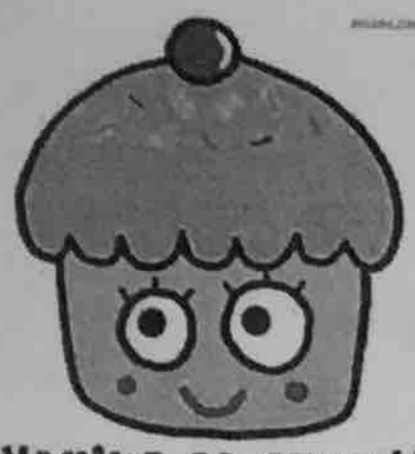
Name Key Date 2018-19 Period ____



Super Chemists' Unit 5 Sweet Sheet

Unit 5 Test will cover the following topics:

1. Finding Molar and Molecular Mass
2. Stoichiometry
3. Balancing and Writing Chemical Equations
4. Empirical and Molecular Formulas
5. Percent Composition

Review Questions

Part A: True or False

State whether the statement is True or False. If False, correct the statement.

1. If the empirical formula of a compound is known, then the compound's true formula is also known.

False, we need the molar - mass

2. If the empirical formula of a compound is known, then the arrangement of the compound's atoms are known.

False, we only know how many of each atom

3. If the empirical formula of a compound is known, then the compound's percent composition can be calculated.

True

4. If the empirical formula of a compound is known, then the molecular mass of the compound can be determined.

False, we can determine the empirical molar mass

5. According to the law of conservation of mass, the total mass of the products must be more than the total mass of the reactants.

False, they should all equal the same mass

6. To balance a chemical equation, you may adjust the subscripts.

False - only adjust the coefficients

7. To balance a chemical equation, you may adjust the formulas of the products or reactants.

False, coefficients only

8. To balance a chemical equation, you may adjust the coefficients.

True

9. The molecular formula for a compound can be calculated if one knows the empirical formula and the molar mass of the compound.

True

Part B: Empirical and Molecular Formulas

1. Find the empirical formula of a compound, given that the compound is found to be 47.9% zinc and 52.1% chlorine by mass.

$\frac{47.9\text{g Zn}}{}\left|\frac{1\text{mol Zn}}{65.3\text{g Zn}}\right. = .7335 \quad \frac{.7335}{.7335} = 1$

$\frac{52.1\text{g Cl}}{}\left|\frac{1\text{mol Cl}}{35.5\text{g Cl}}\right. = 1.47 \quad \frac{1.47}{.7335} = 2$

1 Zn

2 Cl

$ZnCl_2$

2. Find the empirical formula of a compound, given that a 48.5g sample of the compound contains 1.75g of carbon and 46.75g of Bromine.

$\frac{1.75\text{g C}}{}\left|\frac{1\text{mol C}}{12\text{g C}}\right. = .1458 \quad \frac{.1458}{.1458} = 1$

$\frac{46.75\text{g}}{}\left|\frac{1\text{mol Br}}{80\text{g Br}}\right. = .584 \quad \frac{.584}{.1458} = 4$

CBr_4

3. Find the molecular formula of a compound that contains 42.56g of palladium and 0.80g of hydrogen. The molar mass of the compound is 216.8 g/mol.

$\frac{42.56\text{g Pd}}{}\left|\frac{1\text{mol Pd}}{106\text{g Pd}}\right. = .4015 \quad \frac{.4015}{.4015} = 1$

$\frac{0.80\text{g H}}{}\left|\frac{1\text{mol H}}{1\text{g H}}\right. = .80 \quad \frac{.80}{.4015} = 2$

Pd = 106

H = 2

PdH_2

Empirical molar mass = 108g

$\frac{216.8}{108} = 2$

2

Pd_2H_4

4. Ninhydrin is a compound that reacts with amino acids and proteins to produce a dark-colored complex. It is used by forensic chemists and detectives to see fingerprints that might other wise be invisible. Ninhydrin's composition is 60.08% carbon, 3.40% hydrogen, and 35.92% oxygen. What is the empirical formula? If Ninhydrin's molar mass is 178 g/mol, what is the molecular formula?

