Surname	Centre Number	Candidate Number
Other Names		0

GCSE

C410U10-1

S19-C410U10-1

THURSDAY, 16 MAY 2019 – MORNING

CHEMISTRY – Component 1
Concepts in Chemistry

FOUNDATION TIER

2 hours 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**5**	
3.	**8**	
4.	**9**	
5.	**9**	
6.	**9**	
7.	**5**	
8.	**9**	
9.	**8**	
10.	**5**	
11.	**6**	
12.	**10**	
13.	**7**	
14.	**7**	
15.	**7**	
16.	**9**	
Total	**120**	

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ADDITIONAL MATERIALS

In addition to this paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

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

Question **9***(a)* is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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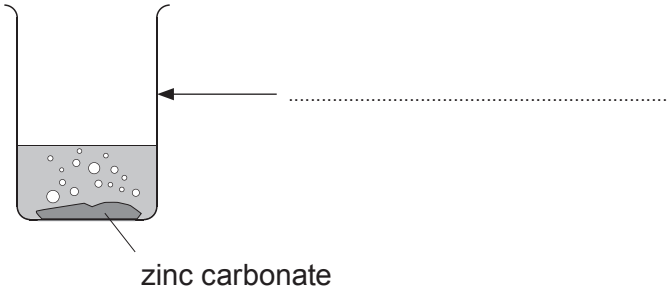
Answer **all** *questions*.

1. David carried out an experiment to prepare a sample of zinc chloride crystals.

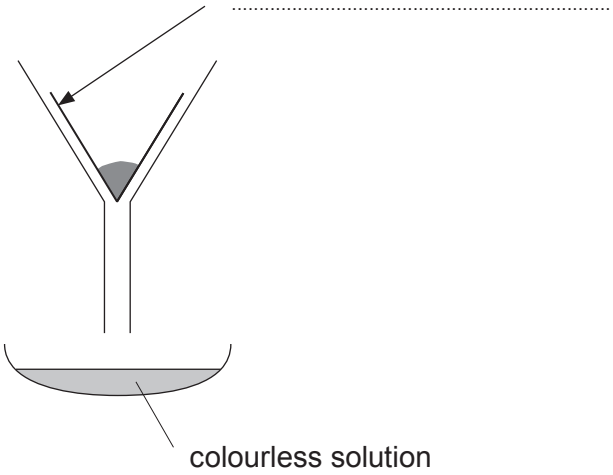
(a) Complete the labelling on the diagrams. Choose apparatus from the box. [3]

evaporating basin	**conical flask**	**filter funnel**	**filter paper**	**beaker**

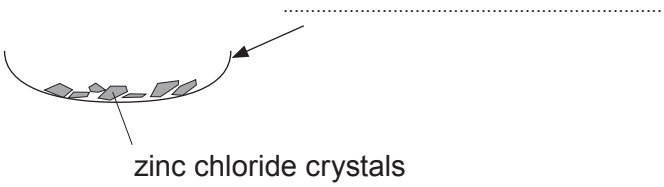
Stage 1
add zinc carbonate to dilute hydrochloric acid until no more reacts



Stage 2
remove the unreacted zinc carbonate



Stage 3
obtain crystals of zinc chloride



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(b) The gas formed in **stage 1** turns limewater milky. Underline the name of this gas. [1]

oxygen **hydrogen** **carbon dioxide** **nitrogen**

(c) Give **one** way that David would know that the reaction has stopped in **stage 1**. [1]

.....

(d) Name the process used to remove water in **stage 3**. Choose your answer from the box. [1]

boiling	**distillation**	**evaporation**	**filtration**

.....

(e) Zinc chloride contains the ions Zn^{2+} and Cl^{-}.

Underline the correct formula for zinc chloride. [1]

ZnCl **$ZnCl_2$** **Zn_2Cl** **Zn2Cl**

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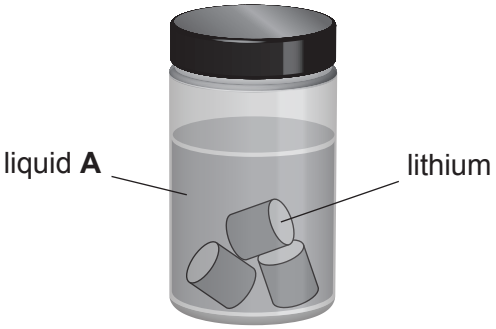
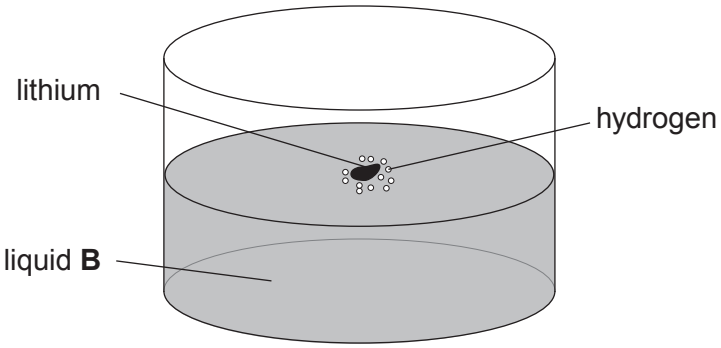
2. *(a)* The diagrams show the storage and some reactions of lithium.

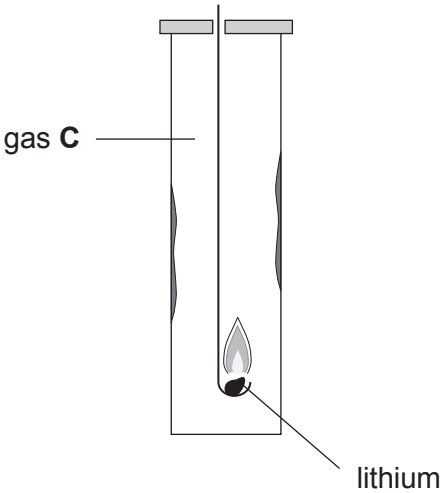
Lithium stored in liquid **A**



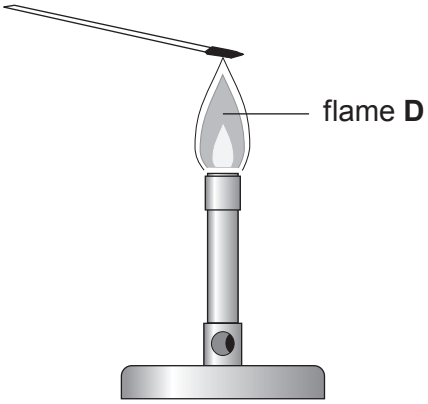
Lithium reacts quickly with liquid **B** forming hydrogen gas and lithium hydroxide solution



Lithium forms lithium chloride when burned in gas **C**



A flame test using lithium chloride gives coloured flame **D**



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Use **only** words from the box to answer parts (i) and (ii).

oxygen	**hydrogen**	**water**	**lilac**	**bromine**
oil	**yellow**	**chlorine**	**red**	

(i) Give the names of the following. [3]

liquid **A** .....

liquid **B** .....

gas **C** .....

(ii) Give the colour of flame **D**. [1]

.....

(b) Lithium reacts with oxygen to form lithium oxide.

Write the **formula** for lithium oxide to complete the equation. [1]

$4Li + O_2 \longrightarrow 2$ .....

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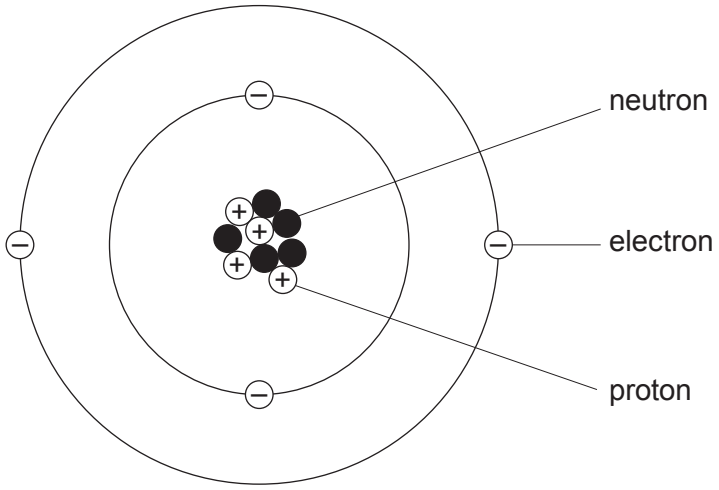
3. *(a)* The diagram shows an atom of beryllium.



