Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3430UB0-1

S18-3430UB0-1

SCIENCE (Double Award)

Unit 2: CHEMISTRY 1
HIGHER TIER

WEDNESDAY, 13 JUNE 2018 – MORNING

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**7**	
3.	**6**	
4.	**8**	
5.	**5**	
6.	**6**	
7.	**11**	
8.	**9**	
Total	**60**	

3430UB01
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. Do not use 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.*

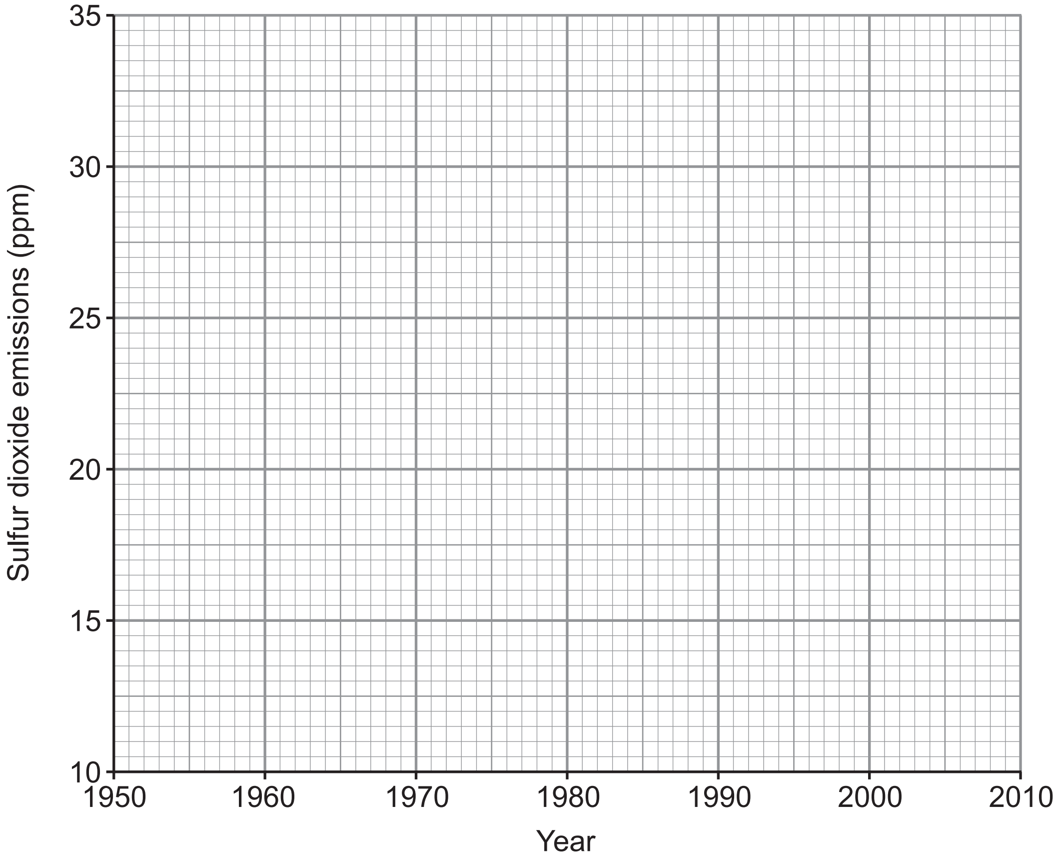
1. Burning fossil fuels containing sulfur causes sulfur dioxide, SO_2, to be released into the atmosphere.

The table shows sulfur dioxide emissions in the UK between 1950 and 2010.

Year	Sulfur dioxide emissions (ppm)
1950	12.0
1960	16.0
1970	21.5
1980	29.5
1990	29.0
2000	24.0
2010	18.5

ppm = parts per million

(a) (i) On the grid plot the sulfur dioxide emissions against the year and draw a suitable line. [3]



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(ii) Describe how sulfur dioxide emissions changed between 1950 and 2010. [2]

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(iii) The UK government introduced a regulation to reduce sulfur dioxide emissions in the 1980s. From your graph, state why it is difficult to decide exactly the year when the regulation came into force. [1]

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(b) Sulfur dioxide can be converted to sulfur and water by reacting it with hydrogen sulfide, H_2S.

Complete and balance the symbol equation for this reaction. [2]

$$SO_2 + \square\, H_2S \longrightarrow \square\, S + \square \ldots\ldots\ldots$$

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2. The table shows some physical properties of Group 6 elements.

