

--

--	--	--	--	--

--	--	--	--

9701/51

May/June 2012

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO NOT WRITE IN ANY BARCODES.

Use of a Data Booklet is unnecessary.

The number of marks is given in brackets [] at the end of each question or part question.

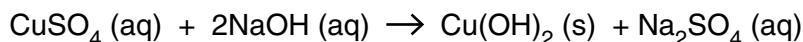
For Examiner's Use	
1	
2	
Total	

This document consists of **8** printed pages.

- 1 When an excess of aqueous sodium hydroxide, NaOH, is added to 100 cm³ of aqueous copper(II) sulfate, CuSO₄, a precipitate of copper(II) hydroxide, Cu(OH)₂, is produced.

For
Examiner's
Use

The stoichiometric equation for this reaction is,



The following information gives some of the hazards associated with these reactants.

Copper(II) sulfate (solid hydrated copper(II) sulfate CuSO₄·5H₂O)

Harmful. Dangerous for the environment.

Harmful if swallowed. Irritating to eyes and skin.

Solutions of concentrations equal to or greater than 1 mol dm⁻³ should be labelled HARMFUL.

Sodium hydroxide (solid NaOH)

Corrosive. Solutions of concentrations equal to or greater than 0.5 mol dm⁻³ are CORROSIVE.

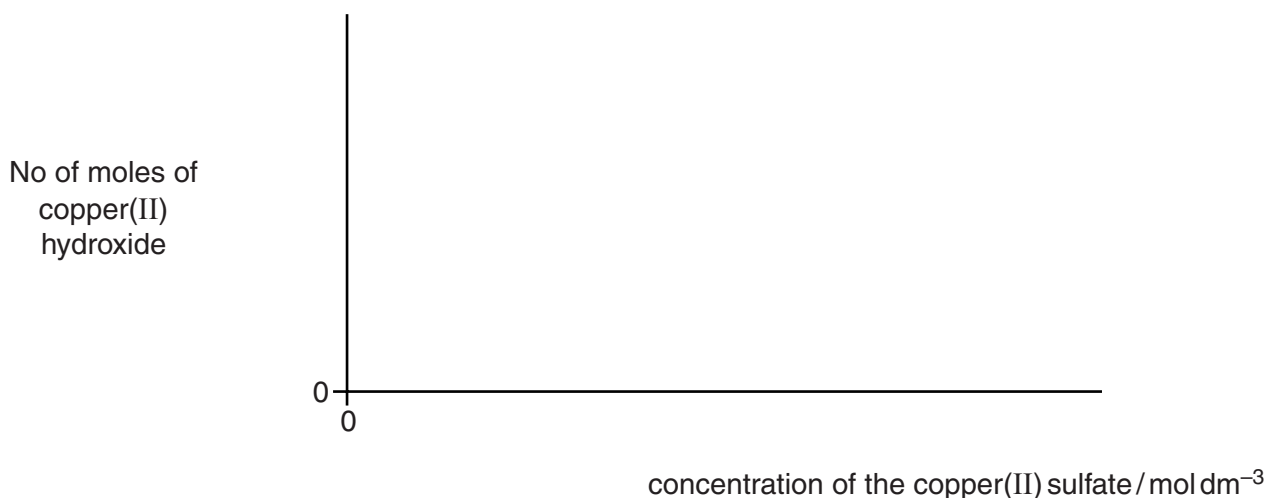
Solutions of concentrations equal to or greater than 0.05 mol dm⁻³ but less than 0.5 mol dm⁻³ are IRRITANT.

You are to plan an experiment to investigate the molar ratio of the equation above and confirm that it remains unchanged as the concentration of the copper(II) sulfate changes.

- (a) (i) Predict quantitatively how the number of moles of the precipitated copper(II) hydroxide varies as the molar concentration of the copper(II) sulfate increases until saturation is reached.

.....
.....
.....

- (ii) Display your prediction in the form of a sketch graph. Remember that you are using 100 cm³ of aqueous copper(II) sulfate. Label clearly the point representing the saturated solution of copper(II) sulfate. A saturated solution at 25°C has a concentration of 1.39 mol dm⁻³. Give appropriate numerical scales to the two axes.



[3]

(b) In the experiment you are about to plan, identify the following.

- (i)** the independent variable
- (ii)** the dependent variable
- (iii)** one other variable to be controlled [2]

(c) Design a laboratory experiment to investigate your prediction in **(a)**.

In addition to the standard apparatus present in a laboratory you are provided with the following materials.

aqueous sodium hydroxide, NaOH (2.0 mol dm^{-3})
solid hydrated copper(II) sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Give a step-by-step description of how you would

- (i)** prepare enough solutions of copper(II) sulfate of an appropriate range of concentrations to give sufficient data to plot a graph as in **(a)(ii)**,
- (ii)** collect and dry the precipitated copper(II) hydroxide,
- (iii)** calculate the molar concentration of one of the solutions of copper(II) sulfate.
[A_r : H, 1.0; O, 16.0; S, 32.1; Cu, 63.5]

[5]

- (d) (i) State two hazards that must be considered when planning the experiment.

.....

.....

.....

- (ii) State a precaution that should be taken to minimise the risk of one of these hazards.