Use the information in the diagram to complete the following sentences. [5]

..... and ..... are found in the nucleus of the beryllium atom.

..... and ..... have equal but opposite charges.

The atomic number of beryllium is .....

The mass number of beryllium is .....

The electronic structure of beryllium is (..... , ...).

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(b) Complete the following sentence by underlining the correct words. [1]

The radius of the beryllium atom is (**smaller than** / **bigger than** / **the same as**) the radius of the nucleus.

(c) Calculate the relative formula mass (M_r) of beryllium carbonate, $BeCO_3$. [2]

A_r(Be) = 9 A_r(C) = 12 A_r(O) = 16

M_r = ...

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4. *(a)* The table shows the melting point and boiling point of some elements.

Element	Melting point (°C)	Boiling point (°C)
sulfur	114	444
carbon	3550	4827
oxygen	−218	−182
lead	327	1749
mercury	−39	357
phosphorus	44	280

Use **only** information from the table to answer parts (i)-(iii).

(i) Name the element with the **lowest** melting point. [1]

.....

(ii) Name the element which is a liquid at 20 °C. [1]

.....

(iii) Give the temperature at which phosphorus turns from a solid to a liquid. [1]

..... °C

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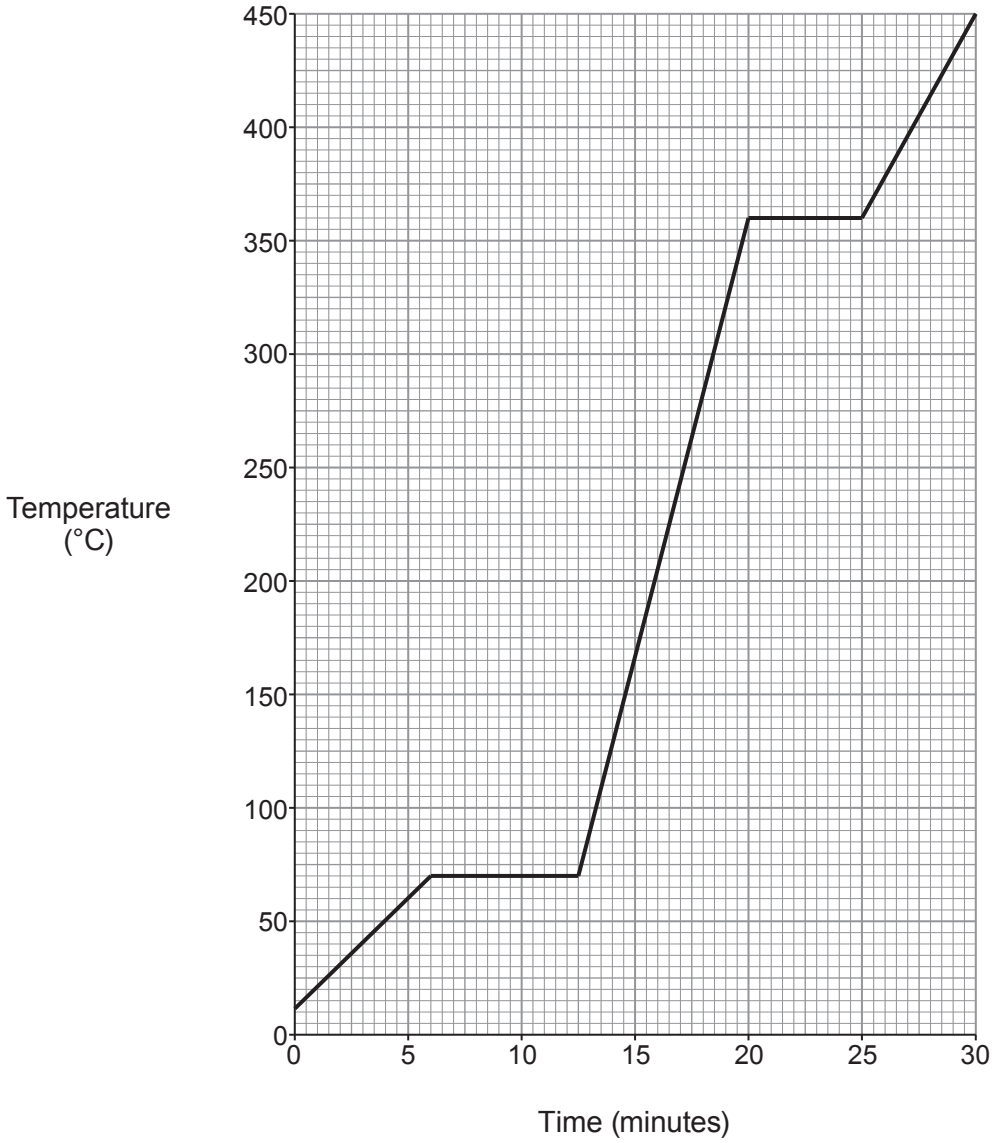
(b) In an experiment stearic acid was heated and the temperature recorded using a temperature sensor. The results are shown on the grid.



Use the graph to answer parts (i) and (ii).

(i) Give the melting point of stearic acid. [1]

..... °C

(ii) Give the state (**solid**, **liquid** or **gas**) of stearic acid after 28 minutes. [1]

.....

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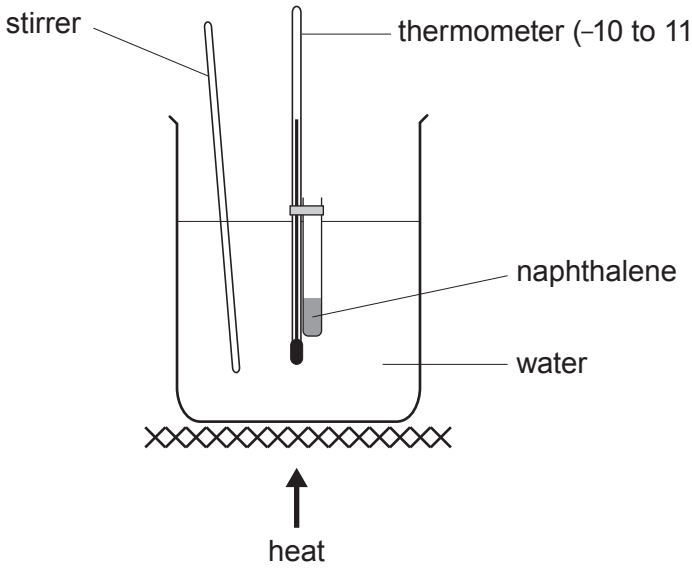
(c) The melting point of pure naphthalene is 80 °C. The apparatus below can be used to measure it.



The melting point of benzoic acid is 120 °C. State **two** changes to the apparatus that would be needed to measure the melting point of benzoic acid. Give the reason for each change. [4]

Change 1

.....

.....

Reason

.....

.....

Change 2

.....

.....

Reason

.....

.....

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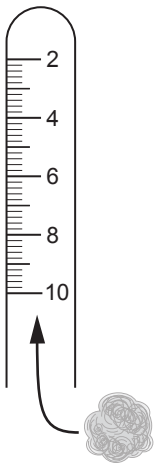
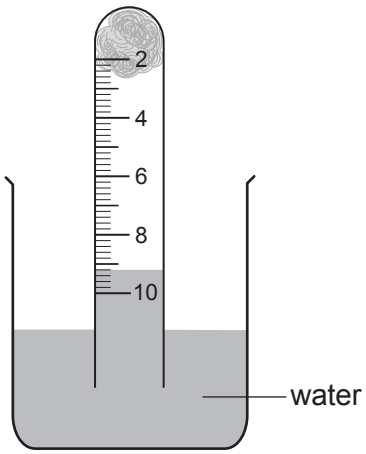
5. *(a)* The diagrams show the apparatus a student used to find the percentage of oxygen in air.

