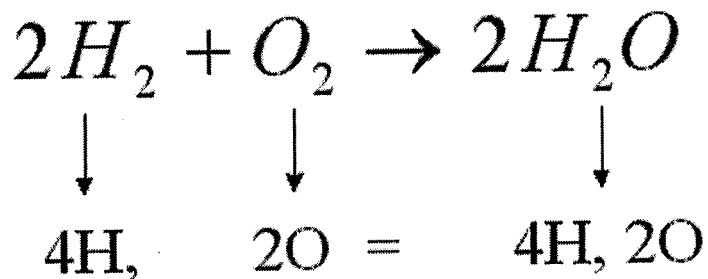


Unit #6: Math of Chemistry: Stoichiometry

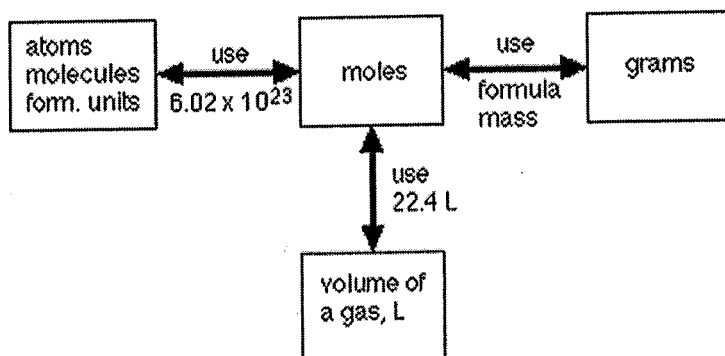


Formula mass step Percentage step

$$\begin{array}{l}
 C = 2 \times 12 = 24 / 46 = 52\% \text{ C} \\
 H = 6 \times 1 = 6 / 46 = 13\% \text{ H} \\
 O = 1 \times 16 = 16 / 46 = 35\% \text{ O} \\
 \hline
 46 \text{ u}
 \end{array}$$

← A % Comp calculation should look like this.

Mole Map



Index

P 1. Key Objectives and Vocabulary

P 3. Math of Chemistry/Stoichiometry notes

P 8. Determining Formula Mass and Percent Composition

P 11. Balancing Equations

P 22. Mole to Mole Conversions

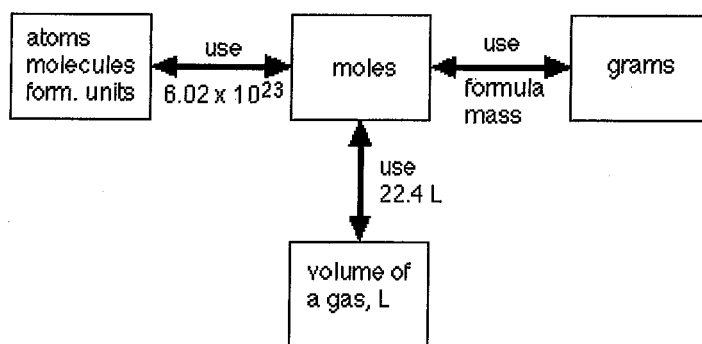
P 24. Practice quizzes and worksheets

P 52. Chemistry Compound Sweet 16 Tournament

Key Objectives:

- Calculate the formula mass of a substance
- Define the term *mole* in relation to number of particles, mass of a substance and volume of an ideal gas at STP
- Calculate the molar mass of a substance
- Solve mole problems using the factor label method
- Solve percent composition problems
- Calculate empirical formulas of a substance from its percent composition by mass
- Calculate density of an ideal gas at STP
- Determine the molar mass of a substance from its gas density at STP
- Solve mole, mass and volume conversion problems involving chemical equations
- Solve problems involving number of particles, limiting reactants and percent yields

Mole Map



Mass $\xleftrightarrow{\text{Molar Mass}}$ Moles $\xleftrightarrow{\text{Avogadro's Number}}$ Atoms

$$\text{Moles (mol)} \times \text{Molar Mass (g/mol)} = \text{Mass (g)}$$

$$\text{Moles (mol)} \times \text{Avogadro's Number (atoms/mol)} = \text{atoms}$$

$$\frac{\text{Mass (g)}}{\text{Molar Mass (g/mol)}} = \text{Moles (mol)}$$

$$\frac{\text{Atoms}}{\text{Avogadro's Number (atoms/mol)}} = \text{Moles (mol)}$$

①

Math of Chemistry (STOICHIOMETRY) Vocabulary and Key Objectives

Vocabulary:

analysis a chemical reaction in which a compound is broken down (decomposed) into simpler substances

catalyst a substance that alters the speed of a chemical reaction without being permanently changed

chemical change a reaction in which the composition of a substance is changed

chemistry the study of the composition of matter and changes that occur in it

coefficient the number placed before a formula indicating the number of units of that substance

decomposition a chemical reaction in which a compound is broken down into simpler substances

double replacement a chemical reaction in which ions exchange places

empirical formula the simplest integer ratio in which atoms combine to form a compound

endothermic a chemical reaction that absorbs heat, producing products with more potential energy than the reactants

exothermic a chemical reaction that releases heat, producing products with less potential energy than the reactants

formula mass the sum of the atomic masses of all atoms present

formula symbols and subscripts used to represent the composition of a substance

gram formula mass the formula mass expressed in grams instead of atomic mass units

mole the number of atoms of carbon present in 12.000 g of carbon-12

molecule the smallest unit of a covalently bonded substance that has the properties of that substance

molecular formula the actual ratio of the atoms in a molecule

percentage composition the composition of a compound as a percentage of each element compared with the total mass of the compound

physical change a change that does not alter the chemical properties of a substance

polyatomic ion a covalently bonded group of atoms that have a net electric charge

product a substance formed in a chemical reaction, shown to the right of the arrow in an equation

qualitative information that cannot be counted or measured

quantitative information that can be either counted or measured

reactant a starting substance in a reaction, shown to the left of the arrow in an equation

single replacement a reaction in which an element replaces a less reactive element in a compound

subscript the number written after a chemical symbol in a formula indicating the number of atoms present

synthesis a reaction in which two or more substances combine to form one product

1 **Stoichiometry**

Math of Chemistry

2

- Atomic Mass: a relative mass for one atom based on a standard of Carbon at 12.00amu (atomic mass units)
- Formula Mass: sum of atomic masses in a formula
- Ex#1. $H_2O = 18.0amu$
 - $H = 1.0amu * 2 \text{ atoms H} = 2.0amu$
 - $+O = 16.0amu * 1 \text{ atom O} = 16.0amu$
 - $= 18.0amu$

3 **Formula and Molar Mass**

- Ex. #2 $HC_2H_3O_2$ (acetic acid) = 60.0amu
 - $H = 1.0amu * 4 \text{ atoms H} = 4.0amu$
 - $C = 12.0amu * 2 \text{ atoms C} = 24.0amu$
 - $+O = 16.0amu * 2 \text{ atoms O} = 32.0amu$
 - $= 60.0amu$
- Molar Mass (gram formula mass/gfm): gram(g) equivalent to formula mass that represents a mole of particles. **Unit is g/mol**

4 **Percent Composition**

- (Mass of Part/Mass of Whole)*100
- What is the % composition of Glucose $C_6H_{12}O_6$
 - Find Molar Mass/Gram formula mass 1st
 - Determine percentages separately (totaling 100% for all parts)
 - $C = 12.0amu * 6 \text{ atoms} = 72.0amu$
 - $H = 1.0amu * 12 \text{ atoms} = 12.0amu$
 - $O = 16.0amu * 6 \text{ atoms} = 96.0amu$
 - $180.0amu$
 - $\%C = (72.0amu/180.0amu) * 100 = 40.0\%$
 - $\%H = (12.0amu/180.0amu) * 100 = 6.7\%$
 - $\%O = (96.0amu/180.0amu) * 100 = 53.3\%$
 - 100%

5 **The Mole and Avogadro's Number $6.02 * 10^{23}$**

- Avogadro's number $\rightarrow 6.02 * 10^{23}$ particles (atoms, molecules, formula units) equals one mole
- One mole of Lead(Pb) would have a molar mass of 207.2g/mol, while a mole of Carbon(C) would be 12.0g/mol
- Both 1 mole of Pb and C would have $6.02 * 10^{23}$ atoms each (or any other element as well)

6 **Molecules to Atoms**

3

- **Molecules:** are considered to be a whole unit
- Ex. 6.02×10^{23} molecules of H_2O in a mole of water
- 6.02×10^{23} molecules of H_2 in a mole of hydrogen gas
- To determine the # of atoms present in a mole when starting with molecules
 - Break molecule into its elements (number present)
 - Multiply Avogadro's number by # of atoms
 - $H_2O = (3 \text{ atoms/molecule}) (6.02 \times 10^{23} \text{ molecules})$
 - $18.06 \times 10^{23} \text{ atoms} \rightarrow 1.81 \times 10^{24} \text{ atoms}$

7 Moles to Atoms

- A mole of glucose ($C_6H_{12}O_6$) is:
 - 6 moles of C atoms
 - 12 moles of H atoms
 - 6 moles of O atoms
 - 24 moles of atoms
- $(24 \text{ moles})(6.02 \times 10^{23} \text{ atoms/mole}) = 144.4 \times 10^{23} \text{ atoms}$
- $1.44 \times 10^{25} \text{ atoms}$
- Random Avogadro facts:
 - If you had a mole of pennies, you could give out a million dollars a day for 3000 years
 - a mole of paper would be stacked beyond our solar system

