Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

General Certificate of Education
June 2006
Advanced Subsidiary Examination

CHEMISTRY   CHM3/P
Unit 3(b)   Practical Examination

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Thursday 18 May 2006   9.00 am to 11.00 am

For Examiner's Use			
Number	Mark	Number	Mark
Skill 1			
Skill 2			
Skill 3			
Skill 4			
Total (Column 1) ⟶			
Total (Column 2) ⟶			
TOTAL			
Examiner's Initials			

For this paper you must have
• a calculator.

Time allowed: 2 hours

Instructions
• Use blue or black ink or ball-point pen.
• Fill in the boxes at the top of this page.
• Carry out **all three** exercises.
• Answer **all** questions.
• Answer questions in the spaces provided. All working must be shown.
• Do all rough work in this book. Cross through any work you do not want marked.
• Take careful note of all the instructions given in each exercise.
• The Periodic Table/Data Sheet is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information
• You must **not** use note books and laboratory books.
• The maximum mark for this paper is 30.
• The skills which are being assessed are
  Skill 1 Planning (8 marks)
  Skill 2 Implementing (8 marks)
  Skill 3 Analysing (8 marks)
  Skill 4 Evaluating (6 marks)
• You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.

Advice
• You are advised to spend about 40 minutes on each of the three exercises.
• You are advised to carry out Exercise 1 first.

CHM3/P

This paper consists of the following.

Exercise 1 **Implementing and Analysing**   Determination of the temperature rise during a neutralisation reaction

Exercise 2 **Analysing and Evaluating**   Determination of the relative molecular mass, M_r, of a volatile liquid

Exercise 3 **Planning**   The relative molecular mass, M_r, of a Group I metal carbonate.

An essential part of any practical work is to plan for the most efficient use of the time available. There is enough time to complete the exercises set provided that a sensible approach is used.

You are advised to spend approximately

40 minutes on Exercise 1
40 minutes on Exercise 2
40 minutes on Exercise 3

The Periodic Table of the Elements

- The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

Key

relative atomic mass — 6.9
Li
Lithium
atomic number — 3

I	II		III	IV	V	VI	VII	0
1.0 **H** Hydrogen 1								4.0 **He** Helium 2
6.9 **Li** Lithium 3	9.0 **Be** Beryllium 4		10.8 **B** Boron 5	12.0 **C** Carbon 6	14.0 **N** Nitrogen 7	16.0 **O** Oxygen 8	19.0 **F** Fluorine 9	20.2 **Ne** Neon 10
23.0 **Na** Sodium 11	24.3 **Mg** Magnesium 12		27.0 **Al** Aluminium 13	28.1 **Si** Silicon 14	31.0 **P** Phosphorus 15	32.1 **S** Sulphur 16	35.5 **Cl** Chlorine 17	39.9 **Ar** Argon 18
39.1 **K** Potassium 19	40.1 **Ca** Calcium 20		69.7 **Ga** Gallium 31	72.6 **Ge** Germanium 32	74.9 **As** Arsenic 33	79.0 **Se** Selenium 34	79.9 **Br** Bromine 35	83.8 **Kr** Krypton 36
85.5 **Rb** Rubidium 37	87.6 **Sr** Strontium 38		114.8 **In** Indium 49	118.7 **Sn** Tin 50	121.8 **Sb** Antimony 51	127.6 **Te** Tellurium 52	126.9 **I** Iodine 53	131.3 **Xe** Xenon 54
132.9 **Cs** Caesium 55	137.3 **Ba** Barium 56		204.4 **Tl** Thallium 81	207.2 **Pb** Lead 82	209.0 **Bi** Bismuth 83	210.0 **Po** Polonium 84	210.0 **At** Astatine 85	222.0 **Rn** Radon 86
223.0 **Fr** Francium 87	226.0 **Ra** Radium 88							

Transition elements:

