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GCSE – NEW

3410UA0-1

S18-3410UA0-1

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

HIGHER TIER

WEDNESDAY, 13 JUNE 2018 – MORNING

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**9**	
3.	**5**	
4.	**9**	
5.	**11**	
6.	**6**	
7.	**10**	
8.	**10**	
9.	**8**	
10.	**6**	
Total	**80**	

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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.

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 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 **6** 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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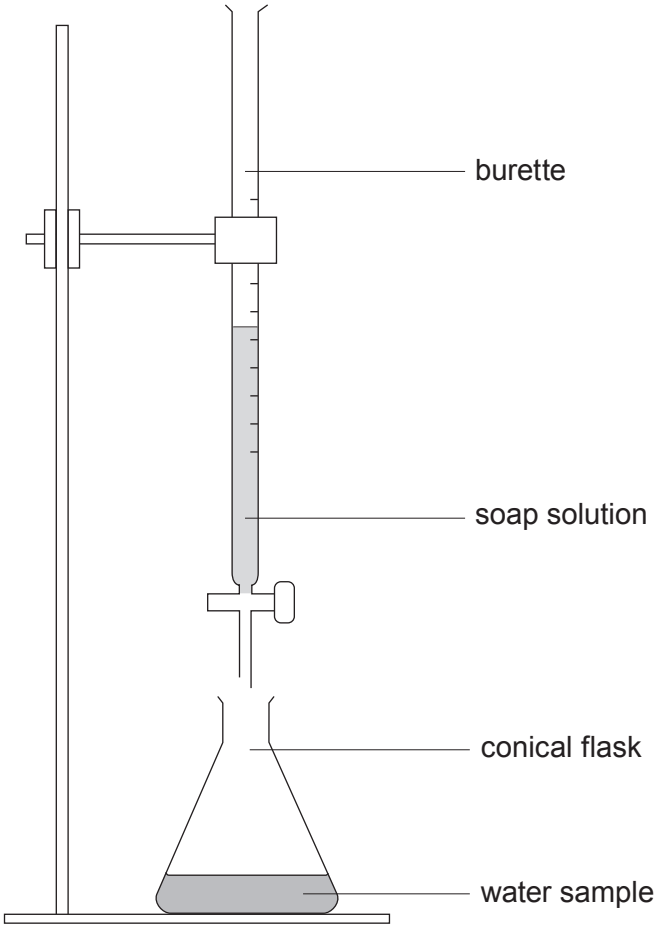
Answer **all** *questions.*

1. Water samples **A**, **B**, **C** and **D** were tested for hardness using the apparatus shown.



Soap solution was added 1 cm^3 at a time to each sample and the volume required to produce a permanent lather on shaking was recorded. Each sample was tested before and after boiling. The results are shown in the table.

Water sample	Volume of soap solution required (cm^3)	
	Before boiling	After boiling
A	1	1
B	10	10
C	15	1
D	15	8

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(a) (i) State which water sample contains **only** temporary hardness. Explain your answer. [2]

Water sample .....

Explanation .....

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(ii) Give **one** similarity in the composition of temporary and permanent hard water. [1]

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(b) Discuss the benefits and drawbacks of living in a hard water area. [3]

