Name:____Period:_________

Ms. Randall Regents Chemistry

Unit 2: Matter and Naming Unit Notes

Unit Objectives:

- Classify types of matter
- Draw particle diagrams to represent different types of matter
- Recognize various techniques that can be used to separate matter
- Differentiate between physical and chemical changes
- Determine state of matter at STP
- Represent chemical changes as equations

Focus Questions for the Unit:

- What is matter?
- How can matter change?

Define the following vocabulary:

- Matter
- Element
- Compound
- Mixture
- Heterogeneous Mixture
- Aqueous
- Monoatomic element
- Diatomic element
- STP
- Phase change
- Homogeneous Mixture
- Pure Substance
- Particle Diagram
- Chromatography
- Filtration
- Distillation
- IUPAC
- Polyatomic ion

Lesson 1: Chapter Diary 2

Objective: To summarize unit 2 concepts

Read the pages linked below and answer the questions in your workbook

Link: Chapter Diary 2 Matter

Lesson 2: Matter

Objective: To compare and contrast representative forms of matter

Matter

Anything that has mass and volume (takes up space)

Can NOT be separated by physical means

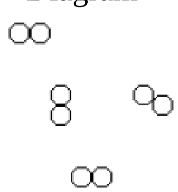
PURE SUBSTANCES
(each piece looks the same – PURE!)
-each piece has exact same composition.

Can NOT be separated by chemical means

ELEMENT (simplest form of matter)

Example: Na, Cl_2

Particle Diagram

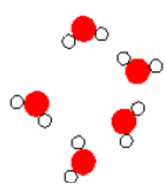


Separated by chemical means, only

COMPOUND or MOLECULE
(2+ different elements chemically combined)

Example: NaCl (table salt), H_2O (water)

Particle Diagram



CAN be Separated by PHYSICAL means

MIXTURES (each piece is different – not pure)

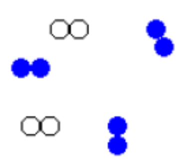
Same composition throughout

HOMOGENEOUS MIXTURE (uniform throughout—distinct pattern)

Example: saltwater, iced tea

Homo = same

Particle Diagram



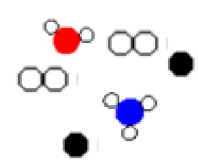
Different composition throughout

HETEROGENEOUS MIXTURE (not uniform throughout—no pattern)

Example: Italian dressing, concrete, soil, chocolate chip cookie

Hetero = opposite

Particle D



Matter- can ... be defined as ... anything tha ... iagram mass and volume (takes up space).

Matter can be be sub catagorized as pure substances or mixtures. Elements and compounds are pure substances.

1. An **element** is the simplest form of matter that can exist under lab conditions.

- Elements cannot be separated into simpler substances.
- They are represented by a symbol; ONE Capital Letter. (Each capial letter represents one element.) Sometimes a lowercase letter is used as well.
- Elements are shown on the Periodic Table
    - There are only 92 naturally-occurring elements. EXAMPLES: Br, Ag, O, N, H etc.
- There are some elements (only 7!) that exist in nature only as **diatomic elements**.
    - These are: H, O, F, Br, I, N, Cl
    - That means there are two atoms of one kind stuck (bonded) together so you should always use a subscript of 2 when you see them in an equation!
    - So these should really be written as **H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2**

2. A **compound** is a substance made up of two or more elements in a fixed proportion. Two or more elements are ***chemically*** combined with each other.

- Compounds can be separated into simpler substances chemically.
- A compound has a fixed composition. It is always the same.
- Formulas for compounds are written in a certain way.

EXAMPLES: H_2O CO_2 NaCl

- The little numbers **directly** following an element symbol are called **subscripts**. This tells you how many atoms of that element are in the compound.