45.0 **Sc** Scandium 21	47.9 **Ti** Titanium 22	50.9 **V** Vanadium 23	52.0 **Cr** Chromium 24	54.9 **Mn** Manganese 25	55.8 **Fe** Iron 26	58.9 **Co** Cobalt 27	58.7 **Ni** Nickel 28	63.5 **Cu** Copper 29	65.4 **Zn** Zinc 30
88.9 **Y** Yttrium 39	91.2 **Zr** Zirconium 40	92.9 **Nb** Niobium 41	95.9 **Mo** Molybdenum 42	98.9 **Tc** Technetium 43	101.1 **Ru** Ruthenium 44	102.9 **Rh** Rhodium 45	106.4 **Pd** Palladium 46	107.9 **Ag** Silver 47	112.4 **Cd** Cadmium 48
138.9 **La** Lanthanum 57 *	178.5 **Hf** Hafnium 72	180.9 **Ta** Tantalum 73	183.9 **W** Tungsten 74	186.2 **Re** Rhenium 75	190.2 **Os** Osmium 76	192.2 **Ir** Iridium 77	195.1 **Pt** Platinum 78	197.0 **Au** Gold 79	200.6 **Hg** Mercury 80
227 **Ac** Actinium 89 †									

* 58 – 71 Lanthanides

140.1 **Ce** Cerium 58	140.9 **Pr** Praseodymium 59	144.2 **Nd** Neodymium 60	144.9 **Pm** Promethium 61	150.4 **Sm** Samarium 62	152.0 **Eu** Europium 63	157.3 **Gd** Gadolinium 64	158.9 **Tb** Terbium 65	162.5 **Dy** Dysprosium 66	164.9 **Ho** Holmium 67	167.3 **Er** Erbium 68	168.9 **Tm** Thulium 69	173.0 **Yb** Ytterbium 70	175.0 **Lu** Lutetium 71

† 90 – 103 Actinides

232.0 **Th** Thorium 90	231.0 **Pa** Protactinium 91	238.0 **U** Uranium 92	237.0 **Np** Neptunium 93	239.1 **Pu** Plutonium 94	243.1 **Am** Americium 95	247.1 **Cm** Curium 96	247.1 **Bk** Berkelium 97	252.1 **Cf** Californium 98	(252) **Es** Einsteinium 99	(257) **Fm** Fermium 100	(258) **Md** Mendelevium 101	(259) **No** Nobelium 102	(260) **Lr** Lawrencium 103

3

Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Table 1
Proton n.m.r chemical shift data

Type of proton	δ/ppm
RCH_3	0.7–1.2
R_2CH_2	1.2–1.4
R_3CH	1.4–1.6
$RCOCH_3$	2.1–2.6
$ROCH_3$	3.1–3.9
$RCOOCH_3$	3.7–4.1
ROH	0.5–5.0

Table 2
Infra-red absorption data

Bond	Wavenumber/cm^{-1}
C—H	2850–3300
C—C	750–1100
C=C	1620–1680
C=O	1680–1750
C—O	1000–1300
O—H (alcohols)	3230–3550
O—H (acids)	2500–3000

Turn over for the first exercise

Turn over ▶

Exercise 1   Determination of the temperature rise during a neutralisation reaction

Skills assessed   **Implementing** (8 marks) **and Analysing** (2 marks)

Introduction

You are provided with aqueous solutions of nitric acid and sodium hydroxide. The concentration of both solutions is $1.00 \, mol \, dm^{-3}$. You are required to determine the temperature rise for the neutralisation of a sample of nitric acid by sodium hydroxide.

Wear eye protection at all times.
Assume that all solutions are toxic and corrosive.

Procedure

1   Rinse a burette with the nitric acid provided. Set up the burette and, using a funnel, fill it with the nitric acid provided.

2   Using the burette, transfer $25.0 \, cm^3$ of the nitric acid to a clean, dry plastic cup.

3   Measure the temperature of the nitric acid in the cup to one decimal place. Record your result.

Temperature of the nitric acid / °C	

4   Wash the thermometer with distilled or de-ionised water and dry the thermometer.

5   Rinse a pipette with the sodium hydroxide solution provided. Using this pipette and a filler, transfer $25.0 \, cm^3$ of the sodium hydroxide solution to a second clean, dry plastic cup.

6   Place the plastic cup containing the sodium hydroxide solution in a beaker to provide support and additional insulation. Mount the thermometer in the cup using a clamp and stand. The bulb of the thermometer must be fully immersed in the solution. Place a stirrer in the cup.

7   Stir the sodium hydroxide solution in the cup and measure the temperature to one decimal place. Record your result in the table below. Every minute for a further three minutes stir the solution, measure the temperature and record each result in the table.

8   At the fourth minute add the $25.0 \, cm^3$ of nitric acid from the plastic cup. Stir the mixture but do not record the temperature.

9   Continue to stir the mixture, and measure the temperature at the fifth minute, and then every subsequent minute up to ten minutes. Record each temperature in the table.

