Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3410U10-1

S25-3410U10-1

FRIDAY, 13 JUNE 2025 – MORNING

CHEMISTRY – Unit 1:
Chemical Substances, Reactions and Essential Resources
FOUNDATION TIER

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**8**	
3.	**7**	
4.	**14**	
5.	**10**	
6.	**5**	
7.	**10**	
8.	**5**	
9.	**6**	
10.	**9**	
Total	**80**	

3410U101
01

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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 page(s) 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 **7**(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.

JUN253410U10101

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Answer **all** questions.

1. The diagram shows part of the Periodic Table.

	1	2											3	4	5	6	7	0
1								H										He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg											Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe

(a) Tick (✓) the box next to the number of the **group** in the Periodic Table that contains the element chlorine, Cl. [1]

5 ☐

6 ☐

7 ☐

(b) Tick (✓) the box next to the number of the **period** in the Periodic Table that contains the element chlorine, Cl. [1]

1 ☐

2 ☐

3 ☐

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(c) Tick (✓) the box next to the colour of chlorine gas. [1]

green ☐

orange ☐

blue ☐

(d) Sodium metal reacts with chlorine gas to form sodium chloride.

$$2\,Na + Cl_2 \longrightarrow 2\,NaCl$$

(i) Tick (✓) the box next to the word that describes sodium chloride. [1]

element ☐

compound ☐

mixture ☐

(ii) Sodium ions in sodium chloride can be identified using a **flame test**.

Tick (✓) the box next to the colour of the flame produced by sodium ions in a flame test. [1]

red ☐

yellow ☐

green ☐

(e) Sodium reacts with bromine to form sodium bromide.

(Circle) the correct formula of sodium bromide. [1]

NaBr **SBr** **nabr** **NaB**

6

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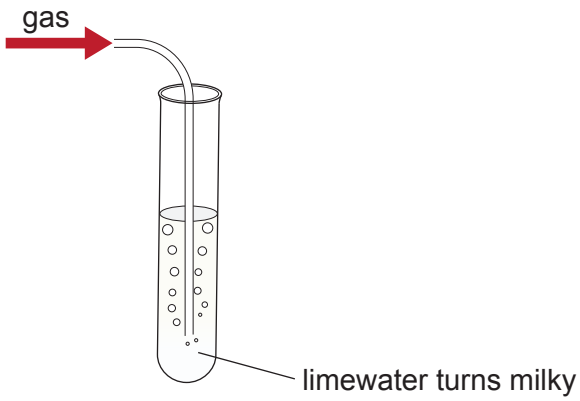
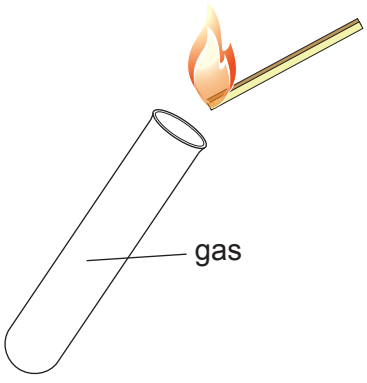
2. (a) Tick (✓) the box next to the name of the gas that is being identified by the test in each diagram. [2]



carbon dioxide ☐

oxygen ☐

hydrogen ☐



there is a squeaky pop when a lit splint is held at the top of the tube

carbon dioxide ☐

oxygen ☐

hydrogen ☐

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(b) The gases in the early atmosphere came from volcanic eruptions.

The table shows the percentages of some gases in the early atmosphere and today's atmosphere.

Name of gas	Percentage of gas (%)	
	Early atmosphere	Today's atmosphere
oxygen	0	21
water vapour	20	0-3
carbon dioxide	35	0.04

(i) **Use only the information in the table** to complete the sentence. [2]

Over geological time, the amount of ..... in the atmosphere has increased and the amounts of ..... and ..... have decreased.

(ii) Underline the names of **two** processes which **use** oxygen from the atmosphere. [2]

photosynthesis **sedimentation** **respiration** **combustion**

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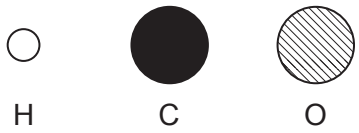
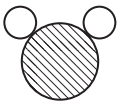
(c) The following symbols represent atoms of hydrogen, carbon and oxygen.

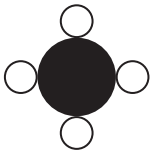


A molecule of water, H_2O, can be represented by the following diagram.



(i) Use the key to draw a molecule of carbon dioxide, CO_2. [1]

(ii) Write the formula of the following molecule. [1]



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3. Lithium, sodium, potassium and rubidium are all Group 1 elements.