Element	Melting point (°C)	Boiling point (°C)	Density (g/cm^3)	Electrical conductor
oxygen	–219	–183	0.0014	no
sulfur	115	445	2.0	no
selenium	221	685	4.8	semi-conductor
tellurium	450	988	6.2	semi-conductor

(a) (i) Describe the trend in the melting points of the Group 6 elements. [1]

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(ii) Give the physical state of selenium at 400 °C. Give a reason for your choice. [2]

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(iii) Explain why it is difficult to classify selenium as either a metal or a non-metal. [1]

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(b) Selenium dioxide reacts with sodium hydroxide to produce sodium selenite and water.

$$SeO_2 + 2NaOH \longrightarrow Na_2SeO_3 + H_2O$$

selenium dioxide — sodium selenite

(i) Calculate the relative formula mass (M_r) of sodium selenite, Na_2SeO_3. [1]

$A_r(Na) = 23$ $A_r(Se) = 79$ $A_r(O) = 16$

M_r = ...

(ii) Calculate the percentage by mass of selenium in sodium selenite. [2]

Percentage = ... %

7

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3. *(a)* The table gives the composition of six particles, **A**-**F**, which are either atoms or ions.

Particle	Number of protons	Number of neutrons	Number of electrons
A	14	14	14
B	19	20	18
C	15	16	18
D	16	16	16
E	11	12	11
F	12	12	10

(i) Which particles are atoms? Explain your choice. [2]

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(ii) Which particles are positive ions? Give the charges on the particles you have chosen. [2]

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(b) Carbon has two isotopes – carbon-12 and carbon-14.

Using these examples, explain what is meant by the term *isotope*. [2]

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6

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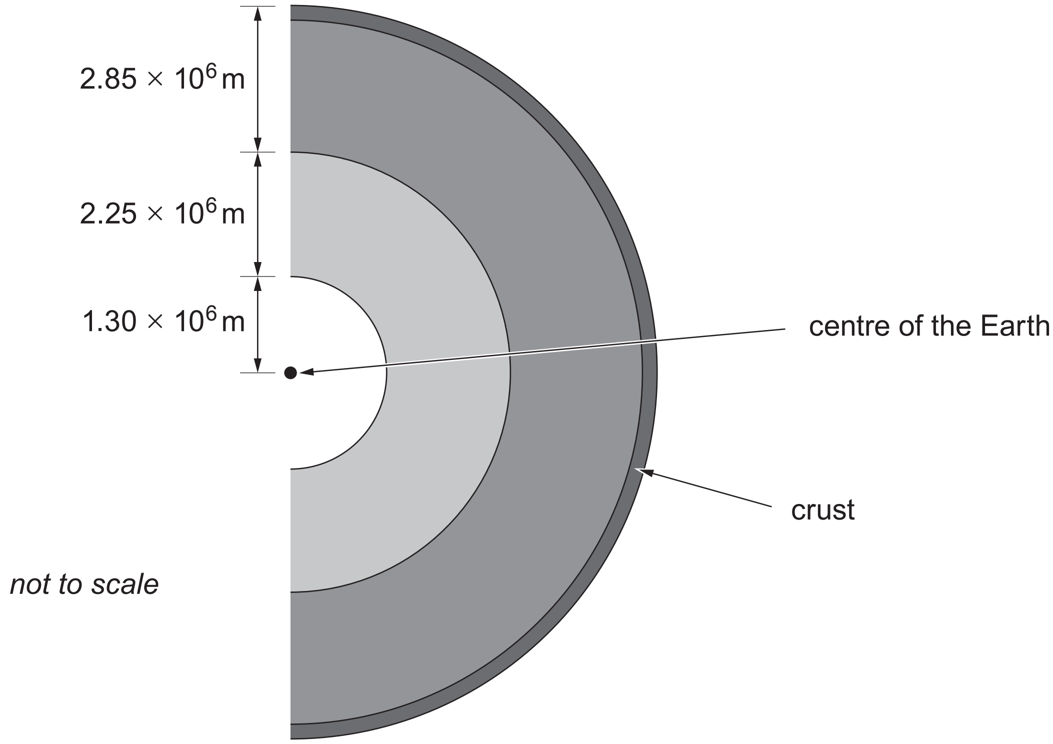
4. The Earth is almost spherical. The diagram shows a section of the layered structure of the Earth.



(a) The thickness of the crust at one location is 0.97 % of the distance from the surface to the centre of the Earth.