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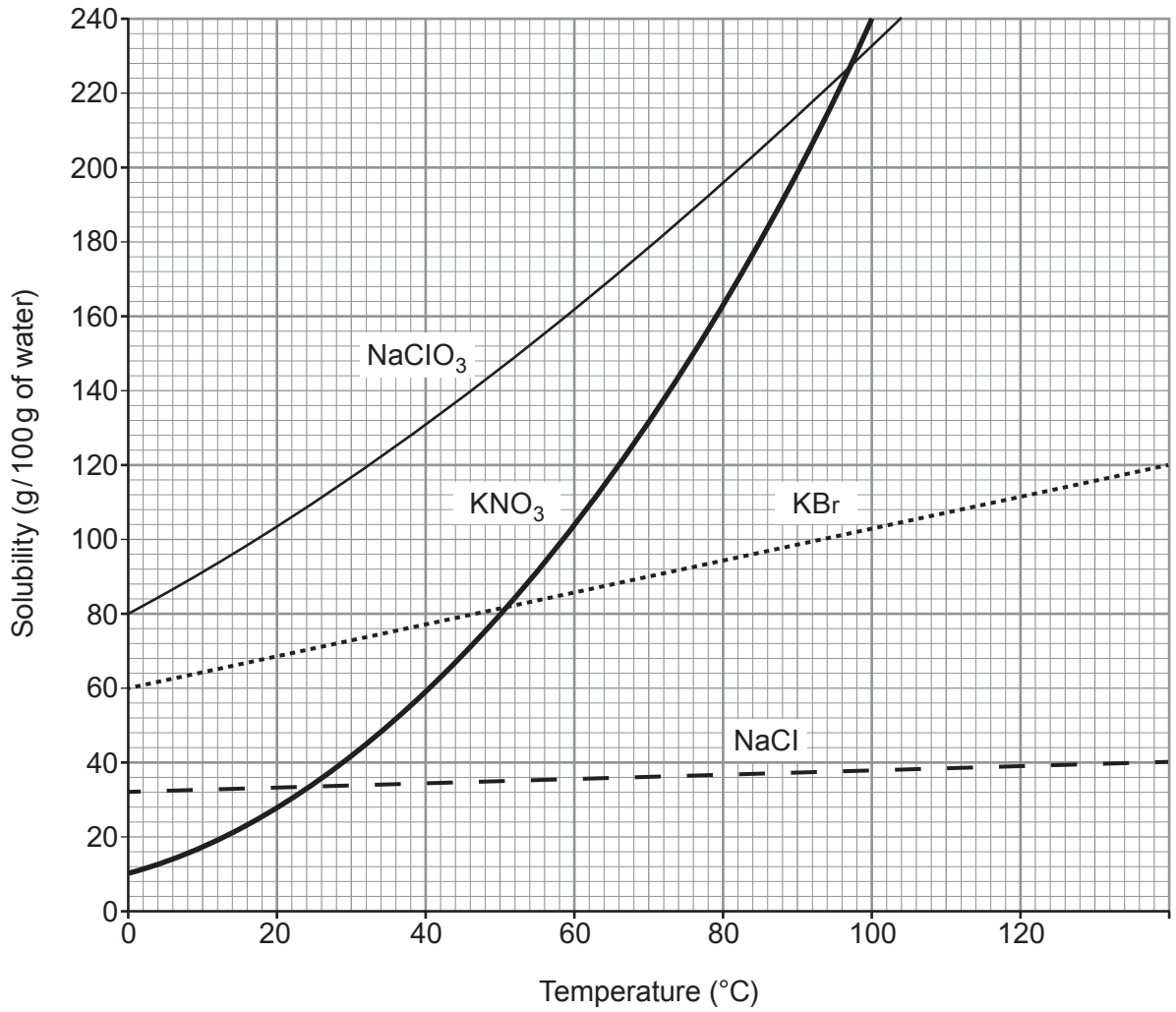
2. The grid below shows the solubility curves for four ionic compounds.



$NaClO_3$	sodium chlorate
KNO_3	potassium nitrate
KBr	potassium bromide
NaCl	sodium chloride

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(a) (i) Give the temperature at which the solubility of potassium nitrate and potassium bromide is the same. [1]

..... °C

(ii) Calculate the mass of solid potassium nitrate that would form if a saturated solution in 200 g of water were cooled from 100 °C to 20 °C. [3]

Mass = ... g

(iii) Suggest why a student may be surprised at the temperature range shown on the solubility curves. [1]

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(b) (i) Give the symbols of the **ions** of Group 1 elements present in the compounds shown on the grid. [1]

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(ii) Explain how these ions are formed from their atoms. [2]

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(c) Potassium nitrate reacts with aluminium hydroxide to produce aluminium nitrate and potassium hydroxide.