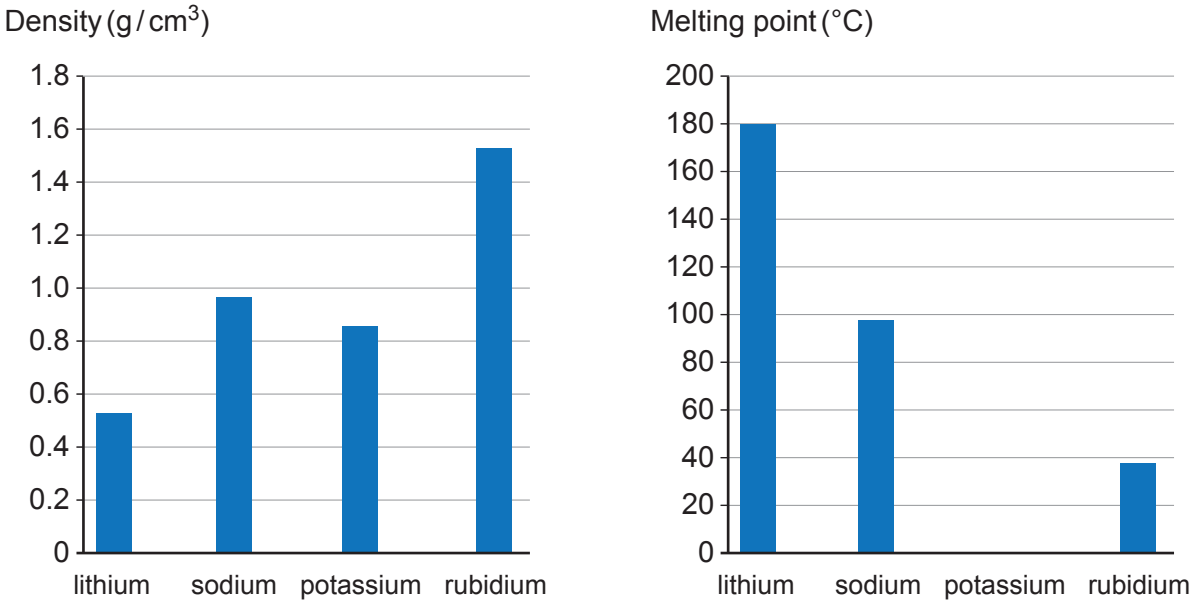
(a) Tick (✓) the box next to the name given to the Group 1 elements. [1]

halogens ☐

noble gases ☐

alkali metals ☐

(b) The charts below show the densities and some of the melting points of the Group 1 elements.



Use only the information in the charts to answer the following questions.

(i) Name the element with the highest density. [1]

.....

(ii) Give the state (solid, liquid or gas) of sodium at 100 °C. [1]

.....

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(iii) Tick (✓) the box next to the most likely melting point of potassium. [1]

25 °C ☐

64 °C ☐

106 °C ☐

(c) (i) Potassium reacts with oxygen to produce potassium oxide.

Potassium oxide contains the ions K^+ and O^{2-}.

(Circle) the correct formula of potassium oxide. [1]

KO **KO_2** **K_2O** **K_2O_2**

(ii) Potassium reacts with water to produce potassium hydroxide solution and hydrogen gas.

I. Put a number in the box to balance the equation for this reaction. [1]

$2K + 2H_2O \longrightarrow \square KOH + H_2$

II. Tick (✓) the box next to the observation which shows that a gas is formed during this reaction. [1]

potassium floats ☐

potassium melts ☐

fizzing ☐

potassium disappears ☐

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7

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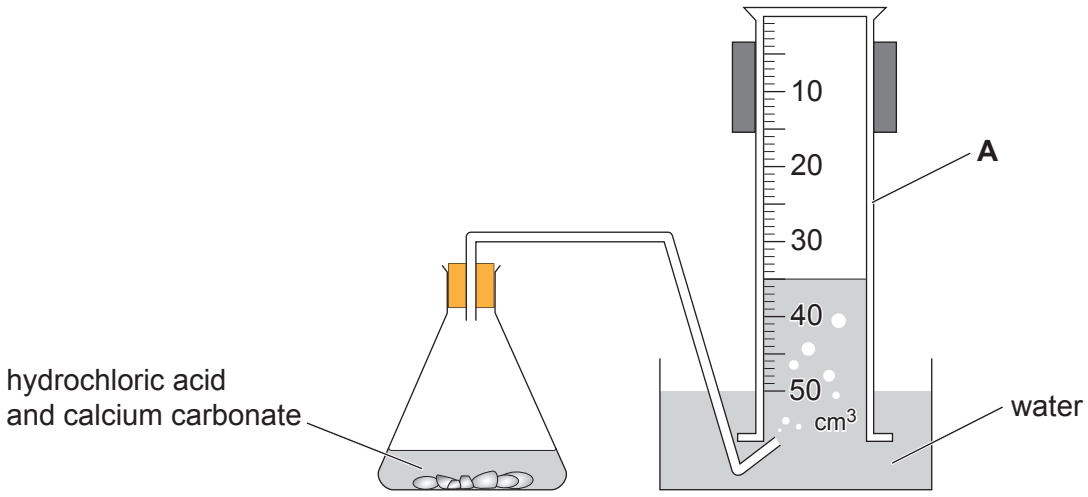
4. (a) Calcium carbonate reacts with hydrochloric acid to produce a gas which can be collected and measured using the apparatus shown.



