Outline

- Classification of Matter
- Properties of Matter
- Energy and Temperature
- Heat Transfer Problems

Classification of Matter

Matter can be classified by composition…

pure substances have definite, fixed composition

mixtures have variable composition (multiple pure substances)

homogeneous – uniform appearance

heterogeneous – physically distinct

water…	pure substance!
vodka…	homogeneous mixture!
and glass, too…	heterogeneous mixture!

Pure substances that…

Cannot be broken down by chemical means: elements

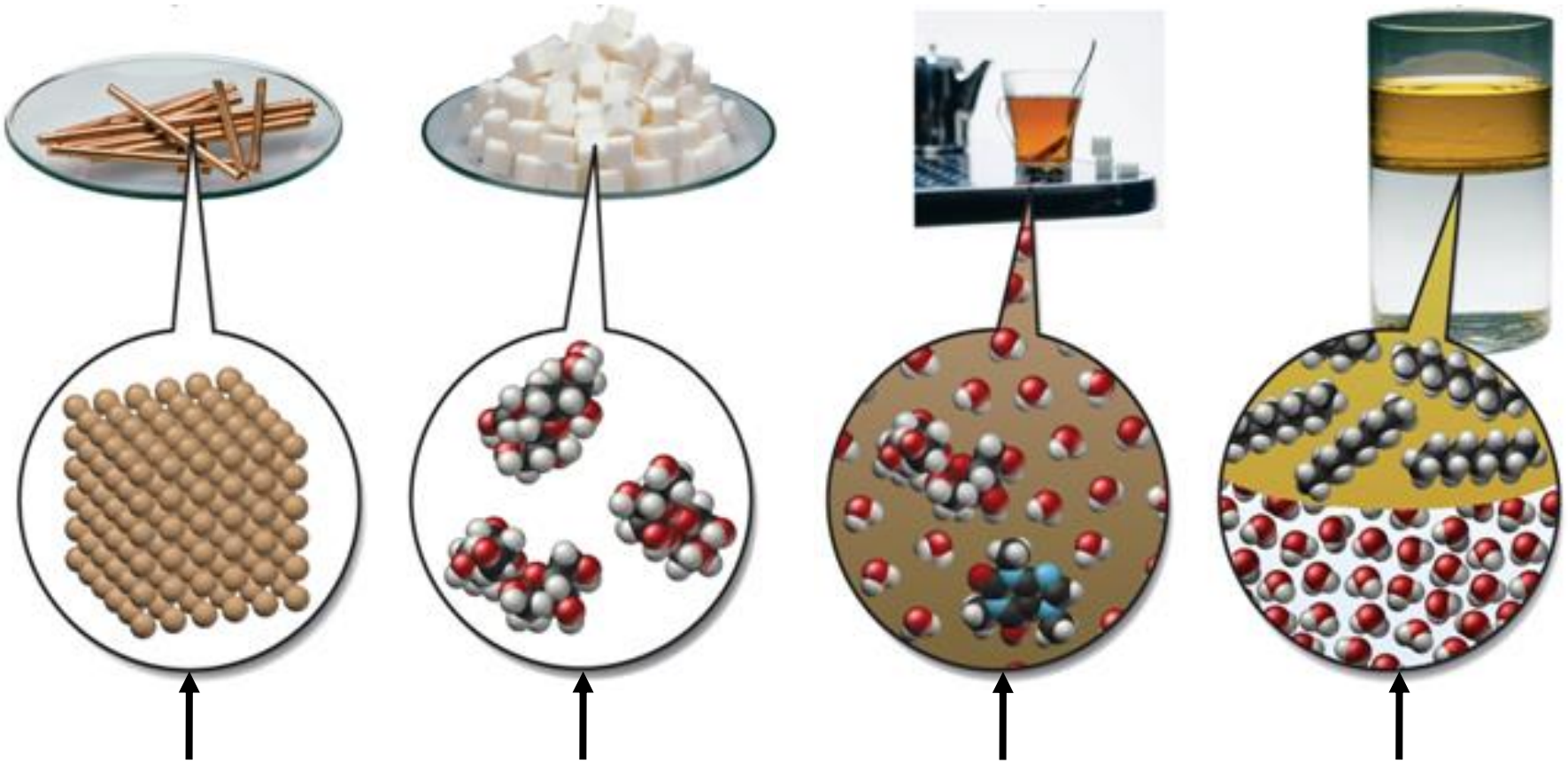
Smallest repeating unit of elements are “atoms”

Elements are represented with symbols

sulfur	S	silver	Ag
helium	He	tungsten	W

Can be broken down by chemical means: compounds

Smallest repeating unit of compounds are “molecules”