Balance the symbol equation for the reaction taking place. [1]

$$\square\ KNO_3 + Al(OH)_3 \longrightarrow Al(NO_3)_3 + \square\ KOH$$

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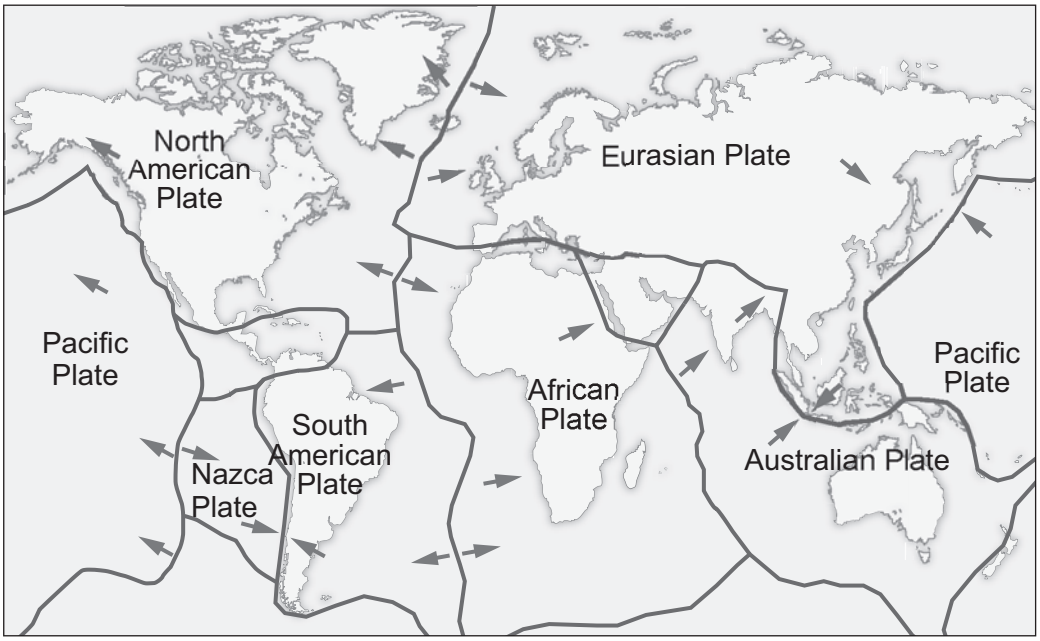
3. The following diagram shows some of the Earth's tectonic plates and the direction in which they move.



(a) The boundary between the Nazca and South American plates is a destructive plate boundary. Describe what happens at a destructive boundary. [2]

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(b) Draw a cross (×) on the diagram to show a constructive plate boundary. Describe what happens at this boundary. [2]

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(c) State **one** effect of plates sliding past each other. [1]

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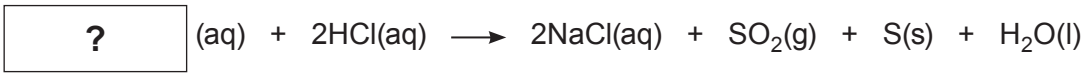
4. *(a)* Dilute hydrochloric acid reacts with sodium thiosulfate to make the products shown in the equation.



(i) Use the equation to work out the formula of sodium thiosulfate. [1]

Formula .....

(ii) The symbol (aq) in the equation tells us that the substances are aqueous. What is meant by this? [1]

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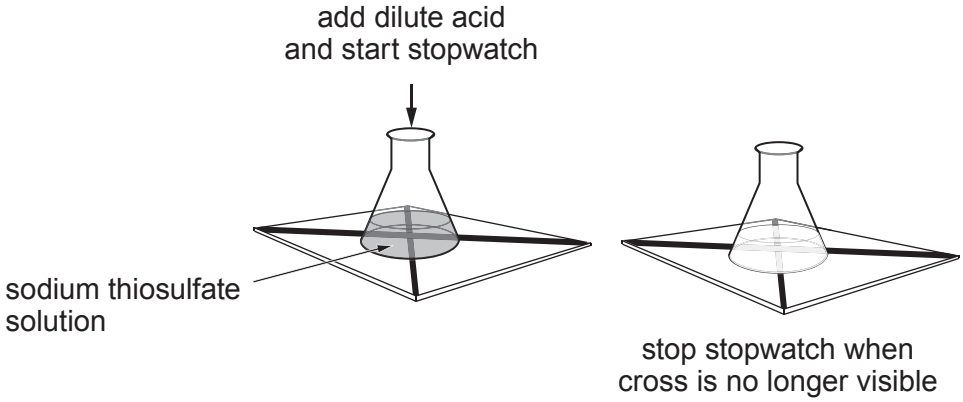
(iii) The rate of this reaction can be studied as shown in the diagram.