(i) Underline the name of the apparatus labelled **A**. [1]

test tube **measuring cylinder** **beaker** **evaporating dish**

(ii) Use the diagram to give the volume of gas collected. [1]

..... cm^3

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(iii) If the experiment is repeated using a higher concentration of acid, the rate of the reaction increases.

Choose words from the box to complete the sentence to explain why the rate increases.

[2]

energy	**particles**	**collisions**	**gases**	**solutions**

When the concentration of the acid increases there are more

..... in the same volume and a higher chance of

successful ..... .

(iv) Apart from increasing the concentration of the acid, give another change that will increase the rate of this reaction. [1]

.....

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11

(b) In a similar experiment, 48 cm^3 of gas was collected in 2 minutes.

The mean rate of the reaction can be calculated using the following equation.

$$\text{mean rate} = \frac{\text{volume of gas}}{\text{time}}$$

Use the equation to calculate the mean rate of the reaction in **cm^3/s**. [2]

Mean rate = ... cm^3/s

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(c) Calculate the relative formula mass, M_r, of calcium carbonate, $CaCO_3$. [2]

$A_r(Ca) = 40$ $A_r(C) = 12$ $A_r(O) = 16$

M_r = ...

(d) The word equation for the reaction is as follows.

calcium carbonate + hydrochloric acid ⟶ calcium chloride + carbon dioxide + water

Complete the symbol equation for the reaction by

- giving the formula of calcium chloride
- putting a number in the box to balance the equation [2]

$CaCO_3$ + ☐ HCl ⟶ ..... + CO_2 + H_2O

(e) Limestone is mainly composed of calcium carbonate. Limestone is quarried on Halkyn mountain in Flintshire.

There are benefits and drawbacks associated with limestone quarrying.

Benefits include the production of an important building material and employment for the local community.

Give **one** drawback of limestone quarrying. [1]

.....

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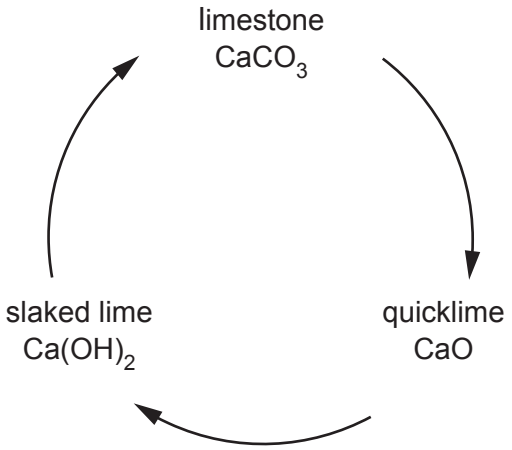
(f) The limestone cycle is shown in the diagram.



(i) Give the chemical name of quicklime, CaO. [1]

.....

(ii) Give the name of the substance added to quicklime, CaO, to convert it to slaked lime, $Ca(OH)_2$. [1]

.....

14

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Turn over.

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5. The hardness of water can be measured by adding soap solution.

A class investigated the hardness of water from different locations in Wales.

They measured the volume of soap solution needed to create a permanent lather when it was shaken in a flask with samples of water from each location.

The results are shown in the table.

Location	Volume of soap solution needed to create a permanent lather (cm^3)		
	Test 1	Test 2	Mean
Abergavenny	23	27	25
Brecon	15	14	15
Carmarthen	52	55	54
Holyhead	37		35
Wrexham	59	57	58

(a) (i) Give the **missing result** for Test 2 used to calculate the mean volume for the sample from Holyhead. [1]

Missing result = ... cm^3

(ii) State **two** factors that must be controlled in this investigation. [2]

Factor 1 .....

Factor 2 .....

