NAME: ANSWERS DATE DUE: ____________

TEACHER: ______________________

Year 11 Term 1 – Chemistry

HOMEWORK SHEET No. 4 – Atomic Structure and Isotopes

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/1	**1.** How many moles are in 3.4 x 10^{23} molecules of H_2SO_4? $n = \frac{\text{no. of particles}}{A_n} = \frac{3.4 \times 10^{23}}{6.02 \times 10^{23}} \doteq \underline{0.56 \text{ moles}}$
/2	**2.** How many molecules are in 25.0 grams of NH_3? $n = \frac{m}{MM} = \frac{25g}{17g/mole} = 1.47 \text{moles}$ no of particles $= n \times A_n = 1.47 \times 6. = \underline{8.85 \times 10^{23} \text{ molecules}}$
/2	**3.** How many grams are in 8.200 x 10^{22} molecules of N_2I_6? $n = \frac{\text{no. of particles}}{A_n} = \frac{8.2 \times 10^{22}}{6.02 \times 10^{23}} = 0.136 \text{ moles}$ $m = n \times MM = 0.136 \times 789.4 = 107.4 g.$
/2	**4.** What's the empirical formula of a molecule containing 18.7% lithium, 16.3% carbon, and 65.0% oxygen? assuming 100g = 18.7g Li, 16.3g C, 65g O $n(Li) = \frac{m}{MM} = \frac{18.7g}{6.94 g/mol} = 2.7 \text{moles}$ Li $n(C) = \frac{m}{MM} = \frac{16.3g}{12g/mole} = 1.36 \text{ moles}$ C $n(O) = \frac{m}{MM} = \frac{65g}{16g/mole} = 4.06$ O $Li_{2.7} C_{1.36} O_{4.06}$ ÷ subscripts by lowest value (1.36) $\underline{Li_2 C_1 O_3}$
/1	**5.** If the molar mass of the compound in question 4 is 73.8 grams/mole, what's the molecular formula? Empirical formula = Li_2CO_3 $M.M = 2 \times 6.94 + 12 + 3 \times 16 = 73.88g.$ is approx equal to MM of the compound therefore molecular formula is the same as the empirical formula $\underline{Li_2CO_3}$

/3	**6.**** Aniline, a starting material for urethane plastic foams, consists of C, H, and N. Combustion of such compounds yields: CO_2, H_2O, and N_2 as products. If the combustion of 9.71g of aniline yields 6.63 g H_2O and 1.46g N_2, what is it's empirical formula? $C_xH_yN_z + O_2 \rightarrow CO_2 + H_2O + N_2$ 6.63g 1.46g step 1 $n(N_2) = \frac{m}{MM} = \frac{1.46g}{28g/mole} = 0.052$ moles N_2 or 0.104 moles N $z = 0.104$ step 2 $n(H_2O = \frac{m}{MM} = \frac{6.63g}{18g/mole} = 0.368$ moles $= 0.74$ moles H_2, $y = 0.74$ step 3 mass of C = 9.71 − 1.46 − 0.74 = 7.5 g. moles of C = $\frac{7.5}{12} = 0.63$ $x = 0.63$ STEP 4 $C_{0.63}H_{0.74}N_{0.104}$ C_6H_7N
/2 /2	**7.** The reaction of aluminium and iron(III) oxide gives off a great deal of heat and light: $2\ Al_{(s)} + Fe_2O_{3(s)} \rightarrow 2\ Fe_{(s)} + Al_2O_{3(s)}$ **a.** What mass of $Fe_2O_3(s)$ is required to react completely with 1.0 kg of Al(*s*) **b.** What mass of Fe(*s*) will be produced based on the quantities in a)? a) $2\ Al + Fe_2O_3 \rightarrow 2\ Fe + Al_2O_3$ 1000g ?g. $n = \frac{m}{MM} = \frac{1000}{27} = 37.04$ 2:1 n(Al) n(Fe_2O_3) 37.04 : ? 18.5 moles Fe_2O_3 $m = n \times MM = 18.5 \times 159.7 = 2954g$. b) $2\ Al + Fe_2O_3 \rightarrow 2\ Fe + Al_2O_3$ 1000g ?g $n = \frac{m}{MM} = \frac{1000}{27} = 37.04$ moles n(Al) 2:2 n(Fe) 37.04 moles of Al 37.04 mole Fe. $m = n \times MM = 37.04 \times 55.85 = 2069g$
/3	**8.** The Marsh test was used historically to detect arsenic in cases of suspected poisoning: $As_2O_{3(s)} + 6\ H_{2(g)} \rightarrow 2\ AsH_{3(g)} + 3\ H_2O_{(g)}$ A sample contains 640 mg of As_2O_3. What mass of AsH_3 will be isolated from the above reaction? Assume that there is enough (excess) H_2 to react with all the As_2O_3. $As_2O_3 + 6H_2 \rightarrow 2\ AsH_3 + 3H_2O$ 640mg excess ?g 0.64g $n = \frac{m}{MM} = \frac{0.64}{197.8} = 0.0032$ n(As_2O_3 1 : 2 n(AsH_3) 0.0032 moles : 0.0064 moles AsH_3 $m = n \times MM = 0.0064 \times 97.9$ 0.63 g.

