# Chapter 4
P. 85 - 109

# Mixtures, Elements and Compounds

# Classes of Matter – How do humans organize all of the matter that matters? ☺

- Classification system – a way of organizing or grouping objects according to their characteristics.
- Classifying objects makes it easier to organize them.
- Matter needs to be classified…so why not use the phases of matter to organize matter?

# How do we Classify Matter?

- Scientists classify matter according to its makeup – (how matter is "constructed")
- Matter can exist as:
  - I. Mixtures
  - II. Solutions
  - III. Elements
  - IV. Compounds

# I. Mixtures

- *Def. - Matter that consists of two or more substances mixed together but NOT chemically combined.*
- Properties of Mixtures
  - Substances are not chemically combined
  - Substances may change in physical appearance – ex – dissolving sugar in water – water and sugar still exist – they have not changed chemically
  - Substances that make up mixtures can be present in any amount. (any ratio)
  - Mixtures can be separated out by simple physical means

# Separating a Mixture Activity

- Given a mixture of iron filings, sand and salt, separate the three components of the mixture out using the physical properties of each component.
- On the next slide, write the step-by-step procedure for separating this mixture.

# Separating a Mixture Activity

# Two Types of Mixtures

- *1) Heterogenous – Def. a mixture that does not appear to be the same throughout.*
  - Appears to be the "least mixed" of all the mixtures.
  - Particles in it are large enough to be seen and separated from each other.
  - Particles settle when allowed to stand.
  - Ex – pebbles in water (L&S), oil and vinegar (L&L), chex mix (S&S), etc.

# Two Types of Mixtures

- *2) Homogeneous – Def. a mixture that appears to be the same throughout*
  - Is a "well mixed" mixture.
  - Particles in it are very small and not easily recognizable.
  - Particles do not settle when allowed to stand.
  - Ex – stainless steel, gold jewelry, chocolate

# Colloids

- Special type of homogenous mixture is a colloid - milk, whipped cream, mayonnaise, toothpaste are all examples
- Particles are relatively large in size
- Particles are kept permanently suspended – (they won't settle out)
- Colloids often appear cloudy
  - Jello (L in S)
  - Whipped Cream (G in L)
  - Smoke (S in G)
  - Fog (L in G)
  - Mayonnaise ( L in L)
  - Paint (S in L)
  - Butter (L in S)

# Solutions

- *Solution – Def. – A type of homogeneous mixture of two or more substances in a single physical state.*
- It is the "best mixed " of all mixtures.
- Examples:
  - Ocean water, iced tea, lemonade, antifreeze, lava!, air!

# Properties of Solutions

- Always has a substance being dissolved (solute) and a substance that does the dissolving (solvent).
- Particles are so small, they can't be separated by simple physical means.
- Particles are too small to scatter light like colloids.
- Particles are evenly spread out.

# The "Sol…" Words

- Solution – a type of homogeneous mixture of 2 or more substances in a single physical state.
- Solvent – the substance that does the dissolving – ex water.
- Solute – the substance that is dissolved – ex salt, sugar, drink mix.
- Soluble – a substance that that will dissolve in another substance is said to be "soluble"
- Solubility – the amount of solute that can be completely dissolved in a given amount of solvent at a specific temperature.

# Special Solutions…

- Solutions may exist as gases (air), liquids (iced tea) or solids (alloy)
- Alloys – a metal solution of a solid dissolved in a solid.
- Examples
  - Gold jewelry = gold & copper
  - Brass = copper & zinc
  - Sterling Silver = silver & copper
  - Stainless steel = iron & chromium

# II. Elements

- Before you understand what an element is, you have to understand what a pure substance is…
- Pure substance – def – made of only one kind of material and has definite properties. It's the same throughout and all of the particles in a pure substance are exactly the same.
  - Examples – iron, aluminum, water, sugar, salt.

# Elements, cont’d

- Element – Def – the simplest pure substance.
- Elements can’t be changed into a simpler substance by heating or any chemical process.
- Atoms are the smallest particle that a substance can be made of and an element has all of the same atoms.

# Elements, cont'd

- Atom – def. – the smallest particle of an element that that the properties of that element.
- Atoms are the basic building block of all matter in the UNIVERSE!
- Atoms of the same elements are alike, atoms of different elements are different.

# Elements, cont'd

- Examples of elements:
  - Gold
  - Aluminum
  - Uranium
  - Iron
- Scientists decided to create symbols for all of the elements in the early 1800's to make writing the elements easier.

# Elements, cont'd

- Chemical symbols are shorthand way of representing the elements. Each symbol consists of one or two letters.
- Some element's symbols come from their name in English:
  - Carbon = C
  - Chlorine = Cl
  - Aluminum = Al

# Elements, cont’d

- Some element’s symbols come from their name in Latin:
  - Gold = Aurum = Au
  - Silver = Argentum = Ag
  - Iron = Ferrum = Fe
  - Copper = Cuprum = Cu
  - Mercury = Hydragyrum = Hg

# III. Compounds

- Compound - Def. - A pure substance that is made of more than one element
- Made of molecules – 2 or more atoms bonded together
- It can be broken down into simpler substances – the elements that make it up.

# Compounds, cont'd

- Compounds are written as chemical formulas that describe the molecules that make up the compound.
- The formula is a list of all of the elements that make it up
- Elements and their symbols can be found in the Periodic Table of the Elements
- Beside each element's symbol is a number called a subscript – this tells you how many of that atom is in the molecule.