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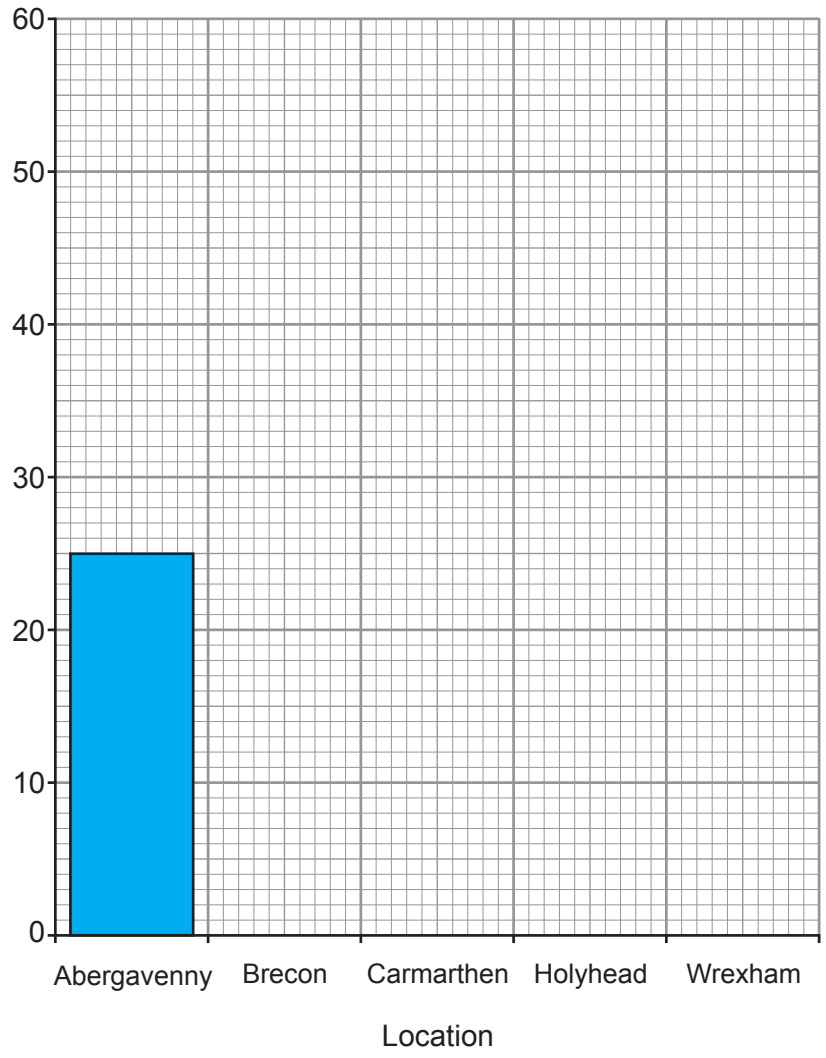
(iii) Complete the bar chart to show the mean volume of soap solution needed to create a permanent lather for the water from each location.

The first bar has been drawn for you. [2]



(iv) Give the location with the hardest water. Explain your answer. [2]

Location .....

.....

.....

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(b) Give the name of an ion which causes hard water. [1]

.....

(c) Tick (✓) the boxes next to the **two** benefits of hard water. [2]

makes boilers more efficient	☐
reduces the risk of heart disease	☐
strengthens bones	☐
less detergent is needed to wash dishes	☐
prevents limescale forming	☐

10

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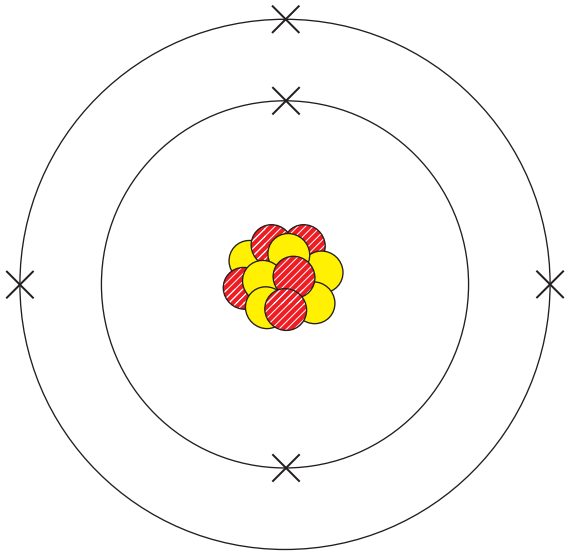
6. (a) The diagram shows an atom of the element boron.



(i) Complete the sentence. [1]

The nucleus of the boron atom contains five ..... and six ..... .

(ii) Give the mass number of the boron atom. [1]

.....