EXAMPLES: H_2O (2 H's and 1 O) CO_2 (1 C and 2 O's) NaCl (1 Na and 1 Cl)

- A common mistake by students such as yourself happens in compounds like CO_2. The 2 goes ONLY TO THE O… NOT TO THE C

3. A **mixture** is a ***physical*** combination of two or more substances (elements or compounds)

- **Homogeneous Mixtures** are uniform throughout**. Aqueous** is another term meaning homogeneous solution.
  Examples: salt in water, air
- **Heterogeneous Mixtures** are non-uniform

Examples: chunky chicken soup, dirt in water

- **<u>Homogeneous and Heterogeneous</u>** are both ***relative*** terms. This means that some of your answers will depend on your prior experiences and knowledge. As long as you can defend/explain why you answered your question the way you did, it is acceptable.

Na + S is a **mixture**. Likewise Na_2S + KCl is a **mixture**

Please notice that for a **pure substance** such as Na_2S, the ratio of Na to S is always 2:1. That is, if I have:

$1Na_2S$ or
$4Na_2S$ or
$50Na_2S$ the ratio of Na to S always is 2:1.

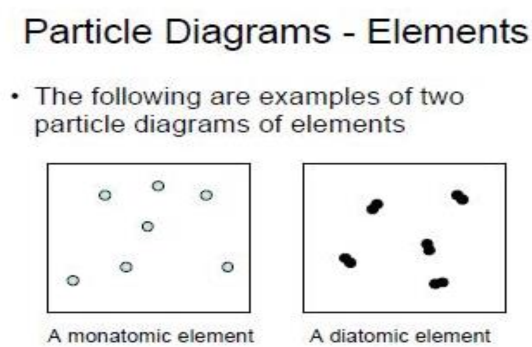
For a **mixture**, however, the ratios of Na and S can be changed. In other words, I can have: 3Na and 2S, or 17Na and 4 S, or 2Na and 9S

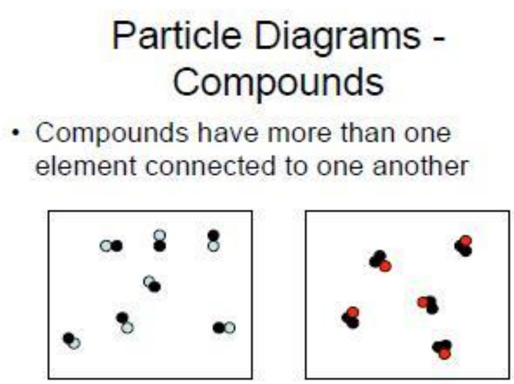
Lesson 3: Particle Diagrams

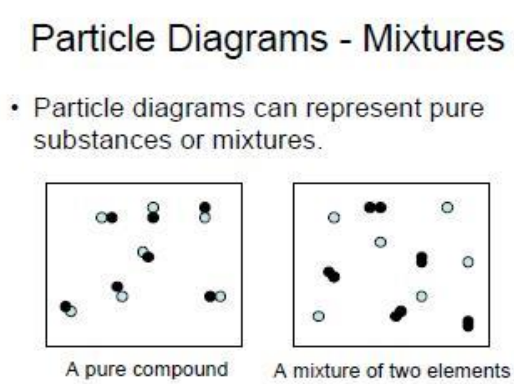
Objective: To represent forms of matter using particle diagrams

Watch this! *Elements Compounds and Mixtures Oh my!*

Science is not the study of nature. It is rather the study of shared representations of nature. John Dalton's records from the early 1800's contain particle diagrams which he used to represent chemical change. We will use a system of particle diagrams, similar to Dalton's as our notation through which we will share representations of matter and eventually chemical reactions. These diagrams can represent elements and compounds, and their molecular composition (depending on how they are arranged in the diagram).







<u>Lesson 4: Methods of Separating a Mixture</u>

<u>Objective:</u> To compare and contrast methods for separating mixtures based on properties

One way scientists talk about matter or substance—that is, the stuff in the world—is in terms of *pure substances* and *mixtures*. *Pure substances* are substances that contain only one kind of molecule. Water with nothing else in it is a pure substance. This is because it contains nothing but water molecules. On the other hand, suppose we put a teaspoon of sugar in a glass of water and let it dissolve. Now we have a glass full of mostly water molecules with some sugar molecules here and there between the water molecules. So our sugar-water isn't a pure substance. It consists of more than one kind of molecule; thus it is a *mixture*.

