CHAPTER 10
ENERGY AND STATES OF MATTER

Measuring Heat Energy

Energy and Nutrition

HEAT

- Energy that flows from something warm to something cooler
- A hotter substance gives KE to a cooler one
- When heat is transferred (lost or gained), there is a change in the energy within the substance

SAMPLE QUESTION 1

A. When you touch ice, heat is transferred from

1) your hand to the ice
2) the ice to your hand

B. When you drink a hot cup of coffee, heat is transferred from

1) your mouth to the coffee
2) the coffee to your mouth

SOLUTION 1

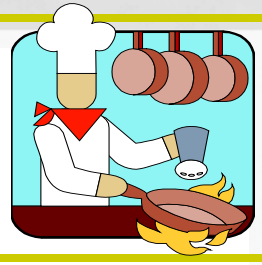
A. When you touch ice, heat is transferred from

1) your hand to the ice

B. When you drink a hot cup of coffee, heat is transferred from

2) the coffee to your mouth

SAMPLE QUESTION 2



When you heat 200 g of water for 1 minute, the water temperature rises from 10°C to 18°C.

200 g

400 g

If you heat 400 g of water at 10°C in the same pan with the same amount of heat for 1 minute, what would you expect the final temperature to be?

1) 10 °C 2) 14°C 3) 18°C

SOLUTION 2

2)14°C

Heating twice the mass of water using the same amount of heat will raise the temperature only half as much.

200 g

400 g

SOME EQUALITIES FOR HEAT

Heat is measured in calories or joules

- 1 kcal = 1000 cal
- 1 calorie = 4.18J
- 1 kJ = 1000 J

SPECIFIC HEAT

- Why do some foods stay hot longer than others?
- Why is the beach sand hot, but the water is cool on the same hot day?

SPECIFIC HEAT

Different substances have different capacities for storing energy

It may take 20 minutes to heat water to 75°C. However, the same mass of aluminum might require 5 minutes and the same amount of copper may take only 2 minutes to reach the same temperature.

SPECIFIC HEAT VALUES

Specific heat is the amount of heat needed to raise the temperature of 1 kg of a substance by 1°C

	cal/g°C	J/kg°C
water	1.00	4186
aluminum	0.22	900
copper	0.093	387
silver	0.057	234
gold	0.031	129

SAMPLE PROBLEM 3

A. A substance with a large specific heat

1) heats up quickly 2) heats up slowly

B. When ocean water cools, the surrounding air

1) cools 2) warms 3) stays the same

C. Sand in the desert is hot in the day, and cool at night. Sand must have a

1) high specific heat 2) low specific heat

SOLUTION 3

A. A substance with a large specific heat

2) heats up slowly

B. When ocean water cools, the surrounding air

2) warms

C. Sand in the desert is hot in the day, and cool at night. Sand must have a

2) low specific heat

MEASURING HEAT

Requires

- Kilograms of substance
- Temperature change ΔT
- Specific heat of the substance

CALCULATING HEAT

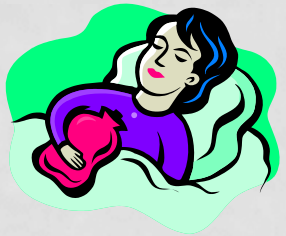
$$Q = Cp \cdot m \cdot \Delta T$$

Energy = Specific Heat x mass x change in temp

(J) = (J/kg* ˚C) x (kg) x ($T_{final} - T_{initial}$)

SAMPLE PROBLEM 4

A hot-water bottle contains 0.750 kg of water at 65°C. If the water cools to body temperature (37°C), how many joules of heat could be transferred to sore muscles?



DETERMINING SPECIFIC HEAT CAPACITY OF A METAL

If a hot substance is placed in an insulated container of cool water, energy conservation requires that the energy the substance gives up must equal the energy absorbed by the water.

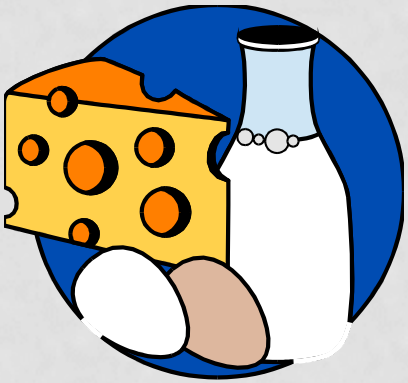
$$Q_{water} = -Q_{metal}$$

$$Cp,_w \cdot m \cdot \Delta T_w = -Cp,_m \cdot m \cdot \Delta T_m$$

ENERGY AND NUTRITION

1 Calorie (nutritional) = 1 kcal

1 Cal = 1000 cal



CALORIC FOOD VALUES

Carbohydrate = 4 kcal/g

Fat = 9 kcal/g

Protein = 4 kcal/g