(iii) Explain why an atom of boron has no overall charge. [2]

.....

.....

.....

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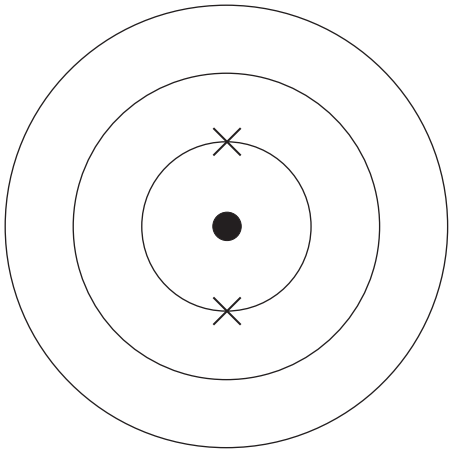
(b) An atom of aluminium has 13 electrons.

Complete the diagram to show the electronic structure of an aluminium atom. [1]



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7. (a) The photograph shows the chromatogram produced when the dyes in a purple ink were separated using water as the solvent.

Diagrams **A** and **B** show two possible ways of setting up the apparatus to produce this chromatogram.

Diagram **A**

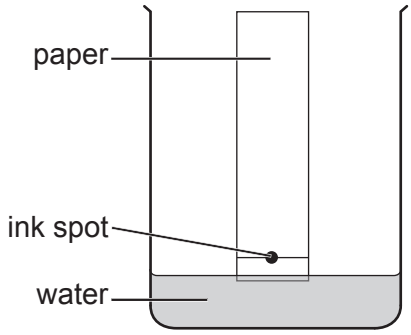
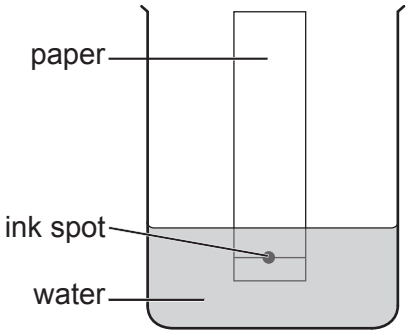


Diagram **B**



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Explain why

- chromatography can separate dyes in this way
- the set up in diagram **A** rather than diagram **B** would produce the chromatogram shown

[6 QER]

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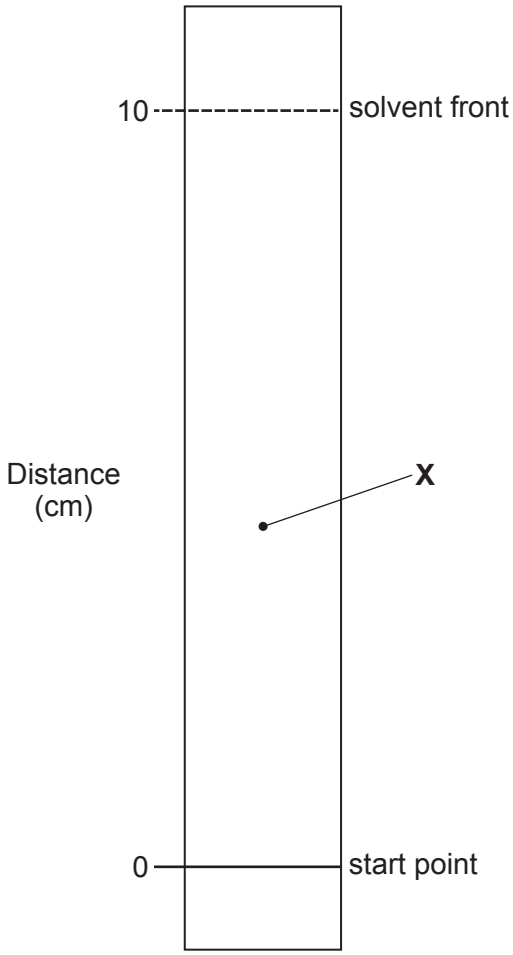
(b) The diagram shows a simplified chromatogram produced in another experiment.



The R_f value of a dye can be calculated using the equation

$$R_f = \frac{\text{distance travelled by dye}}{\text{distance travelled by solvent}}$$

Measure the distance travelled by dye **X** and use the equation to calculate its R_f value. [2]

R_f = ...

