Items you may bring: One page, double-sided, of notes and a non-programmable, non-graphin calculator.

I. KEY VOCABULARY

pts. 1. What is the name given to the quantitative relationships between the compounds in a chemica reaction? Stoichiometry

pt each 2. What is the SI unit for mass? kg temperature? kelvin quantity? mole electric current? a

1 pt 3. What is the numerical value of Avogadro's number?

6.02×10^{23}

2 pts. 4. What is the difference between molarity and molality?

Molarity = $\frac{\text{moles of solute}}{\text{liters of solution}}$ Molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

1 pt. 5. What is the name of a reactant in a chemical equation that is completely consumed and stops the reaction? Limiting reactant or limiting reagent

II. STOICHIOMETRY

i. Balance the following equations:

3 pts 1. $2\ H_{2(g)} + 1\ O_{2(g)} \rightarrow 2\ H_2O_{(l)}$

4 pts 2. $2\ HCl_{(aq)} + 1\ Ba(OH)_{2(aq)} \rightarrow 2\ H_2O_{(l)} + 1\ BaCl_{2(aq)}$

5 pts 3. $2\ HC_2H_3O_{2(aq)} + 1\ Na_2CO_{3(aq)} \rightarrow 1\ H_2O_{(l)} + 1\ CO_{2(g)} + 2\ NaC_2H_3O_{2(aq)}$

3 pts 4. $1\ P_2O_{5(s)} + 3\ H_2O_{(l)} \rightarrow 2\ H_3PO_{4(aq)}$

4 pts 5. $2\ CuS_{(s)} + 3\ O_{2(g)} \rightarrow 2\ CuO_{(s)} + 2\ SO_{2(g)}$

ii. Solve the following problems:

2 pts 1. Copper (II) Oxide will decompose when it is heated strongly.

$4CuO_{(s)} \rightarrow 2Cu_2O_{(s)} + O_{2(g)}$

How many grams of oxygen can be obtained from 2.64 g $CuO_{(s)}$?

$\text{CuO} \times \frac{1\text{ mol CuO}}{79.55\text{ g CuO}} \times \frac{1\text{ mol O}_2}{4\text{ mol CuO}} \times \frac{32\text{ g}}{1\text{ mol O}_2}$

5 pts. 2. Barium Hydroxide will react with phosphoric acid in an acid-base reaction. Predict the products, then identify how many grams of each product is produced if 1.00 mol of barium hydroxide is reacted in an excess of phosphoric acid.

$3Ba(OH)_2(aq) + 2H_3PO_4(aq) \rightarrow 6H_2O(l) + Ba_3(PO_4)_2(s)$

$1.00\text{ mol } Ba(OH)_2 \times \frac{6\text{ mol } H_2O}{3\text{ mol } Ba(OH)_2} \times \frac{18.016\text{ g } H_2O}{1\text{ mol } H_2O} = \boxed{36.0\text{ g } H_2O}$

$1.00\text{ mol } Ba(OH)_2 \times \frac{1\text{ mol } Ba_3(PO_4)_2}{3\text{ mol } Ba(OH)_2} \times \frac{601.928\text{ g } Ba_3(PO_4)_2}{1\text{ mol } Ba_3(PO_4)_2} = \boxed{201\text{ g } Ba_3(PO_4)_2}$

2 pts. → TIC TAC TOE CHECK #5

3. How many milliliters of 0.240 M MnO_4^- solution will be needed to titrate a 1.56 g sample of pure $Fe(NO_3)_2$?

$1.56\text{ g } Fe(NO_3)_2 \times \frac{1\text{ mol } Fe(NO_3)_2}{180\text{ g } Fe(NO_3)_2} \times \frac{1\text{ mol } Fe^{2+}}{1\text{ mol } Fe(NO_3)_2} \times \frac{1\text{ mol } MnO_4^-}{5\text{ mol } Fe^{2+}} \times \frac{1000\text{ mL } MnO_4^-}{0.240\text{ mol } MnO_4^-}$

$= \boxed{17.22\text{ mL } MnO_4^-}$

4 pts. 4. What is the percentage of Fe, O, H, and OH^- polyatomic ion in $Fe(OH)_3$?

Fe: $100\text{ g } Fe(OH)_3 \times \frac{1\text{ mol } Fe(OH)_3}{106.8\text{ g } Fe(OH)_3} \times \frac{1\text{ mol Fe}}{1\text{ mol } Fe(OH)_3} \times \frac{55.8\text{ g Fe}}{1\text{ mol Fe}} = 52.2\text{ g Fe}$ $\quad \frac{52.2\text{ g Fe}}{100\text{ g } Fe(OH)_3} \times 100 = \boxed{52.2\%\text{ Fe}}$

O: $100\text{ g } Fe(OH)_3 \times \frac{1\text{ mol } Fe(OH)_3}{106.8\text{ g } Fe(OH)_3} \times \frac{3\text{ mol O}}{1\text{ mol } Fe(OH)_3} \times \frac{16\text{ g O}}{1\text{ mol O}} = 44.9\text{ g O}$ $\quad \frac{44.9\text{ g O}}{100\text{ g } Fe(OH)_3} \times 100 = \boxed{44.9\%\text{ O}}$

