PQ1 Heat

Q and A

Q1

How much heat is needed to raise the temperature of 50.0 g of water from 4.5°C to 83.0°C?

$$Q = mC\Delta T$$
$$= (0.0500\ \text{kg})(4180\ \text{J/kg}\cdot^\circ\text{C})$$
$$(83.0^\circ\text{C} - 4.5^\circ\text{C})$$
$$= 1.64\times10^4\ \text{J}$$

Q2

A 5.00×10^{2}-g block of metal absorbs 5016 J of heat when its temperature changes from 20.0°C to 30.0°C. Calculate the specific heat of the metal.

$$Q = mC\Delta T$$

$$\text{so } C = \frac{Q}{m\Delta T}$$

$$= \frac{5016\ \text{J}}{(5.00\times10^{-1}\ \text{kg})(30.0^{\circ}\text{C} - 20.0^{\circ}\text{C})}$$

$$= 1.00\times10^{3}\ \text{J/kg}\cdot^{\circ}\text{C}$$

$$= 1.00\times10^{3}\ \text{J/kg}\cdot\text{K}$$

Q3

The cooling system of a car engine contains 20.0 L of water (1 L of water has a mass of 1 kg).

a. What is the change in the temperature of the water if the engine operates until 836.0 kJ of heat is added?

$$Q = mC\Delta T$$

$$\Delta T = \frac{Q}{mC} = \frac{(8.36\times10^5\ \text{J})}{(20.0\ \text{kg})(4180\ \text{J/kg·K})}$$

$$= 10.0\ \text{K}$$

Q3 continued

Suppose that it is winter, and the car's cooling system is filled with methanol. The density of methanol is 0.80 g/cm^3. What would be the increase in temperature of the methanol if it absorbed 836.0 kJ of heat?

The mass of methanol would be 0.80 times the mass of 20.0 L of water, or 16 kg.

$$Q = mC\Delta T$$

$$\Delta T = \frac{Q}{mC} = \frac{8.36\times10^5\ \text{J}}{(16\ \text{kg})(2450\ \text{J/kg·K})}$$

$$= 21\ \text{K}$$

Q3 continued

c. Which is the better coolant, water or methanol? Explain.

For temperatures above 0°C, water is the better coolant because it can absorb heat without changing its temperature as much as methanol does.

Q4

Electric power companies sell electricity by the kWh, where 1 kWh = 3.6×10^6 J. Suppose that it costs \$0.08 per kWh to run an electric water heater in your neighborhood. How much does it cost to heat 75 kg of water from 15°C to 43°C to fill a bathtub?

$$Q = mC\Delta T$$

$$= (75\text{ kg})(4180\text{ J/kg}\cdot\text{K})(43^\circ\text{C} - 15^\circ\text{C})$$

$$= 8.8\times10^6\text{ J}$$

$$\frac{8.8\times10^6\text{ J}}{3.6\times10^6\text{ J/kWh}} = 2.4\text{ kWh}$$

$$(2.4\text{ kWh})(\$0.15\text{ per kWh}) = \$0.36$$

Q5

Thermal Energy Could the thermal energy of a bowl of hot water equal that of a bowl of cold water? Explain your answer.

Thermal energy is the measure of the total energy of all the molecules in an object. The temperature (hot or cold) measures the amount of energy per molecule. If the bowls are identical and contain the same amount of water, they have the same number of molecules, but the bowl of hot water has more total thermal energy. However, if the cold water mass is slightly more than that of the hot water, the two energies could be equal.

Q6

Heat The hard tile floor of a bathroom always feels cold to bare feet even though the rest of the room is warm. Is the floor colder than the rest of the room?

The floor is usually at the same temperature as the rest of the room, but the tile conducts heat more efficiently than most materials, so it conducts heat from a person's feet, making them feel cold.

Q7

Specific Heat If you take a plastic spoon out of a cup of hot cocoa and put it in your mouth, you are not likely to burn your tongue. However, you could very easily burn your tongue if you put the hot cocoa in your mouth. Why?

The plastic spoon has a lower specific heat than the cocoa, so it does not transmit much heat to your tongue as it cools.