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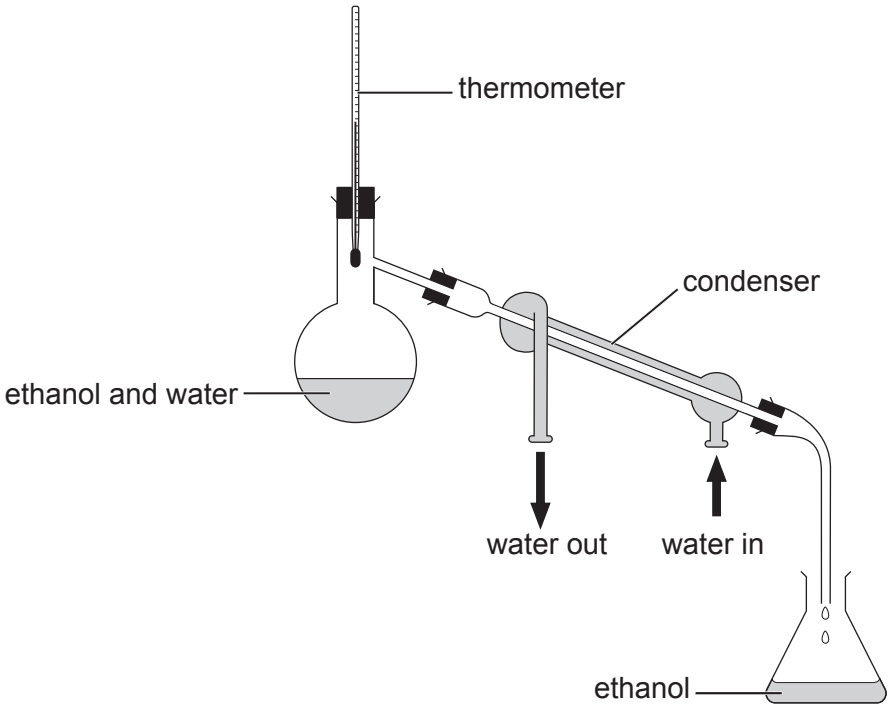
(c) The diagram shows the apparatus used to separate a mixture of ethanol and water.



Explain why a mixture of ethanol and water is separated when it is heated in this apparatus. [2]

.....

.....

.....

.....

10

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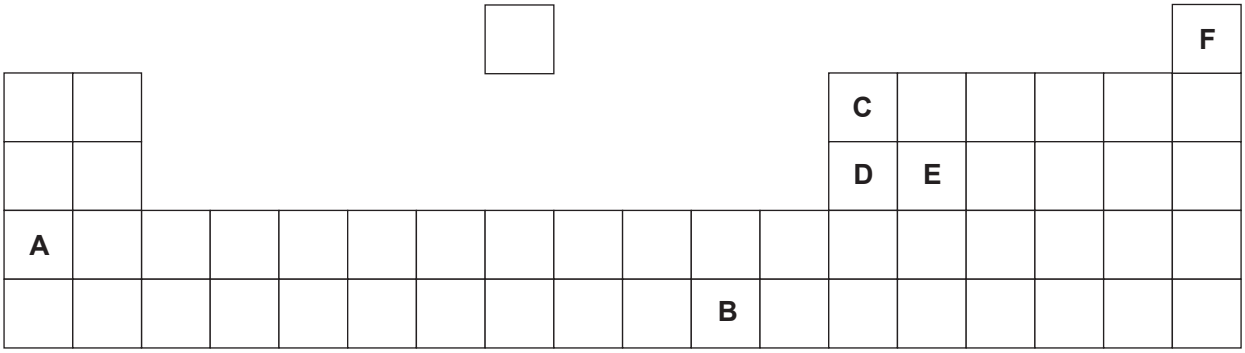
8. The diagram represents part of the Periodic Table.

The letters shown are **not** the symbols of the elements.



(a) **Use letters from the diagram** to answer parts (i) and (ii).

(i) Give the letters of two elements that have atoms with three electrons in their outer shell. [1]

..... and .....

(ii) Give the letter of the element that has atoms with four electron shells. [1]

.....

(b) Name the element represented by the letter **F**. Give **one** use of this element. [1]

Name .....

Use .....

(c) State **two** properties that you would expect element **B** to have. [2]

Property 1 .....

Property 2 .....