.....

.....

.....[3]

- (e) Draw up a table with appropriate headings to show the data you would record when carrying out your experiments and the values you would calculate in order to construct a graph to support or reject your prediction in (a). The headings should include the appropriate units.

[2]

[Total: 15]

- 2 The variation of the volume with temperature of a fixed mass of an ideal gas at constant pressure may be represented by a relationship known as Charles's law,

$$V = kT$$

where V is the volume of a gas, T is the temperature in Kelvin and k is a constant.

An experiment was carried out to attempt to verify this law.

- A specially adapted gas syringe was filled with a sample of gas. The syringe was placed in a temperature controlled chamber at 25°C and left for 5 minutes. The initial volume of gas at this temperature was 26.0cm^3 .
- The temperature was adjusted and, after leaving for 5 minutes, the change in gas volume for the new temperature was recorded.
- The experiment was repeated several times at different temperatures and the results recorded.

(a) The results of the experiment are recorded below.

Process the results in the table to calculate the volume of the gas and the corresponding temperature in Kelvin to enable you to plot a graph to show their inter-relationship.

(Note 0°C is 273K).

Record these values to **three significant figures** in the additional columns of the table. You may use some or all of the columns.

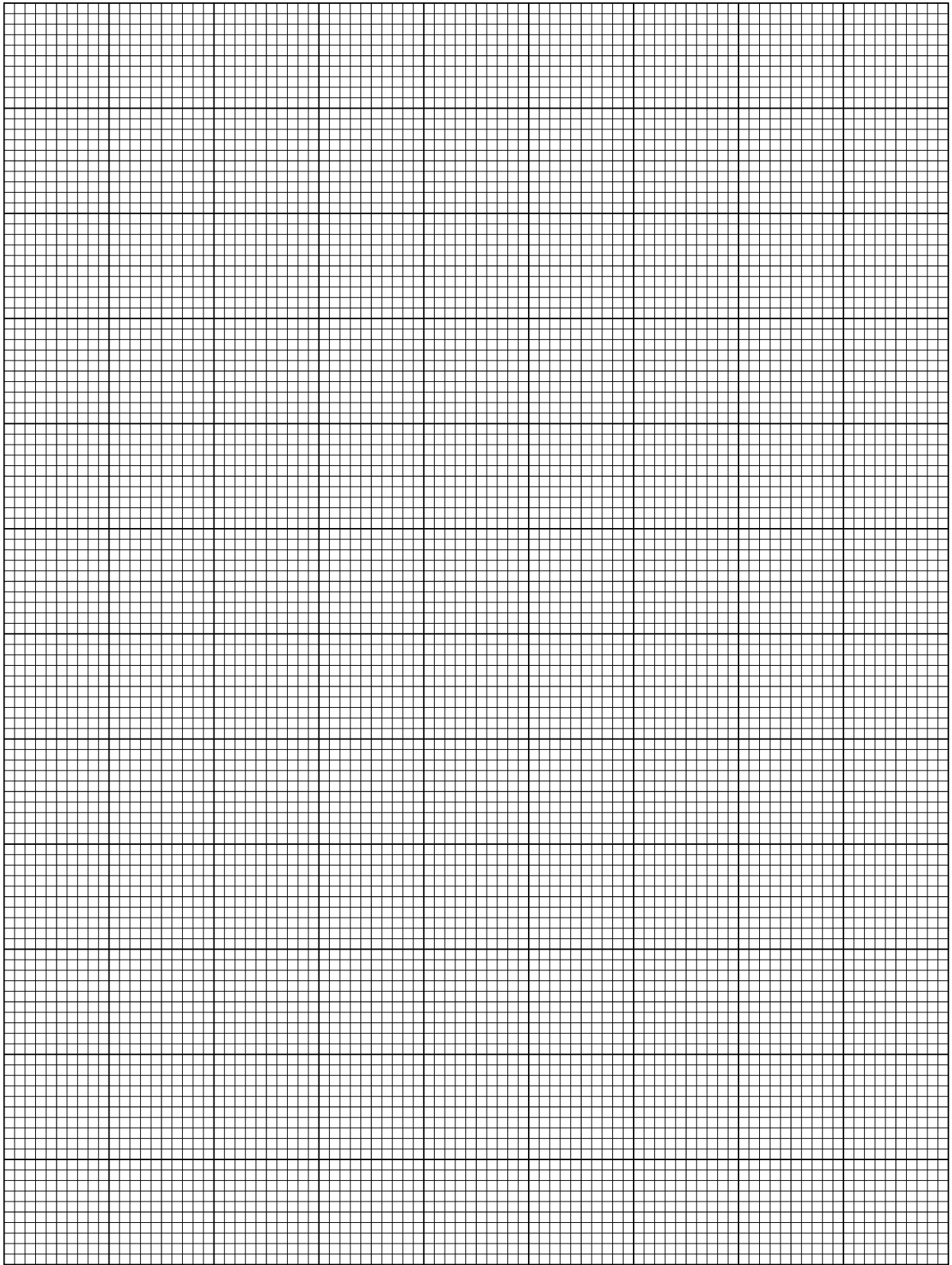
Label the columns you use. For each column you use include units where appropriate and an expression to show how your values are calculated.