$$\frac{60.08\text{g C}}{} \left| \frac{1\text{mol C}}{12\text{g C}} \right. = \frac{5.01}{2.245} = 2.23 \cdot 4 = 9\text{C}$$

$$\frac{3.40\text{g H}}{} \left| \frac{1\text{mol H}}{1\text{g H}} \right. = \frac{3.4\text{ mol}}{2.245} = 1.51 \cdot 4 = 6\text{H}$$

$$\frac{35.92\text{g O}}{} \left| \frac{1\text{mol O}}{16\text{g O}} \right. = \frac{2.245}{2.245} = 1 \cdot 4 = 4\text{O}$$

$\boxed{C_9H_6O_4}$

C 9.12 = 108
6H 6
4O 64
178g ✓

Part C: Stoichiometry

Complete the following stoichiometric calculations, balancing equations where necessary.

1. Consider the combustion of octane (C_8H_{18}):

16
9
1
25

$$\underline{2}\ C_8H_{18} + \underline{25}\ O_2 \rightarrow \underline{16}\ CO_2 + \underline{18}\ H_2O$$

a. How many grams of CO_2 are produced when 191.6 g of octane are burned?

$$\frac{191.6\text{g } C_8H_{18}}{} \left| \frac{1\text{mol } C_8H_{18}}{114\text{g } C_8H_{18}} \right. \left| \frac{16\text{mol } CO_2}{2\text{mol } C_8H_{18}} \right. \left| \frac{44\text{g } CO_2}{1\text{mol } CO_2} \right. = 591.6\text{g } CO_2$$

b. How many grams of oxygen gas are required to burn 47.03 g of octane?

$$\frac{47.03\text{g } C_8H_{18}}{} \left| \frac{1\text{mol } C_8H_{18}}{114\text{g } C_8H_{18}} \right. \left| \frac{25\text{mol } O_2}{2\text{mol } C_8H_{18}} \right. \left| \frac{32\text{g } O_2}{1\text{mol } O_2} \right. = 165.0\text{ g } O_2$$

c. How many grams of H_2O are produced when 91.2 g oxygen gas are consumed?

$$\frac{91.2\text{ g } O_2}{32\text{ g } O_2} \left| \frac{1\text{ mol } O_2}{25\text{ mol } O_2} \right| \frac{18\text{ mol } H_2O}{1\text{ mol } H_2O} \left| \frac{18\text{ g } H_2O}{1\text{ mol } H_2O} \right| = 36.9\text{ g } H_2O$$

d. How many liters of CO_2 are produced at STP when the reaction yields 5.05 g of H_2O?

$$\frac{5.05\text{ g } H_2O}{18\text{ g } H_2O} \left| \frac{1\text{ mol } H_2O}{8\text{ mol } H_2O} \right| \frac{16\text{ mol } CO_2}{1\text{ mol } CO_2} \left| \frac{22.4\text{ L of } CO_2}{1\text{ mol } CO_2} \right| = 5.59\text{ L of } CO_2$$

2. When aluminum reacts with hydrogen bromide, aluminum bromide and hydrogen gas are produced.

a. Write and balance the chemical equation.

$$2Al + 6HBr \rightarrow 2AlBr_3 + 3H_2$$

b. When 3.22 moles of Al react with excess moles of HBr, how many moles of hydrogen gas are formed?

$$\frac{3.22 \cancel{\text{ mol Al}}}{2 \cancel{\text{ mol Al}}} \left| \frac{3\text{ mol } H_2}{2 \cancel{\text{ mol Al}}} \right| = 4.83\text{ mol } H_2$$

c. If 8.2 L of hydrogen gas (STP) are produced, how many grams of hydrogen bromide were reacted?