/2 /2 /2	**9.** Titanium (IV) chloride can be made by the following reaction: $2\ FeTiO_{3(s)} + 7\ Cl_{2(g)} + 6\ C_{(s)} \rightarrow 2\ TiCl_{4(g)} + 6\ CO_{(g)} + 2\ FeCl_{3(s)}$ **a.** If you start with 100.0 g of each reactant, which one limits the reaction? **b.** What is the theoretical yield of $TiCl_4$ based on the amounts in a)? **c.** If only 70.0 g of $TiCl_4$ is recovered, what is the percent yield of the reaction? $2FeTiO_3 + 7Cl_2 + 6C \longrightarrow 2TiCl_4 + 6CO + 2FeCl$ 100g 100g 100g $n=\frac{m}{MM}$ $n=\frac{m}{MM}$ $n=\frac{m}{MM}$ $n(FeTiO_3)$ $n(Cl_2)$ $n(C)$ 0.66 moles 1.41 moles 8.33 moles 7:2 $n(TiCl_4) = 1.41 \times \frac{2}{7} = 0.4$ moles $m = n \times MM = 0.4 \times 189.7 = 75.9g$ (b) a) LIMITING REAGENT $FeTiO_3: \frac{0.66}{2} : 0.33$ $Cl_2: \frac{1.41}{7} : 0.2$ LR $C: \frac{8.33}{6} : 1.4$ (c) % Yield = $\frac{actual}{theoretical} \times 100 = \frac{70.0}{75.9} \times 100 = 92\%$
/2 /2 /2	**10.** Hydrazine is used in rocket fuel. It reacts with Oxygen according to the equation below $N_2H_{4(l)} + O_{2(g)} \rightarrow N_{2(g)} + 2\ H_2O_{(g)}$ In a particular rocket engine, 2.29 g of hydrazine and 3.14 g of Oxygen are available to react. **a.** Identify the limiting reagent and show your calculations **b.** Determine the mass of unreacted reagent that will be left after the reaction and show your calculations **c.** Calculate the mass of water produced from the amounts stated in a). $N_2H_4 + O_2 \longrightarrow N_2 + 2H_2O$ 2.29g 3.14g a) L. Reagent $n(N_2H_4) = \frac{m}{MM} = \frac{2.29}{32} = 0.072$ $n(O_2) = \frac{m}{MM} = \frac{3.14}{32} = 0.098$ Coeff are 1:1 so N_2H_4 = LR (b) $n(O_2$ left over$) = 0.098 - 0.072 = 0.026$ moles $m(O_2) = n \times MM = 0.026 \times 32 = 0.083g$ (c) $n(H_2O) = 2 \times n(N_2H_4) = 2 \times 0.072 = 0.144$ $m(H_2O) = n \times MM = 0.144 \times 18 = 2.6g$
/3	**11.**** A 0.423 g sample of <u>impure</u> Sodium Nitrate was heated, converting all the Sodium Nitrate to 0.2864 g of Sodium Nitrite and Oxygen gas. Determine the percent of sodium Nitrate in the original sample. $2NaNO_3 \xrightarrow{heat} 2NaNO_2 + O_2$ 0.423g 0.2864g $n = \frac{m}{MM} = \frac{0.423}{85} = 0.005$ $n(NaNO_3)$ 0.005 moles $\xrightarrow{2:2}$ $n(NaNO_2)$ 0.005 moles $m = n \times MM = 0.005 \times 69 = 0.345$ % Yield = $\frac{actual}{theoretical} \times 100 = \frac{0.2864}{0.345} \times 100 = 83\%$ This indicates the % purity of the original sample.