You may use the column headings A to E in these expressions (e.g. A–B).

A	B	C	D	E
temperature of the gas / $^{\circ}\text{C}$	change in volume of the gas / cm^3			
–23	–4.20			
–4	–2.50			
11	–2.10			
29	0.40			
42	1.50			
63	3.30			
77	4.50			
94	7.00			
117	8.00			
131	9.20			

[2]

(b) Present the data calculated in **(a)** in graphical form. Draw the line of best fit.



[3]

- (c) Circle and label on the graph any point(s) you consider to be anomalous. For each anomalous point give a different reason why it is anomalous, clearly indicating which point(s) you are describing.

For
Examiner's
Use

.....

.....

.....

.....

.....

.....[3]

- (d) (i) Determine the slope of the graph. Mark clearly on the graph any construction lines and show clearly in your calculation how the intercepts were used in the calculation of the slope.

- (ii) Record the volume of the gas at 273K.

[3]

- (e) Comment on the reliability of the data provided in (a).

[1]

- (f) Indicate whether the results do or do not confirm Charles's law.

For
Examiner's
Use

.....

Give a reason for your answer.

.....

.....

.....

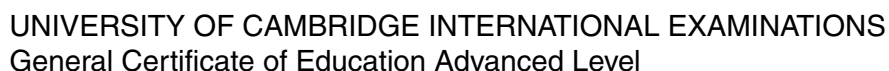
.....[2]

- (g) As the pressure of a gas is reduced its volume increases. On your graph on page 6 draw another line showing how the volume varies with temperature if the experiment were repeated using the same fixed mass of gas at a lower pressure. [1]

[Total: 15]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9701/52

May/June 2012

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

Use of a Data Booklet is unnecessary.

The number of marks is given in brackets [] at the end of each question or part question.

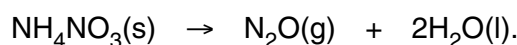
For Examiner's Use	
1	
2	
Total	

This document consists of **11** printed pages and **1** blank page.

- 1 When ammonium nitrate(V), NH_4NO_3 , is heated it decomposes completely into nitrogen(I) oxide, N_2O , and water vapour, H_2O , which if allowed to cool will condense to liquid water.

For
Examiner's
Use

The stoichiometric equation for this decomposition is



The following information gives some of the hazards associated with ammonium nitrate(V).

Ammonium nitrate(V) NH_4NO_3

Oxidising: Contact with combustible material may cause fire. Explosive when mixed with combustible material.

Do not allow the salt to become contaminated with organic matter and do not grind it.

You are to plan an experiment to investigate the molar ratio of nitrogen(I) oxide and ammonium nitrate(V) at 25°C , and confirm that it remains unchanged as the mass of ammonium nitrate(V) changes.

- (a) (i) Predict quantitatively how the number of moles of nitrogen(I) oxide varies as the number of moles of ammonium nitrate(V) increases, if the products are measured at room temperature 25°C .

.....

.....

.....

.....

- (ii) Predict quantitatively how the sum of the number of moles of water vapour and nitrogen(I) oxide varies as the number of moles of ammonium nitrate(V) increases, if the products are measured at 110°C .

.....

.....

.....

.....

- (iii) Display both your predictions in the form of sketch graphs on the axes below. Label clearly each axis and each graph line.

*For
Examiner's
Use*



[3]

(b) In the experiment you are about to plan to test your prediction in **(a)(i)** at 25 °C, identify the following.

(i) the independent variable

(ii) the dependent variable [2]

(c) Draw a diagram of the apparatus and the experimental set up you would use to carry out this experiment. Your apparatus should use only standard items found in a school or college laboratory and show clearly

(i) how the solid will be heated,

(ii) how the water vapour will be condensed into a liquid and collected. Ice is available,

(iii) how the nitrogen(I) oxide will be collected.

Label each piece of apparatus used, indicating its size or capacity.

[3]

- (d) Using the apparatus shown in (c) design a laboratory experiment to test your prediction in (a)(i) for an experiment at 25 °C.

For
Examiner's
Use

In addition to the standard apparatus present in a laboratory you are provided with the following materials.

a sample of solid ammonium nitrate(V)
crushed ice

Give a step-by-step description of how you would carry out the experiment,

- (i) to produce enough results to give sufficient data to plot a graph as in (a)(iii),
 - (ii) by stating the volumes of nitrogen(I) oxide you would collect,
 - (iii) by calculating the mass of ammonium nitrate(V) needed to produce one of the volumes of nitrogen(I) oxide suggested in (ii),
 - (iv) by stating how you would ensure that decomposition was complete.
- [A_r : H, 1.0; N, 14.0; O, 16.0; the molar volume of a gas at 25 °C, 24.0 dm³]

[4]

- (e) State one hazard that must be considered when planning the experiment and describe a precaution that should be taken to minimise the risk from this hazard.

For
Examiner's
Use

.....

.....

.....

.....[1]

- (f) Draw a table with appropriate headings to show the data you would record when carrying out your experiments and the values you would calculate in order to construct a graph to support or reject your prediction in (a)(i). The headings should include the appropriate units.