Use information **from the equation** to explain why the cross disappears. [2]

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(b) A student studied the effect of temperature on the rate of this reaction. He obtained the following results.

Temperature (°C)	Time taken for cross to disappear (s)			
	1	2	3	Mean
15	130	128	129	129
30	53	53	53	53
45	21	29	23	24.3
60	7	7	6	6.7

(i) Another student said that one of the mean values was incorrect. Identify the incorrect mean. Give your reasoning. [2]

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(ii) State what conclusion can be drawn about the effect of temperature on the rate of this reaction. Explain your conclusion using particle theory. [3]

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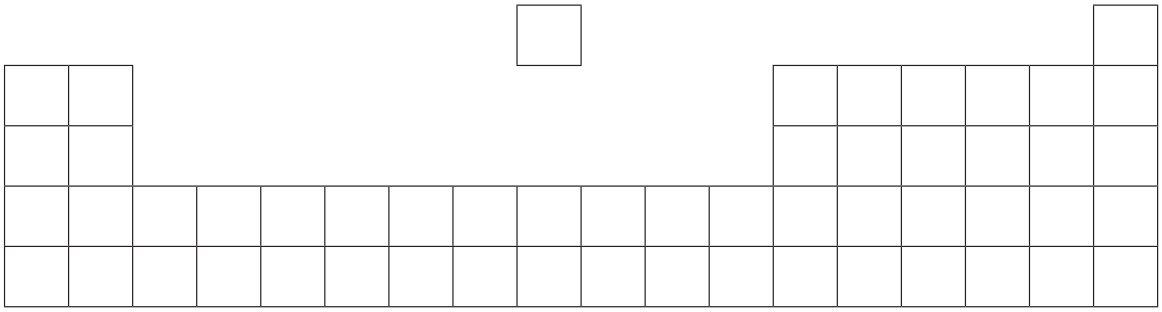
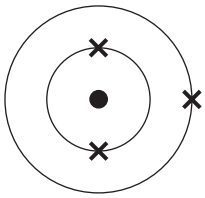
5. The following diagram is an outline of the Periodic Table.



(a) Write letters **A**, **B** and **C** on the **diagram** in the positions of the elements that fit the following descriptions. [3]

A the element with the electronic structure 

B the element in Group 2 and Period 4

C an element that shows both metallic and non-metallic properties

(b) The following table shows the atomic numbers and boiling points of the inert gases.

Inert gas	helium	neon	argon	krypton	xenon
Atomic number	2	10	18	36	54
Boiling point (°C)	−269	−246	−186	−153	−108

(i) Plot this data on the grid opposite. Draw a suitable line. [3]

