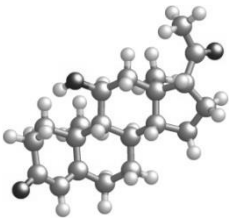

Chem!stry

Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Mole Calculations Assignment Three

1. Hydrochloric acid reacts with sodium carbonate to form a salt, water and carbon dioxide.

a) Write the balanced chemical equation for the reaction between hydrochloric acid and sodium carbonate.

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A *primary standard solution* was made by dissolving 1.272 g of sodium carbonate in 250.0 cm^3 of distilled water. 25.0 cm^3 of the sodium carbonate primary standard solution was then pipetted into a 250 cm^3 conical flask. A few drops of methyl orange indicator were added to the contents of the conical flask. Hydrochloric acid was then run from a burette into the conical flask until a "champagne" colour was observed. After performing the titration several times, the average volume of hydrochloric acid required to react exactly with the sodium carbonate was found to be 16.00 cm^3.

b) Calculate the concentration of the sodium carbonate primary standard solution.

c) Calculate the number of moles of hydrochloric acid that reacted with the sodium carbonate.

d) Calculate the concentration of the hydrochloric acid.

2. Hydrazine, N_2H_4, is a liquid at room temperature and pressure. It is used as the fuel in rocket thrusters that manoeuvre small space craft in Earth's orbit. The liquid hydrazine decomposes into gaseous ammonia and gaseous nitrogen. This large increase in volume provides the thrust that moves the spacecraft.

a) Write the balanced chemical equation, including state symbols, for the decomposition of hydrazine.

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b) 89.6 g of hydrazine were used to manoeuver a satellite in Earth's orbit. Calculate the **total** volume of gas produced when the 89.6 g of hydrazine decomposed.

3. A carbonate of metal **M** has the formula $\mathbf{M}_2CO_3$. The equation for the reaction of $\mathbf{M}_2CO_3$ with hydrochloric acid is given below.

$$\mathbf{M}_2CO_3(s) + 2HCl(aq) \rightarrow 2\mathbf{M}Cl(aq) + CO_2(g) + H_2O(l)$$

0.2415 g of $\mathbf{M}_2CO_3$ was found to exactly neutralise 17.5 cm^3 of hydrochloric acid of concentration 0.200 mol/dm^3.

a) Calculate the number of moles of hydrochloric acid used.

b) Calculate the number of moles of $\mathbf{M}_2CO_3$ present in 0.2415 g.

c) Calculate the relative molecular mass of $\mathbf{M}_2CO_3$ and hence identify metal **M**.

4. Compound **Y** was found to have the following percentage composition by mass:

C = 54.5 %

H = 9.09 %

O = 36.4 %

a) Calculate the empirical formula of compound **Y**.

b) Compound **Y** has a relative molecular mass of 88. Calculate the molecular formula of compound **Y**.

5. Aqueous iron(III) nitrate reacts with aqueous sodium hydroxide to form a reddish-brown precipitate of iron(III) hydroxide.

a) Write a balanced chemical equation for the reaction between aqueous iron(III) nitrate and aqueous sodium hydroxide.

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20.0 cm^3 of 0.300 mol/dm^3 aqueous iron(III) nitrate reacted with 60.0 cm^3 of 0.200 mol/dm^3 of aqueous sodium hydroxide.

b) By calculation, identify the limiting reagent for this reaction.

c) Calculate the mass of iron(III) hydroxide precipitated by this reaction.

6. 20.1 g of a monobasic acid, H**X**O_4, were dissolved in 1.00 dm^3 of distilled water. 20.0 cm^3 of this solution were found to react exactly with 40.0 cm^3 of 0.100 mol/dm^3 aqueous sodium hydroxide. The balanced chemical equation for the reaction is given below:

$$H\mathbf{X}O_4(aq) + NaOH(aq) \rightarrow Na\mathbf{X}O_4(aq) + H_2O(l)$$

a) Calculate the number of moles of aqueous sodium hydroxide used in the experiment.

b) Calculate the mole concentration of the monobasic acid H**X**O_4.

c) Calculate the relative molecular mass of the monobasic acid H**X**O_4 and hence identify the chemical element represented by **X**.

7. The ionic half-equation for the reaction between $MnO_4^-(aq)$ and $Fe^{2+}(aq)$ is given below:

$$MnO_4^-(aq) + 5Fe^{2+}(aq) + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(l)$$

The reaction between $MnO_4^-(aq)$ and $Fe^{2+}(aq)$ can be used in the quantitative analysis of iron(II)salts. Ammonium iron(II) sulphate crystals have the following formula:

$$(NH_4)_2SO_4 \cdot FeSO_4 \cdot nH_2O$$

In an experiment to determine the value of *n*, 8.45 g of ammonium iron(II) sulphate crystals were dissolved in 250.0 cm^3 of dilute sulphuric acid. 25.0 cm^3 of this solution was further acidified and titrated against a 0.0150 mol/dm^3 solution of $MnO_4^-(aq)$. 22.50 cm^3 of $MnO_4^-(aq)$ were required for the reaction.

a) Calculate moles of $MnO_4^-(aq)$ used in the reaction.

b) Calculate moles of ammonium iron(II) sulfate dissolved in 250.0 cm^3 of solution.

c) Calculate the relative molecular mass of ammonium iron(II) sulfate and hence calculate the value of *n*.

8. A fertiliser contains a mixture of ammonium sulphate and potassium sulphate. A sample of this fertiliser was warmed with an excess of aqueous sodium hydroxide (50.00 cm^3 of a solution of concentration 0.500 mol/dm^3) until the evolution of ammonia ceased.

$$(NH_4)_2SO_4(s) + 2NaOH(aq) \rightarrow 2NH_3(g) + Na_2SO_4(aq) + 2H_2O(l)$$

The excess of sodium hydroxide was neutralised by 38.40 cm^3 of hydrochloric acid of concentration 0.500 mol/dm^3.

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

a) Calculate moles of hydrochloric acid used to neutralise the excess sodium hydroxide, and hence calculate moles of excess sodium hydroxide present at the end of the reaction.

b) Calculate moles of sodium hydroxide originally added to the fertilizer.

c) From **8 a)** and **8 b)** calculate moles of sodium hydroxide that reacted with the ammonium sulfate and hence calculate the mass of ammonium sulfate present in the fertilizer.

- Scan the QR code below for the answers to this assignment.

http://www.chemist.sg/mole/assignments/mole_three_ans.pdf