8 Formula Units (ionic Compounds)

- **Formula Unit:** lowest whole # ratio of an Ionic compound
- 6.02×10^{23} formula units in a mole of NaCl
 - broken down into 2 moles of ions
 - 1 mole Na^+ ion 1 mole Cl^- ion
- 6.02×10^{23} formula units in a mole of $CaCl_2$
 - broken down into 3 moles of ions
 - 1 mole Ca^{+2} ion 2 moles Cl^- ion

9 Molar Conversions

10 Molar Conversions samples

- Mass \rightarrow moles (Given Mass)(1mol/gfm) = #mol
- Ex#1. How many moles are in 11.2g of NaCl?
- Find molar mass
- Use factor label method to convert mass into moles
 - gfm NaCl = 58.5g
 - $(11.2g \text{ NaCl})(1mol/58.5gNaCl) = 0.191mol$
- Ex#2. How many moles of water are in a 1kg sample?
 - $(1kg \text{ H}_2O)(1000g/kg)(1mol/18.0g \text{ H}_2O) = 55.5mol$

11 Molar Conversions samples

- Moles \rightarrow Mass (Given moles)(gfm/1mol) = mass

4

- Ex#1. What is the mass of 2.50 moles of NaCl?
- $(2.50\text{mol NaCl})(58.5\text{g}/1\text{mol NaCl}) = 146\text{g}$

- Ex#2. What is the mass of 5.00 moles of CO_2 ?
- $(5.00\text{mol CO}_2)(44.0\text{g}/1\text{mole CO}_2) = 220\text{g}$

12 Molar Conversions samples

- Molar Volume: 1 mole of a gas at STP will occupy or fill up 22.4L
-
- Moles \rightarrow Volume (Given moles)(22.4L/mol)
- Ex#1 A reaction produced 0.82mol of O_2 gas, what volume would this occupy at STP?
- $(0.82\text{mol O}_2)(22.4\text{L}/\text{mol O}_2) = 18\text{L}$
-
- Ex#2 Determine the volume of 3.00 moles of a gas.
- $(3.00\text{ mol})(22.4\text{L}/\text{mol}) = 67.2\text{L}$

13 MULTIPLE STEP CONVERSIONS

- Volume \rightarrow Particles
- (Given Vol)(1mol/22.4L)(6.02×10^{23} particles/mol)
- Ex. How many molecules of CO_2 gas are in a 1.0L container.
- $(1.0\text{L CO}_2)(1\text{Mol CO}_2/22.4\text{L})(6.02 \times 10^{23}\text{molecules}/\text{mole CO}_2)$
- $.268 \times 10^{23}$ molecules CO_2
- 2.7×10^{22} molecules CO_2

14 Sample Problems:

- How many atoms are in 0.36 mol of Aluminum?
- $(0.36\text{ mol})(6.02 \times 10^{23}\text{ atoms}/1\text{mol})$
- $\rightarrow 2.2 \times 10^{23}$ atoms
-
-
- A sample of Na_2CO_3 is made of 7.9×10^{24} formula units. How many moles is this?
- $(7.9 \times 10^{24}\text{ formula units Na}_2\text{CO}_3)(1\text{mol}/6.02 \times 10^{23}\text{ formula units})$
- $\rightarrow 1.3 \times 10^1 = 13$ moles

15 Sample Problems continued:

- What is the mass of 7.2×10^{22} atoms of Calcium
- $(7.2 \times 10^{22}\text{ atoms Ca})(1\text{mol}/6.02 \times 10^{23}\text{ atoms})(40.1\text{g}/\text{mol})$
- 4.8g
- 250.g of sugar are used in a cake mix. How many sucrose($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) molecules is

5

this?

- $(250\text{g C}_{12}\text{H}_{22}\text{O}_{11})(1\text{mol}/342.3\text{g})(6.02 \times 10^{23} \text{ molecules}/1\text{mol})$
- $4.4 \times 10^{23} \text{ molecules C}_{12}\text{H}_{22}\text{O}_{11}$

16 **Mole Ratio's: ratio of moles within an equation**

- Ex. $2\text{Al}_2\text{O}_3 (\text{l}) \rightarrow 4\text{Al}(\text{s}) + 3\text{O}_2(\text{g})$
- 2moles \rightarrow 4moles + 3moles
- 2:4:3 ratio exists here
- This is used to find moles/mass/volume/particles needed for, or produced in, a completed reaction with the factor label method

17 **Mole Ratio's continued**

- Ex. Ethane + oxygen \rightarrow Carbon dioxide + water
- $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$
- $\uparrow\# \text{mol C}_2\text{H}_6 \quad \uparrow\# \text{mol O}_2 \quad \uparrow\# \text{mol CO}_2 \quad \uparrow\# \text{mol H}_2\text{O}$
- 2: 7: 4: 6 ratio exists
- Burning 2 moles of C_2H_6 results in 4 mol of CO_2
- Burning 2 moles of C_2H_6 results in 6 mol of H_2O
-

18 **Mole Ratio's continued**

- $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$
-
- Ex#1 How many moles of water are produced from the combustion of 3 mol of ethane gas?
- $(3\text{mol C}_2\text{H}_6)(6\text{mol H}_2\text{O}/2\text{mol C}_2\text{H}_6) = 9\text{mol H}_2\text{O}$
- Ex #2 If 5 moles of ethane are burned, how much carbon dioxide is produced?
- $(5\text{mol C}_2\text{H}_6)(4\text{mol CO}_2 / 2\text{mol C}_2\text{H}_6) = 10\text{mol CO}_2$

19 **Empirical Formula**

- Simplest/lowest whole number ratio of elements in a compound or molecule.
- Ex. Glucose $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow \text{CH}_2\text{O}$
-
- Calculate moles of each atom present
- Divide each by lowest value to obtain whole number ratios for all atoms

20 **Determining Empirical formulas**

- Ex#1. A 100.g sample contains 80% carbon and 20% hydrogen. What is its empirical formula?
- A) Find Moles present
- Moles C = $(80.\text{g C})(1\text{mol}/12.0\text{g C}) = 6.7\text{mol C}$
- Moles H = $(20.\text{g H})(1\text{mol}/1.0\text{g H}) = 20\text{mol H}$
- B) Divide by lower value to convert to whole number ratios

6

- Formula equation
 - $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- Reversible reaction
 - Represented by a double arrow
 - \leftrightarrow or

8

Name _____

Determine the formula mass and percent compositions for the following: SHOW ALL WORK in space provided (answers in tables to the right)

1) Br₂

Molar Mass	% Composition
	Br=

2) C₃H₆

Molar Mass	% Composition
	C=
	H=

3) C₂H₅OH

Molar Mass	% Composition
	C=
	H=
	O=

4) H₂SO₄

Molar Mass	% Composition
	S=
	H=
	O=

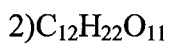
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Name _____

Determine the molar mass and percent composition of the following materials. Show all work in the space provided and place answers in tables to right.



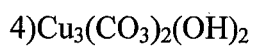
Molar Mass	% Composition
	N=



Molar Mass	% Composition
	C=
	H=
	O=



Molar Mass	% Composition
	Cu=
	Fe=
	S=



Molar Mass	% Composition
	Cu=
	C=
	H=
	O=

10

Unit 2

C.1 SUPPLEMENT: KEEPING TRACK OF ATOMS

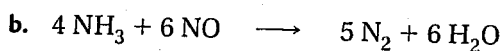
Fill-in-the-Blanks

- A chemical equation is balanced if there are _____ of each kind of _____ on both sides of the equation.
- Before looking at equations, determine the number of atoms of each kind in each of the following:
 - $\text{CaCO}_3 = \text{ ____ Ca, ____ C, ____ O}$
 - $(\text{NH}_4)_2\text{SO}_4 = \text{ ____ N, ____ H, ____ S, ____ O}$
 - $3 \text{H}_2 = \text{ ____ H}$
 - $4 \text{Mg}(\text{OH})_2 = \text{ ____ Mg, ____ O, ____ H}$
 - $\text{Ba}(\text{NO}_3)_2 = \text{ ____ Ba, ____ N, ____ O}$
- Now look at the equations. Count the number of atoms of each kind on each side of the following and determine if the statement is a balanced equation.



<u>Reactants</u>		<u>Products</u>
_____	Na	_____
_____	H	_____
_____	O	_____

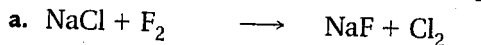
Balanced? Yes _____ No _____



<u>Reactants</u>		<u>Products</u>
_____	N	_____
_____	H	_____
_____	O	_____

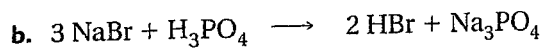
Balanced? Yes _____ No _____

- For each of the following, show the number of each type of atom on each side of the reaction. Decide if the chemical equation is balanced or not.