H: $100\text{ g } Fe(OH)_3 \times \frac{1\text{ mol } Fe(OH)_3}{106.8\text{ g } Fe(OH)_3} \times \frac{3\text{ mol H}}{1\text{ mol } Fe(OH)_3} \times \frac{1.0\text{ g H}}{1\text{ mol H}} = 2.8\text{ g H}$ $\quad \frac{2.8\text{ g H}}{100\text{ g } Fe(OH)_3} \times 100 = \boxed{2.8\%\text{ H}}$

OH^-: $100\text{ g } Fe(OH)_3 \times \frac{1\text{ mol } Fe(OH)_3}{106.8\text{ g } Fe(OH)_3} \times \frac{3\text{ mol } OH^-}{1\text{ mol } Fe(OH)_3} \times \frac{17.0\text{ g } OH^-}{1\text{ mol } OH^-} = 47.8\text{ g } OH^-$

$\frac{47.8\text{ g } OH^-}{100\text{ g } Fe(OH)_3} \times 100 = \boxed{47.8\%\ OH^-}$

pts. 5. What is the empirical formula of a compound that contains 4.0 g of calcium and 7.1 g of chlorine?

$1\,Ca \times \frac{1\,mol\,Ca}{40.0\,g\,Ca} = 0.10\,mol\,Ca$

$1.1\,g\,Cl \times \frac{1\,mol\,Cl}{35.5\,g\,Cl} = 0.20\,mol\,Cl$

$\frac{0.10\,mol\,Ca}{0.10} = 1\,mol\,Ca$ $\Rightarrow$ $CaCl_2$

$\frac{0.20\,mol\,Cl}{0.10} = 2\,mol\,Cl$

1 pt each

III. NOMENCLATURE

Chemical Name	Chemical Formula
Bromate	BrO_3^-
Periodate	IO_4^-
Peroxide	O_2^{2-}
Thiosulfate	$S_2O_3^{2-}$
Dichromate	$Cr_2O_7^{2-}$
Permanganate	MnO_4^-
Cyanide	CN^-
Chlorate	ClO_3^-
Nitrate	NO_3^-
Bicarbonate	HCO_3^-
Acetate	CH_3COO^-
Hydroxide	OH^-
Thiocyanate	SCN^-
Phosphite	PO_3^{3-}
Hypoiodite	IO^-
Bromous Acid	$HBrO_2$
Carbonic Acid	H_2CO_3
Hydrosulfuric Acid	H_2S
Hydrofluoric Acid	HF
Iodous Acid	HIO_2
Nitric Acid	HNO_3
Copper (II) Oxide	CuO
Tetraphosphorus Decoxide	P_4O_{10}
Magnesium Chloride	$MgCl_2$

IV. CHEMICAL REACTIONS

Cancel out spectator ions if applicable

2 pts 1. A bar of zinc metal is immersed in a solution of copper(II) sulfate.

$Zn_{(s)} + CuSO_{4(aq)} \rightarrow Cu_{(s)} + ZnSO_{4(aq)}$

2 pts 2. A small piece of sodium metal is added to distilled water.

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

2 pts 3. Solutions of sodium iodide and lead(II) nitrate are combined.

$2NaI_{(aq)} + Pb(NO_3)_{2(aq)} \rightarrow 2NaNO_{3(aq)} + PbI_{2(s)}$

2 pts 4. Dilute hydrochloric acid is added to a solution of potassium carbonate.

$2H^+_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow H_2O_{(l)} + CO_{2(g)}$

2 pts 5. A piece of solid bismuth is heated strongly in oxygen.

$4Bi_{(s)} + 3O_{2(g)} \rightarrow 2Bi_2O_{3(s)}$

2 pts 6. A piece of aluminum metal is added to a solution of silver nitrate.

$Al_{(s)} + 3Ag^+_{(aq)} \rightarrow Al^{3+}_{(aq)} + 3Ag_{(s)}$

2 pts 7. Liquid bromine is shaken with a sodium iodide solution.

$Br_{2(l)} + 2I^-_{(aq)} \rightarrow 2Br^-_{(aq)} + I_{2(aq)}$

2 pts 8. Gaseous hydrofluoric acid reacts with solid silicon dioxide.

$4HF_{(g)} + SiO_{2(s)} \rightarrow SiF_{4(g)} + 2H_2O_{(l)}$

2 pts 9. Solutions of cobalt(II) nitrate and sodium hydroxide are mixed.

$Co^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Co(OH)_{2(s)}$

2 pts 10. Aqueous ammonia is added to solid zinc hydroxide. → Tie breaker!

$4NH_{3(aq)} + Zn(OH)_{2(s)} \rightarrow [Zn(NH_3)_4]^{2+}_{(aq)} + 2OH^-_{(aq)}$

2 pts 11. A saturated solution of barium hydroxide is mixed with a solution of iron(III) sulfate. → Tie Breaker #2

$3Ba^{2+}_{(aq)} + 2OH^-_{(aq)} + 2Fe^{3+}_{(aq)} + 3SO_4^{2-}{}_{(aq)} \rightarrow 2Fe(OH)_{3(s)} + 3BaSO_{4(s)}$

2 pts 12. Gaseous diborane, B_2H_6, is burned in oxygen.

$B_2H_{6(g)} + 3O_{2(g)} \rightarrow B_2O_{3(s)} + 3H_2O_{(l)}$