Time / minutes	0	1	2	3	4	5	6	7	8	9	10
Temperature / °C											

For Examiner's use only			
M		P	
R		A	

8

10 Plot a graph of **temperature** (*y*-axis) against **time** (*x*-axis) on the graph paper below. Draw a line of best fit for the points before the fourth minute. Draw a second line of best fit for the points after the fourth minute. Extrapolate both lines to the fourth minute. Hence determine an accurate value for the temperature rise at the fourth minute.

Accurate value for the temperature rise .... °C

2

Turn over ▶
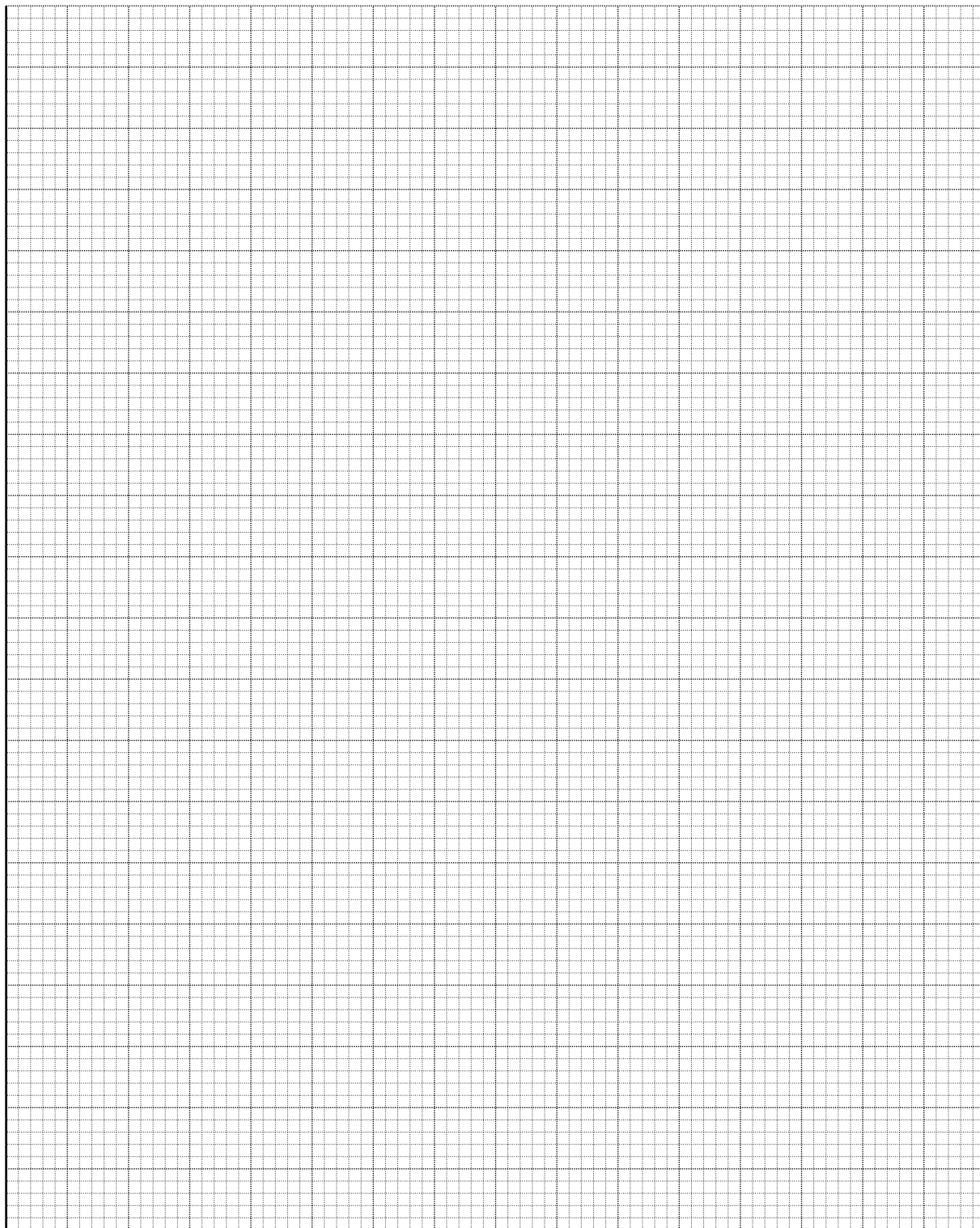
Exercise 2   Determination of the relative molecular mass, M_r, of a volatile liquid

Skills assessed   **Analysing** (6 marks) **and Evaluating** (6 marks)

Introduction

Compound **X** is a volatile liquid. In order to determine the relative molecular mass, M_r, of **X**, a student carried out six experiments. In each experiment a measured mass of **X** was injected into an empty 100 cm^3 gas syringe maintained at a pressure of 100 kPa and a temperature of 373 K. In each of the six experiments the volume of gas produced was measured. The student's results are shown on the graph on page 9.