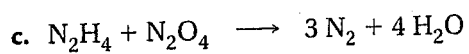
_____	Na	_____
_____	Cl	_____
_____	F	_____

Balanced? Yes _____ No _____

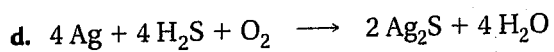


_____ Na _____
_____ Br _____
_____ H _____
_____ P _____
_____ O _____

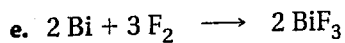
Balanced? Yes _____ No _____



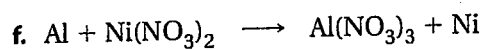
Balanced? Yes _____ No _____



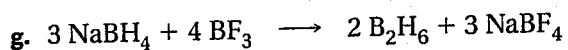
Balanced? Yes _____ No _____



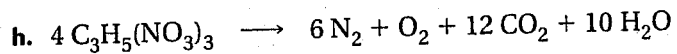
Balanced? Yes _____ No _____



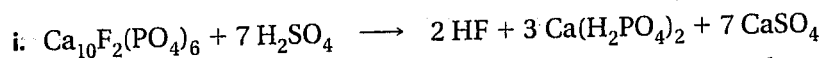
Balanced? Yes _____ No _____



Balanced? Yes _____ No _____



Balanced? Yes _____ No _____



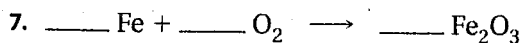
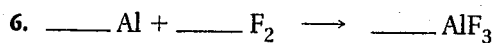
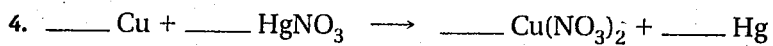
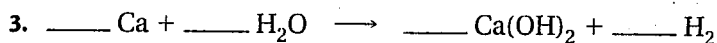
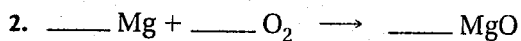
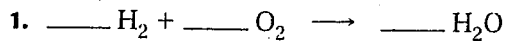
Balanced? Yes _____ No _____

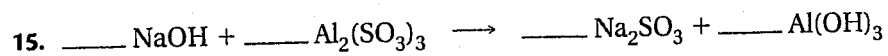
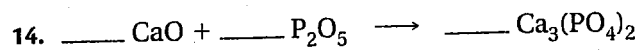
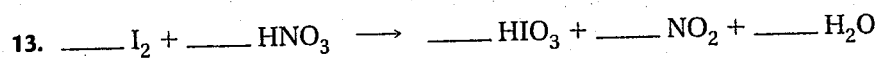
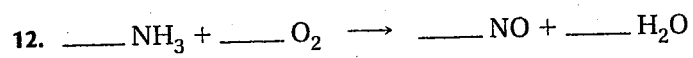
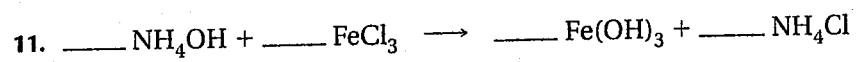
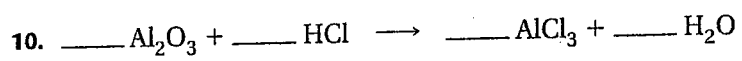
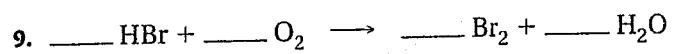
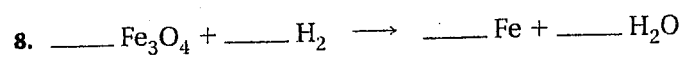
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Unit 2

C.2 SUPPLEMENT: BALANCING EQUATIONS

Balance the following equations.

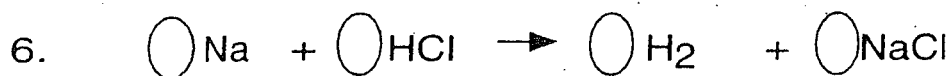
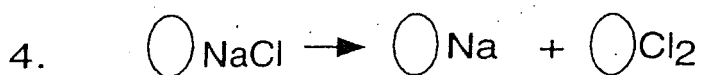
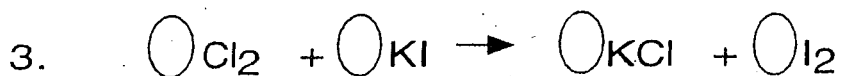
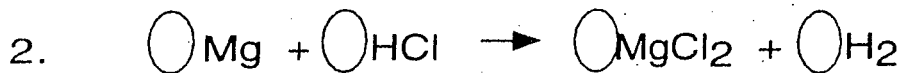
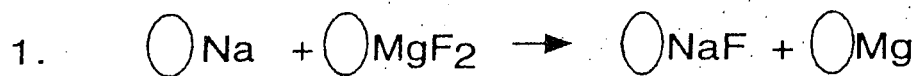




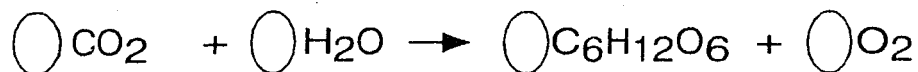
14

Balancing Act

Add coefficients to balance each equation. Be sure to show your lists!



Challenge: This one is tough!



Name _____

CHEMISTRY - WRITING BALANCED CHEMICAL EQUATIONS

Write balanced formula equations for these reactions. Use the space below each one.

1. iron + sulfur ----> iron(II)sulfide

2. sodium chloride + silver nitrate ----> silver chloride + sodium nitrate

3. calcium oxide + water ----> calcium hydroxide

4. calcium hydroxide + carbon dioxide ----> calcium carbonate + water

5. sodium chloride + sulfuric acid (H₂SO₄) ----> sodium hydrogen sulfate
+ hydrogen chloride

6. zinc + copper(II)sulfate ----> zinc sulfate + copper

7. magnesium bromide + chlorine ----> magnesium chloride + bromine

8. hydrogen + chlorine ----> hydrogen chloride

9. aluminum + iron(III)oxide ----> aluminum oxide + iron

10. silver nitrate + copper ----> copper(II)nitrate + silver

11. hydrogen + nitrogen ----> ammonia (NH₃)

12. sodium hydroxide + carbon dioxide ----> sodium carbonate + water

13. ammonium nitrite \rightarrow nitrogen + water
14. barium chloride + sodium sulfate \rightarrow sodium chloride + barium sulfate
15. calcium + hydrochloric acid (HCl) \rightarrow calcium chloride + hydrogen
16. iron(II)sulfide + hydrochloric acid \rightarrow hydrogen sulfide + iron(II)chloride
17. lead(II)nitrate + sulfuric acid \rightarrow lead(II)sulfate + nitric acid (HNO₃)
18. zinc chloride + ammonium sulfide \rightarrow zinc sulfide + ammonium chloride
19. ammonia + oxygen \rightarrow nitric acid + water
20. magnesium + nitric acid \rightarrow magnesium nitrate + hydrogen
21. mercury(I)chloride \rightarrow mercury + mercury(II)chloride
22. nickel + hydrochloric acid \rightarrow nickel(II)chloride + hydrogen
23. sodium iodide + bromine \rightarrow sodium bromide + iodine
24. carbon + steam \rightarrow carbon monoxide + hydrogen
25. zinc + lead(II)acetate \rightarrow lead + zinc acetate
26. calcium carbonate \rightarrow calcium oxide + carbon dioxide
27. iron(III)oxide + carbon monoxide \rightarrow iron + carbon dioxide
28. lead(II)acetate + hydrogen sulfide \rightarrow lead(II)sulfide + acetic acid

31. calcium oxide + diphosphorous pentoxide ----> calcium phosphate

32. copper + chlorine ----> copper(I)chloride

33. iron(III)chloride + sodium hydroxide ----> iron(III)hydroxide + sodium chloride

34. calcium carbonate + hydrochloric acid ----> calcium chloride + water +
carbon dioxide

35. sodium hydrogen carbonate + sulfuric acid ----> sodium sulfate +
water + carbon dioxide

36. calcium hydroxide + phosphoric acid ----> calcium phosphate + water

37. aluminum hydroxide + sulfuric acid ----> aluminum sulfate + water

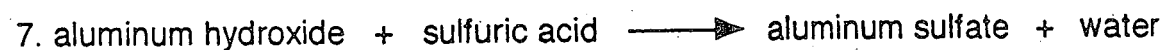
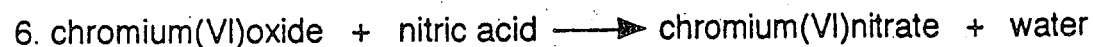
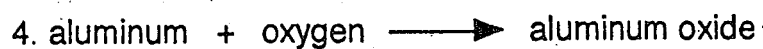
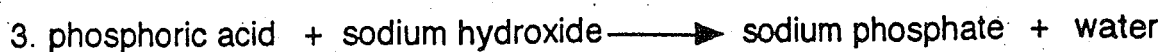
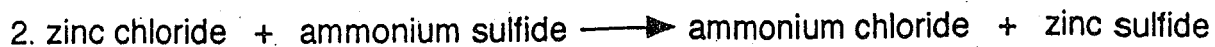
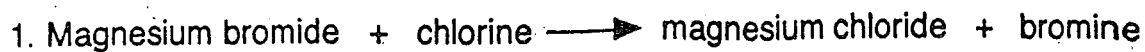
38. copper + sulfuric acid ----> copper(II)sulfate + water + sulfur dioxide

39. sodium sulfite + sulfuric acid ----> sodium sulfate + water + sulfur dioxide

40. calcium hydroxide + ammonium sulfate ----> calcium sulfate + ammonia + water

NAME _____

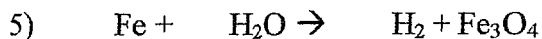
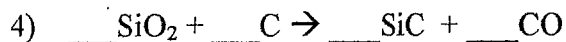
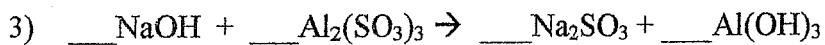
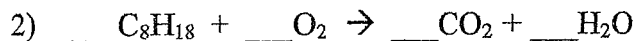
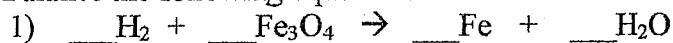
Balance the following equations:



Name _____



Part I: Balance the following equations



Part II: Give the formula for the following terms

6) Magnesium hydroxide

7) Ammonium phosphate

8) Lithium sulfite

9) Aluminum carbonate

10) Strontium hypochlorite

Part III: Determine the molar mass of the following compounds and % composition for each element present

11) $\text{Al}(\text{OH})_3$

Molar Mass = _____

a. Al =

b. O =

c. H =

12) Na_2SO_4

Molar Mass = _____

a. Na =

b. S =

c. O =

13) $\text{Zn}(\text{OH})_2$

Molar Mass = _____

a. Zn =

b. O =

c. H =

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14) NH_4OH

Molar Mass = _____

- a. N=
- b. H=
- c. O=

15) NiCO_3

Molar Mass = _____

- a. Ni=
- b. C=
- c. O=

Part IV: Complete the following conversions between mass and moles for the following questions. You may need to determine the correct molar mass.

