

## Chemistry 1094 Spring 2018 Test 3

Wednesday, March 21, 2018

Time: 1 hour 50 minutes

Name: ANSWERS Student Number: \_\_\_\_\_

This test consists of six pages of questions and a periodic table. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. There are 36 marks available. Good luck!

- 1) [3 marks] A compound has been found to have the empirical formula  $C_2HNO_2$ . If the molar mass of the compound is known to be between 170 and 240 grams, what is the molecular formula of the compound?

$$C_2HNO_2 \text{ MM is } \sim 2 \times 12 + 1 + 14 + 2 \times 16 = 71 \text{ g}$$

So "n" falls in the range

$$\frac{170}{71} = 2.4 \text{ to } \frac{240}{71} = 3.4 \text{ The only whole \# in this range is 3, so MF must be } [C_6H_3N_3O_6]$$

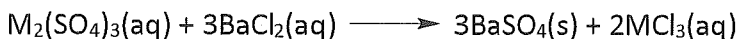
- 2) [3 marks] If you react 20.0 grams of  $CaCl_2$  (111.0 g/mol) with excess  $K_3P$ , how many grams of  $Ca_3P_2$  (182.2 g/mol) should you collect?



$$20.0 \text{ g } CaCl_2 \times \frac{1 \text{ mol}}{111.0 \text{ g}} \times \frac{1 \text{ } Ca_3P_2}{3 \text{ } CaCl_2} \times \frac{182.2 \text{ g}}{\text{mol}}$$

$$= \boxed{10.94 \text{ g}}$$

- 3) [4 marks] A 701.4-mg sample of a compound of formula  $M_2(SO_4)_3$  was reacted with excess  $BaCl_2$ :



A total of 1435.3 mg of  $BaSO_4$  (233.38 g/mol) was collected. What is the metal, M?

$$1435.3 \times 10^{-3} \text{ g } BaSO_4 \times \frac{1 \text{ mol}}{233.38 \text{ g}} \times \frac{1 M_2(SO_4)_3}{3 BaSO_4} = 2.05 \times 10^{-3} \text{ mol } M_2(SO_4)_3$$

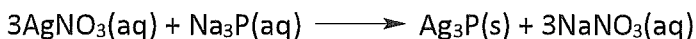
$$2.05 \times 10^{-3} \text{ mol } M_2(SO_4)_3 = 701.4 \text{ mg } M_2(SO_4)_3$$

$$+ 1 \text{ mol } M_2(SO_4)_3 = 342.1 \text{ g}$$

$$\text{So } 2M + 3 \times 32.065 + 12 \times 15.999 = 342.1 \text{ g}$$

$$\Rightarrow M = 26.98, \text{ which is } \boxed{Al}$$

- 4) [4 marks] How many grams of 80.0-percent pure  $AgNO_3$  (169.9 g/mol) are necessary to produce 3.546 grams of  $Ag_3P$  (354.6 g/mol)?



If the mass of impure  $AgNO_3$  is Xg, then...

$$X \text{ g} \times \frac{80 \text{ g } AgNO_3}{100 \text{ g}} \times \frac{1 \text{ mol}}{169.9 \text{ g}} \times \frac{1 Ag_3P}{3 AgNO_3} \times \frac{354.6 \text{ g}}{1 \text{ mol}} = 3.546 \text{ g } Ag_3P$$

Solving for X gives...

$$X = \boxed{6.37125 \text{ g}}$$

- 5) [3 marks] If you made a solution using 30.0 grams of ethanol (molar mass 46.07 grams) and 12.0 grams of water (molar mass 18.02 grams), which compound would be the solute, and which the solvent? (Note: Show all your work and reasoning to receive any credit for your answer.)

$$30 \text{ g} \times \frac{1 \text{ mol}}{46.07 \text{ g}} = 0.651 \text{ mol eth.}$$

$$12 \text{ g} \times \frac{1 \text{ mol}}{18.02 \text{ g}} = 0.666 \text{ mol } \text{H}_2\text{O}$$

solvent: water (greater # of moles)

solute: ethanol (smaller # of moles)

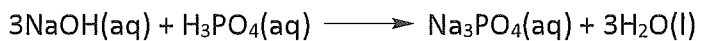
- 6) [4 marks] A 15.00-mL aliquot of 0.500 M NaCl was taken and diluted to 200.0 mL to form solution A. A 25.00-mL aliquot of solution A was taken and diluted to 250.0 mL to form solution B. If you had 1.00 litres of solution B, how many grams of NaCl (58.44 g/mol) would it contain?