5

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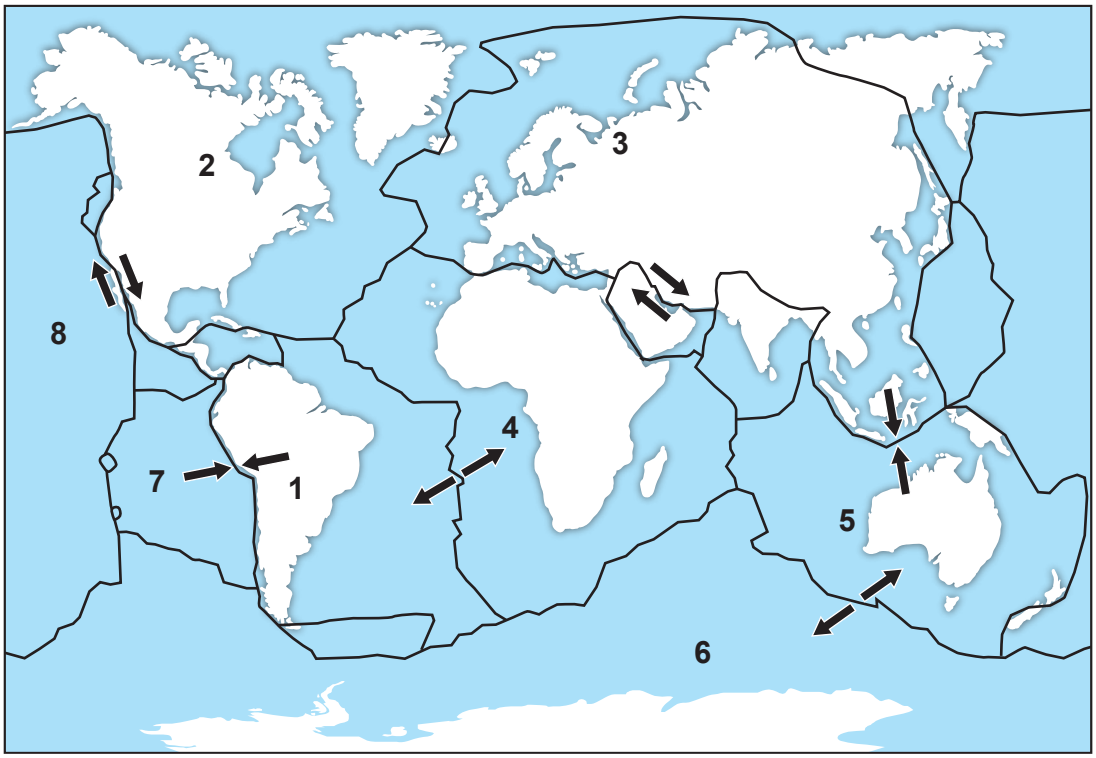
9. (a) The diagram shows some of the Earth's tectonic plates and the directions in which they are moving.



(i) Give the numbers of two plates which share a **constructive** boundary. [1]

..... and .....

(ii) Describe what happens at a **destructive** plate boundary. [2]

.....

.....

.....

.....

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(b) Alfred Wegener proposed that the Earth's continents had once all been joined together in a land mass he called Pangaea and that they had moved apart over time.

He called this the 'theory of continental drift'.

200 million years ago

Present

(i) Give **two** pieces of evidence that Alfred Wegener used to support his theory of continental drift. [2]

Evidence 1 .....

Evidence 2 .....

(ii) State why Wegener's theory was not initially accepted. [1]

.....

.....

6

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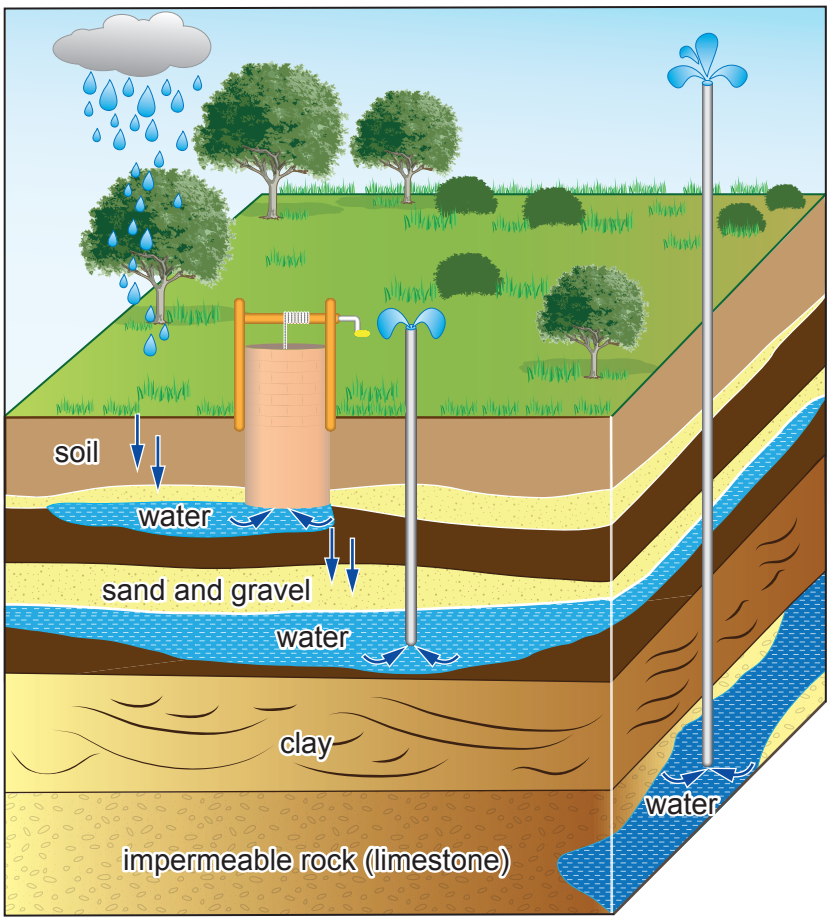
10. Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through layers of soil, sand and rocks called aquifers.