# Compounds, cont'd

- Examples of compounds:
  - $H_2O$
  - $C_6H_{12}O_6$
- The small numbers next to the letter tell you how many of each atom are in the molecule – those are subscripts
- 6 $H_2O$ tells you that there are 6 water molecules presents – the 6 is a coefficient – it gives the number of molecules in an amount of compound.

# Compounds, cont'd

To figure out how many molecules are present in a formula:

1. List all the elements in the molecule and do one element at a time.
2. If there are parentheses, multiply the inside subscripts by the outside number. (this is like using the distributive property)
3. Add all of the subscripts for each element – sometimes an element will be in 2 places in the formula, so you have to add them together (if there is no subscript, that means that there is "1" of that atom.)
4. Multiply all of the totals by the coefficient.

# Compounds, cont'd

Example – steps to calculate $3Ca(NO_3)_2$

| | |
|---|---|
| Ca, N, O | elements listed |
| 1 Ca, 2 N, 6 O | subscripts and parentheses calculated |
| 1 Ca, 2 N, 6 O | like elements added (no change in this case) |
| 3 Ca, 6 N, 18 O | all totals multiplied by the coefficient |

# Compounds, cont'd

List the elements and numbers of each element in:

| | |
|---|---|
| $NaCl$ | 1 sodium, 1 chlorine |
| $NaNO_3$ | 1 sodium, 1 nitrogen, 3 oxygens |
| $4\ NH_3$ | 4 nitrogens, 12 hydrogens |
| $5\ C_6H_{12}O_6$ | 30 carbons, 60 hydrogens, 30 oxygens |
| $8\ Ba(OH)_2$ | 8 bariums, 16 oxygens, 16 hydrogens |
| $Ce_2(SO_4)_3$ | 2 cesiums, 3 sulfurs, 12 oxygens |
| $5\ Cu(NO_3)_2$ | 5 coppers, 10 nitrogens, 30 oxygens |

# Chemical Equations

- Represent a chemical change (reaction)
- Remember that in a chemical change, the substances are changed into new, different substances.
- The substances' atoms are rearranged.
- A chemical equation shows how the atoms changed their "positions"

# Chemical Equations

- Example – charcoal (carbon) burning in a BBQ
- The chemical sentence would read…
- "Carbon atoms plus oxygen molecules produce carbon dioxide molecules"
- The chemical equation would read
- $C + O_2 \longrightarrow CO_2$
- This equation is read as "1 Carbon plus 2 Oxygens yields carbon dioxide"

# Chemical Equations

- $C + O_2 \longrightarrow CO_2$
- What do you notice about the number of atoms of each element on either side of the arrow?

- $H_2 + O_2 \longrightarrow H_2O$
- What do you notice about the number of atoms of each element on wither side of the arrow?

# Chemical Equations

- $H_2 + O_2 \longrightarrow H_2O$
- This equation is not equal!!!
- On the right and left sides there are 2 hydrogens
- BUT…on the left there are 2 oxygens and on the left, there's only 1!!!
- Law of chemistry – atoms do not just disappear!! THEY NEED TO BE ACCOUNTED FOR!!!!

# Balancing Chemical Equations

- $H_2 + O_2 \longrightarrow H_2O$
- We call this process of accounting for all of the atoms BALANCING EQUATIONS
- We balance out the atoms by using COEFFICIENTS in front of as many molecules as necessary to make sure that the atoms of each element on either side of the arrow are equal to each other.

# Balancing Chemical Equations

Steps to balance an equation:

- Do an atom count – list the atoms under each side of the equation.
- Check to see if it’s balanced. If it is, stop!
- If not, find the most complicated compound
- Starting with that compound, go element by element from side to side of the equation, balancing each element by adding coefficients (“playing tennis”)
- Save the “lone” molecules for last as adding a coefficient to them will not affect any other elements
- If an element is repeated on one side of the arrow, save it for last.

# Balancing Chemical Equations

- $H_2 + O_2 \longrightarrow H_2O$
- Let's apply this process to our water equation:
- Start with $H_2O$, there are 2 oxygens on the other side of the equation, so add a 2 as a coefficient to $H_2O$
- $H_2 + O_2 \longrightarrow 2\,H_2O$

# Balancing Chemical Equations

- $H_2 + O_2 \longrightarrow 2\,H_2O$
- OK, there's now 2 Oxygens on each side.
- But, notice that there are 4 Hydrogens on the right and only 2 on the left.
- So, add a 2 as a coefficient to the $H_2$ on the left.
- $2\,H_2 + O_2 \longrightarrow 2\,H_2O$

# Balancing Chemical Equations

- $2H_2 + O_2 \longrightarrow 2H_2O$

- OK, are we balanced?
- 4 Hydrogens on each side
- 2 Oxygens on each side
- BALANCED!!! ☺

# Balancing Chemical Equations

Try These…..

$Mg + HCl \rightarrow MgCl_2 + H_2$

$N_2 + H_2 \rightarrow NH_3$

$H_2O_2 \rightarrow H_2O + O_2$

# Balancing Chemical Equations

$Al + O_2 \rightarrow Al_2O_3$

$HCl + NaOH \rightarrow NaCl + H_2O$

$KClO_3 \rightarrow KCl + O_2$

# Balancing Chemical Equations

Challenges:

$Al + NiBr_2 \rightarrow AlBr_2 + Al_2(SO_4)_3$

$KCl + Zn(PO_4)_2 \rightarrow ZnCl_2 + K_3PO_4$