Separation in the Real World

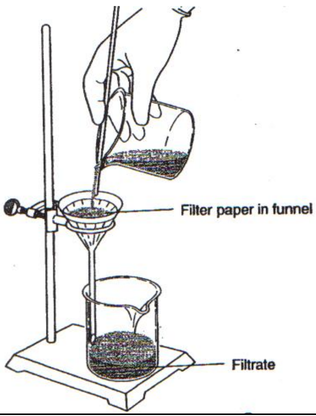
Mixtures are all around us, and most of the things you can touch or feel are mixtures, not pure substances. A lot of times this isn't a problem. Orange juice is a mixture of water, sugar, vitamin C, citric acid, and more, and it's perfectly fine as a mixture. But sometimes we need to separate the different substances in a mixture. For example, milk is a mixture of water, sugar, fat, protein, vitamins, calcium, and more. Calcium and protein are two things your body needs, but fat, while good for growing children, can be unhealthy for adults. To make a healthier milk for adults, we *separate* most of the fat from the milk, creating low-fat or "skim" milk.

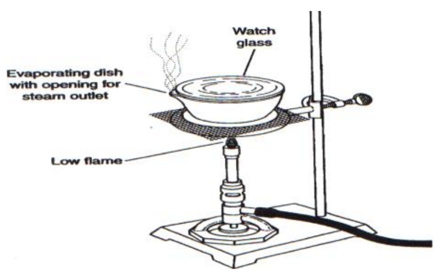
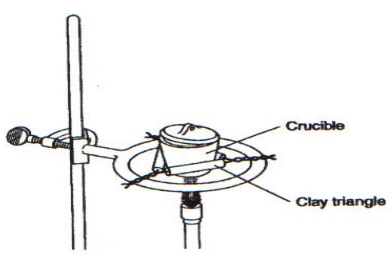
Crude oil (petroleum) is a mixture of all kinds of substances. Some of the substances are used to make gasoline and other fuels. Others are used to make plastics. Still others are used to make medicines. It takes a lot of work to separate all these substances in crude oil from each other. This is done in giant factories called refineries.

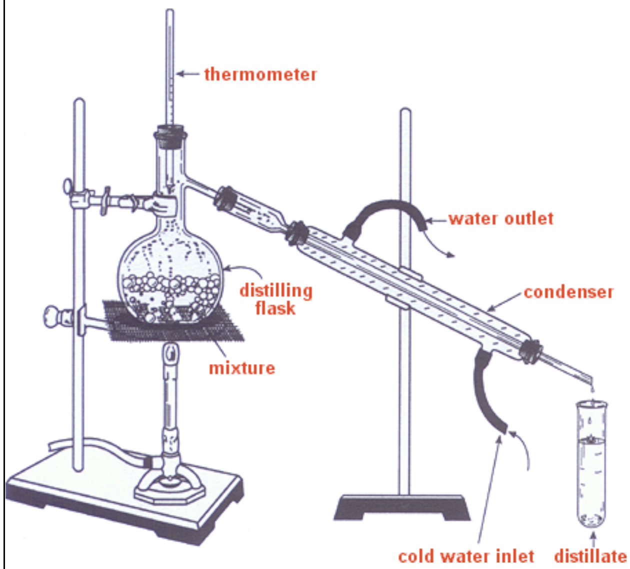
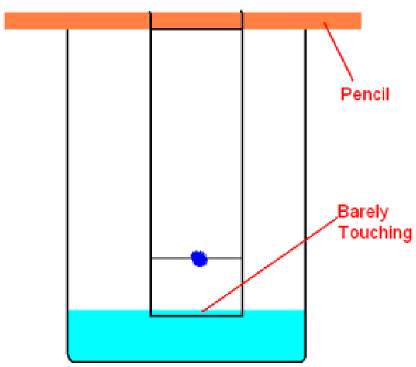
Soybean oil is also a mixture, and the challenge Percy Julian faced at the Glidden Company was to separate and isolate useful substances from it. He separated various types of steroids from soybean oil. He also separated proteins from soybeans that could be made into plastic. Julian separated still other protein compounds that he used to make a new kind of fire extinguisher.