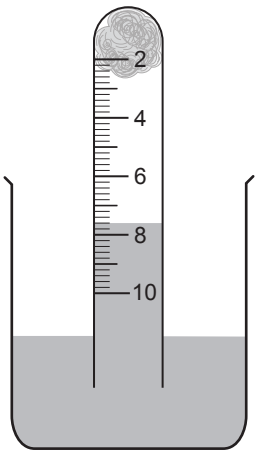


A ball of iron wool was pushed to the bottom of a 10 cm^3 graduated test tube



The volume of air in the test tube at the start was recorded

Volume of air = 9.2 cm^3



After 1 week, the volume of air in the tube was recorded again

Volume of air = 7.6 cm^3

(i) When iron reacts with oxygen, iron(III) oxide is formed.

I. What is the symbol for an iron(III) ion? ..... [1]

II. Give the chemical formula for iron(III) oxide. ..... [1]

(ii) Using the student's results, calculate the percentage of oxygen in air. [3]

Percentage = ... %

(iii) The student's result is not accurate. Put a tick (✓) in the box next to the statement which **best** describes what the student should do to improve the result. [1]

leave the experiment for 1 more day ☐

leave the experiment until all the iron wool has been used up ☐

leave the experiment until the water level in the tube starts to fall ☐

leave the experiment until the water level in the tube stops rising ☐

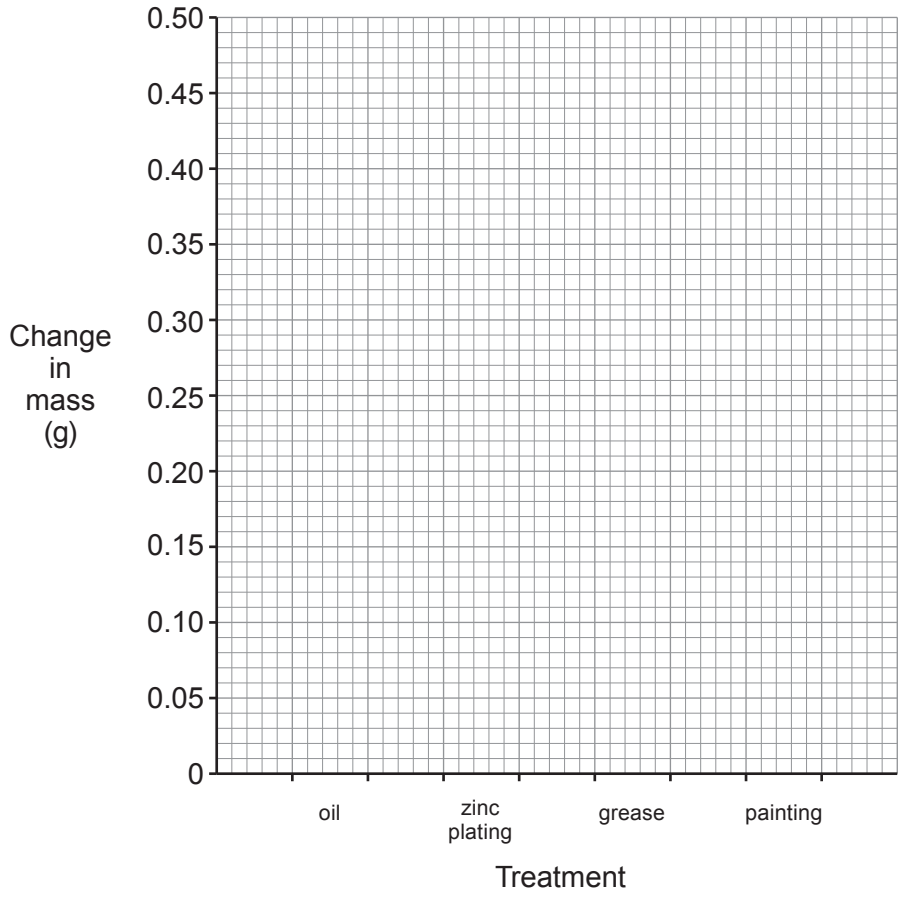
Examiner only

(b) The rusting of four identical nails was investigated by treating each nail as shown in the table.

All four nails were left exposed to the atmosphere for several weeks.

Nail	Treatment	Mass of nail and coating **before** exposure to the atmosphere (g)	Mass of nail and coating **after** exposure to the atmosphere (g)	Change in mass (g)
A	oil	2.00	2.36	0.36
B	zinc plating	2.00	2.00	0.00
C	grease	2.00	2.44	0.44
D	painting	2.00	2.22	0.22

(i) Draw a **bar chart** showing the **change in mass**, if any, for all four nails. [2]



(ii) Which treatment is the **least** effective at preventing rusting? [1]

.....

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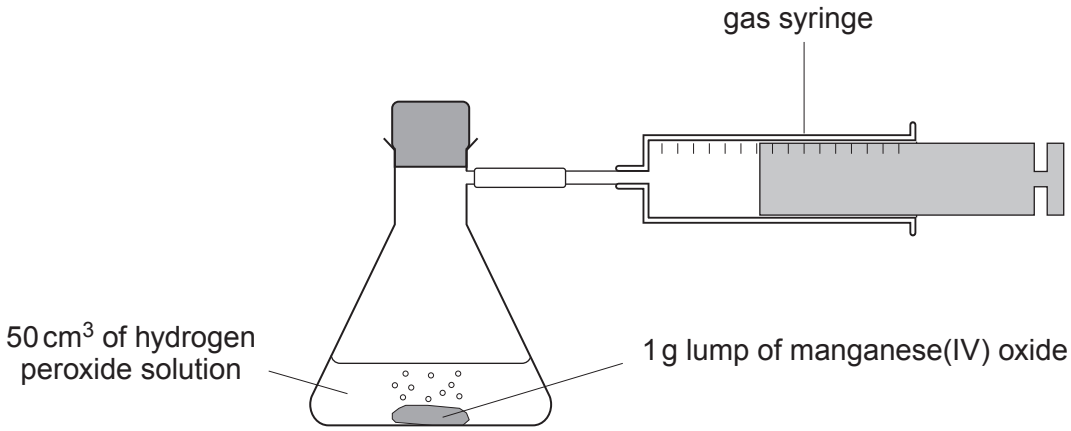
6. Hydrogen peroxide solution breaks down slowly into water and oxygen, O_2, at room temperature.

(a) Complete and balance the equation for this reaction. [2]

$$2H_2O_2 \longrightarrow \text{.....} + \text{.....}$$

(b) Manganese(IV) oxide acts as a catalyst for this reaction.

A 1 g lump of manganese(IV) oxide was added to 50 cm^3 of hydrogen peroxide solution and the volume of oxygen formed was recorded every 20 seconds.

