

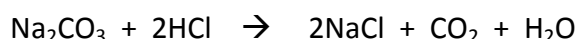
**AS 91161**

**QUANTITATIVE ANALYSIS HELP SHEET**

**Question One:**

A standard solution of  $0.180 \text{ mol L}^{-1}$  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



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

**Question Two:**

Alliin,  $\text{C}_6\text{H}_{10}\text{S}_2\text{O}$ , is the compound responsible for the characteristic smell of garlic. Calculate the percentage composition of this compound. Give your answer to three significant figures.

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

**Question Three:**

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

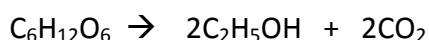
This porphyrin molecule is 78.5 % carbon, 3.20 % hydrogen and 18.3 % nitrogen, and has a molar mass of  $306 \text{ g mol}^{-1}$ .

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

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

**Question Four:**

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



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

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

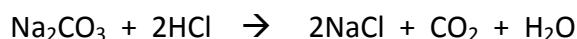
### Question One:

First extract the information you have been given.

**0.180 mol L<sup>-1</sup> hydrochloric acid**

**25.0 mL sodium carbonate**

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



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  $n(\text{HCl})$   $n(\text{HCl}) = cV$   $n(\text{HCl}) = 0.180 \times 0.02329 = 0.0041928 \text{ mol}$
- 4) Calculate  $n(\text{Na}_2\text{CO}_3)$ . Since 1 mol  $\text{Na}_2\text{CO}_3$  reacts with 2 mol HCl;  
 $n(\text{Na}_2\text{CO}_3) = 0.0041928 / 2 = 0.0020964 \text{ mol}$
- 5)  $c = n/V$  Calculate  $c(\text{Na}_2\text{CO}_3) = 0.0020964 / 0.025 = 0.083856 \text{ mol L}^{-1}$
- 6) Write final answer to 3 s.f.  $0.0839 \text{ mol L}^{-1}$  (3 s.f.)

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

- 1) First calculate  $M(\text{C}_6\text{H}_{10}\text{S}_2\text{O})$   $(6 \times 12.0) + (10 \times 1.00) + (2 \times 32.1) + 16.0$   
 $M(\text{C}_6\text{H}_{10}\text{S}_2\text{O}) = 162.2 \text{ g mol}^{-1}$ .
- 2) % C =  $(6 \times 12.0) / 162.2 \times 100 = 44.4 \%$  (3 s.f.)  
% H =  $10 / 162.2 \times 100 = 6.17\%$  (3 s.f.)  
% S =  $(2 \times 32.1) / 162.2 \times 100 = 39.6 \%$  (3 s.f.)  
% O =  $16.0 / 162.2 = 9.86 \%$  (3 s.f.)

**Question Three:**

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

- 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
10	: 5	: 2

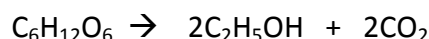
\* as 2.5 will need to multiply all by 2

Empirical formula  $\text{C}_{10}\text{H}_5\text{N}_2$

$M(\text{C}_{10}\text{H}_5\text{N}_2 - \text{empirical formula}) = 153 \text{ g mol}^{-1} (10 \times 12.0) + (5 \times 1.00) + (2 \times 14.0)$

$306/153 = 2$ , so the molecular formula is  $2 \times \text{C}_{10}\text{H}_5\text{N}_2 = \text{C}_{20}\text{H}_{10}\text{N}_4$

**Question Four:**



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

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)  $M(\text{C}_6\text{H}_{12}\text{O}_6) = (6 \times 12.0) + (12 \times 1.00) + (6 \times 16.0) = 180 \text{ g mol}^{-1}$ .
- 2)  $M(\text{C}_2\text{H}_5\text{OH}) = (2 \times 12.0) + (6 \times 1.00) + (1 \times 16.0) = 46.0 \text{ g mol}^{-1}$ .
- 3)  $n(\text{C}_6\text{H}_{12}\text{O}_6) = 540 / 180 = 3 \text{ mol}$
- 4) Since 1 mol glucose is converted into 2 mol of ethanol, 3 mol of  $\text{C}_6\text{H}_{12}\text{O}_6$  could be converted into 6 mol of  $\text{C}_2\text{H}_5\text{OH}$
- 5)  $m = nM$  mass of ethanol =  $6 \times 46.0 = 276 \text{ g}$  (3 s.f.)