Whether we're talking about milk, crude oil, or soybeans, *separation of mixtures* is very important in our world. M**ixtures** are made by ***physically*** combining 2 or more pure substances together; we use ***physical*** techniques to separate them.

The technique used depends on what phase or state of matter the components are.

<table>
<tr><th>Separation Apparatus</th><th>Type of Separation (Physical or Chemical)</th><th>Description of Technique</th><th>What types of Matter will it separate?</th></tr>
<tr><td>Filtration
</td><td>PHYSICAL</td><td>Undissolved particles remain on filter paper (filtrate flows through filter paper)</td><td>HETEROGENEOUS mixtures (ex: sand water)

*Can also centrifuge</td></tr>
<tr><td>Watch Glass Evaporation

Crucible Evaporation
</td><td>PHYSICAL</td><td>Separate solute (dissolved solid) from solvent (liquid) by boiling solution
Solute escapes
Very limited precision</td><td>HOMOGENEOUS mixture (solution)</td></tr>
</table>

Distillation  	PHYSICAL	• Separate solute from solvent by boiling solution and recondensing in receiving flask (both solute and solvent captured) • Separate 2 or more liquids with different boiling points	HOMOGENEOUS (can use to remove impurities from water)
Chromatography  	PHYSICAL	Separates particles based on: 1) size 2) solubility	HOMOGENEOUS

Lesson 5: Properties and Changes of Matter

Objective: To compare and contrast physical/chemical properites vs. changes

A **physical property** of a pure substance is anything that can be o**bserved without changing the identity of the substance.** The observations usually consist of some type of numerical measurement, although sometimes there is a more qualitative (non-numerical) description of the property. There are many physical properties and each textbook will have a different list of examples. Here are some of the more common ones:

melting point	electrical conductivity	color	density
boiling point	thermal conductivity	odor	hardness

There are others which are not mentioned as often. Examples include:

refractive index	atomic radius	ductility
ionization energy	allotropes	malleability

There are more which have not been mentioned. There is no single, definitive list of physical properties. Groups of similar elements or compounds can be characterized by commonality in their physical properties. Metals have a whole bunch of physical properties that are similar. For example, metals are very ductile and very malleable. All easily conduct electricity and heat and all have a bright luster. These all reflect a commonality of structure. However, the similarities in a group do not extend to every property. Both tantalum and sodium are metals. Tantalum's melting and boiling points are 2996 °C and 5425 °C. Sodium? 98 °C and 883 °C. However, they are both considered metals and no one in the scientific world disputes this. The reason is that both exhibit the characteristic arrangement of atoms and electrons all metals have. (This arrangement will be taught later in the course.) The wide disparity (differences) in the melting and boiling points between tantalum and sodium simply highlight the wide range that exists within the common structure all metals have.

Chemical properties, on the other hand, describe the way a substance may **change or react to form other substances**.

Here are some examples.

(1) Iron rusting. When iron (an element, symbol = Fe) rusts, it combines in a complex fashion with oxygen to form a reddish-colored compound called ferric oxide (formula = Fe_2O_3). Not all substances rust.

(2) Glucose, mixed with yeast, ferments to make alcohol. Glucose ($C_6H_{12}O_6$) is a chemical compound which enzymes in yeast can use to make ethyl alcohol (C_2H_5OH). Not all substances ferment.

(3) Trinitrotoluene (TNT) reacts very, very fast when it is ignited. Among other products, it makes LOTS of nitrogen gas and LOTS of heat. Inside the proper container, it can cause an explosion. Not all substances can make an explosion.

There really isn't a set of chemical properties in the same way there is, more or less, a set of physical properties. That's because the chemical properties are tied to the change, whereas a given substance has a property (such as melting point) all to itself. One example was given: flammability - the ability of a substance to burn in the presence of oxygen. Some substances (wood, alcohol) are very flammable, others are not. Iron (see above) reacts with oxygen, but so slowly we do not say the iron burns, but that it rusts. Generally speaking, information about physical properties is clearly laid out and chemical properties are harder to pin down. That's just the way it is sometimes.