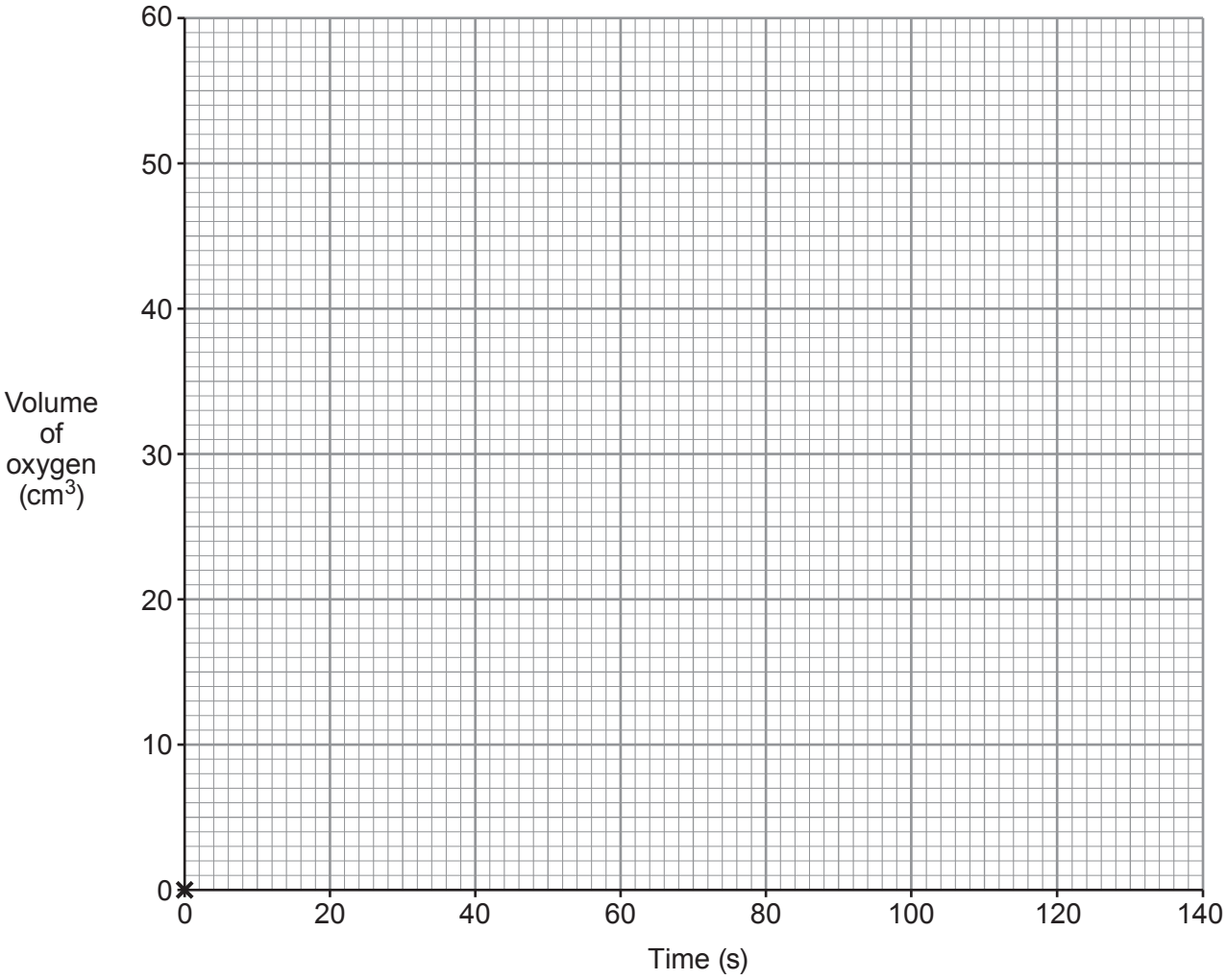


The table shows the results.

Time (s)	0	20	40	60	80	100	120
Volume of oxygen (cm^3)	0	28	42	48	50	50	50

Plot the results on the grid below. Draw a suitable line. [2]

(0,0) has been plotted for you.



(c) **Use the graph** to answer parts (i) and (ii).

(i) Give the volume of gas produced in 24 seconds. [1]

..... cm^3

(ii) Give the time taken for the reaction to end. [1]

..... s

(d) **Sketch on the grid** the graph you would expect if the experiment were repeated using 1 g of manganese(IV) oxide **powder**. [2]

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(e) Put a tick (✓) in the box next to the statement which describes why a catalyst speeds up a reaction. [1]

a catalyst lowers the minimum energy required for successful collisions ☐

a catalyst raises the maximum energy required for successful collisions ☐

a catalyst lowers the maximum energy required for successful collisions ☐

a catalyst raises the minimum energy required for successful collisions ☐

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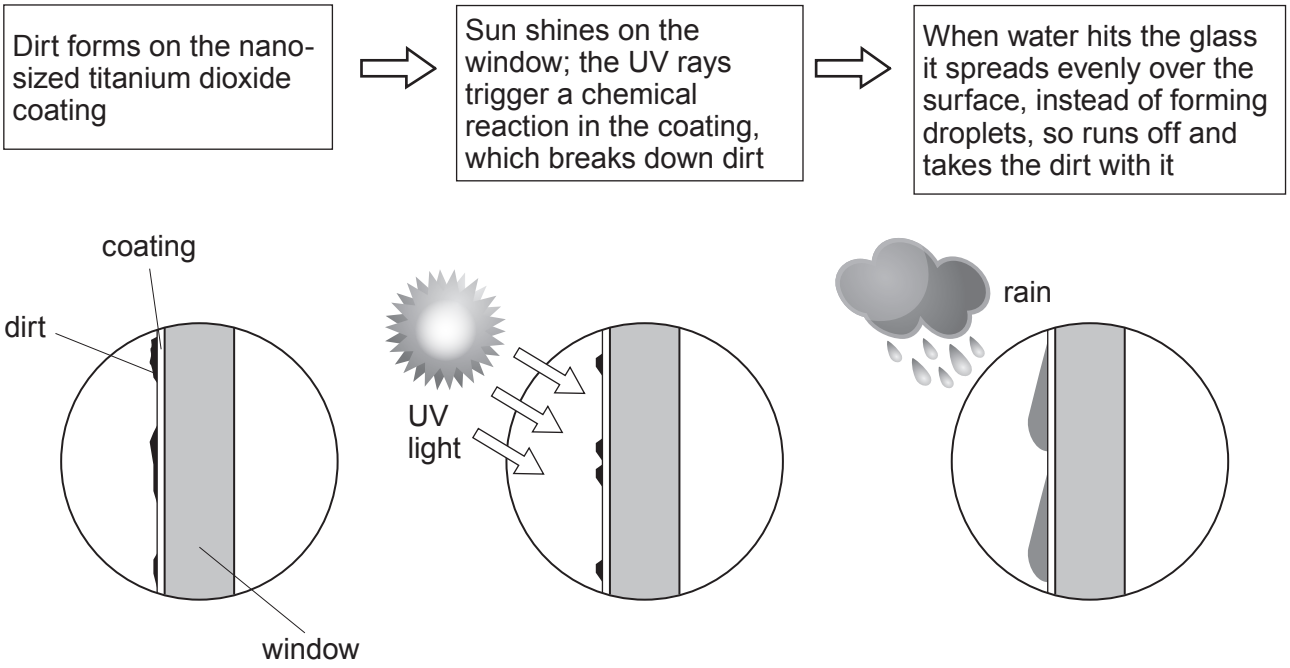
7. Titanium dioxide is a white powder that is widely used as a pigment in paints and food colourings.

Self-cleaning windows use nano-sized titanium dioxide. A 15 nm layer of nano-sized titanium dioxide becomes transparent when it is applied to glass. Self-cleaning glass reduces the need for detergents.

The flow chart shows how self-cleaning windows work.



(a) State why nano-sized titanium dioxide is suitable for self-cleaning windows. [1]

.....

.....

(b) Put the following lengths in order, from the smallest to the largest. [1]

15 mm **15 nm** **15 m**

Smallest .....

.....

Largest .....

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(c) Tick (✓) the boxes next to **two** correct statements. [2]

nano-sized titanium dioxide prevents dirt forming on windows ☐

nano-sized titanium dioxide breaks down dirt in wet weather ☐

nano-sized titanium dioxide breaks down dirt when exposed to UV light ☐

nano-sized titanium dioxide prevents the formation of water droplets ☐

(d) State why using less detergent is beneficial for the environment. [1]

.....

.....

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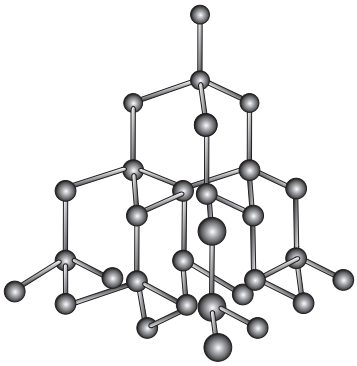
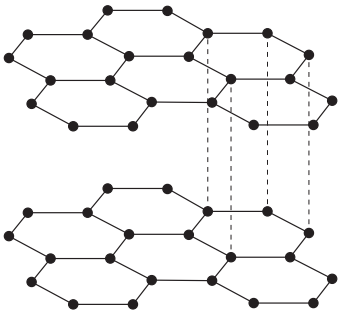
8. *(a)* The diagrams show two different forms of carbon – diamond and graphite.



diamond



graphite

electrical conductor	**electrical insulator**	**transparent**	**soft**	**hard**
drill bits	**wires**	**electrodes**	**catalyst**	

Use information from the box to answer part (i).