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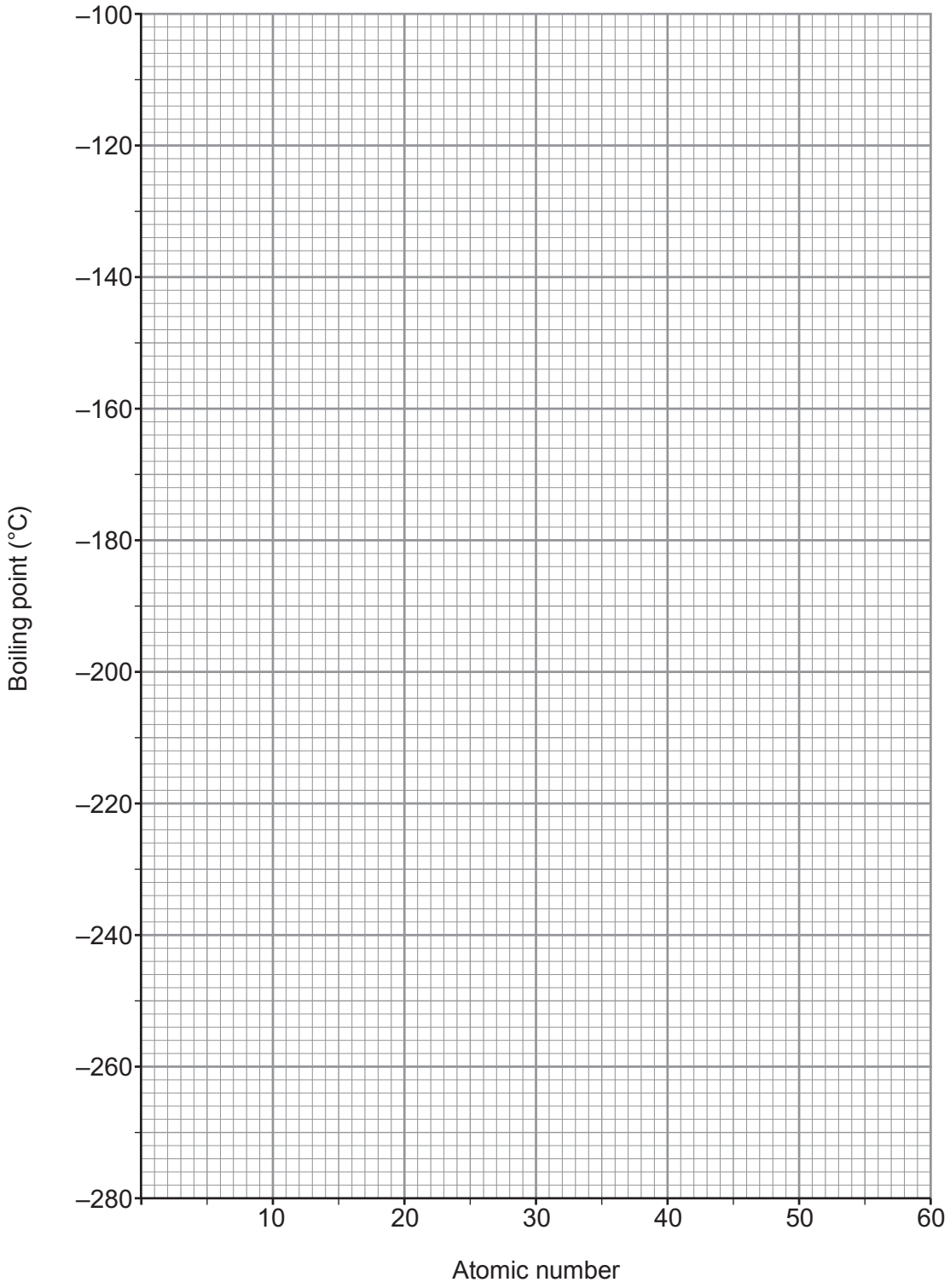

(ii) Describe the trend in boiling point shown on the graph. [1]

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(c) The following table shows the boiling points of the inert gases in both °C and K.

Inert gas	helium	neon	argon	krypton	xenon
Boiling point (°C)	−269	−246	−186	−153	−108
Boiling point (K)	4	27	.....	120	165

Use the information in the table to calculate the boiling point of argon in K. [2]

Boiling point = ... K

(d) Give **one** use of argon. Explain in terms of electronic structure why it is used for this purpose. [2]

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6. Limestone is an important raw material. It can be used as a building material or converted into quicklime and slaked lime.

Describe and explain the sequence of reactions carried out in the laboratory to convert limestone into slaked lime. [6 QER]

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7. *(a)* Group 7 elements are known as the halogens. The following table shows the observations made when the first three members of the group react with hydrogen.

