What is Matter?

Matter

- Anything that has mass and takes up space.
- Remember mass is measured in grams and taking up space is a measurement of volume (which is a derived unit)
- Matter is composed of tiny particles that are always in constant motion
- Examples: Salt, wood, atom, insect
- Matter can be described as either a pure substance or a mixture.

States of Matter

- Solids have very little particle movement (simple vibration back and forth). Solids have definite volume and shape. Solids are also hard to compress.

States of Matter

- Liquids have moderate particle motion. The particles of a liquid can easily slide past one another. Liquids have definite volume, but take the shape of their container. Liquids are hard to compress because their particles are close together.

States of Matter

- Gases particles are in constant, fast, random motion. Gas particles are very far away from each other. Gases can be compressed. Gases do not have a definite volume or shape.

Gases Continued

- There is a difference between what is called a gas and a VAPOR.
- Vapors are gases that are at room temperature (usually around 25^0C)

Properties of Matter

- Physical Properties- are properties that can be OBSERVED without changing the substance.
- Examples: Shape, color, texture, weight, density, odor, hardness, melting point, and boiling point

- Extensive Physical Properties-dependent on the amount of the substance. Examples: Length, volume
- Intensive Physical Properties- independent of the amount of the substance. Examples: Density, color, odor

Chemical Properties

- Chemical Property- ability of a substance to chemically combine with another substance or to change into one or more new substances.
- The inability of a substance to change is also a chemical property (resisting change)

- Examples: Rusting, flammability, baking,

Identify the list below as either a Physical or Chemical Property

- Red hair dye
- A ring turns your finger green
- A hammer left outside in the rain will rust
- Sam weighs 130 lbs
- Basketballs are spheres
- Peroxide bubbles when it comes in contact with an infection
- The density of water is 1 g/mL
- The air freshener smells like pears
- Paper burns
- Tin has a silver color
- Water boils at 100^0C
- Candle wax melts
- Gun powder lights up the sky in firecrackers

Changes in Matter

- Physical Changes-a change that does not alter the composition or identity of the substance
- Example: cutting paper, Hair dye, shattering glass
- ALL PHASE CHANGES ARE PHYSICAL CHANGES

Changes in Matter

- Chemical Changes- when one or more substances change to become NEW substances
- Also called a chemical reaction.
- Baking produces a chemical change

- Terms that indicate a chemical change include: decompose, explode, rust, oxidize, corrode, tarnish, ferment, burn, or rot

Chemical Changes

- Chemical changes are described as chemical reactions
- Reactant → Products
- The Law of Conservation of Mass states that the mass of the reactants must equal the mass of the products after the reaction (mass is neither created nor destroyed; it remains constant but changes forms)

Mixtures of Matter

- Physical combinations of two or more substances (no chemical reactions occur)

Types of Mixtures

- Heterogeneous-different
- Homogeneous-same
  - Solutions
  - Colloids
  - Alloys

Heterogeneous Mixtures

- Mixtures that do not blend together. The parts of the mixture remain separate and do not mix well.
- Examples: Italian Dressing, Pizza, cereal, muddy water, OJ with pulp

Homogeneous Mixtures

- Mixtures that look the same from top to bottom. They have a uniform appearance.
- They are also called solutions
- Solutions can be made of mixtures of solids, liquids and gases

- Examples:
- Steel (iron and carbon)
- Hairspray (liquid and gas)
- Whipped cream (solid and gas)

Identify the type of Mixture

- Flat soda
- Cherry vanilla ice cream
- Salad dressing
- Salt water
- Soil
- Aluminum foil
- Black coffee
- Sugar water
- City air
- Paint
- Alcohol
- Iron
- Beach sand
- Pure air
- Spaghetti sauce

Separating Mixtures

- Because mixtures are not chemically combined they can be separated by physical means like:
- Filtration
- Distilation
- Crystalization
- Sublimation
- Chromatography

How would you separate these mixtures?

- Sand and water
- Sugar and water
- Oil and water
- Sand and gravel
- Mixture of heptane (BP 98^0C) and heptanol (BP 176^0C)
- Mixture of iodine solid and sodium chloride (Hint: Iodine is not soluble in water)
- Mixture of lead and aluminum
- Mixture of salt and iron filings

Pure Substances

- A substance that cannot be separated into simpler substances by physical or chemical means

Pure Substances

- Element- the simplest form of matter
- 92 naturally occurring elements
- Arranged in the Periodic Table of Elements by increasing atomic number
- Ca, Fe, C, S

- Compound- two or more atoms chemically combined. Compounds act together as a unit.
- Compound properties are never the same as the individual element's properties.
- NaCl: Na is explosive and Cl is toxic but put together it is edible

Identify the Type of Matter

- Na
- H_20
- $CuCl_2$
- O_2
- Sn
- CO_2
- FeF_3
- B

- Cobalt
- Xenon hexafluoride
- Gold
- Lithium
- Zinc nitrate
- Hydrochloric acid
- Mercury
- krypton

Review

- Identify the following as a physical or chemical change

1. Sodium hydroxide dissolves in water
2. A pellet of sodium is sliced in two
3. Water is heated and changed to steam
4. Wood rotting
5. A tire is inflated with air