(i) For each form of carbon give **one** property and **one** use which relies on this property. [4]

Diamond

.....

.....

Graphite

.....

.....

(ii) Name the type of bonding in both forms of carbon. [1]

.....

(iii) The diameter of a carbon atom is 0.1 nm.

Underline the factor represented by the letter 'n'. [1]

10^{-9} **10^{-6}** **10^{-3}**

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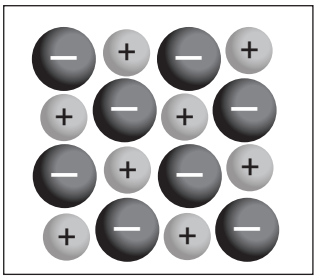
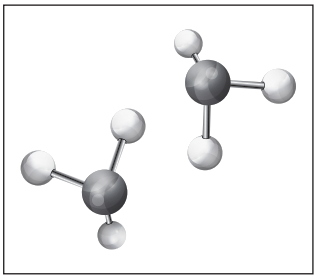
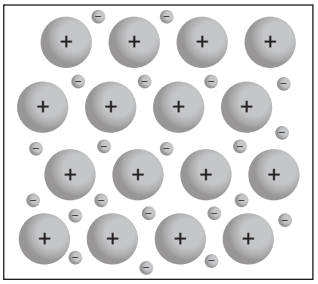
(b) Sodium, ammonia and sodium chloride have different structures and bonding.

Draw **one** line to connect each substance to its structure and a **second** line to connect each structure to its bonding. [3]

Substance	Structure	Bonding
sodium		strong bonding between positive ions and a sea of electrons
ammonia		weak bonding between individual molecules
sodium chloride		strong bonding between oppositely charged ions

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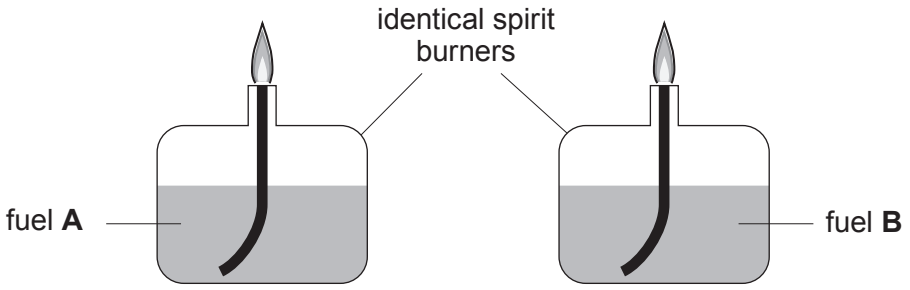
9. *(a)* A group of students are investigating two fuels which are both liquids. Fuel **A** releases more energy per gram than fuel **B**.



Describe a fair test experiment you would carry out to compare the energy released per gram of each fuel. State how the **results** would show that fuel **A** releases more energy per gram than fuel **B**. [6 QER]

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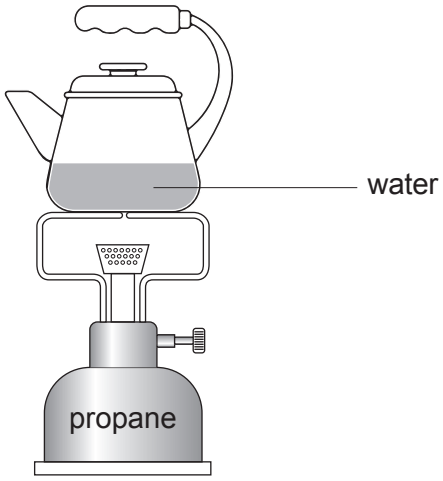
(b) Propane gas is used in camping stoves.



Propane released 672 000 J of energy when heating a kettle of water from 20 to 100 °C.

The energy given out when a fuel burns can be calculated using the formula

energy given out = mass of water × 4.2 × temperature change

Calculate the mass of water in the kettle. [2]

Mass = ... g

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10. Crude oil is a mixture of compounds called hydrocarbons, which can be separated into fractions by fractional distillation.

(a) The table shows information about three fractions.

Fraction	A hydrocarbon found in this fraction	The boiling point of this hydrocarbon (°C)
refinery gases	methane, CH_4	−42
petrol	octane, C_8H_{18}	126
naphtha	decane, $C_{10}H_{22}$	170

(i) Methane, octane and decane all belong to the same homologous series.

Name this homologous series. [1]

.....

(ii) State how the number of carbon atoms in a hydrocarbon affects its boiling point. [1]

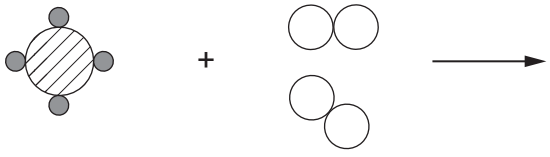
.....

.....

(b) Methane burns in air forming carbon dioxide and water. This reaction is shown by the following symbol equation.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Complete the diagram representing this equation by adding **all** the molecules formed. [2]



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(c) Decane, $C_{10}H_{22}$, undergoes a process called cracking to form smaller more useful hydrocarbons, one of which is ethene, C_2H_4.

Complete the equation for this reaction. [1]

$$C_{10}H_{22} \longrightarrow \text{.....} + C_2H_4$$

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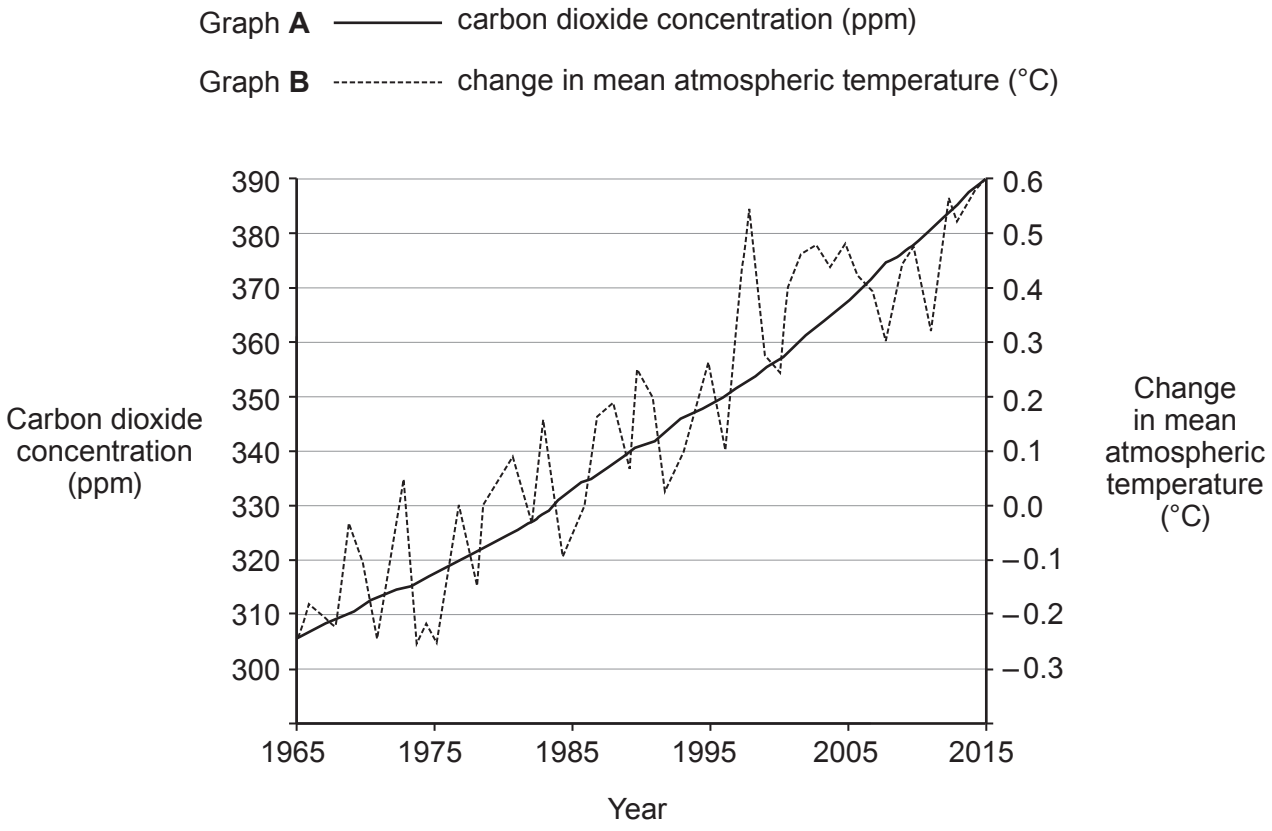
11. *(a)* Graph **A** shows the carbon dioxide concentration in the atmosphere between 1965 and 2015. Graph **B** shows the change in mean atmospheric temperature over the same period.