Halogen	Observations
fluorine	explodes in cold and dark
chlorine	explodes in sunlight
bromine	small explosion when ignited with a flame

(i) Use your knowledge of electronic structure to explain why all the halogens react in a similar way and why they react more slowly on going down the group. [3]

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(ii) Hydrogen fluoride is highly corrosive and can be used to etch glass which is mainly silicon dioxide.

Balance the symbol equation for the reaction between hydrogen fluoride and silicon dioxide. [1]

$$\square\ HF + SiO_2 \longrightarrow SiF_4 + \square\ H_2O$$

(iii) Calcium fluoride reacts with sulfuric acid, H_2SO_4, to produce calcium sulfate and hydrogen fluoride. Give the **symbol** equation for the reaction. [3]

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(b) Chlorine reacts with aluminium to produce aluminium chloride.

A sample of aluminium chloride of mass 26.70 g was found to contain 5.45 g of aluminium. Calculate the simplest formula of this chloride of aluminium.

You **must** show your working. [3]

A_r(Al) = 27 A_r(Cl) = 35.5

Formula .....

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8. Sodium is extracted from sodium chloride.

(a) The overall reaction taking place is shown in the equation below.

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

(i) When carrying out the reaction 120 kg of sodium chloride was found to produce 38.05 kg of sodium.

Calculate the maximum possible mass of sodium that could be produced and use this figure to calculate the percentage yield of this reaction. [4]

A_r(Na) = 23 A_r(Cl) = 35.5

Maximum possible mass = ... kg

Percentage yield = ... %

(ii) Suggest a reason why the yield is less than 100 %. [1]

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(iii) Suggest why this reaction must be carried out under dry conditions. [1]

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(b) A sample of lithium is found to contain two isotopes.

Isotope	Percentage present in sample (%)
lithium-6	7.59
lithium-7	92.41

(i) Calculate the relative atomic mass (A_r) of lithium. Give your answer to **three** significant figures. [3]

$$A_r = \frac{\text{(isotope 1 mass} \times \text{abundance) + (isotope 2 mass} \times \text{abundance)}}{100}$$

A_r = ...

(ii) State the difference between the atomic structures of lithium-6 and lithium-7. [1]

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9. The following table shows the decomposition temperatures of Group 2 metal carbonates and nitrates.

Metal	Temperature at which the carbonate decomposes (°C)	Temperature at which the nitrate decomposes (°C)
magnesium	117	89
calcium	178	561
strontium	235	570
barium	267	700

(a) Describe the trends in the stabilities of the Group 2 carbonates and nitrates. [3]

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(b) When a carbonate decomposes it produces carbon dioxide gas. Describe an experiment that could be carried out to show that carbon dioxide gas is produced during the reaction. [2]

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(c) When calcium nitrate decomposes it forms calcium oxide, oxygen and nitrogen dioxide, NO_2.

Write a **symbol** equation for the reaction. [3]

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10. Fluorine exists naturally as the fluoride ion. It is found in soil, water, foods and several minerals, such as fluorapatite and fluorite.

Fluoride ion concentration in seawater averages 1.3 ppm (parts per million). In fresh water, the natural range is typically between 0.01 and 0.3 ppm. In some parts of the world, fresh water contains fluoride ion levels which are dangerous and can lead to health problems.

In the early 1930s, scientists found that people who were brought up in areas with naturally fluoridated water had up to two-thirds fewer cavities compared to those who lived in areas where the water was not fluoridated. Several studies since then have repeatedly shown that when fluoride is added to people's drinking water in areas where natural levels are low, tooth decay decreases.

However, many European countries which do not fluoridate their water do not have a higher incidence of dental decay than countries which do so. It was also found that in Germany and Finland, decay rates either remained stable or continued in their downward trend after they stopped adding fluoride to their drinking water.

Figure 1 shows data about the effect of fluoridation of drinking water on the mean number of decayed, missing and filled teeth (DMFT) and the amount of fluorosis seen.

Figure 2 shows the change in mean DMFT in three regions of Australia over a four year period.