Changes in in Matter

A physical change is a change in which the substance changes form but keeps its same chemical composition (reversible). Changes of state are considered to be physical changes. Liquid water and ice (frozen water) are both the same substance, water. If you fold a piece of paper it is a physical change. You have changed the form of the paper but you have not changed the fact that it is paper. If you heat an iron bar until it glows red hot, it is still chemically the same iron. The iron has not changed into something else. If you dissolve salt in water you have not changed the materials chemically. You still have salt and you still have water. This can be shown if you choose to separate the mixture by distillation or the simple evaporation of the water. The salt would be the residue and the water would be the distillate.

A **chemical change** is a change in which something new is formed (irreversible). The starting materials change into an entirely different substance or substances. This new substance has a different chemical composition than the starting materials. Examples of chemical changes would be the reaction of iron with air (rusting} or the reaction of a metal and acid. Certain observations will indicate that a chemical change has occurred. These are:

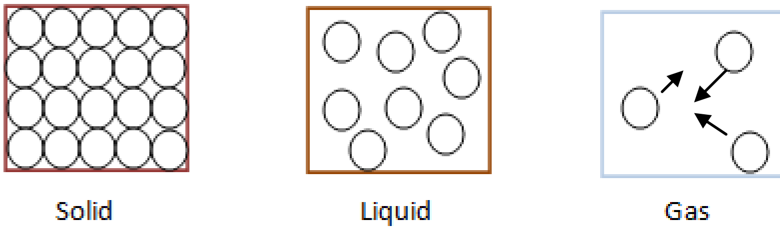
- The reaction produced a change in temperature. The temperature could go up (gets hotter) or the temperature could go down (gets colder). Note: reactions that produce heat are known as exothermic reactions whereas reactions that absorb heat are known as endothermic reactions.
- Formation of gas bubbles.
- Formation of a solid (precipitate).
- A change in color. You may start with two colorless solutions but when they are mixed you might see a bright purple color.
- Formation of a different odor. The starting materials may not smell at all but as you mix these materials you may end up with a bad odor or a pleasant one.

Summary

	Properties of Matter	**Changes in Matter**
Physical	Observable or measurable properties Ex) hardness, color, smell, mass, melting pt.	Altering a substance without changing its composition or properties; the original material can be recovered. (Still the same substance but in a different form)
Chemical	Describes how a substance reacts OR does not react with other substance(s) Ex) Copper reacts with Nitric Acid, Cu does not react with hydrochloric acid (HCl)	A new substance is made that has a different composition and properties; the original material can sometimes (not usually) be recovered, but usually only with great difficulty. (New substanced formed)

Lesson 6: STP and States of Matter

Objective: To use Table S to determine state of matter



Properties describe matter. A block of wood, milk and air all have properties. All the material on earth is in three states-**solid, liquid, and gas**. The "state" of the matter refers to the group of matter with the same properties. In other words, you group the objects together according to their properties.

Solids

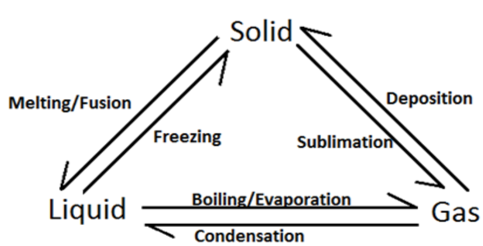
The wood block is solid. A solid has a certain size and shape. The wood block does not change size or shape. Other examples of solids are the computer, the desk, and the floor. You can change the shape of solids. You change the shape of sheets of lumber by sawing it in half or burning it. How might you change the shape of a piece of gum?

Liquids

Milk is a liquid. Milk is liquid matter. It has a size or volume. Volume means it takes up space. But milk doesn't have a definite shape. It takes the shape of its container. Liquids can flow, be poured, and spilled. Did you ever spill juice? Did you notice how the liquid goes everywhere and you have to hurry and wipe it up? The liquid is taking the shape of the floor and the floor is expansive limitless boundary (until it hits the wall). You can't spill a wooden block. You can drop it and it still has the same shape. What about jello and peanut butter? You can spread peanut butter on bread, but peanut butter does not flow. It is not a liquid at room temperature. You have to heat peanut butter up to make it a liquid. When you or your mom makes jello, it is first a liquid. You have to put it in the refrigerator so that it becomes a solid. These are yummy forms of matter with properties of a liquid and a solid.

