CALCULATING VOLUME

1 Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

..... mol

- number of moles of O_2 formed,

..... mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

..... dm^3

[3]

MARKING SCHEME:

(a)	number of moles of $NaNO_3$ used: 3.40 / 85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04 / 2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);	**3**

2 Dilute hydrochloric acid reacts with sodium carbonate solution.

$$2HCl(aq) + Na_2CO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

(a) Explain why effervescence is seen during the reaction.

.....

..... [1]

(b) Dilute hydrochloric acid was titrated with sodium carbonate solution.

- 10.0 cm^3 of 0.100 mol / dm^3 hydrochloric acid were placed in a conical flask.
- A few drops of methyl orange indicator were added to the dilute hydrochloric acid.
- The mixture was titrated with sodium carbonate solution.
- 16.2 cm^3 of sodium carbonate solution were required to react completely with the acid.

(i) What colour would the methyl orange indicator be in the hydrochloric acid?

..... [1]

(ii) Calculate how many moles of hydrochloric acid were used.

..... mol [1]

(iii) Use your answer to **(b)(ii)** and the equation for the reaction to calculate the number of moles of sodium carbonate that reacted.

..... mol [1]

(iv) Use your answer to **(b)(iii)** to calculate the concentration of the sodium carbonate solution in mol / dm^3.

..... mol / dm^3 [2]

(c) In another experiment, 0.020 mol of sodium carbonate were reacted with excess hydrochloric acid.

Calculate the maximum volume (at r.t.p.) of carbon dioxide gas that could be made in this reaction.

..... dm^3 [3]

[Total: 9]

MARKING SCHEME:

(a)	carbon dioxide / a gas is made;	**1**
(b)(i)	red;	**1**
(b)(ii)	0.001;	**1**
(b)(iii)	0.0005;	**1**
(b)(iv)	0.031 (2 marks) **M1 (iii)** / 0.0162;	**2**
(c)	0.48 (dm^3) **M1** moles carbon dioxide = 0.02; **M2** volume carbon dioxide = 0.02 × 24; **M3** = 0.48 (dm^3);	**3** 1 1 1

3 Calcium chloride can be made by reacting calcium carbonate with hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of calcium carbonate was added to 50.0 cm^3 of 0.500 mol / dm^3 hydrochloric acid. The solution was filtered to remove the excess calcium carbonate.

(a) How many moles of HCl were used in this reaction?

..... mol [2]

(b) Deduce the number of moles of carbon dioxide gas made in this reaction.

..... mol [1]

(c) Calculate the mass of carbon dioxide made in this reaction.

..... g [2]

(d) Calculate the volume, in dm^3, of carbon dioxide made in this reaction at room temperature and pressure (r.t.p.).

..... dm^3 [1]

[Total: 6]

MARKING SCHEME:

(a)	0.025 **M1** 50 / 1000 (=0.05) **M2** (0.05 × 0.5) = 0.025	 **1** **1**
(b)	0.0125	**1**
(c)	0.55 **M1** 44 **M2** 0.55	 **1** **1**
(d)	0.3	**1**

4 Ammonia reacts with oxygen as shown.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

(i) Calculate the volume of oxygen at room temperature and pressure, in dm^3, that reacts with 4.80 dm^3 of ammonia.

volume = ... dm^3 [3]

MARKING SCHEME:

	mol of NH_3 = 4.8(0) / 24 = 0.2(0) (1) mol of O_2 = 0.2 × 5 / 4 = 0.25 (1) mol of O_2 = 0.25 × 24 = 6.(0) (1)	**3**

5 When lead(II) nitrate is heated, two gases are given off and solid lead(II) oxide remains. The equation for the reaction is shown.

$$2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$$

(a) Calculate the M_r of lead(II) nitrate.

..... [1]

(b) 6.62 g of lead(II) nitrate are heated until there is no further change in mass.

(i) Calculate the mass of lead(II) oxide produced.

..... g [2]

(ii) Calculate the volume of oxygen, O_2, produced at room temperature and pressure (r.t.p.).

..... dm^3 [2]

MARKING SCHEME:

(a)	331	**1**
(b)(i)	**M1** mol = 6.62 / 331 **OR** 0.02 **M2** 0.02 × 223 = 4.46 (g)	**1** **1**
(b)(ii)	**M1** mol O_2 = 0.02 ÷ 2 **OR** 0.01 **M2** vol = 0.01 × 24 = 0.24 (dm^3)	**1** **1**