[2]

[Total: 15]

- 2 The variation of the volume with pressure of a fixed mass of any ideal gas at constant temperature may be represented by a relationship known as Boyle's law,

For
Examiner's
Use

$$PV = \text{constant}$$

where P is the pressure of the gas, V is the volume of the gas.

A gas such as carbon dioxide, under certain conditions of temperature and pressure, does not always behave as an ideal gas.

An experiment was carried out on carbon dioxide to investigate its behaviour.

- A calibrated glass tube was filled with a sample of carbon dioxide.
- The tube was attached to a calibrated pressure pump.
- The pressure and the volume of the gas sample were recorded.
- The measured pressure on the gas was increased and the new volume recorded.

- (a) The results of the experiment are recorded in the table below.

A graph of V against P has been plotted for you.

Process the results in the table to enable you to plot two further graphs:

- PV against P
- $1/V$ against P

Record these values to **three significant figures** in the additional columns of the table.

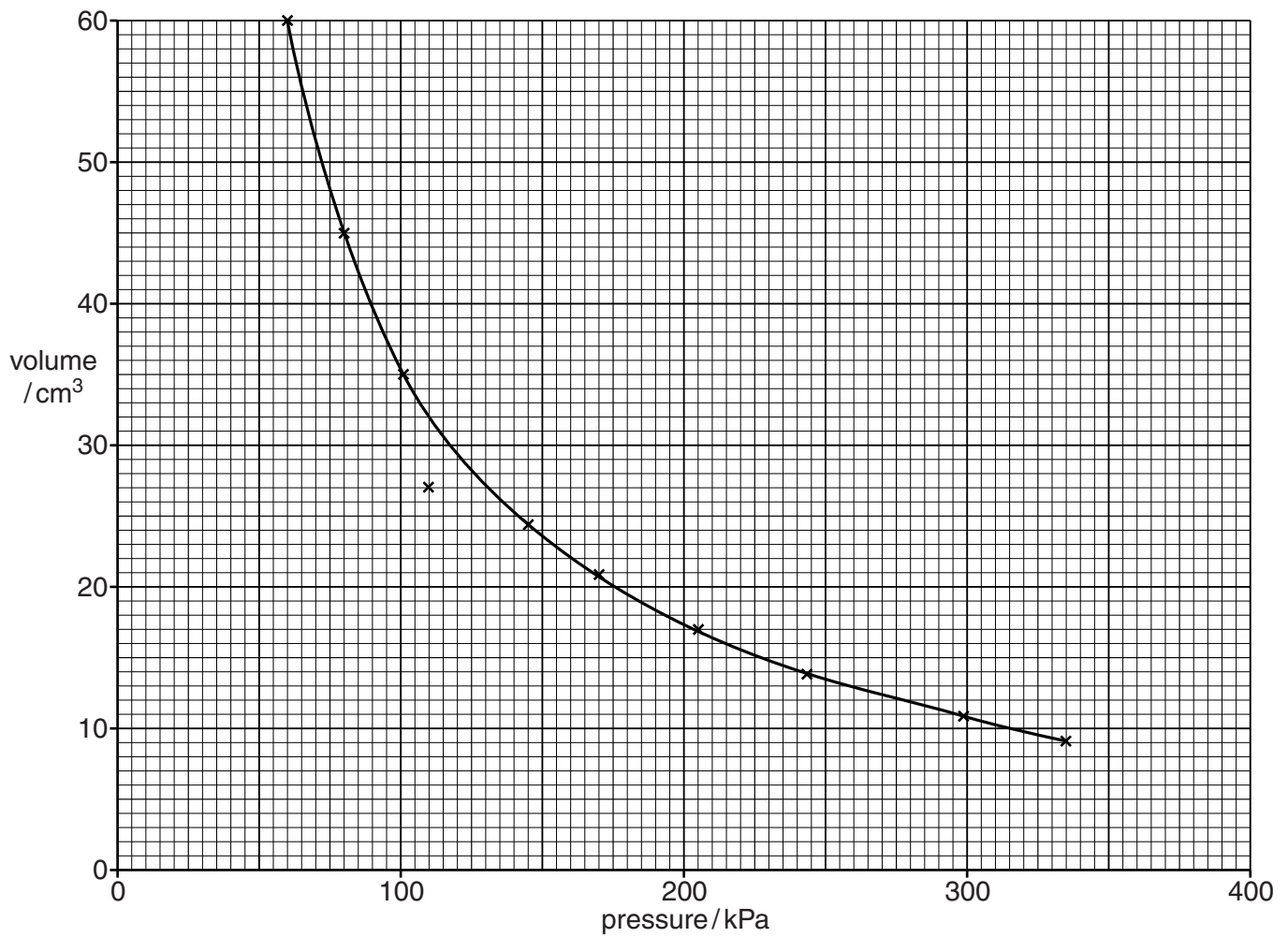
Label the columns you use. For each column you use include units where appropriate and an expression to show how your values are calculated.

You may use the column headings A to D for these expressions (e.g. A–B).