Gases

Run in place very fast for a minute. Do you notice how hard you are breathing? What you are breathing is oxygen? You need oxygen to live. That's why you can only hold your breath for a certain amount of time. You can't see oxygen. It's invisible. It is a gas. A gas is matter that has no shape or size of its own. Gases have no color. Gases are all around you. You can feel gas when the wind blows. The wind is moving air. Air is many gases mixed together.



We can use **Table S to determine the State of an element** at Room Temperature or at

“Standard” Temperature .

Substance	Color	Melting Point (ºC)	Boiling Point (ºC)
Bromine	Red-Brown	-7	59
Chlorine	Green-yellow	-101	-34
Ethanol	Colorless	-117	78
Mercury	Silvery-white	-39	357
Neon	colorless	-249	-246
Sulfur	yellow	115	445
Water	**colorless**	**0**	**100**

Notice water’s MP/BP! You will be expected to know this throughout the year! This refers to ***distilled*** water (pure H_2O), ***not tap*** water (what comes out of your sink that has extra substances in it).

	←MP→		←BP→	
Description	If temp is lower than the melting point, it has not melted yet.	If temp is higher than the melting point, it has melted already.	If temp is lower than the boiling point, it has not boiled yet.	If temp is higher than the boiling point, it has boiled already.
Resulting Phase	Solid	Liquid	Liquid	Gas

Lesson 7: Changes Written as Equations

Objective: To represent chemical changes with chemical symbols

Chemical formulas are used in chemical equations to describe matter. A **subscript** in a formula tells how many atoms of each kind are in a molecule. (no subscript = 1 atom)

Examples:	H_2O	2 H's and 1 O in each molecule
	C_2H_6	2 H's and 6H's in each molecule
	Na_2SO_4	2 Na, 1 S and 4 O in each molecule

Subscripts are distributive when there are parentheses

Example: $Ca(NO_3)_2$ 1 Ca, 2 N and 6 O in each molecule

Chemical reactions happen all around us: when we light a match, start a car, eat dinner, or walk the dog. A **chemical reaction** is the process by which substances bond together (or break bonds) and, in doing so, either release or consume **energy.** A **chemical equation** is the shorthand that scientists use to describe a chemical reaction. Let's take the reaction of hydrogen with oxygen to form water as an example. If we had a container of hydrogen gas and burned this in the presence of oxygen, the two gases would react together, releasing energy, to form water. To write the chemical equation for this reaction, we would place the substances reacting (the **reactants**) on the left side of an equation with an arrow pointing to the substances being formed on the right side of the equation (the **products**). Given this information, one might guess that the equation for this reaction is written:

$$H + O \rightarrow H_2O$$

The plus sign on the left side of the equation means that hydrogen (H) *and* oxygen (O) are reacting. Unfortunately, there are two problems with this chemical equation. First, in nature, both hydrogen and oxygen are found as diatomic molecules, H_2 and O_2. Hydrogen gas, therefore, consists of H_2 molecules; oxygen gas consists of O_2. Correcting our equation we get:

$$H_2 + O_2 \rightarrow H_2O$$

But we still have one problem. As written, this equation tells us that one hydrogen molecule (with two H atoms) reacts with one oxygen molecule (two O atoms) to form one water molecule (with two H atoms and one O atom). In other words, we seem to have lost one O atom along the way! To write a chemical equation correctly, the number of atoms on the left side of a chemical equation has to be precisely **balanced** with the atoms on the right side of the equation. How does this happen? In actuality, the O atom that we "lost" reacts with a second molecule of hydrogen to form a second molecule of water.

The balanced equation is therefore written:

$$2H_2 + O_2 \rightarrow 2H_2O$$

In writing chemical equations, the number in front of the molecule's symbol, called a **coefficient** indicates the number of molecules participating in the reaction. If no coefficient appears in front of a molecule, we interpret this as meaning one. In order to write a correct chemical equation, we must **balance** all of the atoms on the left side of the reaction with the atoms on the right side. We will practice balancing equations more later on in the course. The equality of atoms or matter on either side of a chemical equation is called a **balanced equation**; it illustrates the principle of the **Conservation of Matter.**

Conservation of Matter: Matter can neither be created or destroyed , but the atoms in the reactants can become rearranged in a chemical change. Weighing the system before and after a chemical change is a way to prove this.