Groundwater provides 550 megalitres of the total water needed on average per day in Wales, approximately 5% of the total volume used. Some of the negative ions dissolved in groundwater include carbonate, chloride and sulfate ions.

Groundwater can also contain pollutants which can cause harm to humans if consumed. Many of these pollutants are natural, such as bacteria and viruses. However, there are now a number of man-made pollutants present in our water supplies, including fertilisers, pesticides and chemicals from industrial and household landfill waste.



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(a) (i) Tick (✓) the box next to the approximate total volume of water used daily in Wales. [1]

110 megalitres ☐

550 megalitres ☐

11 000 megalitres ☐

(ii) Suggest why recycling more industrial chemicals could improve the quality of groundwater. [1]

.....

.....

(iii) Tick (✓) the box next to the solution that could be used to identify one of the negative ions present in groundwater supplies. [1]

sodium hydroxide, NaOH ☐

silver nitrate, $AgNO_3$ ☐

potassium nitrate, KNO_3 ☐

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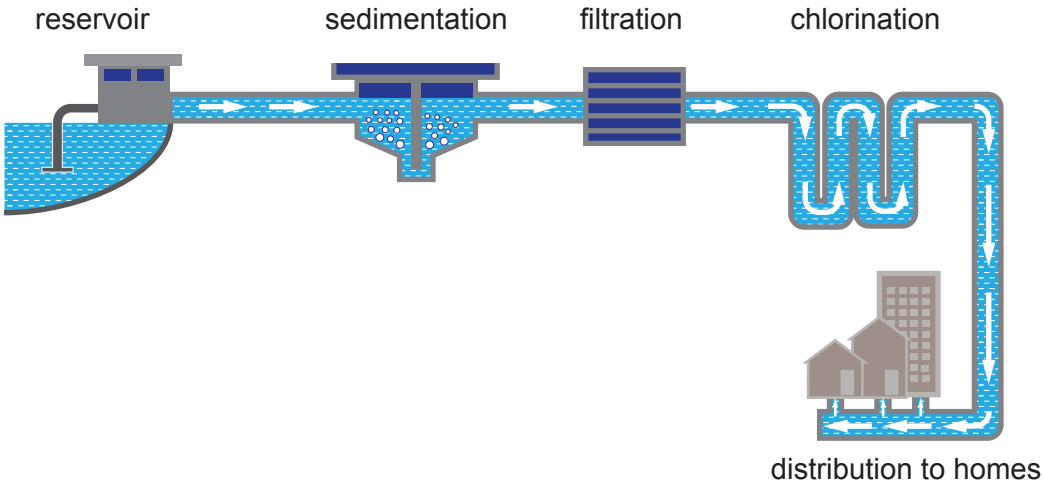
(b) The diagram shows the stages of treatment of the public water supply when it leaves reservoirs before being distributed to our homes.



The first stage of treatment of the public water supply is sedimentation.

The purpose of sedimentation is to remove large insoluble particles from the water.

Give the purpose of the filtration and chlorination stages of water treatment. [2]

Filtration .....

.....

Chlorination .....

.....

(c) (i) In some areas, fluoride is added to water supplies.

Give the reason why fluoride is added to water supplies. [1]

.....

(ii) Give **one** reason why some people disagree with the addition of fluoride to water supplies. [1]

.....

.....

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(iii) Fluoride is added to water in compounds such as sodium fluorosilicate, Na_2SiF_6.

The relative formula mass (M_r) of Na_2SiF_6 is 188.

Calculate the percentage by mass of sodium in Na_2SiF_6. [2]

$A_r(Na) = 23$

Percentage = ... %

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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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+}		

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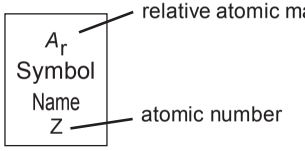
THE PERIODIC TABLE

Group 1	2											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



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