CHEM 130 **Name** ________________________________

Quiz 5 – Sept. 29, 2017

Complete the following problems. You must show your work to receive full credit. Show your answers to the correct number of significant figures with the correct units.

1. In the laboratory, you weigh out 0.114 grams of solid $AlCl_3 \bullet 6H_2O$ (molar mass 241.43 g/mol), dissolve it, and dilute it to a total volume of 100.0 mL to make solution A. You then transfer 3.00 mL of solution A into a 25.0 mL volumetric flask and dilute to the mark to make solution B. *What is the molarity of aluminum ion in solution B?* (9 pts.)

First find the concentration of solution A:

$$0.114\ \text{~~g AlCl}_3\bullet 6\text{H}_2\text{O~~} \times \frac{1\ \text{~~mol AlCl}_3\bullet 6\text{H}_2\text{O~~}}{241.43\ \text{~~g AlCl}_3\bullet 6\text{H}_2\text{O~~}} \times \frac{1\ \text{mol Al}^{3+}}{1\ \text{~~mol AlCl}_3\bullet 6\text{H}_2\text{O~~}} \times \frac{1}{0.1000\ \text{L}} = \frac{0.004722\ \text{mol Al}^{3+}}{\text{L}}$$

Now determine the concentration of solution B:

$$M_1V_1 = M_2V_2$$

$$(0.004722\ \text{M})(3.00\ \text{mL}) = M_2(25.00\ \text{mL})$$

$$\frac{0.004722\ \text{mol Al}^{3+}}{\text{L}} \times \frac{3.00\ \text{mL}}{25.0\ \text{mL}} = \mathbf{\frac{5.67\times10^{-4}\ \text{mol Al}^{3+}}{\text{L}}}$$

So, the final concentration of aluminum is 5.67×10^{-4} M

2. The 50.0 g $Ca(OCl)_2$ (molar mass 142.98 g/mol) and 275 mL of 3.00 M HCl are allowed to react in the reaction below. If 15.8 g of Cl_2 is produced, *what is the percent yield for the reaction*? (9 pts.)

$$Ca(OCl)_2\,(s) + 4HCl\,(aq) \rightarrow 2Cl_2(g) + CaCl_2(aq) + 2\,H_2O(l)$$

We need to determine the limiting reagent first:

$$50.0\ \text{~~g Ca(OCl)}_2\text{~~} \times \frac{1\ \text{~~mol Ca(OCl)}_2\text{~~}}{142.98\ \text{~~g Ca(OCl)}_2\text{~~}} \times \frac{2\ \text{~~mol Cl}_2\text{~~}}{1\ \text{~~mol Ca(OCl)}_2\text{~~}} \times \frac{70.9054\ \text{g Cl}_2}{1\ \text{~~mol Cl}_2\text{~~}} = 49.59\ \text{g Cl}_2$$

$$0.275\ \text{~~L HCl~~} \times \frac{3.00\ \text{~~mol HCl~~}}{1\ \text{~~L HCl~~}} \times \frac{2\ \text{~~mol Cl}_2\text{~~}}{4\ \text{~~mol HCl~~}} \times \frac{70.9054\ \text{g Cl}_2}{1\ \text{~~mol Cl}_2\text{~~}} = 29.25\ \text{g Cl}_2$$

So, HCl is the limiting reagent and our theoretical yield is 29.25 g Cl_2

Therefore, our percent yield is:

$$\frac{15.8\ \text{g Cl}_2}{29.25\ \text{g Cl}_2} \times 100\% = \mathbf{54.0\ \%\ yield}$$

3. Billions of kilograms of urea ($CO(NH_2)_2$ molar mass = 60.06 g/mol) are produced each year for use as fertilizer. The reaction involves combining ammonia (NH_3) with carbon dioxide to produce urea and water. *What mass of carbon dioxide is required to convert 1.00 kg of ammonia to urea? What mass of urea is formed?* (8 pts.)

$$2NH_3 + CO_2 \rightarrow CO(NH_2)_2 + H_2O$$

$$1.00\ \cancel{\text{kg } NH_3} \times \frac{1\ \cancel{\text{mol } NH_3}}{\cancel{17.03\text{ g } NH_3}} \times \frac{1\ \cancel{\text{mol } CO_2}}{2\ \cancel{\text{mol } NH_3}} \times \frac{44.01\text{g } CO_2}{1\ \cancel{\text{mol } CO_2}} = \mathbf{1.29\ kg\ CO_2}$$

$$1.00\ \cancel{\text{kg } NH_3} \times \frac{1\ \cancel{\text{mol } NH_3}}{\cancel{17.03\text{ g } NH_3}} \times \frac{1\ \cancel{\text{mol}}\ CO(NH_2)_2}{2\ \cancel{\text{mol } NH_3}} \times \frac{60.06\text{g } CO(NH_2)_2}{1\ \cancel{\text{mol}}\ CO(NH_2)_2} = \mathbf{1.76\ kg\ CO(NH_2)_2}$$

Possibly Useful Information

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.00794																	2 He 4.00260
3 Li 6.941	4 Be 9.01218											5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
11 Na 22.9898	12 Mg 24.3050											13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9381	26 Fe 55.847	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.757	52 Te 127.60	53 I 126.904	54 Xe 131.29
55 Cs 132.905	56 Ba 137.327	57 *La 138.906	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	89 †Ac 227.028	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (272)							

*Lanthanide series	58 Ce 140.115	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
†Actinide series	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)