Note: **Conservation of Matter** is also called **Conservation of Mass**. They are interchangable terms. To see if an equation has ***conservation of matter or mass***, we look for the one that is ***balanced***.

Just as there is a **Law of Conservation of Matter**, there is a **Law of Conservation of Energy.**

Law of Conservation of Energy- Energy can neither be created or destroyed.
Usually there is an energy change involved in either a chemical change or a physical change.

Reaction	How I Know	Direction of Heat Flow	Type of Energy Change	Reactant or Product (in Equation)
Requires Heat	Feels cold around the change	From the surroundings into the system	Endothermic	Reactant
Releases Heat	Feels hot around the change	From the system into the surroundings	Exothermic	Product

In summary:

Some important vocabulary to keep in mind :

- An **equation** describes a chemical change or reaction. The equation shows substances which react with each other once mixed to form other substances.

- **Reactants** (the substances that we start with, or in other words that react) are on the left side of the equation.

- **Products** (the substances that we end with, or in other words are produced) are on the right side of the equation.

- Reactants and products are separated by an **arrow**→. It shows the direction of the equation.

- **System** is another word for **reaction** that is often used by chemists.

Lesson 8 : Naming and Writing Binary Compounds

Objective: To construct and name binary compounds

Recall…

Elements are the basic form of all matter and cannot be broken down by physical or chemical changes. **Compounds** are composed of 2 or more elements that have been chemically combined. They can only be broken down by a chemical change.

While there are many thousands of different chemical compounds there is a very definite system of nomenclature whereby we can name or write chemical formulas for most compounds. We divide the compounds into two main types – binary compounds and tertiary compounds.

Many times atoms can be altered to have a charge. This is called an **ion.**

An **ion** is an atom that has a **charge.** **You can find the charge by looking on the periodic table in the upper right hand corner of each element's box (oxidation state).**

1. If the ion has a *positive charge* it is called a **cation.**

Metal atoms lose electrons to form positively charged ions. A cation formed from a single atom is called a *monatomic* cation. Some metals form one ion, while others can form multiple ions.

- **One ion**: Some metals form only one ion. Metals of groups 1, 2, 3, 13 & Zn form only one ion each. These ions are named as follows:

Element name + **ion**

Example: Na^{+} = sodium ion Sr^{2+} = strontium ion Zn^{2+} = zinc ion

- **Multiple ions**: Transition metals (groups 3-12) and nonmetals (groups 14-17) often form more than one ion. Since these atoms form more than one ion, the *charge* on the ion must be specified in the name to tell the ions apart. The Stock system is used to name transition metal cations and nonmetal cations as follows:

Element name (charge as Roman numeral) + **ion**

Roman numerals

I 1	II 2	III 3	IV 4	V 5
VI 6	VII 7	VIII 8	IX 9	X 10

Example: Fe^{2+} = iron(II) ion Pb^{4+} = lead(IV) ion Cu^{+} = copper(I) ion C^{+4}= carbon (IV)

2. If the ion has a negative charge it is called an **anion.**

Example:
"N" Nitrogen atom
"N^{-3}" Nitrogen anion.

All true binary compounds contain only **two elements**. The name of ***every*** binary compound ends with "**ide**."

Rules for Naming Simple Binary compounds-monatomic cation

1. The monatomic cation with a single charge is always named first and the anion second.

2. A cation takes its name from the name of the element.

3. An anion is named by taking the first part of the element name (the root) and adding the suffix "ide."

   Example:

   Chlorine becomes chlor**ide**
   Oxygen becomes ox**ide**
   Sulfur becomes sulf**ide**

4. Write the name for the compound by combining the names of the ions.

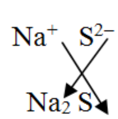
Examples:

NaCl	Sodium chloride
KI	Potassium Iodide
$MgCl_2$	Magnesium chloride

Rules for Writing Chemical formulas for Binary compounds:

1. The sum of the charges (oxidation state) in the compound must equal zero (0).
2. Write each ion separately with their respective charges.
3. "Criss-cross reduce" the values of the charges(not the signs)
4. Write those numbers as subscripts
5. Do not write "1's"as they are just understood to be there.

e.g.