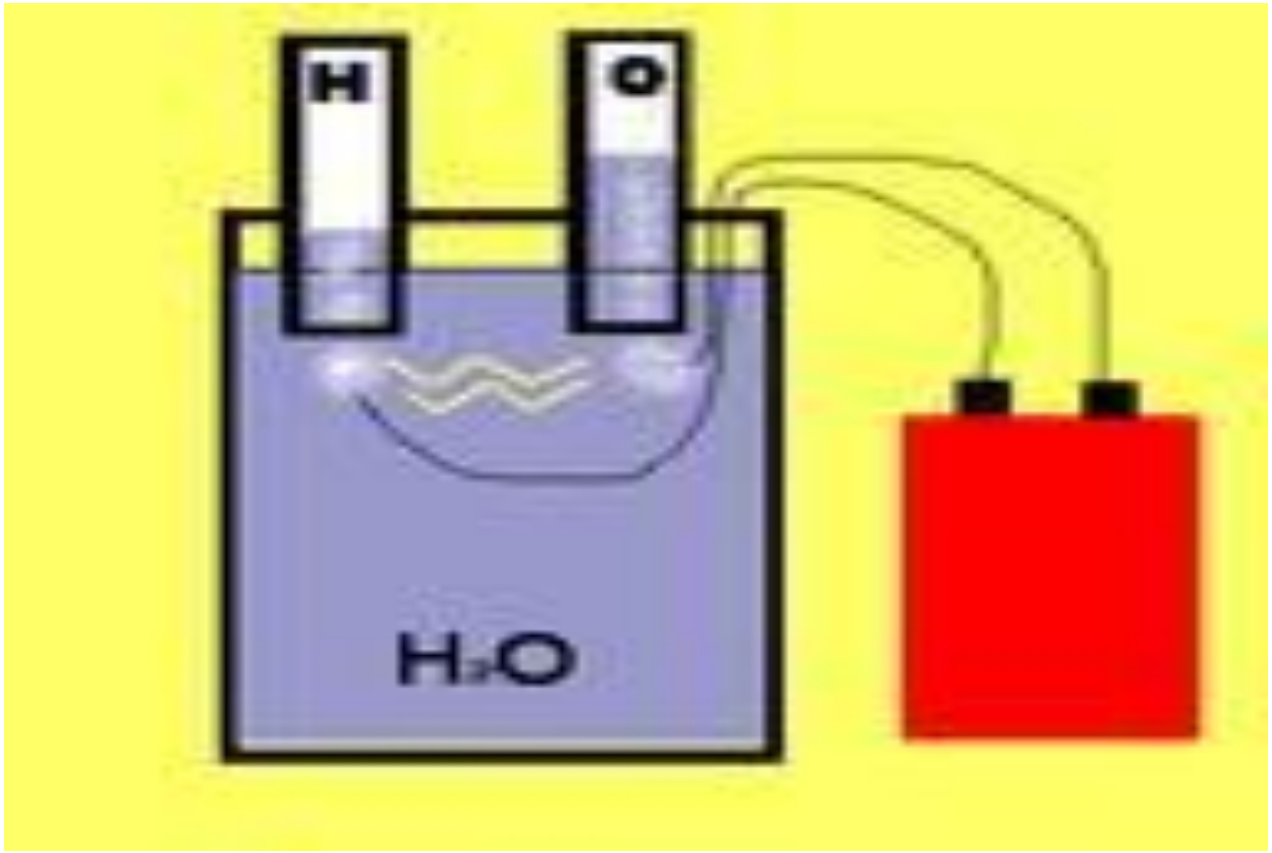
- Identify the following as a physical or chemical property

1. Blue color
2. Flammability
3. Density
4. Solubility
5. Sour taste
6. Reacts with an acid to form water
7. Melting point

Separating Compounds

- Chemical means must be used to separate compounds
- External energy must be used to separate. The energy could be heat or electricity
- Example: Electrolysis- electricity is used to split a water molecule to produce hydrogen and oxygen gas.
- $2H_20$ ---------> $2H_2$ + O_2

Electrolysis



Properties of Compounds

- Compounds combine two or more atoms.
- Compounds have their own distinct characteristics that are different from the atoms that were used to make the compound.

Properties of Compounds

$2K\,(s) + I_2\,(g) \rightarrow 2\,KI\,(s)$

Making Compounds

- They must always combine in definite proportions
- The proportions are determined by the number of chemical bonds that can be formed by each atom.