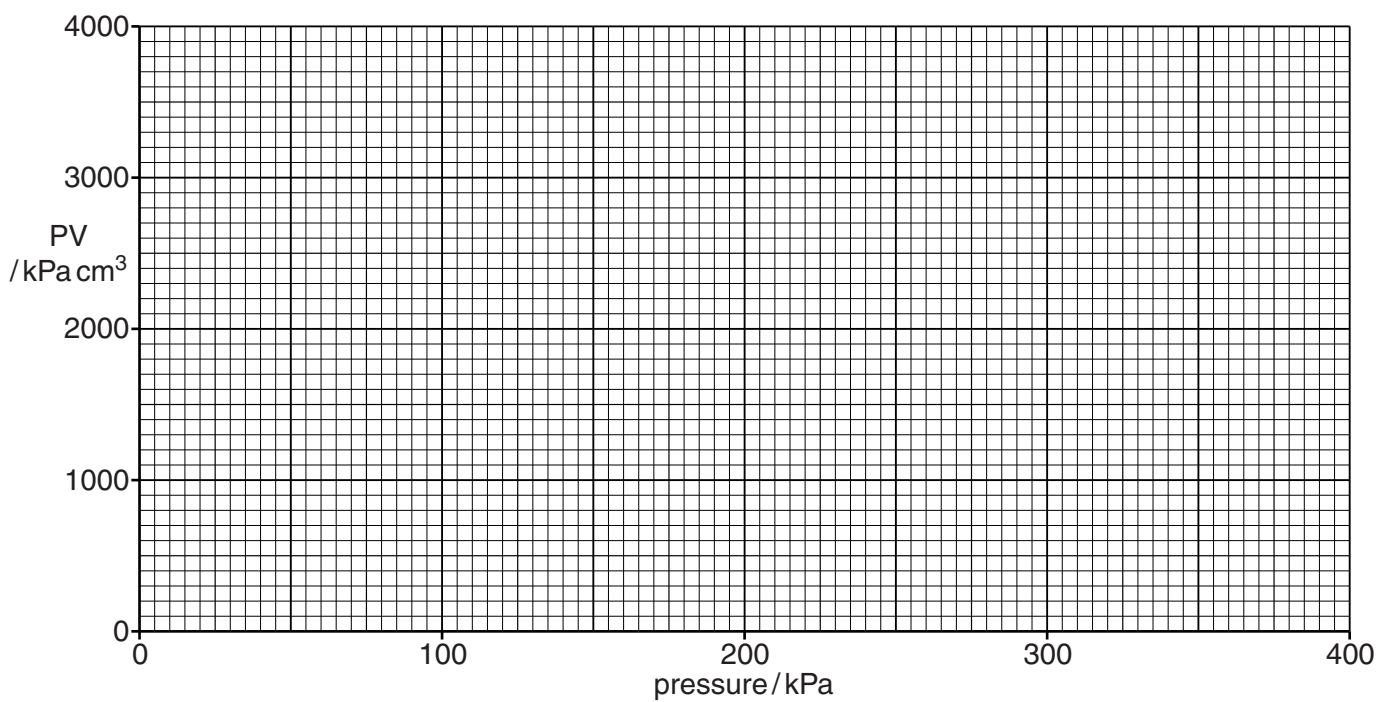
A	B	C	D
pressure of the gas/kPa	volume of the gas/cm ³		
335	9.09		
298	10.9		
243	13.9		
205	17.0		
170	20.8		
145	24.4		
110	27.0		
101	35.0		
80.0	45.5		
60.0	60.0		

[2]