From Tro's "Introductory Chemistry", 3rd Ed. (Pearson/Prentice Hall)

Properties of Matter

Properties are characteristics used in identification and description

Physical properties are observed without changing substance into another

color, odor, taste, physical state, melting point…

Chemical properties are observed when changing substance into another

burning, rusting, bleaching, decomposition…

Iron rusts in moist air (chemical)

Water is liquid at room temperature (physical)

Aluminum dissolves in acid producing hydrogen gas (chemical)

Changes in appearance with…

no change in composition are physical changes

change in composition are chemical changes (reactions)

Digesting food (chemical)
Break glass (physical)
Burning gasoline (chemical)

Lavoisier's law of conservation of mass…

matter is neither lost nor gained during a chemical reaction

mass of reactants = mass of products

Energy and Temperature

Energy is capacity to do work or transfer heat…

Energy is measured in units of joules (J) and calories (cal)

4.184 J = 1.000 cal 1000 cal = 1 Cal

Energy is neither be created nor destroyed...

it can be converted from one form to another!

is transferred in chemical changes (reactions)!

Thermal energy is a measure of the motion of small particles of matter

Temperature is a measure of the amount of thermal energy

Greater thermal energy (motion) is seen at greater temperatures

Temperature is measured with a thermometer

Thermometers contain a liquid that expands and rises with increasing temperature

Common units: Fahrenheit (^oF), Celsius (^oC), Kelvin (K)

Important Relationships…

$T_K = T_C + 273.15$ and $T_F = T_C \times 1.8 + 32$

What is ^{o}F at 0.0 K?

$$T_K = T_C + 273.15 \quad \Rightarrow \quad 0.0 = T_C + 273.15 \quad \Rightarrow \quad T_C = \underline{-273.2\ ^{o}C}$$

$$T_F = T_C \times 1.8 + 32 = -273.\underline{1}5 \times 1.8 + 32 = \underline{-459.7\ ^{o}F}$$

Energy needed to raise 1 g of a substance by 1 ^{o}C is <u>specific heat</u>

Temperature changes calculated using specific heat…

energy change = $q = mC\Delta T$

m = mass

C = specific heat

ΔT = temperature change

Energy needed (in J) to warm 146 g water 5.6 ^{o}C?

$$q = mC\Delta T = (146\ g)(4.184\ J/g\ ^{o}C)(5.6\ ^{o}C) = 3\underline{4}20.8\ J = \underline{3400\ J}$$

Energy need (in cal) to warm 104 g of water from 11 ^{o}C to 95 ^{o}C?

$$q = mC\Delta T = (104\ g)(1.000\ cal/g\ ^{o}C)(84\ ^{o}C) = 8\underline{7}36\ cal = \underline{8700\ cal}$$

Coal produces 5500 cal of energy for each 1 g burned. How many grams must be burned to warm 10.0 g of water 45 ^{o}C?

$$q = mC\Delta T = (10.0\ g)(1.000\ cal/g\ ^{o}C)(45\ ^{o}C) = 4\underline{5}0\ cal$$

$$4\underline{5}0\ cal \times factor = ?\ g$$

$$4\underline{5}0\ cal \times \frac{1\ g}{5500\ cal} = 0.08\underline{1}8\ g = \underline{0.082\ g}$$

Heat Transfer Problems

Something hot, something cold... Something cools, something warms...

A 325.0 g piece of gold at 427.0 °C is dropped into 200.0 g of water at 22.0 °C. The specific heat of gold is 0.131 J/g°C. Calculate the final temperature of the mixture.

$-q_G = +q_W$

$-m_G C_G \Delta T_G = +m_W C_W \Delta T_W$

$T_f - 427.0\ ^\circ C = -19.\underline{6}5\,(T_f - 22.0\ ^\circ C)$

$-85\underline{9}.4 = -20.\underline{6}5\ T_f$

$T_f = 41.\underline{6}1\ ^\circ C = \underline{41.6\ ^\circ C}$

A 234.1 g piece of aluminum at 146 ^{o}C is dropped into 155.2 g of water at 45 ^{o}C. The specific heat of aluminum is 0.903 J/g^{o}C. Calculate the final temperature of the mixture.

$$-q_{Al} = +q_{W}$$

$$-m_{Al}C_{Al}\Delta T_{Al} = +m_{W}C_{W}\Delta T_{W}$$

$$T_f - 146\ ^{o}C = -3.071\,(T_f - 45\ ^{o}C)$$

$$-284\ ^{o}C = -4.071\ T_f$$

$$T_f = 69.8\ ^{o}C = \underline{70\ ^{o}C}$$