**Unit 6 Note-Taking Guide**

**Podcast 7.1: Chemical Reactions**

Describing Chemical Reactions

Chemical Reactions occur every day all the time

****Examples:

1.

2.

3.

4.

Evidence of Chemical Reactions

1.

2.

3.

4.

5.

Chemical Equations: A representation of a chemical reaction

Example:

Reactants =

Products =

🡪 =

Chemical Sentences: Names of elements or compounds are used to indicate substances and the amounts used in a reaction.

Example:

Chemical Sentence

Word Equations: Names of elements or compounds are used to indicate substances and the amounts used in a reaction

Example:

Word Equation

Example

Fe(s) + O2(g) → Fe2O3(s)

What are the products?

What are the reactants?

What is the chemical sentence?

What is the word equation?

Other Symbols to know…

(s) = substance is in a \_\_\_\_\_\_\_\_\_\_\_\_ state

(l) = substance is in a \_\_\_\_\_\_\_\_\_\_ state

(aq) = aqueous solution - substance is \_\_\_\_\_\_\_\_\_\_\_\_\_ in water

(g) = substance is in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ state

Other Symbols to know…

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = used to separate two reactants or two products

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = separates reactants from products

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = for reversible reactions

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = indicate that heat is used in the reaction

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = A formula (could be any – in this case platinum) indicates it is used as a catalyst

Catalyst: A substance that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a chemical reaction but is not used in the reaction

Example:

Fe(s) + O2(g) $→$ Fe2O3(s)

What are the catalysts in this reaction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What phase state is each substance in for this reaction?

Fe= O2 = Fe2O3 =

Writing Chemical Equations:

Reactants → Products

Word Equations

Chemical Equations

Law of Conservation of Matter: Matter Cannot be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a Chemical or Physical Process.

Balanced Equations – both sides of the equation must have the same number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for each element

\*\*only \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may be adjusted to balance an equation, NEVER change the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which identify the substance itself

Examples

C(s) + O2(g) → CO2(g)

Fe(s) + S8(s) 🡪 FeS (s)

\*\*Look out for BrINClHOF elements! They are diatomic in their **pure** form.

\*\*You can change the Quantity, but not the Identity of a substance!

**Podcast 7.2 A: The "Basic 4" Reactions**

1.

**Synthesis or Combination:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ substances combine to form a single compound

* There is only a single product
* Red Flag: Usually just see elements as the reactants and only \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_
* Examples:

Analogy: (Sketch story below)

Example: The combination of iron and sulfur to form iron (II) sulfide

**Decomposition:** A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ compound breaks down into two or more products

* Opposite of Synthesis or Combination
* **Red Flag**: There is only \_\_\_\_\_\_\_\_\_\_\_\_ compound as your reactant.
* Examples:
	+ PbO2 🡪
	+ HI 🡪
	+ NaCl 🡪
	+ CaCO3 🡪

Analogy: (Sketch Story Below)

Example: The electrolysis of water to make oxygen and hydrogen gas:

**Single-Replacement:** Atoms of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ replacement atoms of a second element in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* **Red Flag**: A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Element is reacting with a Compound
* Sometimes they work, and sometimes there is no reaction!
	+ Have to use \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ of Metals to find out! Metals that are more reactive replace metals that are less reactive
	+ For Nonmetals it is based on their location on the periodic table (Reactivity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as you move down the column)

Analogy: (Sketch Story Below)

Example: Aluminum replaces Zinc in Zinc (II) chloride to make Aluminum chloride and Zinc

Using the Activity Series of Metals Examples:

* + Mg + Zn(NO3)2 🡪
	+ Mg + LiNO3 🡪
	+ Cl2 + NaBr 🡪
	+ Br2 + BeF2 🡪
	+ K + AlPO4 🡪

**Double Replacement:** An exchange of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ between two reacting compounds

* **Red Flag**: Two \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are the reactants
* One of three conditions must be met as the products are formed:
	1.
	2.

Examples:

* + HCl + NaOH 🡪
	+ BaCl2 + K2CO3 🡪

Analogy: (Sketch Story Below)

Example: Reaction of lead nitrate with potassium iodide to form lead iodide and potassium nitrate:

Identifying Reaction Types: Identify what type the following reactions are:

* 1. NaOH + KNO3 🠦 NaNO3 + KOH
	2. CH4 + 2 O2 🠦 CO2 + 2 H2O
	3. 2 Fe + 6 NaBr 🠦 2 FeBr3 + 6 Na
	4. CaSO4 + Mg(OH)2 🠦 Ca(OH)2 + MgSO4
	5. Pb + O2 🠦 PbO2
	6. Na2CO3 🠦 Na2O + CO2
1. Synthesis
2. Decomposition
3. Single Replacement
4. Double Replacement

Podcast 7.2 B: Special Types of Reactions – Acid-Base Reactions, Combustion Reactions, and Redox Reactions

Acid-Base Reactions: A reaction that involves an Acid and a Base as reactants that will always produce \_\_\_\_\_\_\_\_\_\_\_\_ and a \_\_\_\_\_\_\_\_\_\_\_\_\_ as Products.

