AS 91161

QUANTITATIVE ANALYSIS HELP SHEET

Question One:

A standard solution of 0.180 mol L^{-1} hydrochloric acid was titrated against 25.0 mL samples of a solution of sodium carbonate. The following volumes of hydrochloric acid solution were used in successive titrations – 24.50 mL, 23.25 mL, 23.35 mL and 23.28 mL.

The equation for the reaction is

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Use this information to determine the concentration of the sodium carbonate solution. Give your answer to three significant figures.

Question Two:

Allicin, $C_6H_{10}S_2O$, is the compound responsible for the characteristic smell of garlic. Calculate the percentage composition of this compound. Give your answer to three significant figures.

M(C) = 12.0, M(H) = 1.00, M(S) = 32.1, M(O) = 16.0 g mol^{-1}.

Question Three:

The porphryn molecule forms an important part of the haemoglobin structure.

This porphryn molecule is 78.5 % carbon, 3.20 % hydrogen and 18.3 % nitrogen, and has a molar mass of 306 g mol^{-1}.

Calculate **both** the **empirical formula** and the **molecular formula** of porphryn.

M(C) = 12.0, M(H) = 1.00, M(N) = 14.0 g mol^{-1}.

Question Four:

Wine makers convert sugars such as glucose to ethanol and carbon dioxide:

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

M(C) = 12.0, M(H) = 1.00, M(O) = 16.0 g mol^{-1}.

Starting with 540 g of glucose, what is the mass of ethanol that can be obtained by this process? Give your answer to three significant figures.

ANSWERS

Question One:

First extract the information you have been given.

0.180 mol L^{-1} hydrochloric acid

25.0 mL sodium carbonate

24.50 mL, 23.25 mL, 23.35 mL and 23.28 mL hydrochloric acid

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$$

Use this information to determine the concentration of the sodium carbonate solution. Give your answer to three significant figures.

1) Choose THREE (or more) values that are within a 0.2 mL range.

   23.25 mL 23.35 mL 23.28 mL

2) Calculate the average titre & convert the volume to mL.

   Average titre = 23.29 mL = 0.02329 L

3) n= cV Calculate n(HCl) n(HCl) = cV n(HCl) = 0.180 x 0.02329 = 0.0041928 mol

4) Calculate n(Na_2CO_3). Since 1 mol Na_2CO_3 reacts with 2 mol HCl;

   n(Na_2CO_3) = 0.0041928 / 2 = 0.0020964 mol

5) c = n/V Calculate c(Na_2CO_3) = 0.0020964 / 0.025 = 0.083856 mol L^{-1}

6) Write final answer to 3 s.f. 0.0839 mol L^{-1} (3 s.f.)

Question Two: M(C) = 12.0, M(H) = 1.00, M(S) = 32.1, M(O) = 16.0 g mol^{-1}.

1) First calculate M($C_6H_{10}S_2O$) (6 x 12.0) + (10 x 1.00) + (2 x 32.1) + 16.0

   M($C_6H_{10}S_2O$) = 162.2 g mol^{-1}.

2) % C = (6 x 12.0) / 162.2 x 100 = 44.4 % (3 s.f.)

   % H = 10 / 162.2 x 100 = 6.17% (3 s.f.)

   % S = (2 x 32.1) /162.2 x 100 = 39.6 % (3 s.f.)

   % O = 16.0 / 162.2 = 9.86 % (3 s.f.)

Question Three:

The porphryn molecule is 78.5 % carbon, 3.20 % hydrogen and 18.3 % nitrogen, and has a molar mass of 306 g mol^{-1}. M(C) = 12.0, M(H) = 1.00, M(N) = 14.0 g mol^{-1}.

1) Assume you have 100 g of the substance. Masses are 78.5 g carbon, 3.20 g hydrogen and 18.3 g nitrogen
2) Calculate the amount (in mol) of each

C	H	N
78.5/12.0	3.20/1.00	18.3/14.0
6.54 mol	3.20 mol	1.31 mol

3) Divide each amount (mol) by the smallest to get the simplest whole number ratio

	C		H		N	
	6.54/1.31		3.20/1.31		1.31/1.31	
	4.99	:	2.44	:	1	
≈	5	:	2.5*	:	1	* as 2.5 will need to multiply all by 2
	10	:	5	:	2	

Empirical formula $C_{10}H_5N_2$

M($C_{10}H_5N_2$ - empirical formula) = 153 g mol^{-1} (10 x 12.0) + (5 x 1.00) + (2 x 14.0)
306/153 = 2, so the molecular formula is 2 x $C_{10}H_5N_2$ = $C_{20}H_{10}N_4$

Question Four:

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

M(C) = 12.0, M(H) = 1.00, M(O) = 16.0 g mol^{-1}.

Starting with 540 g of glucose, what is the mass of ethanol that can be obtained by this process? Give your answer to three significant figures.

1) M($C_6H_{12}O_6$) = (6 x 12.0) + (12 x 1.00) + (6 x 16.0) = 180 g mol^{-1}.
2) M(C_2H_5OH) = (2 x 12.0) + (6 x 1.00) + (1 x 16.0) = 46.0 g mol^{-1}.
3) n($C_6H_{12}O_6$) = 540 / 180 = 3 mol
4) Since 1 mol glucose is converted into 2 mol of ethanol, 3 mol of $C_6H_{12}O_6$ could be converted into 6 mol of C_2H_5OH
5) m = nM mass of ethanol = 6 x 46.0 = 276 g (3 s.f.)