- 16) How many moles is 90 grams of NaOH?
- 17) If I have a sample of gold that is 42g, how many moles of gold do I have?
- 18) If you were required to use 15 moles of distilled water to dissolved a solute in you next lab, how many grams (or mL) of water would this require, or equate to?
- 19) Which has a larger mass? 4 moles of CH_4 , 2 moles of S, 1 mole of Cu or 0.5 moles of Te?
Please show all work determining each of the four parts to validate answers. (You may round to the nearest whole number for this question)
- 20) A typical soda may have about 30g of sugar ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) in it. If you consume a whole can in one sitting, how many moles of sugar have you ingested?

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11-1 Practice Problems

Mole-Mole Problems

- Lead will react with hydrochloric acid to produce lead(II) chloride and hydrogen. How many moles of hydrochloric acid are needed to completely react with 0.36 mol of lead?
$$\text{Pb} + 2\text{HCl} \rightarrow \text{PbCl}_2 + \text{H}_2$$
- How many moles of HNO_3 will be produced when 0.51 mol of N_2O_5 reacts according to the following equation?
$$\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3$$
- Carbon will react with zinc oxide to produce zinc and carbon dioxide. How many moles of carbon dioxide will be produced if 0.38 mol of ZnO is completely reacted?
$$\text{C} + \text{ZnO} \rightarrow \text{Zn} + \text{CO}_2$$
- How many moles of NaBr will be produced when 0.69 mol of bromine reacts according to the following equation?
$$\text{Br}_2 + 2\text{NaI} \rightarrow 2\text{NaBr} + \text{I}_2$$
- Phosphorus will react with bromine to produce phosphorus tribromide. How many moles of phosphorus tribromide will be produced if 0.78 mol of bromine is reacted?
$$2\text{P} + 3\text{Br}_2 \rightarrow 2\text{PBr}_3$$
- How many moles of hydrogen will be produced if 0.44 mol of CaH_2 reacts according to the following equation?
$$\text{CaH}_2 + 2\text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + 2\text{H}_2$$
- How many moles of oxygen will be needed to react with 0.38 mol of C_3H_8 according to the following equation?
$$\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$$
- Nitrogen can react with hydrogen to produce ammonia. How many moles of nitrogen will be needed to produce 0.48 mol of NH_3 ?
$$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$$
- Iron will react with oxygen to produce Fe_2O_3 . How many moles of Fe_2O_3 will be produced if 0.18 mol of Fe reacts?
$$4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$$
- How many moles of water will be produced if 2.35 mol of oxygen reacts according to the following equation?
$$2\text{C}_6\text{H}_6 + 15\text{O}_2 \rightarrow 12\text{CO}_2 + 6\text{H}_2\text{O}$$

Mole - Mole Problems

44. Given the reaction $4\text{Al}(s) + 3\text{O}_2(g) \rightarrow 2\text{Al}_2\text{O}_3(s)$, what is the minimum number of moles of oxygen gas required to produce 1.00 mol of aluminum oxide?
45. Given the reaction $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$, what is the maximum number of moles of H_2O that can be produced when 2.0 mol of NH_3 are completely reacted?
46. Given the reaction $2\text{KClO}_3(s) \rightarrow 2\text{KCl}(s) + 3\text{O}_2(g)$, what is the total number of moles of KClO_3 needed to produce 6 mol of O_2 ?
47. Given the reaction $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$, what amount of oxygen is needed to completely react with 1 mol of CH_4 ?
48. Given the reaction $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$, what is the total number of moles of O_2 required to produce 40 mol of NO ?
49. Given the reaction $2\text{CH}_3\text{OH}(l) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 4\text{H}_2\text{O}(g)$, how many moles of $\text{O}_2(g)$ are needed to produce exactly 20. mol of $\text{CO}_2(g)$?
50. Given the reaction $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$, how many moles of oxygen are completely consumed in the production of 1.00 mol of Na_2O ?
51. Given the reaction $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$, what is the total number of moles of Ca needed to react completely with 4.0 mol of H_2O ?
52. Consider the following equation.
 $\text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(g)$
How many moles of oxygen are needed for the complete combustion of 3.0 mol of $\text{CH}_4(g)$?
53. According to the reaction $2\text{Al} + 3\text{H}_2\text{SO}_4 \rightarrow 3\text{H}_2 + \text{Al}_2(\text{SO}_4)_3$, the total number of moles of H_2SO_4 needed to react completely with 5.0 mol of Al is
54. Given the equation $\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)$, what is the total number of moles of NH_3 produced when 10. mol of H_2 reacts completely with N_2 ?

Name _____
Math of Chemistry Quiz #2

March 18, 2004

- 1) Balance the following equation: $\text{H}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow \text{NH}_3(\text{g})$
- 2) What is the percent composition of the product from question #1?
- 3) If I had 50.0g of the product (from #1), how many molecules would that be?
- 4) The empirical formula of a compound is CH_2 and its molar mass is 70.0g. What is its molecular formula?
- 5) How much silver can be produced from the breakdown of a 150.g sample of Ag_2S ?
- A. Show the correct balanced equation for this reaction
- B. Determine the mass of silver produced.

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SHOW ALL WORK

- 1) Determine the empirical formula for a compound containing 7.30g Na, 5.08g S and 7.62g O.

- 2) Determine the empirical formula for a compound containing 36.0g C, 8.0g O and 6.0g H.

- 3) What is the molecular formula of a compound with an empirical formula of CH_2 and a molar mass of 210.0g?

- 4) When oxygen and hydrogen are reacted, water is produced. In order to produce 81.0g of water, how many grams of oxygen are needed?
 - a. Show balanced equation

 - b. Show all work to determine the amount of oxygen needed

Peace Corps Bonus Questions:

- 1) Name two well known former Peace Corps Volunteers: _____ + _____
- 2) What two organisms were found at Mr. Gardner's site and on his Shirt on Monday? _____ + _____
- 3) If a war canoe had a head holding a head on it, what would that mean?

Name _____

Unit 2C Quiz

Answer each problem accordingly

1) What is Avogadro's number? _____

2) What do the following symbols represent?

a) (l) _____

b) (g) _____

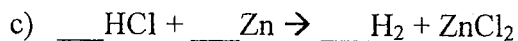
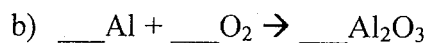
c) (aq) _____

3) What is the molar mass of a molecule of Fluorine (F₂)?

4) What is the molar mass and Percent composition of Phosphoric acid (H₃PO₄)

Molar Mass	Percent Composition
	H=
	P=
	O=

5) Balance the following equations



BONUS: How many gifts were given in the song "The twelve days of Christmas?"

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Name _____

Density, volume and molar mass

Show all work for the following questions

- 1) The molar mass of a gas is 112g/mol. What is the density at STP of this gas?

- 2) The density of a gas is 6.0g/L at STP. What is its molar mass?

- 3) A sample with a mass of 50.0g occupies a volume of 20.0L at STP. What is the molar mass of this gas?

- 4) If 3.00 moles of a gas has a mass of 54g and you have 45g of the gas, what would its volume be at STP?

- 5) The density of a gas is 1.30g/L. What is its molar mass?

- 6) What is the density of 84.0g of $N_{2(g)}$?

- 7) List how many moles of ions $Ca_3(PO_4)_2$ would dissolve into.

- 8) How many moles of atoms make up H_2SO_4 ?

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Math of Chemistry**Multiple Choice**

Identify the letter of the choice that best completes the statement or answers the question.

