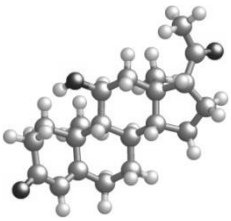

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Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

Concentration of Solution / Titration Calculations

Question One:

a) Write a balanced chemical equation - including state symbols - for the reaction between hydrochloric acid and aqueous sodium hydroxide, forming sodium chloride and water as the reaction products.

b) 30.0 cm^3 of a 0.200 mol/dm^3 solution of hydrochloric acid were exactly neutralised by 40.0 cm^3 of aqueous sodium hydroxide. Calculate the concentration of the aqueous sodium hydroxide.

Question Two:

a) Write a balanced chemical equation - including state symbols - for the reaction between nitric acid and aqueous potassium hydroxide, forming potassium nitrate and water as the reaction products.

b) 20.0 cm^3 of a 0.500 mol/dm^3 solution of nitric acid were exactly neutralised by a 0.400 mol/dm^3 aqueous solution of potassium hydroxide. Calculate the volume of potassium hydroxide that reacted with the nitric acid.

Question Three:

a) Write a balanced chemical equation - including state symbols - for the reaction between sulphuric acid and aqueous potassium hydroxide, forming potassium sulphate and water as the reaction products.

b) 25.0 cm^3 of a 0.300 mol/dm^3 solution of sulphuric acid were exactly neutralised by 45.0 cm^3 of aqueous potassium hydroxide. Calculate the concentration of the aqueous potassium hydroxide.

Question Four:

a) Write a balanced chemical equation - including state symbols - for the reaction between phosphoric acid and aqueous sodium hydroxide, forming sodium phosphate and water as the reaction products.

b) 50.0 cm^3 of a 0.0500 mol/dm^3 solution of phosphoric acid were exactly neutralised by a 0.250 mol/dm^3 aqueous solution of sodium hydroxide. Calculate the volume of sodium hydroxide that reacted with the phosphoric acid.

Question Five:

The ionic equation for the reaction between potassium manganate(VII) and iron(II) sulphate is given below:

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

During an experiment, 34.0 cm^3 of a 0.0200 mol/dm^3 solution of potassium manganate(VII) was titrated against 25.0 cm^3 of aqueous iron(II) sulphate. Complete the following calculations in order to determine the concentration of the aqueous iron(II) sulphate solution.

a) What are the spectator ions in this reaction?

b) Calculate the number of moles of MnO_4^- used during the titration.

c) Calculate the number of moles of Fe^{2+} that reacted with the MnO_4^- during the titration.

d) Calculate the concentration of Fe^{2+} in mol/dm^3

e) Calculate the mass concentration of $FeSO_4$, *i.e.* the concentration of $FeSO_4$ in g/dm^3

Question Six:

The ionic equation for the reaction between aqueous vitamin C and aqueous iodine is given below:

$$C_6H_8O_6(aq) + I_2(aq) \rightarrow C_6H_6O_6(aq) + 2I^-(aq) + 2H^+(aq)$$

A student performed a titration to determine the amount of vitamin C present in a 200.0 cm^3 carton of fruit juice. The student's results are given in the table below:

Results for Aqueous Iodine Solution (Burette)	Rough	First	Second	Third	Fourth
Final burette reading / cm^3	28.95	29.60	26.45	27.45	27.20
Initial Burette reading / cm^3	1.60	2.70	0.00	0.90	0.50
Volume of aqueous iodine solution used / cm^3	27.35	26.90	26.45	26.55	26.70
Results averaged for the calculation			✓	✓	

Concentration of aqueous iodine solution = 0.01 mol /dm^3

Volume of fruit juice pipetted into conical flask = 25.0 cm^3

a) Calculate the number of moles of iodine used during the titration.

b) Calculate the number of moles of vitamin C that reacted with the iodine during the titration.

c) Calculate the number of moles of vitamin C that is present in 200 cm^3 of the fruit juice.

d) Calculate the mass (in grams) of vitamin C that is present in 200 cm^3 of the fruit juice.

Question Seven:

In a laboratory accident, a bottle containing 2.00 dm^3 of hydrochloric acid of concentration 10.0 mol/dm^3 is broken and the acid spills on the floor. The acid is neutralised by sprinkling powdered calcium carbonate onto the spillage.

a) Write a balanced chemical equation - including state symbols - for the reaction between solid calcium carbonate and hydrochloric acid.

b) Calculate the number of moles of hydrochloric acid spilled on the floor.

c) Calculate the mass of calcium carbonate needed to neutralise all the hydrochloric acid.

Question Eight:

A carbonate of metal **M** has the formula M_2CO_3. The equation for the reaction of M_2CO_3 with hydrochloric acid is given below:

$$M_2CO_3(s) + 2HCl(aq) \rightarrow 2MCl(aq) + CO_2(g) + H_2O(l)$$

0.245 g of M_2CO_3 was found to exactly neutralise 23.6 cm^3 of hydrochloric acid of concentration 0.150 mol/dm^3. Carry out the following calculations and hence deduce the identity of **M**.

a) Calculate the number of moles of hydrochloric acid.

b) Calculate the number of moles of M_2CO_3.

c) Calculate the relative molecular mass of M_2CO_3.

d) Calculate the relative atomic mass of metal **M** and hence deduce its identity.

Question Nine:

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 (50.0 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 38.4 cm^3 of hydrochloric acid of concentration 0.500 mol/dm^3.

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

a) Calculate the number of moles of hydrochloric acid used to neutralise the excess sodium hydroxide.

b) Calculate the number of moles of sodium hydroxide that reacted with this number of moles of hydrochloric acid.

c) Calculate the number of moles of sodium hydroxide present in the original 50.0 cm^3 of 0.500 mol/dm^3 solution.

d) Calculate the number of moles of sodium hydroxide that reacted with the ammonium sulphate.

e) Calculate the number of moles of ammonium sulphate present in the sample of fertiliser.

f) Calculate the mass of ammonium sulphate present in the sample of the fertiliser.

Question Ten:

A newly discovered rock is known to contain calcium carbonate combined with an inert mineral. 1.40 g of the rock was added to a beaker containing 50.0 cm^3 of 0.500 mol/dm^3 nitric acid (excess). The mixture was warmed gently and stirred to ensure that all of the calcium carbonate had reacted. The excess nitric acid remaining after the reaction with the calcium carbonate was exactly neutralised by 37.5 cm^3 of a 0.200 mol/dm^3 aqueous solution of sodium hydroxide. Complete the following calculations to determine the percentage calcium carbonate present in the rock.

a) Write a balanced chemical equation – including state symbols – for the reaction between calcium carbonate and nitric acid.

b) Write a balanced chemical equation – including state symbols – for the reaction between nitric acid and aqueous sodium hydroxide.

c) Calculate the number of moles of nitric acid that are added to the sample of rock.

d) Calculate the number of moles of sodium hydroxide that are required to neutralise the excess nitric acid.

e) Calculate the number of moles of nitric acid that remain in excess after the reaction with the calcium carbonate in the sample of rock.

f) Calculate the number of moles of nitric acid that reacted with the calcium carbonate in the sample of rock.

g) Calculate the number of moles of calcium carbonate present in the sample of rock.

h) Calculate the mass (in grams) of calcium carbonate present in the sample of rock.

i) Calculate the percentage calcium carbonate present in the sample of rock.

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

http://www.chemist.sg/mole/solution_calc_ans.pdf