This data is often used by the media in reports on global warming.



Describe how the evidence from the graphs can be used to support or oppose the statement:

"Global warming is caused by an increase of carbon dioxide in the atmosphere." [2]

Support .....

.....

.....

.....

Oppose .....

.....

.....

.....

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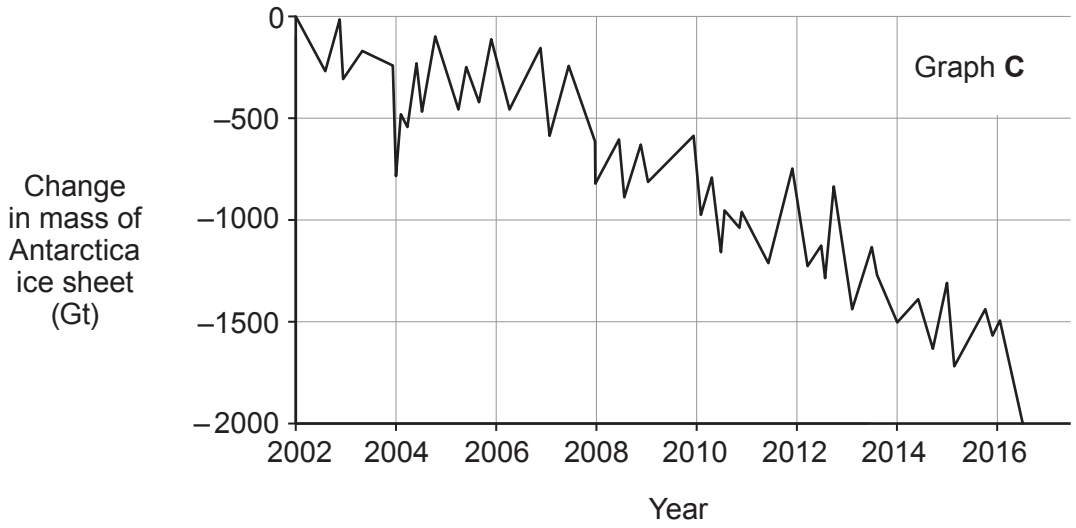
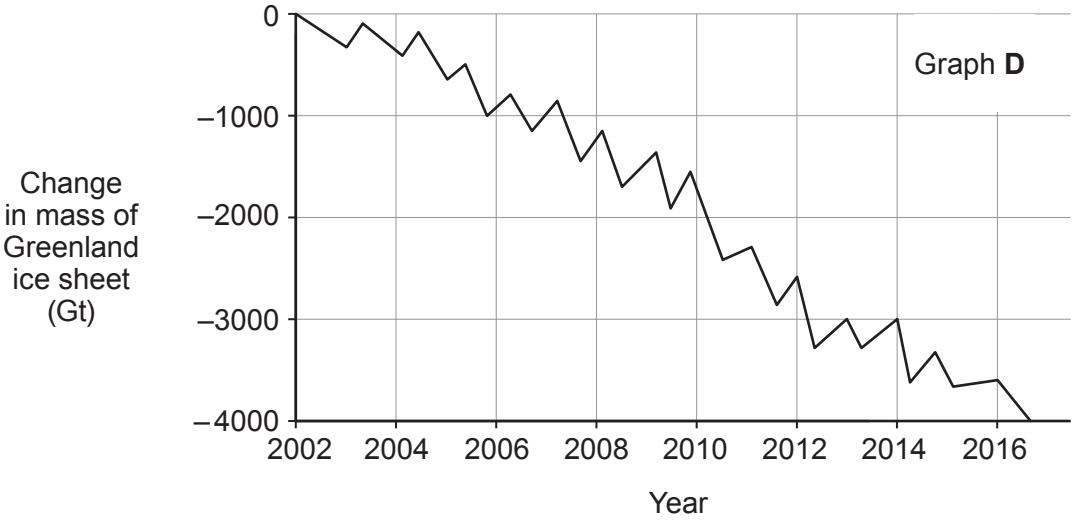
(b) Graphs **C** and **D** show the change in the mass of ice sheets at Antarctica and Greenland since 2002. The mass change is measured in Gigatonnes (Gt).





Compare the change in mass of the two ice sheets between **2002** and **2014**. [2]

.....

.....

.....

(c) Explain **one** environmental consequence of the melting of ice sheets. [2]

.....

.....

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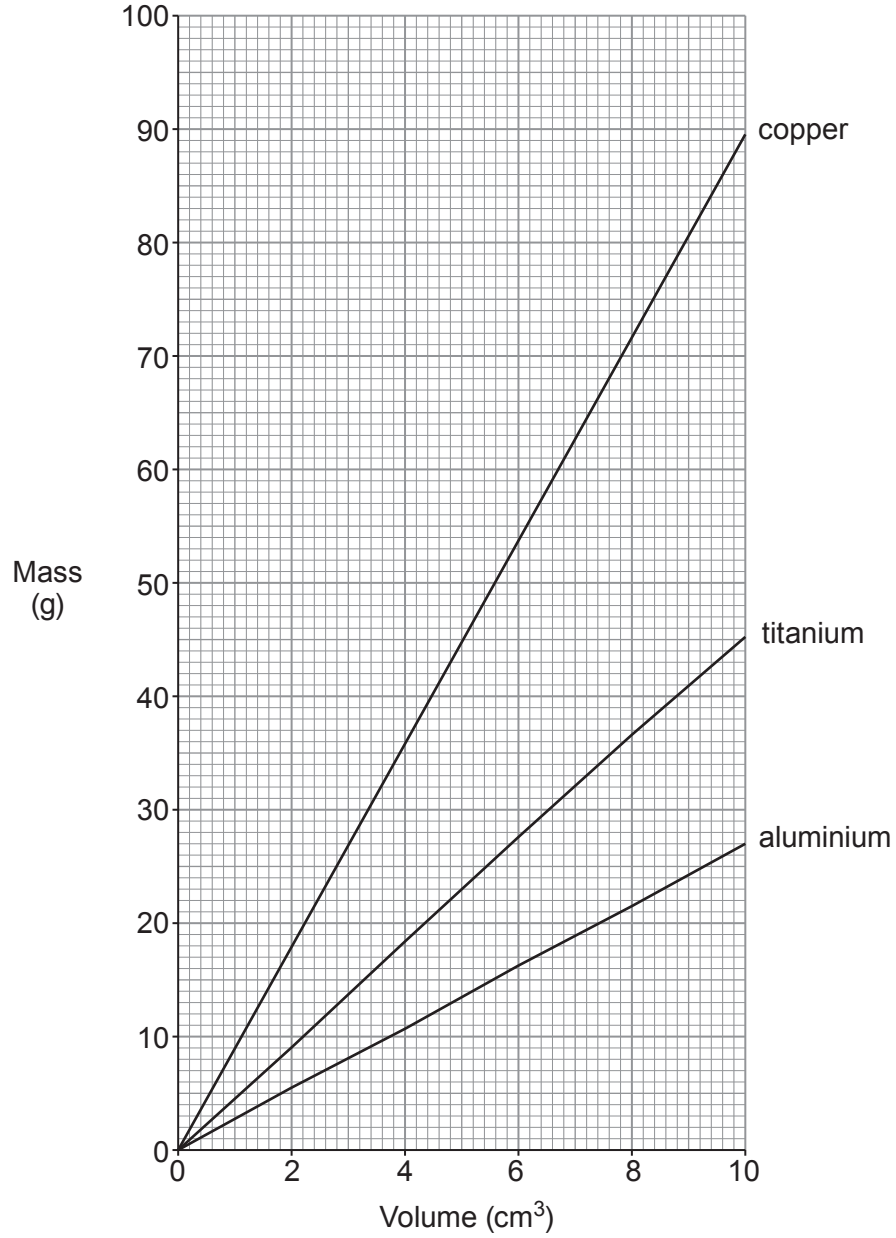
12. *(a)* The graphs show how the mass of three metals changes with volume.