* + Chemical Formulas for Acids will begin with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (H2SO4 – Sulfuric Acid)
	+ Chemical Formulas for Bases will end with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (KOH – Potassium Hydroxide)
	+ Acid-Base Reaction is a specific type of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Reactions

Examples

H2SO4 and KOH

HCl and NaOH

* *Note: Acids and Bases are opposites. One is always used to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the other.*

Combustion Reactions: An element or a compound reacts with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ gas to produce energy in the form of heat and light

* Commonly Involve \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Combustion of Hydrocarbons will ALWAYS produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as products
* Combustion will stop when \_\_\_\_\_\_\_\_\_\_\_\_\_ supply is used up or the fuel runs out

Examples

C2H5OH – Ethanol or Ethyl Alcohol “Flame Writing”

C2H5OH + O2 🡪

CH4 – Methane Gas “Light Your Teacher On Fire”

CH4 + 2O2 🡪

CH3OH – Methanol or Methyl Alcohol “Whoosh Bottle”

CH3OH + O2 🡪

Redox Reactions: A reaction that involves the \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of electrons. It can also deal with the addition of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to a compound.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – Loss of electrons from a substance or the addition of Oxygen to a compound
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – Gain of electrons to a substance or the Loss of Oxygen to a compound
* Both Processes occur simultaneously. One cannot occur without the other



* Single-Replacement, Combination, Decomposition, and Combustion Reactions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Redox Reactions. There is a transfer of electrons in the process.
* Double-Replacement and Acid-Base Reactions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Redox Reactions. No electrons are exchanged between the different elements, the ions are just trading partners.

*For each statement, classify the change of the underlined element as [O]xidation, [R]eduction, or [N]either:*

1. \_\_\_\_\_ Cu° → Cu2+ + 2e-
2. \_\_\_\_\_ Al3+ + 3e- → Al°
3. \_\_\_\_\_ CH4 → CO2
4. \_\_\_\_\_ NaOH + HCl → NaCl + H2O
5. \_\_\_\_\_ gaining electrons
6. \_\_\_\_\_ oxidation number increases
7. \_\_\_\_\_ Zn° + 2HCl → ZnCl2 + H2
8. \_\_\_\_\_ Mg + ½O2 → MgO

**Podcast 7.3: Balancing Chemical Equations**

How molecules are symbolized (Sketch each one)

Cl2 2Cl 2Cl2

How many of each atom are in the following?

a) NaOH

b) Ca(OH)**2**

c) 3Ca(OH)**2**

Balancing equations: burning of MgO

* The law of conservation of mass states that matter can neither be created or destroyed; atoms are only \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a chemical reaction
* Thus, the number of a particular atom is the same on both sides of a chemical equation

Example 1

Magnesium + Oxygen (sketch)

Mg + O2 → MgO

Balance equations by “inspection”

Hints:

1. start with elements that occur in one compound on each side.

2.Treat\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ions that repeat as if they were a single entity.

Examples: Balance the following equations by inspection

1. P**4** + O**2** → P**4**O**10**
2. Li + H**2**O → H**2**+ LiOH
3. Bi(NO**3**)**3** + K**2**S → Bi**2**S**3** + KNO**3**

d) C**2**H**6** + O**2** → CO**2** + H**2**O

Balance by “Atom Inventory”: Set up a table to keep track of the number of atoms of each element on both sides of the equation.

 Mg + HCl → MgCl2 + H2

 Mg \_\_\_\_\_ Mg \_\_\_\_\_

H \_\_\_\_\_ H \_\_\_\_\_

 Cl \_\_\_\_\_ Cl \_\_\_\_\_

1. Ca + N2  → Ca3N2

Ca\_\_\_\_\_ Ca\_\_\_\_\_

N \_\_\_\_\_ N \_\_\_\_\_

1. NH4NO3 → N2O + H2O

N\_\_\_\_\_ N\_\_\_\_\_

H\_\_\_\_\_ H\_\_\_\_\_

O\_\_\_\_\_ O\_\_\_\_\_

1. BiCl3 + H2S → Bi2S3 + HCl

Bi\_\_\_\_\_ Bi\_\_\_\_\_

Cl\_\_\_\_\_ Cl\_\_\_\_\_

H\_\_\_\_\_ H\_\_\_\_\_

S\_\_\_\_\_ S\_\_\_\_\_

1. C4H10 + O2 → CO2 + H2O

C\_\_\_\_\_ C\_\_\_\_\_

H\_\_\_\_\_ H\_\_\_\_\_

O\_\_\_\_\_ O\_\_\_\_\_

**Use the Matrix Method, or Mathematical Method to Balance Equations**
 Ca3(PO4)2 + H2SO4 → CaSO4 + H3PO4

1. Assign letters to unknown coefficients:

\_\_\_\_\_Ca3(PO4)2 + \_\_\_\_\_ H2SO4 → \_\_\_\_\_CaSO4 + \_\_\_\_\_ H3PO4

1. Make a grid indicating the appearance of element (or ion!) in each species, or term, of the equation. Use a whole number and the coefficient “letter” to indicate each appearance.

\_\_\_\_\_Ca3(PO4)2 + \_\_\_\_\_ H2SO4 → \_\_\_\_\_CaSO4 + \_\_\_\_\_ H3PO4

Ca2+

PO43-

H+

SO42-

1. Simplify Each Equation
2. Solve for the coefficients:

Let a=1 and solve for each variable

 a =1

 b = \_\_\_\_\_

 c = \_\_\_\_\_

 d = \_\_\_\_\_

1. Write the equation

\_\_\_\_\_ Ca3(PO4)2 + \_\_\_\_\_H2SO4 → \_\_\_\_\_CaSO4 + \_\_\_\_\_H3PO4

\*It’s not necessary to write the number 1, but it’s shown here to help you remember that a = 1.

\*What if you get fractions? Get rid of them! Multiply by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_