- _____ 1. What is conserved in the reaction shown below?
$$\text{N}_2(\text{g}) + 3\text{F}_2(\text{g}) \rightarrow 2\text{NF}_3(\text{g})$$

a. atoms only b. mass only c. mass and atoms only d. moles only
- _____ 2. In a chemical reaction, the mass of the products _____.
a. is less than the mass of the reactants b. is greater than the mass of the reactants c. is equal to the mass of the reactants d. has no relationship to the mass of the reactants
- _____ 3. In the reaction $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g})$, what is the ratio of moles of oxygen used to moles of CO_2 produced?
a. 1:1 b. 2:1 c. 1:2 d. 2:2
- _____ 4. Which of the following is true about the total number of reactants and the total number of products in the reaction shown below?
$$\text{C}_5\text{H}_{12}(\text{l}) + 8\text{O}_2(\text{g}) \rightarrow 5\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$$

a. 9 moles of reactants chemically change into 11 moles of product. b. 9 grams of reactants chemically change into 11 grams of product. c. 9 liters of reactants chemically change into 11 liters of product. d. 9 atoms of reactants chemically change into 11 atoms of product.
- _____ 5. How many moles of aluminum are needed to react completely with 1.2 mol of FeO?
$$2\text{Al}(\text{s}) + 3\text{FeO}(\text{s}) \rightarrow 3\text{Fe}(\text{s}) + \text{Al}_2\text{O}_3(\text{s})$$

a. 1.2 mol b. 0.8 mol c. 1.6 mol d. 2.4 mol
- _____ 6. How many moles of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, can be "burned" biologically when 10.0 mol of oxygen is available?
$$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$$

a. 0.938 mol b. 1.67 mol c. 53.3 mol d. 60.0 mol
- _____ 7. Which of the following elements exists as a diatomic molecule?
a. neon b. lithium c. nitrogen d. sulfur
- _____ 8. Avogadro's number of representative particles is equal to one _____.
a. kilogram b. gram c. kelvin d. mole
- _____ 9. How many atoms are in 0.075 mol of titanium?
a. 1.2×10^{25} b. 2.2×10^{24} c. 6.4×10^2 d. 4.5×10^{22}
- _____ 10. What is the molar mass of $(\text{NH}_4)_2\text{CO}_3$?
a. 144 g b. 138 g c. 96 g d. 78 g
- _____ 11. What information is needed to calculate the percent composition of a compound?
a. the weight of the sample to be analyzed and its density b. the weight of the sample to be analyzed and its molar volume c. the formula of the compound and the atomic mass of its elements d. the formula of the compound and its density

Name: _____

ID: A

- _____ 12. What is the percent composition of carbon, in heptane, C_7H_{16} ?
a. 12% b. 19% c. 68% d. 84%
- _____ 13. The ratio of carbon atoms to hydrogen atoms to oxygen atoms in a molecule of dicyclohexyl maleate is 4 to 6 to 1. What is its molecular formula if its molar mass is 280 g?
a. $C_4H_6O_1$ b. $C_8H_{12}O_2$ c. $C_{12}H_{18}O_3$ d. $C_{16}H_{24}O_4$
- _____ 14. Which of the following is NOT true about empirical and molecular formulas?
a. The molecular formula of a compound can be the same as its empirical formula. b. The molecular formula of a compound can be some whole-number multiple of its empirical formula. c. Several compounds can have the same empirical formula, but have different molecular formulas. d. The empirical formula of a compound can be triple its molecular formula.

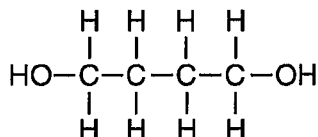
Short Answer

15. If 8.00 mol of NH_3 reacted with 14.0 mol of O_2 , how many moles of H_2O will be produced?
 $4NH_3(g) + 7O_2(g) \rightarrow 4NO_2 + 6H_2O(g)$

29

Name: _____

- ___ 1) Which formula correctly represents the composition of iron (III) oxide?
 A) Fe_3O_2 C) FeO_3
 B) Fe_3O D) Fe_2O_3
- ___ 2) What is the chemical formula for copper (II) hydroxide?
 A) CuOH_2 C) $\text{Cu}(\text{OH})_2$
 B) $\text{Cu}_2(\text{OH})$ D) CuOH
- ___ 3) Which of the following is an empirical formula?
 A) P_2O_5 C) C_2H_4
 B) C_3H_6 D) P_4O_6
- ___ 4) Given the structural formula:



What is the empirical formula of this compound?

- A) $\text{C}_8\text{H}_{20}\text{O}_4$ C) $\text{C}_2\text{H}_5\text{O}$
 B) $\text{C}_4\text{H}_{10}\text{O}_2$ D) CH_3O
- ___ 5) Which pair of compounds has the same empirical formula?
 A) C_2H_6 and C_3H_8
 B) CH_3CHO and CH_3COOH
 C) C_2H_2 and C_6H_6
 D) CH_3OH and $\text{C}_2\text{H}_5\text{OH}$
- ___ 6) Given the reaction:



Which type of reaction is represented?

- A) synthesis
 B) single replacement
 C) decomposition
 D) double replacement
- ___ 7) Which equation represents a double replacement reaction?
 A) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
 B) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
 C) $\text{LiOH} + \text{HCl} \rightarrow \text{LiCl} + \text{H}_2\text{O}$
 D) $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$

- ___ 8) If an equation is balanced properly, *both* sides of the equation must have the same number of
 A) moles of molecules
 B) atoms
 C) molecules
 D) coefficients
- ___ 9) Which chemical equation is correctly balanced?
 A) $2\text{NaCl}(\text{s}) \rightarrow \text{Na}(\text{s}) + \text{Cl}_2(\text{g})$
 B) $\text{N}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g})$
 C) $2\text{KCl}(\text{s}) \rightarrow 2\text{K}(\text{s}) + \text{Cl}_2(\text{g})$
 D) $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g})$
- ___ 10) Given the unbalanced equation:

When the equation is balanced using the *smallest* whole-number coefficients, what is the coefficient of Al?

- A) 1 C) 3
 B) 2 D) 4
- ___ 11) A sample of a compound contains 65.4 grams of zinc, 12.0 grams of carbon, and 48.0 grams of oxygen. What is the mole ratio of zinc to carbon to oxygen in this compound?
 A) 5:1:4 C) 1:4:6
 B) 1:1:3 D) 1:1:2
- ___ 12) The gram formula mass of NH_4Cl is
 A) 22.4 g/mole C) 95.5 g/mole
 B) 53.5 g/mole D) 28.0 g/mole
- ___ 13) What is the percent composition by mass of aluminum in $\text{Al}_2(\text{SO}_4)_3$ (gram-formula mass = 342 grams/mole)?
 A) 15.8% C) 7.89%
 B) 36.0% D) 20.8%
- ___ 14) A hydrated salt is a solid that includes water molecules within its crystal structure. A student heated a 9.10-gram sample of a hydrated salt to a constant mass of 5.41 grams. What percent by mass of water did the salt contain?
 A) 3.69% C) 40.5%
 B) 59.5% D) 16.8%
- ___ 15) A substance has an empirical formula of CH_2 and a molar mass of 56 grams per mole. The molecular formula for this compound is
 A) C_8H_4 C) CH_2
 B) C_4H_6 D) C_4H_8

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Stoichiometry-Math of Chemistry**Multiple Choice**

Identify the choice that best completes the statement or answers the question.

- Chemical reactions _____.
a. occur only in living organisms b. create and destroy atoms c. only occur outside living organisms
d. produce new substances
- In the chemical equation $\text{H}_2\text{O}_2(aq) \rightarrow \text{H}_2\text{O}(l) + \text{O}_2(g)$, the O_2 is a _____.
a. catalyst b. solid c. product d. reactant
- This symbol (\rightleftharpoons) indicates that _____.
a. heat must be applied b. an incomplete combustion reaction has occurred c. a gas is formed by the reaction
d. the reaction is reversible
- Which of the following is the correct skeleton equation for the reaction that takes place when solid phosphorus combines with oxygen gas to form diphosphorus pentoxide?
a. $\text{P}(s) + \text{O}_2(g) \rightarrow \text{PO}_2(g)$ b. $\text{P}(s) + \text{O}(g) \rightarrow \text{P}_5\text{O}_2(g)$ c. $\text{P}(s) + \text{O}_2(g) \rightarrow \text{P}_2\text{O}_5(s)$ d. $\text{P}_2\text{O}_5(s) \rightarrow \text{P}_2(s) + \text{O}_2(g)$
- If you rewrite the following word equation as a balanced chemical equation, what will the coefficient and symbol for fluorine be?
nitrogen trifluoride \rightarrow nitrogen + fluorine
a. 6F_2 b. F_3 c. 6F d. 3F_2
- Which of the following statements is NOT true about what happens in all chemical reactions?
a. The ways in which atoms are joined together are changed. b. New atoms are formed as products. c. The starting substances are called reactants. d. The bonds of the reactants are broken and new bonds of the products are formed.
- Chemical equations must be balanced to satisfy _____.
a. the law of definite proportions b. the law of multiple proportions c. the law of conservation of mass
d. Avogadro's principle
- What are the missing coefficients for the skeleton equation below?
 $\text{Al}_2(\text{SO}_4)_3(aq) + \text{KOH}(aq) \rightarrow \text{Al}(\text{OH})_3(aq) + \text{K}_2\text{SO}_4(aq)$
a. 1, 3, 2, 3 b. 2, 12, 4, 6 c. 4, 6, 2, 3 d. 1, 6, 2, 3
- The type of reaction that takes place when one element reacts with a compound to form a new compound and a different element is a _____.
a. combination reaction b. decomposition reaction c. single-replacement reaction d. double-replacement reaction
- What is conserved in the reaction shown below?
 $\text{N}_2(g) + 3\text{F}_2(g) \rightarrow 2\text{NF}_3(g)$
a. atoms only b. mass only c. mass and atoms only d. moles only