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The mass of a substance can be calculated using the equation

mass = volume × density

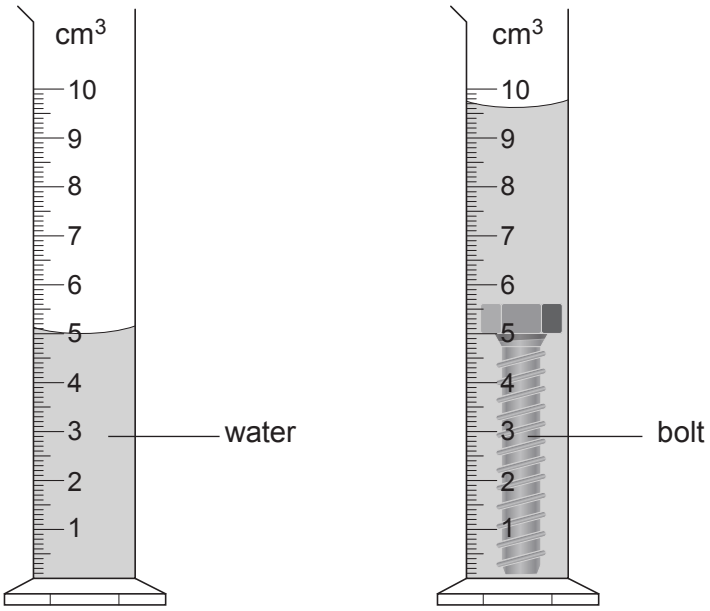
(i) Use the relevant graph and the equation to calculate the density of titanium. [2]

Density = ... g/cm^3

(ii) Iron has a density of 7.9 g/cm^3.

On the grid opposite, draw the graph that shows how the mass of iron changes with volume. [2]

(iii) A 12.5 g metal bolt was put into a measuring cylinder containing 5.0 cm^3 of water.



Use the diagrams and the graphs to identify the metal used to make the bolt.
You **must** show your working. [2]

Name of metal .....

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(b) The table shows some physical properties of the four metals named in part *(a)*.

Metal	Melting point (°C)	Boiling point (°C)	Electrical conductivity (S/m × 10^6)	Thermal conductivity (W/m.k)	Ductility Perfect ductility = 1 Absolute brittleness = 0
copper	1084	2562	58.5	401	0.62
iron	1538	2861	10.1	80	0.43
titanium	1668	3287	2.4	21	0.54
aluminium	660	2519	36.9	237	0.65

Use information from the **table** and the **graphs** in part *(a)* in your answers to parts (i) and (ii).

Copper is used for electrical wiring and over-head power cables are made of aluminium.

(i) Give **two** properties of **both** metals which make them suitable for these uses. [2]

Property 1 .....

Property 2 .....

(ii) State what makes copper more suitable than aluminium for use in electrical wiring. [1]

.....

.....

(iii) State what makes aluminium more suitable than copper for use in over-head power cables. [1]

.....

.....

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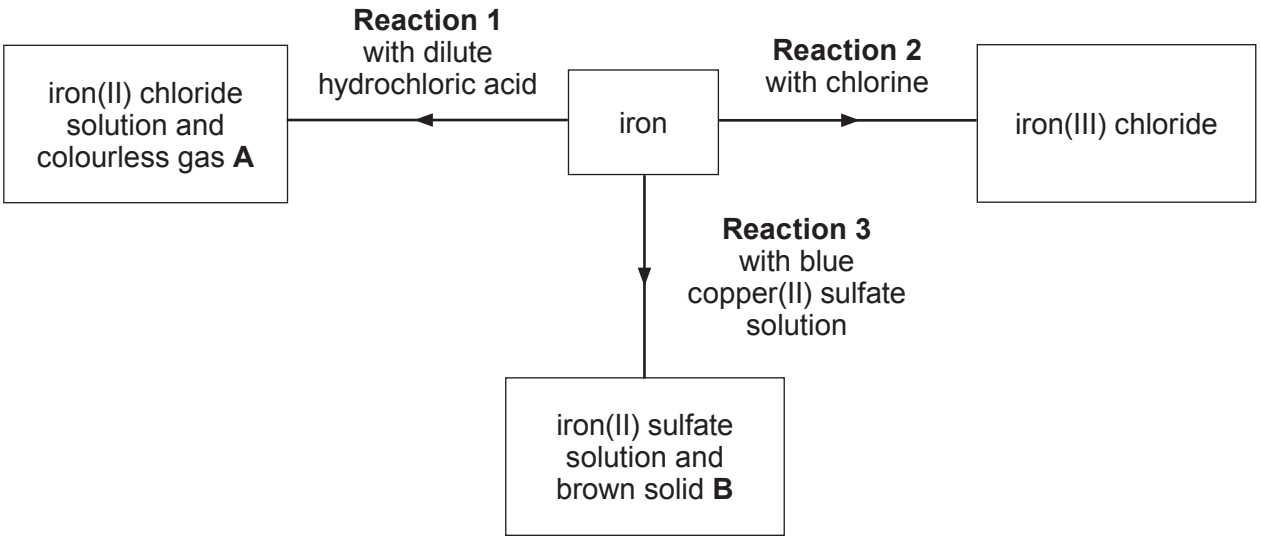
13. *(a)* The flow diagram shows some reactions of iron.



(i) Name the colourless gas **A** formed in reaction **1**. [1]

.....

(ii) Name the brown solid **B** formed in reaction **3**. [1]

.....

(iii) Complete and balance the symbol equation for reaction **2**. [2]

2Fe + ☐ Cl_2 ⟶ ☐ .....

(b) When sodium hydroxide solution is added to iron(II) sulfate solution a green precipitate of iron(II) hydroxide is formed.

Complete the symbol equation for this reaction. Include **state symbols** in your answer. [3]

$2NaOH(aq) + FeSO_4(aq) \longrightarrow$ ..... + ...

7

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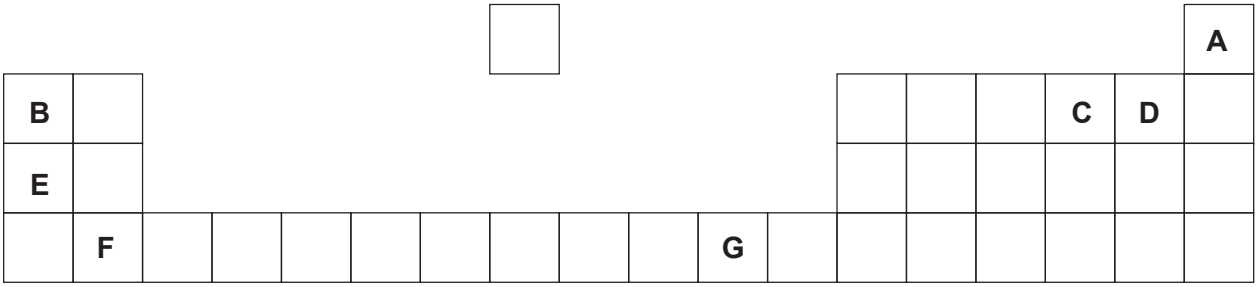
14. *(a)* The following diagram shows an outline of part of the Periodic Table.