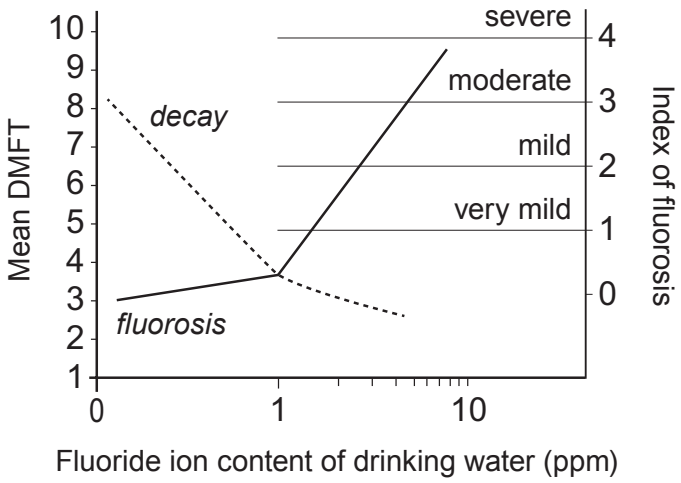

Figure 1

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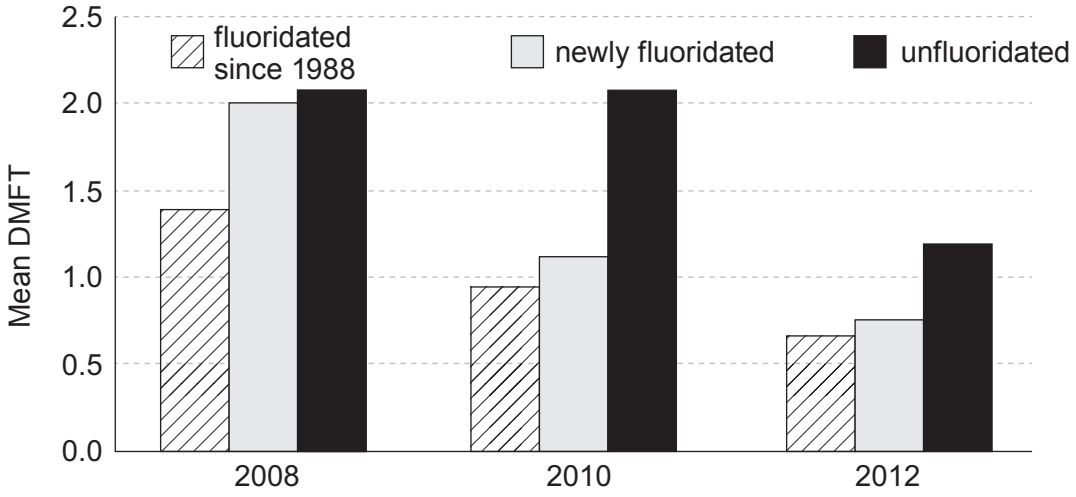

Figure 2

(a) Describe the effects of adding varying concentrations of fluoride ions to drinking water. [3]

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(b) Tick (✓) the statement below that best describes why Germany stopped fluoridating its water supplies. [1]

Ten years after stopping adding fluoride there was no increase in tooth decay ☐

They found that adding fluoride caused fluorosis ☐

Natural water supplies already contain fluoride in a high concentration ☐

Studies showed that areas with no fluoridation did not have higher levels of decay than areas that did fluoridate ☐

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(c) Tick (✓) the box which gives **one** definite conclusion that can be drawn using **only** the data in **Figure 2**. [1]

Fluoridation has no effect on levels of decay	☐
People have reduced their intake of sugary foods over this period	☐
More than one factor affects levels of decay	☐
Fluoridation is the main cause of falling levels of decay	☐

(d) 'Mass medication' is an argument often given to oppose fluoridation of water supplies. Explain what is meant by the term *mass medication*. [1]

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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

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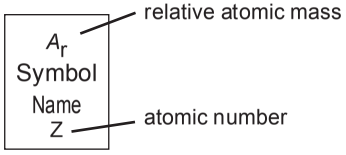
Group 1	Group 2											Group 3	Group 4	Group 5	Group 6	Group 7	Group 0
						1 H Hydrogen 1											4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 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



28

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