11. In a chemical reaction, the mass of the products _____.
a. is less than the mass of the reactants b. is greater than the mass of the reactants c. is equal to the mass of the reactants d. has no relationship to the mass of the reactants
12. In the reaction $2\text{CO}(g) + \text{O}_2(g) \rightarrow 2\text{CO}_2(g)$, what is the ratio of moles of oxygen used to moles of CO_2 produced?
a. 1:1 b. 2:1 c. 1:2 d. 2:2
13. Which of the following is true about the total number of reactants and the total number of products in the reaction shown below?
 $\text{C}_5\text{H}_{12}(l) + 8\text{O}_2(g) \rightarrow 5\text{CO}_2(g) + 6\text{H}_2\text{O}(g)$
a. 9 moles of reactants chemically change into 11 moles of product. b. 9 grams of reactants chemically change into 11 grams of product. c. 9 liters of reactants chemically change into 11 liters of product. d. 9 atoms of reactants chemically change into 11 atoms of product.
14. Which of the following is an INCORRECT interpretation of the balanced equation shown below?
 $2\text{S}(s) + 3\text{O}_2(g) \rightarrow 2\text{SO}_3(g)$
a. 2 atoms S + 3 molecules $\text{O}_2 \rightarrow 2$ molecules SO_3 b. 2 g S + 3 g $\text{O}_2 \rightarrow 2$ g SO_3 c. 2 mol S + 3 mol $\text{O}_2 \rightarrow 2$ mol SO_3 d. none of the above
15. How many moles of aluminum are needed to react completely with 1.2 mol of FeO?
 $2\text{Al}(s) + 3\text{FeO}(s) \rightarrow 3\text{Fe}(s) + \text{Al}_2\text{O}_3(s)$
a. 1.2 mol b. 0.8 mol c. 1.6 mol d. 2.4 mol
16. How many moles of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, can be "burned" biologically when 10.0 mol of oxygen is available?
 $\text{C}_6\text{H}_{12}\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(l)$
a. 0.938 mol b. 1.67 mol c. 53.3 mol d. 60.0 mol
17. Which of the following statements is true about the following reaction?
 $3\text{NaHCO}_3(aq) + \text{C}_6\text{H}_8\text{O}_7(aq) \rightarrow 3\text{CO}_2(g) + 3\text{H}_2\text{O}(l) + \text{Na}_3\text{C}_6\text{H}_5\text{O}_7(aq)$
a. 22.4 L of $\text{CO}_2(g)$ are produced for every liter of $\text{C}_6\text{H}_8\text{O}_7(aq)$ reacted. b. 1 mole of water is produced for every mole of carbon dioxide produced. c. 6.02×10^{23} molecules of $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7(aq)$ are produced for every mole of $\text{NaHCO}_3(aq)$ used. d. 54 g of water are produced for every mole of $\text{NaHCO}_3(aq)$ produced.
18. What SI unit is used to measure the number of representative particles in a substance?
a. kilogram b. ampere c. kelvin d. mole
19. How many hydrogen atoms are in 5 molecules of isopropyl alcohol, $\text{C}_3\text{H}_7\text{O}$?
a. $5 \times (6.02 \times 10^{23})$ b. 5 c. 35 d. $35 \times (6.02 \times 10^{23})$
20. Which of the following elements exists as a diatomic molecule?
a. neon b. lithium c. nitrogen d. sulfur
21. How many moles of tungsten atoms are in 4.8×10^{25} atoms of tungsten?
a. 8.0×10^2 moles b. 8.0×10^1 moles c. 1.3×10^{-1} moles d. 1.3×10^{-2} moles
22. How many atoms are in 0.075 mol of titanium?
a. 1.2×10^{25} b. 2.2×10^{24} c. 6.4×10^2 d. 4.5×10^{22}

23. The atomic masses of any two elements contain the same number of _____.
a. atoms b. grams c. ions d. milliliters
24. Which of the following is NOT a true about atomic mass?
a. The atomic mass is 12 g for magnesium. b. The atomic mass is the mass of one mole of atoms. c. The atomic mass is found by checking the periodic table. d. The atomic mass is the number of grams of an element that is numerically equal to the mass in amu.
25. What is true about the molar mass of chlorine gas?
a. The molar mass is 35.5 g. b. The molar mass is 71.0 g. c. The molar mass is equal to the mass of one mole of chlorine atoms. d. none of the above
26. What information is needed to calculate the percent composition of a compound?
a. the weight of the sample to be analyzed and its density b. the weight of the sample to be analyzed and its molar volume c. the formula of the compound and the atomic mass of its elements d. the formula of the compound and its density
27. What is the percent composition of chromium in BaCrO_4 ?
a. 4.87% b. 9.47% c. 20.5% d. 25.2%
28. The lowest whole-number ratio of the elements in a compound is called the _____.
a. empirical formula b. molecular formula c. binary formula d. representative formula
29. Which of the following is NOT an empirical formula?
a. $\text{C}_2\text{N}_2\text{H}_8$ b. $\text{C}_3\text{H}_8\text{O}$ c. BeCr_2O_7 d. Sb_2S_3
30. What is the empirical formula of a substance that is 53.5% C, 15.5% H, and 31.1% N by weight?
a. C_3HN_2 b. $\text{C}_4\text{H}_{14}\text{N}_2$ c. $\text{C}_2\text{H}_8\text{N}$ d. CH_4N_7
31. The equation $\text{Mg}(s) + 2\text{HCl}(aq) \rightarrow \text{MgCl}_2(aq) + \text{H}_2(g)$ is an example of which type of reaction?
a. combination reaction b. single-replacement reaction c. decomposition reaction d. double-replacement reaction
32. An *-ate* or *-ite* at the end of a compound name usually indicates that the compound contains _____.
a. fewer electrons than protons b. neutral molecules c. only two elements d. a polyatomic anion
33. Which element, when combined with fluorine, would most likely form an ionic compound?
a. lithium b. carbon c. phosphorus d. chlorine
34. Which of the following correctly shows a prefix used in naming binary molecular compounds with its corresponding number?
a. *deca-*, 7 b. *nona-*, 9 c. *hexa-*, 8 d. *octa-*, 4
35. In any chemical compound, the elements are always combined in the same proportion by _____.
a. charge b. mass c. volume d. density
36. Which of the following is the correct name for N_2O_5 ?
a. nitrous oxide b. dinitrogen pentoxide c. nitrogen dioxide d. nitrate oxide
37. What is the correct name for $\text{Sn}_3(\text{PO}_4)_2$?
a. tritin diphosphate b. tin(II) phosphate c. tin(III) phosphate d. tin(IV) phosphate

Name: _____

ID: A

Short Answer

38. Solid sodium reacts violently with water, producing heat, hydrogen gas, and sodium hydroxide.

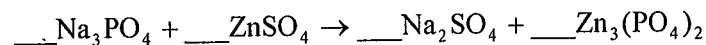
A) Write out the correct and balance equation for this reaction

B) Using your answer from part A, How many molecules of hydrogen gas are formed when 48.7 g of sodium are added to water? (HINT: multi step process here)

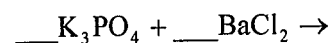
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39. Find the number of moles of argon in 607 g of argon.

40. Balance the following equation.



41. Complete and balance the following double replacement reaction:



Essay

42. Name the compounds

A) CuBr_2 _____

B) SnCl_2 _____

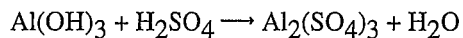
C) BaF_2 _____

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Name: _____

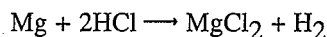
1) A compound has an empirical formula of HCO_2 and a molecular mass of 90. grams per mole. What is the molecular formula of this compound?

___ 2) Given the unbalanced equation:



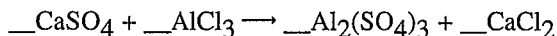
What is the coefficient in front of the H_2O when the equation is completely balanced using the *smallest* whole-number coefficients?

___ 3) Given the reaction:



What is the total number of grams of Mg consumed when 0.50 mole of H_2 is produced?

___ 4) Given the unbalanced equation:

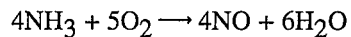


What is the coefficient of $\text{Al}_2(\text{SO}_4)_3$ when the equation is completely balanced using the *smallest* whole-number coefficients?

~~5) Which substance has the *greatest* molecular mass?~~

___ 6) In the balanced equation $\text{H}_3\text{PO}_4(\text{aq}) + \text{NH}_3(\text{aq}) \rightleftharpoons \text{X}(\text{aq}) + \text{NH}_4^+(\text{aq})$, the particle represented by $\text{X}(\text{aq})$ is

___ 7) Given the reaction:



What is the maximum number of moles of H_2O that can be produced when 2.0 moles of NH_3 are completely reacted?

~~8) Which sample contains a total of 6.0×10^{23} atoms?~~

9) What is the gram formula mass of $\text{Mg}(\text{ClO}_3)_2$?

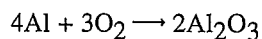
36

___ 10) Which chemical formula is *both* an empirical formula and a molecular formula?

___ 11) What is the total number of moles of hydrogen atoms contained in 1 mole of $(\text{NH}_4)_2\text{C}_2\text{O}_4$?

___ 12) What is the total number of moles of sulfur atoms in 1 mole of $\text{Fe}_2(\text{SO}_4)_3$?

___ 13) Given the reaction:

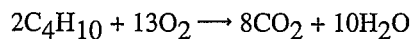


What is the total number of moles of aluminum oxide that can be formed when 54 grams of aluminum reacts completely with oxygen?

___ 14) What is the percent by mass of water present in 1.0 mole of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$?

___ 15) How many grams of sodium are represented by the symbol Na?

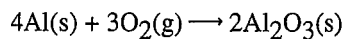
___ 16) Given the equation:



How many moles of carbon dioxide are produced for each mole of butane consumed?

___ 17) If 11 grams of a gas occupies 5.6 liters at STP, what is its gram molecular mass?

___ 18) Given the reaction:



What is the minimum number of grams of oxygen gas required to produce 1.00 mole of aluminum oxide?