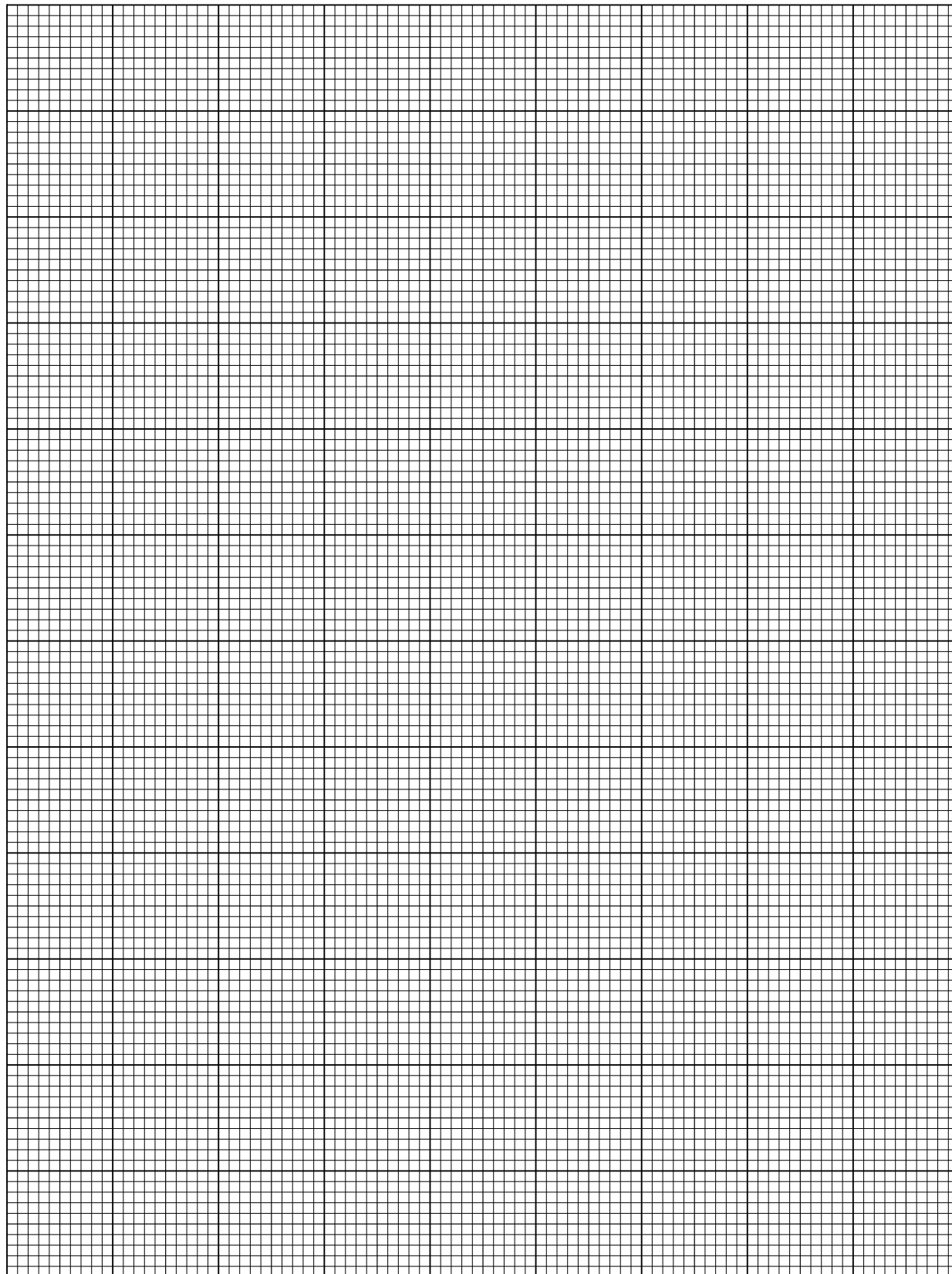
This graph shows the relationship between the volume of the gas and the pressure of the gas.



(b) Plot a graph to show the relationship between the product of the pressure and volume, PV , of the gas and the pressure, P , of the gas. Draw the line of best fit.



- (c) Plot a graph to show the relationship between the reciprocal of the volume of the gas and the pressure ($1/V$ against P) of the gas. Begin the scales on both axes at 0. Draw the line or curve of best fit.



[3]

- (d) Circle and label on the graph in (c) any point(s) you consider to be anomalous. For each anomalous point give a different reason why it is anomalous, clearly indicating which point(s) you are describing.

For
Examiner's
Use

.....

.....

.....

.....

.....[2]

- (e) Determine the initial slope of the graph in (c). Mark clearly on the graph any construction lines and show in your calculation how the intercepts were used in the calculation of the slope.

[2]

- (f) (i) Does the initial shape of your graph in (c) confirm the equation $PV = \text{constant}$?

.....

- (ii) Explain your answer in (i) above.

.....

.....

.....

.....

- (iii) Why is the graph of volume against pressure provided inappropriate for the verification of Boyle's law?

[3]

- (g) (i) Explain why it was important to measure the initial slope of the graph in (e).

For
Examiner's
Use

.....

.....

.....

- (ii) What is the significance of the value of the initial slope?

.....

.....

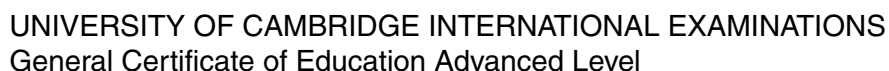
..... [2]

[Total: 15]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

9701/53

May/June 2012

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

Use of a Data Booklet is unnecessary.

The number of marks is given in brackets [] at the end of each question or part question.

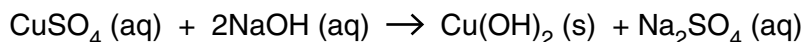
For Examiner's Use	
1	
2	
Total	

This document consists of **8** printed pages.

- 1 When an excess of aqueous sodium hydroxide, NaOH, is added to 100 cm³ of aqueous copper(II) sulfate, CuSO₄, a precipitate of copper(II) hydroxide, Cu(OH)₂, is produced.

For
Examiner's
Use

The stoichiometric equation for this reaction is,



The following information gives some of the hazards associated with these reactants.

Copper(II) sulfate (solid hydrated copper(II) sulfate CuSO₄·5H₂O)

Harmful. Dangerous for the environment.

Harmful if swallowed. Irritating to eyes and skin.

Solutions of concentrations equal to or greater than 1 mol dm⁻³ should be labelled HARMFUL.

Sodium hydroxide (solid NaOH)

Corrosive. Solutions of concentrations equal to or greater than 0.5 mol dm⁻³ are CORROSIVE.

Solutions of concentrations equal to or greater than 0.05 mol dm⁻³ but less than 0.5 mol dm⁻³ are IRRITANT.