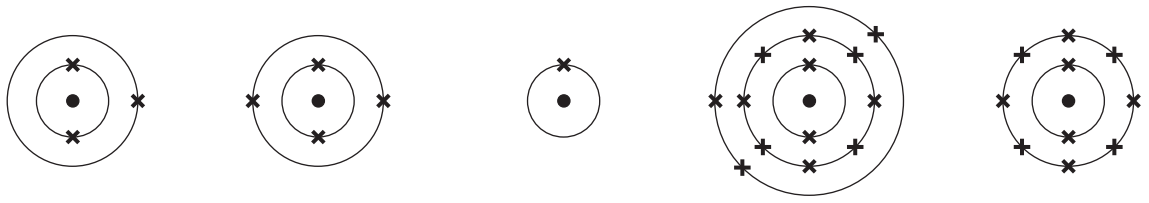
The letters shown are NOT the chemical symbols of the elements.



(i) Choose **letters** from the diagram to match the descriptions in the table below. [5]

	Letter
The element which is completely unreactive	.....
The element in Group 1 and Period 2	.....
The element which forms coloured ions	.....
The element which forms a 2^- ion	.....
The element with the electronic structure 2,8,1	.....

(ii) Diagrams **1**-**5** below show the electronic structure of five elements in the Periodic Table.



1 **2** **3** **4** **5**

Give the number of the diagram which shows the electronic structure of the element which lies directly **below** element **A**. [1]

Number .....

Examiner only

(b) Complete the following table that shows information about an atom of fluorine. [1]

Mass number	Atomic number	Number of protons	Number of neutrons	Number of electrons
19	9	9	.....	.....

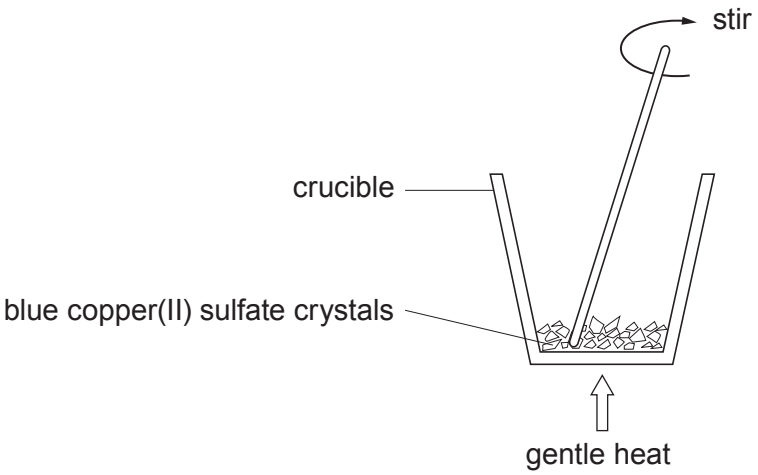
7

Examiner only

15. The blue colour of copper(II) sulfate crystals is due to the presence of water molecules. On gentle heating these water molecules can be removed, forming white copper(II) sulfate powder.

$$\text{blue copper(II) sulfate} \overset{\text{heat}}{\rightleftharpoons} \text{white copper(II) sulfate} + \text{water}$$

A student carried out an experiment to find the percentage of water in a sample of blue copper(II) sulfate. She gently heated a known mass of blue copper(II) sulfate crystals, stirring continuously, until the crystals turned white.



Mass of blue copper(II) sulfate = 6.25 g

Mass of white copper(II) sulfate after heating = 4.15 g

(a) Calculate the mass of water removed during heating. [1]

Mass of water = ... g

(b) Use the equation below to calculate the percentage of water in the blue copper(II) sulfate. [2]

$$\text{percentage of water in blue copper(II) sulfate} = \frac{\text{mass of water}}{\text{mass of blue copper(II) sulfate}} \times 100$$

Percentage of water = ... %

Examiner only

(c) The experimental value for the percentage of water is lower than the actual value although all the masses were accurately measured.

Suggest a reason for this difference. Describe what should be done to get a more accurate value. [2]

.....

.....

.....

.....

(d) State how blue copper(II) sulfate could be reformed. Give the reason for your answer. [2]

.....

.....

.....

7

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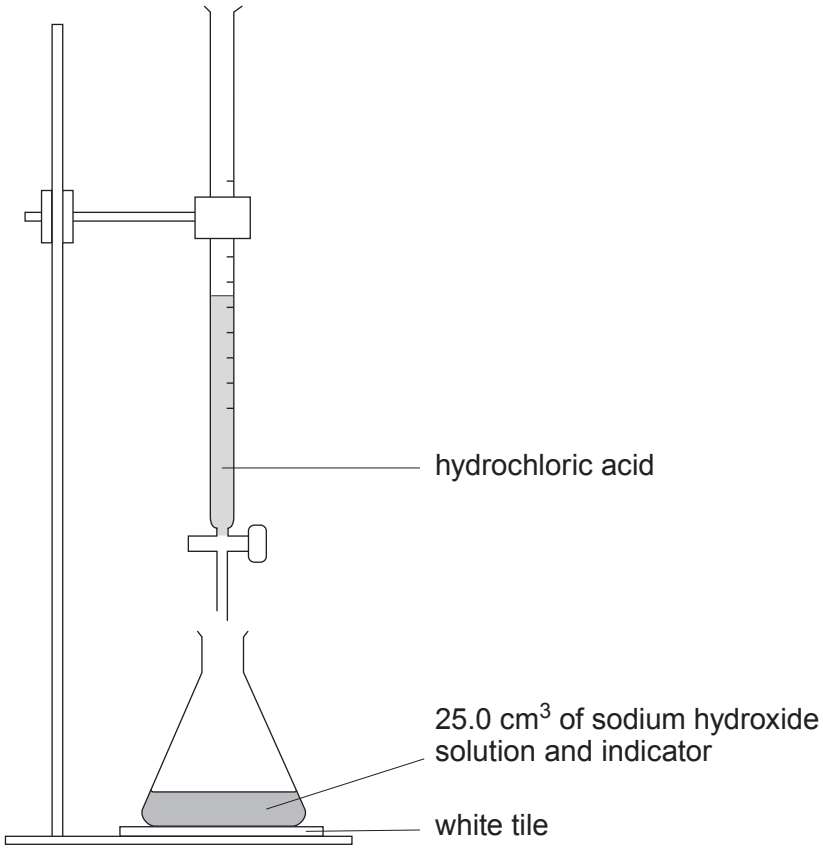
16. Hydrochloric acid neutralises sodium hydroxide solution to form sodium chloride and water only.

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

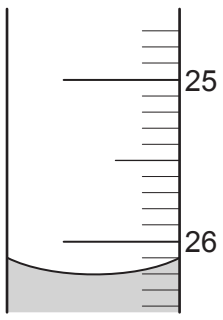
(a) Aleksandr was asked to find the volume of hydrochloric acid needed to neutralise 25.0 cm^3 of a sodium hydroxide solution. He titrated the sodium hydroxide solution with hydrochloric acid.



(i) Why was the conical flask placed on a white tile? [1]

.....

(ii) Aleksandr carried out a trial run. Give the final reading shown on the burette. [1]



Final reading ..... cm^3

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(iii) Aleksandr carried out three further titrations. His results are shown in the table.

	Titre		
	1	2	3
Volume of hydrochloric acid used (cm^3)	24.6	24.8	24.5

Calculate the mean volume of hydrochloric acid needed to neutralise 25.0 cm^3 of the sodium hydroxide solution. Give your answer to **one** decimal place. [2]

Mean volume = ... cm^3

(iv) Aleksandr evaporated all the water from one of his neutralised mixtures from part (iii) in an attempt to obtain pure crystals.

State why the crystals are **not** pure. [1]

.....

(v) Describe what he should do to prepare pure crystals. [2]

.....

.....

.....

.....

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(b) Aleksandr carried out further titration experiments using **different** concentrations of hydrochloric acid and sodium hydroxide.

Complete the table by giving the volume of acid needed to neutralise 20.0 cm^3 of alkali. [2]

Concentration of sodium hydroxide (mol/dm^3)	Concentration of hydrochloric acid (mol/dm^3)	Volume of sodium hydroxide (cm^3)	Volume of hydrochloric acid (cm^3)
1.0	1.0	20.0	20.0
1.0	0.5	20.0	.....
0.5	0.5	20.0	.....

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FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

1	2	Group										3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key