The apparatus used is shown in the diagram below.

Volume/cm^3

Mass/g
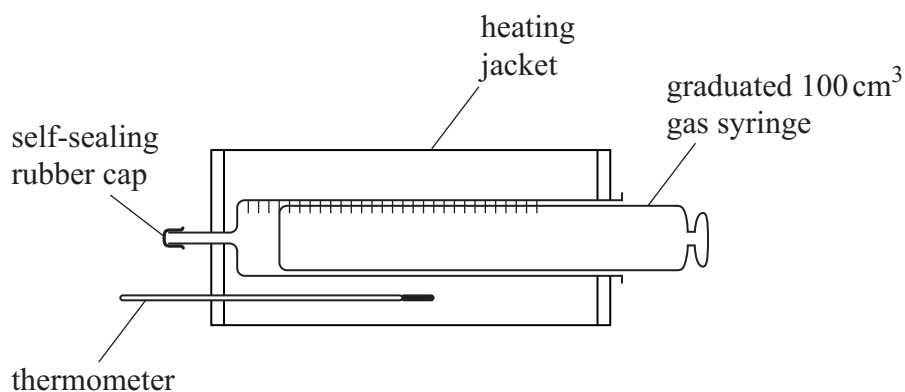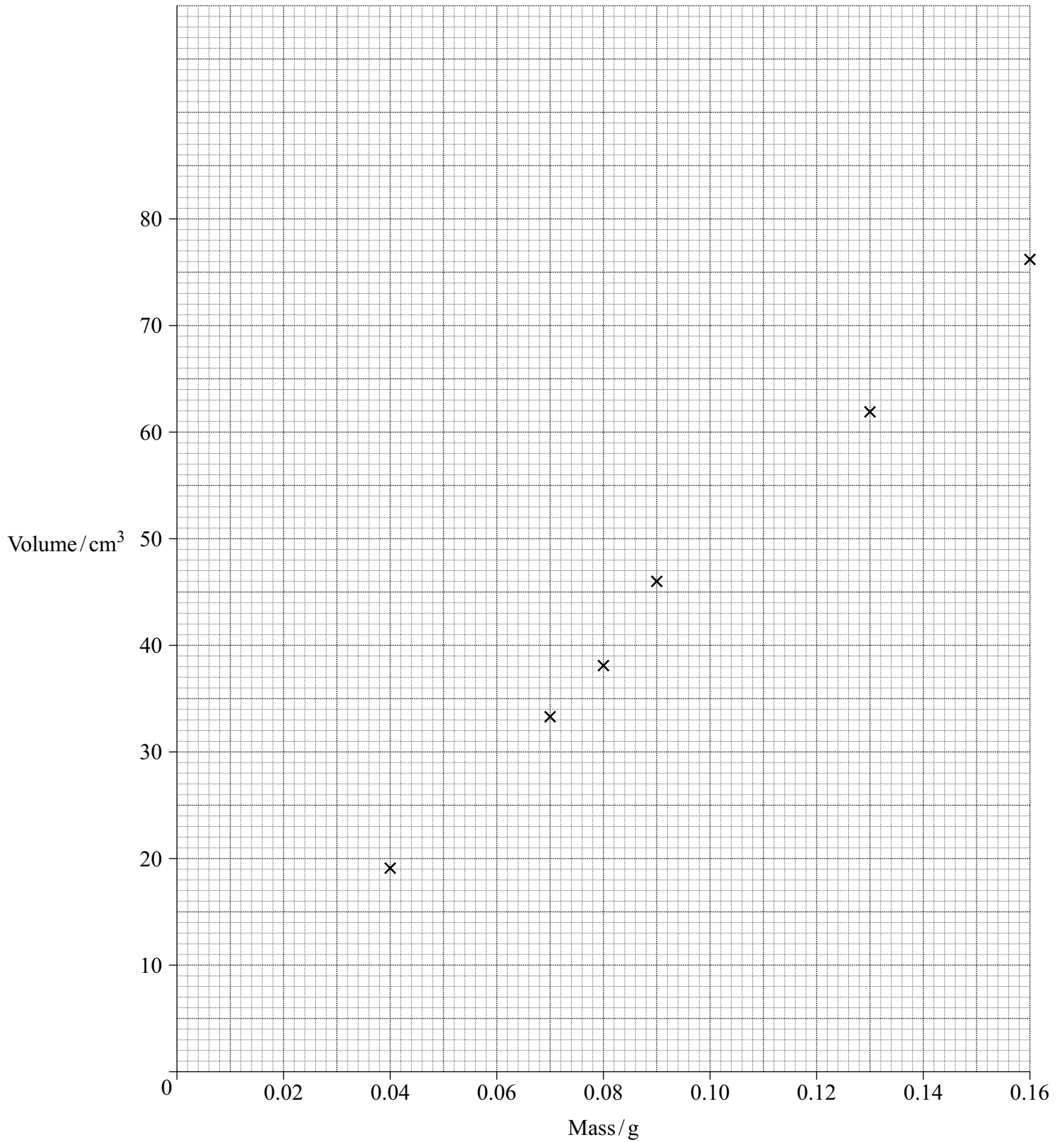
Analysis   **Full marks can only be scored if you show all your working**.