Law of Definite Proportions

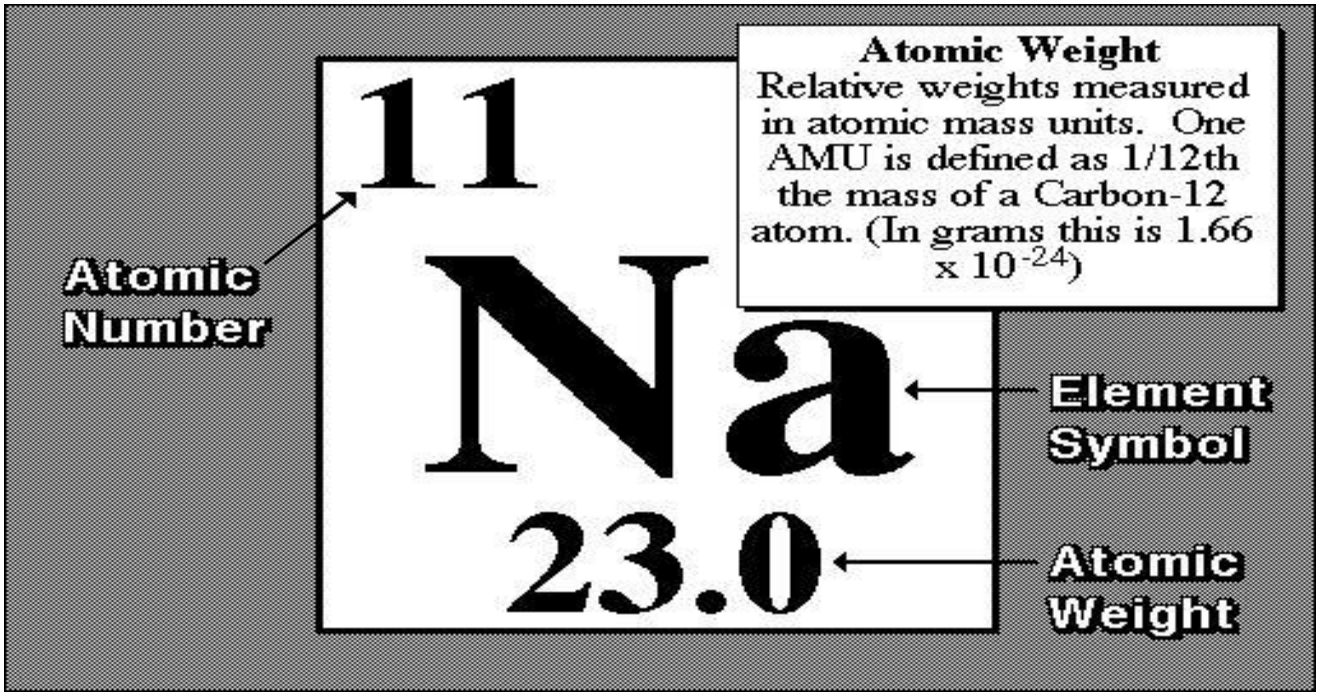
- States that : a compound in always composed of the same elements in the same proportion by mass, no matter the size of the sample.
- 1 g of salt is composed of the same proportion of Na and Cl as 100 g of salt.
- $CuCl_2$ → 1 Cu: 2 Cl
- H_2O_2 → 2 H: 2 O

Percent by Mass Composition

- If compounds combine in proportions then the combinations can be represented by %.

- Percent by mass (%) = $\frac{\text{mass of element}}{\text{mass of the compound}} \times 100$

Where do I find that mass of an element?



Atomic Weight = Atomic mass (g)

Calculating % by Mass

- Compound is peroxide: H_2O_2
- Find the mass of each element (if there is more than one atom of an element, the mass must be multiplied by the subscript)
  - 2 x H = 2 x 1.0 g → 2 g
  - 2 x O = 2 x 16.0 g →+ 32g
- Find the Total Mass = 34 g

- % H = $\frac{2\text{ g}}{34\text{g}}$ x 100 = 5.9 % H
- % O = $\frac{32\text{ g}}{34\text{ g}}$ x 100 = 94.1% O

To check your answer make sure the % add up to 100%

Practice

1. Calculate the % composition of the compound ethane: C_2H_6
   - Answer: 80 % C and 20 % H
2. Calculate the % composition of the compound iron (III) chloride: $FeCl_3$
   - Answer: 34.3% Fe and 65.6 % Cl
3. Calculate the % composition of the compound ammonium fluoride: NH_4F
   - Answer : 37.8% N, 10.8% H, 51.4 % F

Practice Word Problems

- A 78.0 g sample of an unknown compound contains 12.4 g of hydrogen. What is the percent by mass of hydrogen in the compound?
  - Total mass is 78.0 g
  - Mass of H is 12.4 g
  - $\frac{12.4 \text{ g H}}{78.0 \text{ g}} \times 100 = 15.9\% \text{ H}$

Law of Multiple Proportions

- Sometimes the same elements can combine in a variety of ways: H_2O (water), H_2O_2 (hydrogen peroxide)
- These ratios can be determined by mass ratios

More Practice

1. If 45.98 g of sodium combines with excess chlorine gas to form 116.89 g of sodium chloride, what mass of chlorine gas is used in the reaction?
2. A 25 g sample of an unknown compound contains 0.8 g of oxygen. What is the percent by mass of oxygen in the compound?

More Practice

3. Calculate the percent composition of all elements in the compound NH_4ClO_3.
4. What is the percent by mass of carbon in 44 g of carbon dioxide?
5. How would you separate iron filings from salt?
6. Which of the following are physical changes?

   breaking a pencil

   frying an egg

   water freezing and forming ice