You are to plan an experiment to investigate the molar ratio of the equation above and confirm that it remains unchanged as the concentration of the copper(II) sulfate changes.

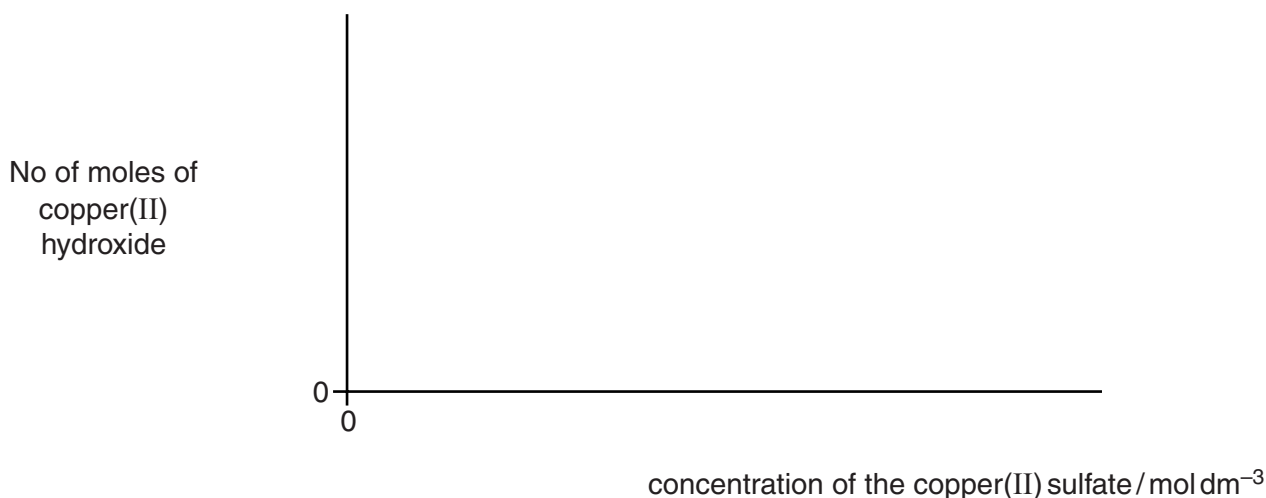
- (a) (i) Predict quantitatively how the number of moles of the precipitated copper(II) hydroxide varies as the molar concentration of the copper(II) sulfate increases until saturation is reached.

.....

.....

.....

- (ii) Display your prediction in the form of a sketch graph. Remember that you are using 100 cm³ of aqueous copper(II) sulfate. Label clearly the point representing the saturated solution of copper(II) sulfate. A saturated solution at 25°C has a concentration of 1.39 mol dm⁻³. Give appropriate numerical scales to the two axes.



[3]

(b) In the experiment you are about to plan, identify the following.

- (i)** the independent variable
- (ii)** the dependent variable
- (iii)** one other variable to be controlled [2]

(c) Design a laboratory experiment to investigate your prediction in **(a)**.

In addition to the standard apparatus present in a laboratory you are provided with the following materials.

aqueous sodium hydroxide, NaOH (2.0 mol dm^{-3})
solid hydrated copper(II) sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

Give a step-by-step description of how you would

- (i)** prepare enough solutions of copper(II) sulfate of an appropriate range of concentrations to give sufficient data to plot a graph as in **(a)(ii)**,
- (ii)** collect and dry the precipitated copper(II) hydroxide,
- (iii)** calculate the molar concentration of one of the solutions of copper(II) sulfate.
[A_r : H, 1.0; O, 16.0; S, 32.1; Cu, 63.5]

[5]

- (d) (i) State two hazards that must be considered when planning the experiment.

.....

.....

.....

- (ii) State a precaution that should be taken to minimise the risk of one of these hazards.

.....

.....

.....[3]

- (e) Draw up a table with appropriate headings to show the data you would record when carrying out your experiments and the values you would calculate in order to construct a graph to support or reject your prediction in (a). The headings should include the appropriate units.

[2]

[Total: 15]

- 2 The variation of the volume with temperature of a fixed mass of an ideal gas at constant pressure may be represented by a relationship known as Charles's law,

$$V = kT$$

where V is the volume of a gas, T is the temperature in Kelvin and k is a constant.

An experiment was carried out to attempt to verify this law.

- A specially adapted gas syringe was filled with a sample of gas. The syringe was placed in a temperature controlled chamber at 25°C and left for 5 minutes. The initial volume of gas at this temperature was 26.0cm^3 .
- The temperature was adjusted and, after leaving for 5 minutes, the change in gas volume for the new temperature was recorded.
- The experiment was repeated several times at different temperatures and the results recorded.

(a) The results of the experiment are recorded below.

Process the results in the table to calculate the volume of the gas and the corresponding temperature in Kelvin to enable you to plot a graph to show their inter-relationship.

(Note 0°C is 273K).

Record these values to **three significant figures** in the additional columns of the table. You may use some or all of the columns.