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Name: _____

- 1) Which sample contains a total of 6.0×10^{23} atoms?
 A) 78 g K
 B) 24 g C
 C) 23 g Na
 D) 42 g Kr
- 2) Which chemical formula is *both* an empirical formula and a molecular formula?
 A) CH_4
 B) $\text{CH}_3\text{CH}_2\text{COOCH}_3$
 C) CH_3COOH
 D) C_2H_6
- 3) What is the total number of moles of hydrogen atoms contained in 1 mole of $(\text{NH}_4)_2\text{C}_2\text{O}_4$?
 A) 4
 B) 6
 C) 8
 D) 2
- 4) If 11 grams of a gas occupies 5.6 liters at STP, what is its gram molecular mass?
 A) 11 g/mol
 B) 44 g/mol
 C) 88 g/mol
 D) 22 g/mol
- 5) Given the reaction:

$$4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$$

 What is the total number of moles of aluminum oxide that can be formed when 54 grams of aluminum reacts completely with oxygen?
 A) 3.0 moles
 B) 4.0 moles
 C) 1.0 mole
 D) 2.0 moles
- 6) What is the total number of moles of sulfur atoms in 1 mole of $\text{Fe}_2(\text{SO}_4)_3$?
 A) 1
 B) 17
 C) 15
 D) 3
- 7) The gram formula mass of NH_4Cl is
 A) 95.5 g/mole
 B) 22.4 g/mole
 C) 53.5 g/mole
 D) 28.0 g/mole
- 8) In which compound is the percent by mass of oxygen *greatest*?
 A) SrO
 B) BeO
 C) MgO
 D) CaO
- 9) The percent by mass of hydrogen in NH_3 is equal to
 A) $\frac{17}{1} \times 100$
 B) $\frac{17}{3} \times 100$
 C) $\frac{3}{17} \times 100$
 D) $\frac{1}{17} \times 100$
- 10) What is the percent by mass of oxygen in H_2SO_4 ? [formula mass = 98]
 A) 98%
 B) 33%
 C) 16%
 D) 65%
- 11) A hydrated salt is a solid that includes water molecules within its crystal structure. A student heated a 9.10-gram sample of a hydrated salt to a constant mass of 5.41 grams. What percent by mass of water did the salt contain?
 A) 3.69%
 B) 59.5%
 C) 40.5%
 D) 16.8%
- 12) What is the molecular formula of a compound that has a molecular mass of 54 and the empirical formula C_2H_3 ?
 A) C_4H_6
 B) C_2H_3
 C) C_8H_{12}
 D) C_6H_9
- 13) Given the reaction:

$$6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

 What is the total number of moles of water needed to make 2.5 moles of $\text{C}_6\text{H}_{12}\text{O}_6$?
 A) 6.0
 B) 2.5
 C) 15
 D) 12
- 14) Given the equation:

$$2\text{C}_2\text{H}_2(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$$

 How many moles of oxygen are required to react completely with 1.0 mole of C_2H_2 ?
 A) 10
 B) 2.0
 C) 2.5
 D) 5.0
- 15) Given the reaction:

$$\text{PbCl}_2(\text{aq}) + \text{Na}_2\text{CrO}_4(\text{aq}) \rightarrow \text{PbCrO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$$

 What is the total number of moles of NaCl formed when 2 moles of Na_2CrO_4 react completely?
 A) 1 mole
 B) 2 moles
 C) 3 moles
 D) 4 moles
- 16) Given the reaction:

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$$

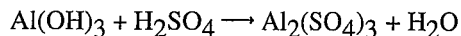
 What is the mole-to-mole ratio between nitrogen gas and hydrogen gas?
 A) 1:2
 B) 2:3
 C) 1:3
 D) 2:2

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Name: _____

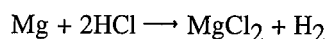
- ___ 1) A compound has an empirical formula of HCO_2 and a molecular mass of 90. grams per mole. What is the molecular formula of this compound?
- A) $\text{H}_6\text{C}_6\text{O}_{12}$ B) $\text{H}_4\text{C}_4\text{O}_8$ C) $\text{H}_2\text{C}_2\text{O}_4$ D) HCO

- ___ 2) Given the unbalanced equation:



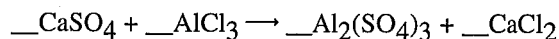
What is the coefficient in front of the H_2O when the equation is completely balanced using the *smallest* whole-number coefficients?

- A) 6 B) 4 C) 2 D) 3
- ___ 3) Given the reaction:



What is the total number of grams of Mg consumed when 0.50 mole of H_2 is produced?

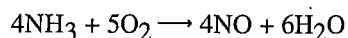
- A) 12 g B) 24 g C) 3.0 g D) 6.0 g
- ___ 4) Given the unbalanced equation:



What is the coefficient of $\text{Al}_2(\text{SO}_4)_3$ when the equation is completely balanced using the *smallest* whole-number coefficients?

- A) 2 B) 4 C) 3 D) 1
- ___ 5) Which substance has the *greatest* molecular mass?
- A) CF_4 B) H_2O_2 C) NO D) I_2
- ___ 6) In the balanced equation $\text{H}_3\text{PO}_4(\text{aq}) + \text{NH}_3(\text{aq}) \rightleftharpoons \text{X}(\text{aq}) + \text{NH}_4^+(\text{aq})$, the particle represented by $\text{X}(\text{aq})$ is
- A) $\text{HPO}_4^{2-}(\text{aq})$ B) $\text{H}_2\text{PO}_4^-(\text{aq})$ C) $\text{H}_3\text{PO}_4(\text{aq})$ D) $\text{PO}_4^{3-}(\text{aq})$

- ___ 7) Given the reaction:



What is the maximum number of moles of H_2O that can be produced when 2.0 moles of NH_3 are completely reacted?

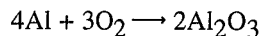
- A) 3.0 B) 2.0 C) 6.0 D) 1.0
- ___ 8) Which sample contains a total of 6.0×10^{23} atoms?
- A) 78 g K B) 24 g C C) 42 g Kr D) 23 g Na
- ___ 9) What is the gram formula mass of $\text{Mg}(\text{ClO}_3)_2$?
- A) 174 g B) 107 g C) 191 g D) 142 g
- ___ 10) Which chemical formula is *both* an empirical formula and a molecular formula?
- A) $\text{CH}_3\text{CH}_2\text{COOCH}_3$ C) CH_4
 B) CH_3COOH D) C_2H_6

- ___ 11) What is the total number of moles of hydrogen atoms contained in 1 mole of $(\text{NH}_4)_2\text{C}_2\text{O}_4$?
- A) 4 B) 6 C) 2 D) 8

___ 12) What is the total number of moles of sulfur atoms in 1 mole of $\text{Fe}_2(\text{SO}_4)_3$?

- A) 15 B) 17 C) 1 D) 3

___ 13) Given the reaction:



What is the total number of moles of aluminum oxide that can be formed when 54 grams of aluminum reacts completely with oxygen?

- A) 2.0 moles B) 4.0 moles C) 3.0 moles D) 1.0 mole

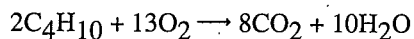
___ 14) What is the percent by mass of water present in 1.0 mole of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$?

- A) 10.% B) 12% C) 21% D) 79%

___ 15) How many grams of sodium are represented by the symbol Na?

- A) 23 g of Na B) 1.0 g of Na C) 11 g of Na D) 10. g of Na

___ 16) Given the equation:



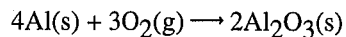
How many moles of carbon dioxide are produced for each mole of butane consumed?

- A) 4 B) 8 C) 2 D) 1

___ 17) If 11 grams of a gas occupies 5.6 liters at STP, what is its gram molecular mass?

- A) 44 g/mol B) 11 g/mol C) 22 g/mol D) 88 g/mol

___ 18) Given the reaction:



What is the minimum number of grams of oxygen gas required to produce 1.00 mole of aluminum oxide?

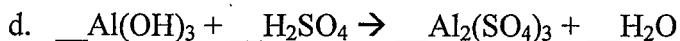
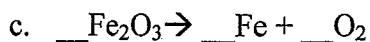
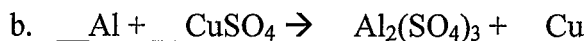
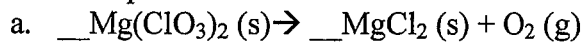
- A) 48.0 g B) 32.0 g C) 96.0 g D) 192 g

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Name _____

Math of Chemistry wkst #2

1) Balance the following reactions: Some blanks may not be filled with a number if the coefficient is equal to one.



.....

2) Determine the empirical formula for a compound with 7.30g Na, 5.08g S and 7.62g O.

3) Determine the empirical formula for a compound with 36.0g C, 8.0g O and 6.0g H.

4) Determine the empirical formula for a compound with 6.5g K, 5.9g Cl and 8.0g O.

5) TNT is made of 37.0% C, 2.20% H, 18.5% N and 42.3% O.

a. Determine the empirical formula for TNT (hint set your % equal to a 100.0g sample)

b. If the molar mass for TNT is 227g/mol, what is the molecular formula?

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6) What is the mass of 112L of Methane gas @ STP?

7) How many molecules are in a 147g sample of H_2SO_4 ?

8) What is the mass of 3.01×10^{23} molecules of methane?

9) What is the density of 75L of gas that has a mass of 50g?

10) Calculate the gram formula mass of a gas with a density of 1.33g/L

11) How many grams of potassium chlorate are necessary to produce potassium chloride and 64g of Oxygen gas?