$$\frac{15.00 \times 10^{-3} \text{ L} \times 0.5 \frac{\text{moles NaCl}}{\text{L}}}{200 \times 10^{-3} \text{ L}} = 0.0375 \text{ M NaCl}$$

$$\frac{25.00 \times 10^{-3} \text{ L} \times 0.0375 \frac{\text{moles NaCl}}{\text{L}}}{250.0 \times 10^{-3} \text{ L}} = 3.75 \times 10^{-3} \text{ M NaCl}$$

$$3.75 \times 10^{-3} \frac{\text{moles NaCl}}{\text{L}} \times 1 \text{ L} \times 58.44 \frac{\text{g}}{\text{mol}} = \boxed{0.21915 \text{ g NaCl}}$$

- 7) [3 marks] A 25.00-mL aliquot of  $\text{H}_3\text{PO}_4$  was taken and titrated with 45.00 mL of 0.01000 M NaOH:



What was the concentration of the  $\text{H}_3\text{PO}_4$ ?

$$45.00 \times 10^{-3} \text{ L} \times \frac{0.01 \text{ moles NaOH}}{\text{L}} \times \frac{1 \text{ H}_3\text{PO}_4}{3 \text{ NaOH}} = 1.5 \times 10^{-4} \text{ moles H}_3\text{PO}_4$$

$$[\text{H}_3\text{PO}_4] = \frac{1.5 \times 10^{-4} \text{ moles}}{25.00 \times 10^{-3} \text{ L}} = 6 \times 10^{-3} \text{ M H}_3\text{PO}_4$$

- 8) [8 marks total] A 50.97-gram sample of  $\text{AgNO}_3$  (169.9 g/mol) was reacted with 20.00 grams of  $\text{Na}_3\text{P}$  (100.0 g/mol).



- a) [3 marks] Identify the limiting reagent.

$$50.97 \text{ g AgNO}_3 \times \frac{1 \text{ mol}}{169.9 \text{ g}} \times \frac{1 \text{ Ag}_3\text{P}}{3 \text{ AgNO}_3} = 0.1 \text{ moles Ag}_3\text{P}$$

$$20.00 \text{ g Na}_3\text{P} \times \frac{1 \text{ mol}}{100.0 \text{ g}} \times \frac{1 \text{ Ag}_3\text{P}}{1 \text{ Na}_3\text{P}} = 0.2 \text{ moles Ag}_3\text{P}$$

∴  $\text{AgNO}_3$  is LR

- b) [2 marks] How many grams of  $\text{Ag}_3\text{P}$  (354.6 g/mol) should be collected?

$$0.1 \text{ moles Ag}_3\text{P} \times \frac{354.6 \text{ g}}{1 \text{ mol}} = 35.46 \text{ g}$$

- c) [3 marks] How many grams of which reagent will remain unreacted after the reaction is complete?

$$20.0 \text{ g Na}_3\text{P} - 50.97 \text{ g AgNO}_3 \times \frac{1 \text{ mol}}{169.9 \text{ g}} \times \frac{1 \text{ Na}_3\text{P}}{3 \text{ AgNO}_3} \times \frac{100 \text{ g}}{1 \text{ mol}}$$

$$= 10 \text{ g Na}_3\text{P}$$

- 9) [4 marks] How many grams of  $\text{AgNO}_3$  (169.9 g/mol) are necessary to produce 3.1914 grams of  $\text{Ag}_3\text{P}$  (354.6 g/mol) if the reaction



is known to proceed with a 90.00 percent yield?

Let mass of  $\text{AgNO}_3$  be  $X$  g:

then...

$$X \text{ g } \text{AgNO}_3 \times \frac{1 \text{ mol}}{169.9 \text{ g}} \times \frac{1 \text{ Ag}_3\text{P}}{3 \text{ AgNO}_3} \times \frac{354.6 \text{ g}}{1 \text{ mol}} \times \frac{90 \text{ g}}{100 \text{ g}} = 3.1914 \text{ g}$$

Solving for  $X$  gives...

$$X = \boxed{5.097 \text{ g } \text{AgNO}_3}$$