Name _____Mr. Perfect_____ Date ___F09_____

1. Calculate the molarity and osmolarity of a solution containing 6.8 g of sodium phosphate dissolved into 4.3 L of water. (5 pts)

$$Molarity = \frac{6.8g \times \frac{mol}{164g}}{4.3\ L} = 9.64\ x\ 10^{-3}\ M$$

$Na_3PO_4 = 3Na^+ + PO_4^{-3}$ = 4 particles

$$Osmolarity = 4\ x\ 9.64x10^{-3} = 0.0386\ osmol$$

2. Fill in the missing information in the following table: (12 pts)

Symbol	Protons	Neutrons	Electrons	Charge
$^{39}K^+$	19	20	18	+1
$^{16}O^{2-}$	8	8	10	-2
^{20}Ne	10	10	10	0
$^{56}Fe^{n+}$	26	30	23	+3

3. Name the following compounds: (8 pts)

a. Cu_2CO_3 b. KI

Copper(I) Carbonate Potassium Iodide

c. MgO d. $CrCl_3$

Magnesium Oxide Chromium(III) Chloride

4. An element has three naturally occurring isotopes with the following masses and abundances:

Isotopic Mass (amu)	Fractional Abundance
38.964	0.9326
39.964	0.0001
40.962	0.0673

What is the atomic weight of this element? (6pts)

Atomic Weight = (38.964)(0.9326) + (39.964)(0.0001) + (40.962)(0.0673) = 39.10 Amu

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5. Write the Lewis dot structures for each of the following elements. (9pts)

a. N b. B c. C

Soluble	Except	Insoluble	Except
Na^+, K^+, Li^+, NH_4^+	None	CO_3^{2-}	Group 1A, NH_4^+
NO_3^-	None	PO_4^{3-}	Group 1A, NH_4^+
Cl^-, Br^-, I^-	Ag^+, Pb^{2+}	S^{2-}	Group 1A, NH_4^+
SO_4^{2-}	Ca^{2+}, Ag^+, Pb^{2+}, Ba^{2+}	OH^-	Group 1A, Ca^{2+}

6. Write the balance molecular equation, complete ionic equation, and net ionic equation for each of the following aqueous metathesis reactions. If no reaction occurs, just write NR after the arrow: (18 pts)

Molecular

a. $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$

Complete Ionic

$Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2Na^+_{(aq)} + SO_4^{-2} \rightarrow BaSO_{4(s)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$

Net Ionic

$Ba^{2+}_{(aq)} + SO_4^{-2} \rightarrow BaSO_{4(s)}$

Molecular

b. $Pb(NO_3)_{2(aq)} + 2KCl_{(aq)} \rightarrow PbCl_{2(s)} + 2KNO_{3(aq)}$

Complete Ionic

$Pb^{+2}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)} + 2K^+_{(aq)} + NO_3^-{}_{(aq)}$

Net Ionic

$Pb^{+2}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2(s)}$

Molecular

c. $3AgNO_{3(aq)} + Na_3PO_{4(aq)} \rightarrow Ag_3PO_{4(s)} + 3NaNO_{3(aq)}$

Complete Ionic

$3Ag^+_{(aq)} + 3NO_3^-{}_{(aq)} + 3Na^+_{(aq)} + PO_4^{-3}{}_{(aq)} \rightarrow Ag_3PO_{4(s)} + 3Na^+_{(aq)} + 3NO_3^-{}_{(aq)}$

Net Ionic

$3Ag^+_{(aq)} + PO_4^{-3}{}_{(aq)} \rightarrow Ag_3PO_{4(s)}$

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7. Urea, $(NH_2)_2CO$, is prepared by reacting ammonia with carbon dioxide:

$$2NH_{3(g)} + CO_{2(g)} \rightarrow (NH_2)_2CO_{(aq)} + H_2O_{(l)}$$
17g/mol 44g/mol 60g/mol 18g/mol

If 637.2 g of NH_3 are treated with 1142 g of CO_2, which is the limiting reagent? How many grams of urea will be produced? How many grams of the excess reagent will be left over? (12pts)

$$637.2\ g\ NH_3 \times \frac{mol}{17g} \times \frac{1\ mol\ urea}{2\ mol\ NH_3} = 18.74\ mol\ urea$$

$$1142\ g\ CO_2 \times \frac{mol}{44g} \times \frac{1\ mol\ urea}{1\ mol\ CO_2} = 25.95\ mol\ urea$$

NH_3 is the limiting reagent.

$$18.74\ mol\ urea \times \frac{60g}{mol} = 1124.4\ g\ urea$$

CO_2 is in excess.

25.95 mol – 18.74 mol = 7.21 mol of CO_2 in excess

$$7.21\ mol\ CO_2 \times \frac{44g}{mol} = 317.2\ g\ CO_2\ left\ over$$

8. Caffeine, a stimulate found in coffee, tea, and chocolate, contains 49.48% carbon, 5.15% hydrogen, 28.87% nitrogen, and 16.49% oxygen by mass and has a molar mass of 194 g/mol. Determine the empirical and molecular formula of caffeine. (10 pts)

Assume a 100 g sample.

$$49.48\ g\ C \times \frac{mol}{12.01g} = 4.12\ mol\ \div 1.03\ mol = 4$$

$$5.15\ g\ H\ \times \frac{mol}{1.01g} = 5.10\ mol\ \div 1.03\ mol = 5$$

$$28.87\ g\ N\ \times \frac{mol}{14.01g} = 2.06\ mol\ \div 1.03\ mol = 2$$

$$16.49\ g\ O\ \times \frac{mol}{15.99g} = 1.03\ mol\ \div 1.03 = 1$$

Empirical Formula

$C_4H_5N_2O$ 97g/mol

$$\frac{molecular\ mass}{empirical\ mass} = \frac{194}{94} = 2$$

Molecular Formula

$C_8H_{10}N_4O_2$

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9. Aluminum burns in bromine, producing aluminum bromide:

$$2Al_{(s)} + 3Br_{2(l)} \rightarrow 2AlBr_{3(s)}$$

When 10.0 g of aluminum was reacted with an excess of bromine, 79.8 g of aluminum bromide was isolated. Calculate the theoretical yield and the percent yield of this reaction. (10pts)

Theoretical Yield

$$10.0\ g \times \frac{mol}{27g} \times \frac{2\ mol\ AlBr_3}{2\ mol\ Al} \times \frac{267g}{mol} = 98.9\ g\ AlBr_3$$

$$\%\ Yield = \frac{actual}{theoretical} \times 100 = \frac{79.8g}{98.9g} \times 100 = 80.7\ \%$$

10. A 25.0 mL sample of sulfuric acid, H_2SO_4, required 43.25 mL of a 0.198 M NaOH solution for neutralization. What is the concentration of the sulfuric acid solution? Write out the balance molecular equation for this reaction. (10 pts)

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

Diprotic acid

$$M_a = \frac{M_b V_b}{2V_a} = \frac{(0.198M)(43.25mL)}{2(25.0ML)} = 0.171\ M\ sulfuric\ acid$$

11. Extra Credit. Hydrogen has two stable isotopes, ^1H and ^2H, and sulfur has four stable isotopes, ^{32}S, ^{33}S, ^{34}S, and ^{36}S. How many peaks would you observe in the mass spectrum of the positive ion of hydrogen sulfide, H_2S^+? *Assume no decomposition of the ion into smaller fragments*. (5 pts)

For	Possible Masses							
$^1H^1H$	34	35	36	__	38			
$^2H^2H$			36	37	38	__	40	
$^1H^2H$		35	36	37	__	39		
	1	2	3	4	5	6	7	7 peaks