1 Draw a best fit straight line on the graph.

2 Use the graph to determine the volume of gas which would have been produced by 0.10 g of **X**.

   Volume of gas ....

3 State the ideal gas equation.

   ....

4 Use your answers to part (2) and part (3) to calculate the M_r of **X** ($R = 8.31 \, \text{J} \, \text{K}^{-1} \text{mol}^{-1}$).

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5 Assume the maximum errors for the apparatus used in this experiment were

   balance $\pm \, 0.01 \, \text{g}$
   gas syringe $\pm \, 1 \, \text{cm}^3$

   Estimate the maximum percentage error in using each piece of apparatus, and hence calculate the overall apparatus error. Use a mass of 0.10 g and the volume from part (2) to calculate these errors.

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Evaluation **Full marks can only be scored if you show all your working**.

1 Consider the graph and comment on the accuracy of the results obtained by the student. Is your line of best fit good enough for you to use with confidence? Identify any anomalous results.

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2 The correct value for the relative molecular mass of **X** is 72.0. Calculate the difference between the student's value and this correct value. Express this difference as a percentage of the correct value.

(If you could not complete the calculation in part (4) of the **Analysis** section, you should assume that the student's value is 78.5. This is not the correct value.)

Difference ....

Percentage ....

....

3 Apart from loss of liquid during transfer to the gas syringe, identify **one** other source of error in this experiment. Suggest **one** improvement to minimise this other source of error.

Source of error ....

....

Improvement ....

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4 Would a loss of liquid during transfer to the gas syringe result in a lower value for the M_r of liquid **X**? Explain your answer.

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Turn over ▶

Exercise 3   The relative molecular mass, M_r, of a Group I metal carbonate

Skill assessed   **Planning** (8 marks)

Introduction

A Group I metal carbonate, M_2CO_3, (relative formula mass, M_r, between 100 and 150) reacts with hydrochloric acid as shown in the equation below.

$$M_2CO_3 \; + \; 2HCl \; \longrightarrow \; 2MCl \; + \; H_2O \; + \; CO_2$$
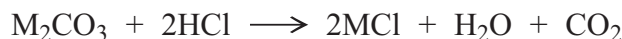
The M_r can be calculated by using the results from a titration in which standard hydrochloric acid is added from a burette to $25.0 \, cm^3$ portions of a solution of the carbonate. Methyl orange is a suitable indicator for this titration; it is red in acid and yellow in alkali.

You are provided with a solid sample of the Group I metal carbonate and a $0.100 \, mol \, dm^{-3}$ solution of hydrochloric acid.

Questions

Use the information above to answer the following questions in the space provided.

1   Suggest a suitable concentration for the Group I metal carbonate solution to be used. Explain your reasons for choosing this concentration.

2   State the volume of the standard solution of the metal carbonate you would prepare. Calculate the mass of the Group I metal carbonate you would need to weigh out to prepare this solution.

3   Describe in **detail** how you would prepare your standard solution. You do **not** need to describe the titration itself.

4   State how much indicator should be used and describe the colour change at the end-point.

5   Show how you would use the titration results to calculate the M_r of the Group I metal carbonate.

6   State **one** potential hazard and the relevant safety precautions you would take.

<div align="center">

END OF QUESTIONS

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