12) What volume of Oxygen will be created with the decomposition of 81 g of water?

13) What mass of mercury is required to react with 44.8L of oxygen to form mercury(II)oxide.

45

Name _____

Molar Conversion Questions

Show all work: This includes units throughout your formulas

1) What is the mass of 3.20 moles of zinc nitrate?

2) What is the mass of 20 moles of water?

3) A bottle contains 100.0g of sodium nitrate. How many moles of sodium nitrate is this?

4) How many moles of lead sulfate are contained in a 53.1 gram sample?

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Name _____

Formula Mass: Sample questions

Directions: Show all work for the following

- 1) What is the atomic mass of 1 mole of Gold?
- 2) What is the gram formula mass of 1 mole of Nitrogen gas?
- 3) What is the gram formula mass of 1 mole of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- 4) What is the gram formula mass of 1 mole of K_2CO_3
- 5) One mole of _____ weighs 200.5g.
- 6) What is the percent compositions of 1 mole of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- 7) What is the percent compositions of 1 mole of K_2CO_3
- 8) Determine the empirical formula for a compound with 7.30g Na, 5.08g S and 7.62g O.

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PART I: Answer 1-25 on the supplied scan-tron sheet. You may write on the exam (3 points each)

1. What is the empirical formula of a compound that contains 30.4% nitrogen and 69.6% oxygen by mass?
 1. NO
 2. NO₂
 3. N₂O₃
 4. N₂O₅

2. What is the total number of molecules in a 0.5-mole sample of He gas?
 1. 6×10^{23}
 2. 2×10^{23}
 3. 3×10^{23}
 4. 4×10^{23}

3. What is the volume, in liters, of 576 grams of SO₂ gas at STP?
 1. 101
 2. 202
 3. 216
 4. 788

4. At STP, 3×10^{23} molecules of SO₂(g) occupy the same volume as
 1. 1 mole of H₂(g)
 2. 6×10^{23} molecules of H₂(g)
 3. 0.5 mole of H₂(g)
 4. 4 grams of H₂(g)

5. What is the gram formula mass of K₂CO₃?
 1. 138 g
 2. 106 g
 3. 99 g
 4. 67 g

6. What is the density of N₂ at STP?
 1. 1.00 g/L
 2. 1.25 g/L
 3. 1.43 g/L
 4. 1.98 g/L

7. A compound whose empirical formula is NO₂ could have a molecular mass of
 1. 23
 2. 39
 3. 92
 4. 120

8. A 2.00-liter sample of a gas has a mass of 1.80 grams at STP. What is the density, in grams per liter, of this gas at STP?
 1. 0.900
 2. 1.80
 3. 11.2
 4. 22.4

9. The empirical formula of a compound is CH₃. The molecular formula of this compound could be
 1. CH₄
 2. C₂H₄
 3. C₂H₆
 4. C₃H₆

10. What is the total number of neon atoms contained in 10.1 grams of neon gas?
 1. 1.01×10^{24}
 2. 2.02×10^{24}
 3. 3.01×10^{23}
 4. 6.02×10^{23}

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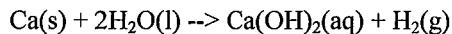
11. Given the equation shown:

What is the total number of moles of HCl(g) produced when 3 moles of H₂(g) is completely consumed?



- | | |
|------------|------------|
| 1. 5 moles | 3. 3 moles |
| 2. 2 moles | 4. 6 moles |

12. Given the reaction:



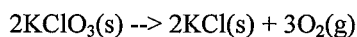
When 40.1 grams of Ca(s) reacts completely with the water, what is the total volume, at STP, of H₂(g) produced?

- | | |
|-----------|-----------|
| 1. 1.00 L | 3. 22.4 L |
| 2. 2.00 L | 4. 44.8 L |

13. What is the empirical formula of a compound that contains 85% Ag and 15% F by mass?

- | | |
|----------------------|-----------------------------------|
| 1. AgF | 3. AgF ₂ |
| 2. Ag ₂ F | 4. Ag ₂ F ₂ |

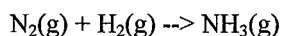
14. Given the reaction at STP:



What is the total number of liters of O₂(g) produced from the complete decomposition of 0.500 mole of KClO₃(s)?

- | | |
|-----------|-----------|
| 1. 11.2 L | 3. 44.8 L |
| 2. 16.8 L | 4. 67.2 L |

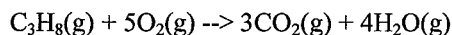
15. Given the unbalanced equation:



When the equation is balanced using smallest whole-number coefficients, the ratio of moles of hydrogen consumed to moles of ammonia produced is

- | | |
|--------|--------|
| 1. 1:3 | 3. 3:1 |
| 2. 2:3 | 4. 3:2 |

16. Given the balanced equation:



What is the total number of liters of CO₂(g) produced when 20.0 liters of O₂(g) are completely consumed?

- | | |
|-----------|-----------|
| 1. 12.0 L | 3. 3.00 L |
| 2. 22.4 L | 4. 5.00 L |

17. Given the reaction: $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$ What is the total number of moles of Ca needed to react completely with 4.0 moles of H₂O?

- | | |
|--------|---------|
| 1. 1.0 | 3. 0.50 |
| 2. 2.0 | 4. 4.0 |

18. What is the total number of atoms contained in 2.00 moles of nickel?

- | | |
|---------|--------------------------|
| 1. 58.9 | 3. 6.02×10^{23} |
| 2. 118 | 4. 1.20×10^{24} |

19. Given the reaction:



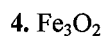
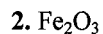
What is the total number of moles of water needed to make 2.5 moles of C₆H₁₂O₆?

- | | |
|--------|-------|
| 1. 2.5 | 3. 12 |
| 2. 6.0 | 4. 15 |

20. Which formula correctly represents the composition of iron (III) oxide?

- | | |
|---------------------|----------------------|
| 1. FeO ₃ | 3. Fe ₃ O |
|---------------------|----------------------|

(49)



21. Given the reaction: . . . (see image)

What is the ratio of moles of CO_2 produced to moles of C_2H_6 consumed?



1. 1 to 1

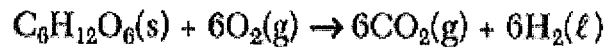
3. 3 to 2

2. 2 to 1

4. 7 to 2

22. Given the reaction: . . . (see image)

How many moles of $\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$ are needed to produce 24 moles of carbon dioxide?



1. 1.0 mole

3. 24 moles

2. 12 moles

4. 4.0 moles

23. What is the total number of moles of atoms contained in 1 mole of NH_3 ?

1. 1 mole

3. 3 moles

2. 2 moles

4. 4 moles

24. If an equation is balanced properly, both sides of the equation must have the same number of

1. atoms

3. molecules

2. coefficients

4. moles of molecules

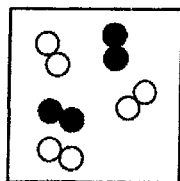
25. Which is an empirical formula?

1. P_2O_5 3. C_2H_4 2. P_4O_6 4. C_3H_6

PART II : Show all work on the paper in order to receive full credit!!! (5 points each)

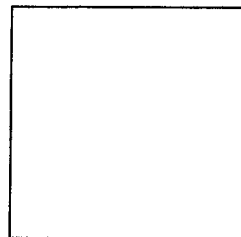
26. Given the reaction between two different elements in the gaseous state: (see image)

Box A represents a mixture of the two reactants before the reaction occurs. The product of this reaction is a gas. In Box B, draw the system after the reaction has gone to completion, based on the Law of Conservation of Matter. *Be sure to include all materials from



Box A

System Before Reaction



Box B

System after Reaction

27. Given the balanced equation: $\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$

A) What type of reaction is occurring here _____

B) At STP, what is the total number of liters of hydrogen gas produced when 3.00 moles of hydrochloric acid solution is completely consumed?

28. Given the reaction: $2\text{C}_2\text{H}_2\text{(g)} + 5\text{O}_2\text{(g)} \rightarrow 4\text{CO}_2\text{(g)} + 2\text{H}_2\text{O(g)}$

A) What type of reaction is occurring here _____

B) What is the total number of grams of $\text{O}_2\text{(g)}$ needed to react completely with 0.50 mole of $\text{C}_2\text{H}_2\text{(g)}$?

29. Will the following reactions occur? (yes or no will suffice)



30. The following reaction was carried out in the laboratory: $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$

If the product was determined to have a mass of 104g, what would the percent yield be?

51

Sweet 16 Chemistry Compound Tournament

Winner

Finals

Semifinals

Second Round

First Round

Sodium acetate

Potassium thiocyanate

Potassium carbonate

Zinc chloride

Ammonium sulfate

Potassium permanganate

Calcium hypochlorite

Potassium ferricyanide

Mercury(I) sulfate

Titanium dioxide

Iron(III) sulfate

Sodium chlorate

Copper(I) chloride

Sodium chromate

Calcium hydroxide

Potassium phosphate

Rules

1. First Round — Write formula, most number of atoms in formula unit wins
2. Second Round — Greater number of ions in the formula unit wins
3. Semis — Higher charge on anion wins
4. Finals — The larger molar mass wins

52

NOTE: Be sure you actually do study this year...Each night, put some time in and you will see the exponential growth of your knowledge that will help you on upcoming exams in this class.

Math of Chemistry/Stoichiometry can be a tough unit so you need to be diligent in your work and efforts. Stay after 10th period if you need help with any of the formulas or questions and concepts we discuss in this unit.

Math of Chemistry/Stoichiometry

Mr. Gardner