$$\frac{8.2 \cancel{\text{ L } H_2}}{22.4 \cancel{\text{ L } H_2}} \left| \frac{1 \cancel{\text{ mol } H_2}}{3 \cancel{\text{ mol } H_2}} \right| \frac{6 \cancel{\text{ mol HBr}}}{1 \cancel{\text{ mol HBr}}} \left| \frac{81\text{ g HBr}}{1 \cancel{\text{ mol HBr}}} \right| = 59.3\text{ g HBr}$$

d. If 8.02×10^{28} molecules of aluminum bromide are produced, how many moles of aluminum were reacted?

$$\frac{8.02\times10^{28}\ \text{mc of } AlBr_3}{6.02\times10^{23}\ \text{mc } AlBr_3} \times \frac{1\ \text{mol } AlBr_3}{1} \times \frac{2\ \text{mol Al}}{2\ \text{mol } AlBr_3} = 1.33\times10^{5}\ \text{mol Al}$$

e. If 4.59 grams of aluminum are reacted, how many liters (STP) of hydrogen gas are produced?

$$\frac{4.59\ g\ Al}{27\ g\ Al} \times \frac{1\ \text{mol Al}}{1} \times \frac{3\ \text{mol } H_2}{2\ \text{mol Al}} \times \frac{22.4\ L\ \text{of } H_2}{1\ \text{mol } H_2} = 5.71\ L\ \text{of } H_2$$

3. When copper (II) chloride and potassium iodide react, copper (I) iodide, potassium chloride and iodine gas are produced.

a. Write and balance the chemical equation.

$$2CuCl_2 + 4KI \rightarrow 2CuI + 4KCl + I_2$$

* b. If 0.56 moles of copper (II) chloride reacts with unlimited potassium iodide, how many moles of potassium chloride are produced?

$$\frac{0.56\ \text{mol } CuCl_2}{2\ \text{mol } CuCl_2} \times \frac{4\ \text{mol KCl}}{1} = 1.12\ \text{mol KCl}$$

c. If 3.56 L of iodine gas (STP) are produced, how many grams of copper (I) iodide were also produced?

$$\frac{3.56\ L\ \text{of } I_2}{22.4\ L\ I_2} \times \frac{1\ \text{mol } I_2}{1} \times \frac{2\ \text{mol CuI}}{1\ \text{mol } I_2} \times \frac{190.5\ g\ CuI}{1\ \text{mol CuI}} =$$

$$60.6\ g\ CuI$$

d. If 19.7 g of potassium iodide are used up, how many grams of iodine gas were produced? STP

$$\frac{19.7\text{ g KI}}{166\text{ g KI}} \left| \frac{1\text{ mol KI}}{4\text{ mol KI}} \right| \frac{1\text{ mol } I_2}{1\text{ mol } I_2} \left| \frac{254\text{ g } I_2}{1\text{ mol } I_2} = 7.54\text{ g } I_2 \right.$$

4. Sulfuric acid and sodium hydroxide react together to form sodium sulfate and water.

a. Write and balance the chemical reaction.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

* b. If 3.7 moles of sulfuric acid react, how many grams of water will be produced?

$$\frac{3.7\text{ mol } H_2SO_4}{1\text{ mol } H_2SO_4} \left| \frac{2\text{ mol } H_2O}{1\text{ mol } H_2SO_4} \right| \frac{18\text{ g } H_2O}{1\text{ mol } H_2O} = 133.2\text{ g } H_2O$$

c. If 9.4 grams of sodium sulfate are produced, how many moles of sodium hydroxide were reacted?

$$\frac{9.4\text{ g } Na_2SO_4}{142\text{ g } Na_2SO_4} \left| \frac{1\text{ mol } Na_2SO_4}{1\text{ mol } Na_2SO_4} \right| \frac{2\text{ mol NaOH}}{1\text{ mol } Na_2SO_4} = .1324\text{ mol NaOH}$$

5. Tin (IV) phosphate reacts with sodium carbonate to make tin (IV) carbonate and sodium phosphate.

a. Write and balance the chemical reaction.