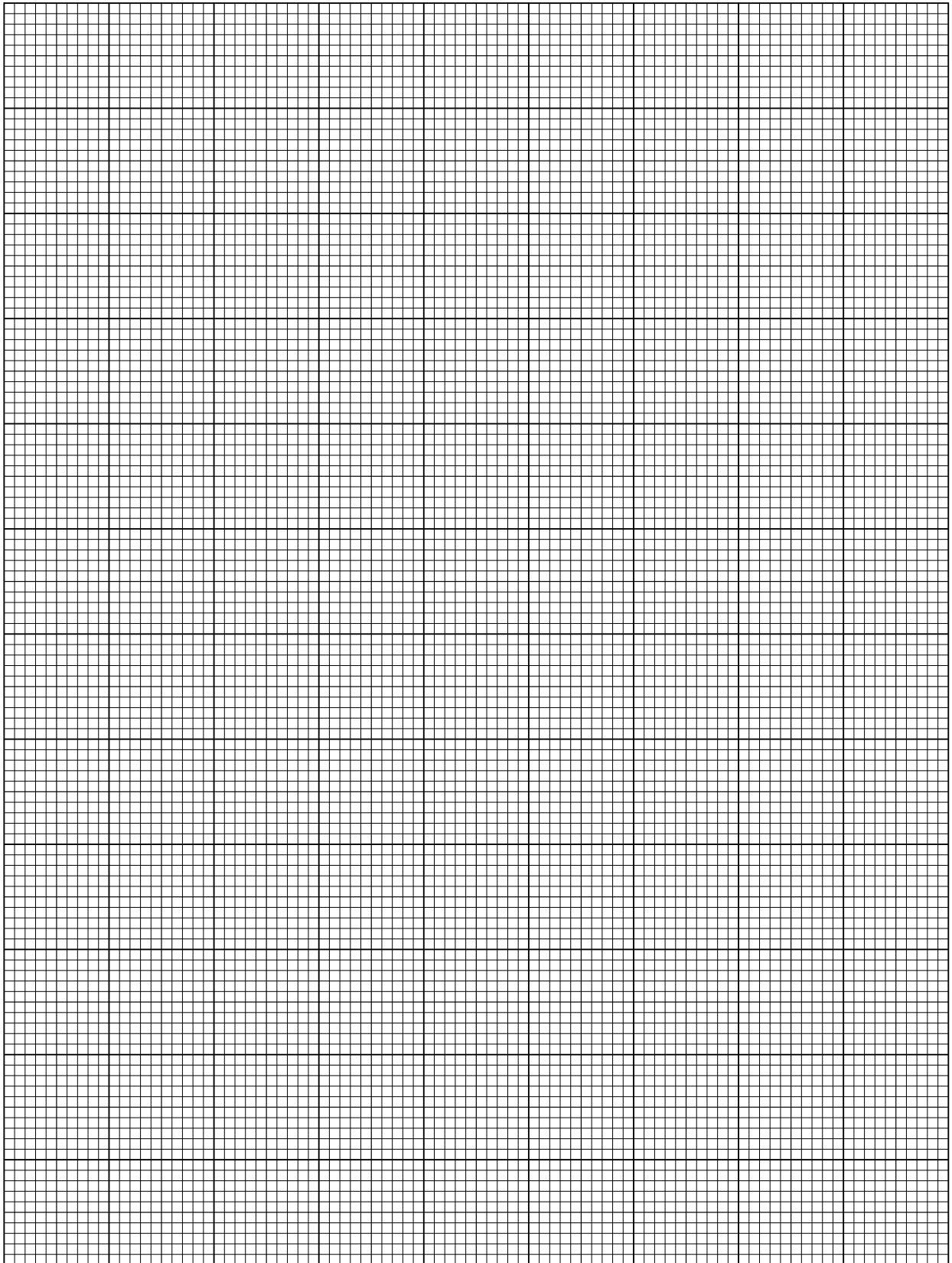
Label the columns you use. For each column you use include units where appropriate and an expression to show how your values are calculated.

You may use the column headings A to E in these expressions (e.g. A–B).

A	B	C	D	E
temperature of the gas $/^{\circ}\text{C}$	change in volume of the gas $/\text{cm}^3$			
–23	–4.20			
–4	–2.50			
11	–2.10			
29	0.40			
42	1.50			
63	3.30			
77	4.50			
94	7.00			
117	8.00			
131	9.20			

[2]

(b) Present the data calculated in (a) in graphical form. Draw the line of best fit.



[3]

- (c) Circle and label on the graph any point(s) you consider to be anomalous. For each anomalous point give a different reason why it is anomalous, clearly indicating which point(s) you are describing.

For
Examiner's
Use

.....

.....

.....

.....

.....

.....[3]

- (d) (i) Determine the slope of the graph. Mark clearly on the graph any construction lines and show clearly in your calculation how the intercepts were used in the calculation of the slope.

- (ii) Record the volume of the gas at 273K.

[3]

- (e) Comment on the reliability of the data provided in (a).

[1]

- (f) Indicate whether the results do or do not confirm Charles's law.

For
Examiner's
Use

.....

Give a reason for your answer.

.....

.....

.....

.....[2]

- (g) As the pressure of a gas is reduced its volume increases. On your graph on page 6 draw another line showing how the volume varies with temperature if the experiment were repeated using the same fixed mass of gas at a lower pressure. [1]

[Total: 15]

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.