Examples:

Cu^{+} O^{-2}	Mg^{+2} F^{-}	K^{+} P^{-3}
Cu_2O	MgF_2	K_3P
Ag^{+} Cl^{-}	Ca^{+2} S^{-2}	
AgCl	CaS	

******We can use the rules for writing formulas to name our multiple ion compounds.******

<u>Rules for Naming Complex binary compounds-multiple ions</u>

1. Figure out the charge of the cation by reverse criss –cross.

2. The cation with a multiple charge is always named first and the anion second.

3. A complex cation takes its name from the name of the element and a roman numeral denoting its charge (oxidation state).

4. An anion is named by taking the first part of the element name (the root) and adding the letters "IDE."

5. Write the name for the compound by combining the names of the ions.

Examples:

Fe_2O_3	Fe^{+3} O^{-2}	Iron (III) oxide
PbS	Pb^{+2} S^{-2}	Lead(II) sulfide
$CuCl_2$	Cu^{+2} Cl^{-1}	Copper(II) chloride

Lesson 9: Writing and Naming Tertiary compounds

Objective: Identify polyatomic ions and use them to name and write chemical formulas.

Groups of atoms that gain or lose electrons are called **polyatomic ions**. Polyatomic ions are groups of bonded atoms that must *gain* or *lose* electrons to be more stable.

Nearly all polyatomic ions are anions; there is only one common polyatomic cation, NH_4+. Polyatomic ions do not follow a predictable naming pattern – their names must be *memorized* or looked up on Reference table E.

Table E
Selected Polyatomic Ions

Formula	Name	Formula	Name
H_3O^+	hydronium	CrO_4^{2-}	chromate
Hg_2^{2+}	mercury(I)	$Cr_2O_7^{2-}$	dichromate
NH_4^+	ammonium	MnO_4^-	permanganate
$C_2H_3O_2^-$ / CH_3COO^-	acetate	NO_2^-	nitrite
		NO_3^-	nitrate
CN^-	cyanide	O_2^{2-}	peroxide
CO_3^{2-}	carbonate	OH^-	hydroxide
HCO_3^-	hydrogen carbonate	PO_4^{3-}	phosphate
$C_2O_4^{2-}$	oxalate	SCN^-	thiocyanate
ClO^-	hypochlorite	SO_3^{2-}	sulfite
ClO_2^-	chlorite	SO_4^{2-}	sulfate
ClO_3^-	chlorate	HSO_4^-	hydrogen sulfate
ClO_4^-	perchlorate	$S_2O_3^{2-}$	thiosulfate

Polyatomic ions can form compounds in the same way as other atoms that have become ions.

Rules for Naming Tertiary compounds Polyatomic cation

1. The polyatomic cation with a single charge is always named first and the anion second.

2. A cation takes its name from the name of the polyatomic ion as found on Table E.

3. An anion is named by taking the first part of the element name (the root) and adding the suffix "ide."

Example:

NH_4Cl Ammonium chloride

Rules for Naming Tertiary compounds Polyatomic anion

1. The cation with a single charge is always named first and the polyatomic anion second.

2. A cation takes its name from the name of the element or from the name of the element and a roman numeral denoting its charge (oxidation state) depending on where the atom is located in the reference table.

3. A polyatomic anion takes its name from the name of the polyatomic ion as found on Table E.

Examples:

$KClO_4$ Potassium perchlorate

$Pb(NO_3)_2$ Lead(II) nitrate

Rules for Writing Chemical formulas for Tertiary compounds:

1. The sum of the charges (oxidation state) in the compound must equal zero (0).
2. Write each ion separately with their respective charges.
3. "Criss-cross reduce" the values of the charges(not the signs)
4. Write those numbers as subscripts
5. Do not write "1's"as they are just understood to be there.
6. If there is more than one of the polyatomic, put it in parenthesis with the subscript in the outside right corner.