat of $0.80 \text{ kcal/kg}\cdot^\circ\text{K}$. (a) Estimate the rate of rise of the leaf's temperature. (b) Calculate the temperature the leaf would reach if it lost all its heat by radiation to the surroundings at 20°C . (c) In what other ways can the heat be dissipated by the leaf?
59. Using the result of part (a) in Problem 58, take into account radiation from the leaf to calculate how much water must be transpired (evaporated) by the leaf per hour to maintain a temperature of 35°C .
60. An iron meteorite melts when it enters the Earth's atmosphere. If its initial temperature was -125°C outside of Earth's atmosphere, calculate the minimum velocity the meteorite must have had before it entered Earth's atmosphere.
61. The temperature within the Earth's crust increases about 1.0°C for each 30 m of depth. The thermal conductivity of the crust is $0.80 \text{ W/C}^\circ\cdot\text{m}$. (a) Determine the heat transferred from the interior to the surface for the entire Earth in 1 day. (b) Compare this heat to the amount of energy incident on the Earth in 1 day due to radiation from the Sun.
62. In a typical game of squash (Fig. 14–22), two people hit a soft rubber ball at a wall until they are about to drop due to dehydration and exhaustion. Assume that the ball hits the wall at a velocity of 22 m/s and bounces back with a velocity of 12 m/s, and that the kinetic energy lost in the process heats the ball. What will be the temperature increase of the ball after one bounce? (The specific heat of rubber is about $1200 \text{ J/kg}\cdot^\circ\text{C}$.)



FIGURE 14–22 Problem 62.

63. What will be the final result when equal masses of ice at 0°C and steam at 100°C are mixed together?
64. In a cold environment, a person can lose heat by conduction and radiation at a rate of about 200 W. Estimate how long it would take for the body temperature to drop from 36.6°C to 35.6°C if metabolism were nearly to stop. Assume a mass of 70 kg. (See Table 14–1.)
65. After a hot shower and dishwashing, there is “no hot water” left in the 50-gal (185-L) water heater. This suggests that the tank has emptied and refilled with water at roughly 10°C . (a) How much energy does it take to reheat the water to 50°C ? (b) How long would it take if the heater output is 9500 W?
66. The temperature of the glass surface of a 60-W lightbulb is 65°C when the room temperature is 18°C . Estimate the temperature of a 150-W lightbulb with a glass bulb the same size. Consider only radiation, and assume that 90% of the energy is emitted as heat.

Answers to Exercises

A: 0.21 kg.

B: The drapes trap a layer of air between the outside wall and the room, which acts as an excellent insulator.