$$Sn_3(PO_4)_4 + 6\,Na_2CO_3 \rightarrow 3\,Sn(CO_3)_2 + 4\,Na_3PO_4$$

b. If 36 grams of tin (IV) phosphate is mixed with excess of sodium carbonate, how many grams of tin (IV) carbonate will form?

$$\frac{36\text{ g } Sn_3(PO_4)_4}{737\text{ g } Sn_3(PO_4)_4} \left| \frac{1\text{ mol } Sn_3(PO_4)_4}{1\text{ mol } Sn_3(PO_4)_4} \right| \frac{3\text{ mol } Sn(CO_3)_2}{1\text{ mol } Sn(CO_3)_2} \left| \frac{239\text{ g } Sn(CO_3)_2}{1\text{ mol } Sn(CO_3)_2} = \right.$$

$$\boxed{35.0\text{ g } Sn(CO_3)_2}$$

3 Sn 357
4 P 124
+ 160 + 256
737 g

Part D: Percent Composition

Find the percent composition of all the elements in the following compounds.

1. $CuBr_2$ Cu 64
2Br 160
224g

Cu = 64/224 = 28.57% Br = 160/224 = 71.43%

2. NaOH Na 23
O 16
H + 1
40 g

Na 23/40 = 57.5% O = 16/40 = 40% H = 1/40 = 2.5%

3. $(NH_4)_3PO_4$ 3N 42
12H 12
1P 31
4O + 64
149g

N = 42/149 = 28.2% H = 12/149 = 8.05%
P = 31/149 = 20.8% O = 64/149 = 42.95%

4. PbO_2 Pb 207
2O + 32
239g

Pb 207/239 = 86.6% O = 32/239 = 13.4%

5. H_2SO_4 2H 2
S 32
4O + 64
98g

H = 2/98 = 2.04% S = 32/98 = 32.65%
O = 64/98 = 65.31%

Balancing Chemical Equations

Balance the equations below:

1) 1 N_2 + 3 H_2 → 2 NH_3

2) 2 $KClO_3$ → 2 KCl + 3 O_2

3) 2 NaCl + 1 F_2 → 2 NaF + 1 Cl_2

4) 2 H_2 + 1 O_2 → 2 H_2O

5) 1 $Pb(OH)_2$ + 2 HCl → 2 H_2O + 1 $PbCl_2$

6) 2 $AlBr_3$ + 3 K_2SO_4 → 6 KBr + 1 $Al_2(SO_4)_3$

7) 1 CH_4 + 2 O_2 → 1 CO_2 + 2 H_2O

8) 1 C_3H_8 + 5 O_2 → 3 CO_2 + 4 H_2O

9) 2 C_8H_{18} + 25 O_2 → 16 CO_2 + 18 H_2O

10) 1 $FeCl_3$ + 3 NaOH → 1 $Fe(OH)_3$ + 3 NaCl

11) 4 P + 5 O_2 → 2 P_2O_5

12) 2 Na + 2 H_2O → 2 NaOH + 1 H_2

13) 2 Ag_2O → 4 Ag + 1 O_2

14) 1 S_8 + 12 O_2 → 8 SO_3

15) 6 CO_2 + 6 H_2O → 1 $C_6H_{12}O_6$ + 6 O_2

16) 1 K + 1 MgBr → 1 KBr + 1 Mg

17) 2 HCl + 1 $CaCO_3$ → 1 $CaCl_2$ + 1 H_2O + 1 CO_2

18) 1 HNO_3 + 1 $NaHCO_3$ → 1 $NaNO_3$ + 1 H_2O + 1 CO_2

19) 2 H_2O + 1 O_2 → 2 H_2O_2

20) 2 NaBr + 1 CaF_2 → 2 NaF + 1 $CaBr_2$

21) 1 H_2SO_4 + 2 $NaNO_2$ → 2 HNO_2 + 1 Na_2SO_4