Use this information to calculate the thickness of the crust. Give your answer in **standard form**. [3]

Thickness of crust = ... m

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(b) (i) Describe the theory of plate tectonics. [3]

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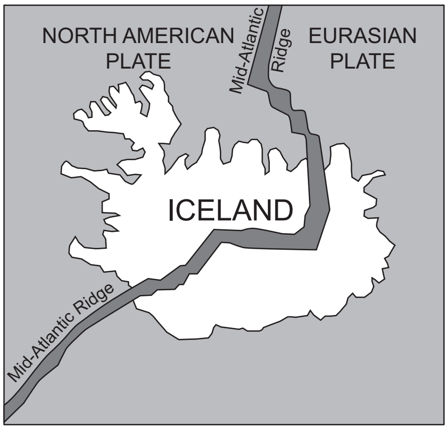
(ii) Iceland lies on the Mid-Atlantic Ridge which is formed at a constructive plate boundary. Explain the formation of the Mid-Atlantic Ridge. [2]



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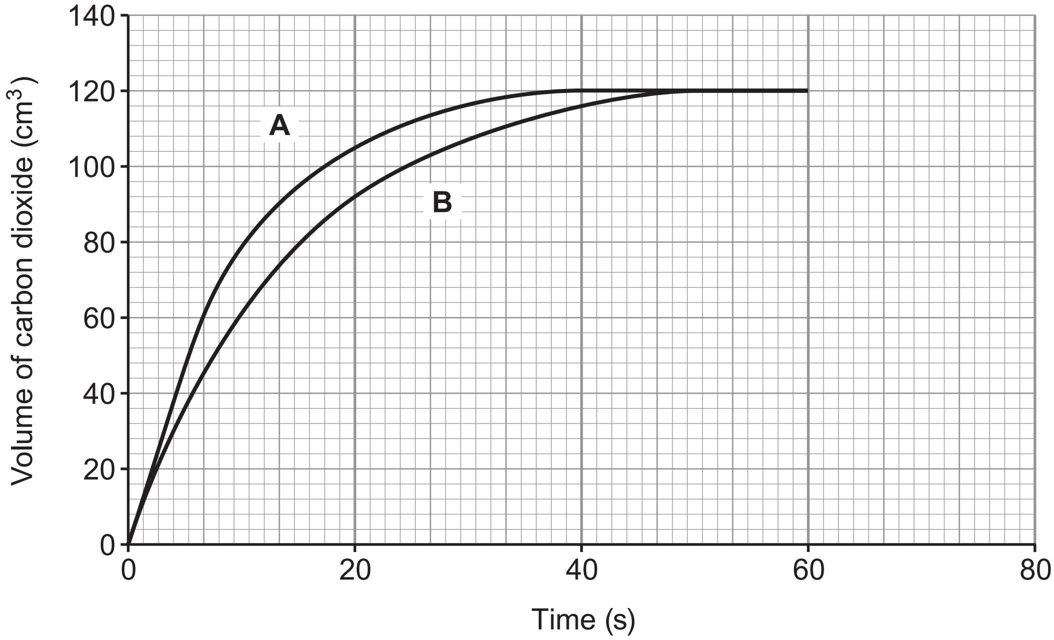
5. The rate of reaction between hydrochloric acid and calcium carbonate was studied. Two experiments, **A** and **B**, were carried out. The same concentration of acid and the same mass of calcium carbonate were used, with the acid in excess each time. The volume of gas produced was measured for 60 seconds. The results of these experiments are shown in the graphs.



(a) Using the particle theory, state and explain **two** factors that may be responsible for the higher rate seen in experiment **A**. [4]

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(b) State how the graphs show that the same mass of calcium carbonate was used in both experiments. [1]

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6. Explain the trends in reactivity of the elements in Groups 1 and 7 of the Periodic Table. [6 QER]

6

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7. *(a)* (i) A group of students were given three water samples. One was soft water, one was temporary hard water and one was permanent hard water.

Describe a method that the students could use to find out which is which. Give the expected results. You do **not** need to include the detail required to ensure a fair test. [4]

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(ii) The samples from part (i) were labelled **X**, **Y** and **Z** and sent to have their ion content measured. The table shows the results.

Ions present	Ion content in water sample (mg/dm^3)		
	X	**Y**	**Z**
sodium	29	116	23
potassium	12	15	11
magnesium	31	4	98
calcium	141	2	27
hydrogencarbonate	30	19	219
chloride	17	14	20
sulfate	346	6	27
nitrate	12	15	19

Use this information to find whether sample **Z** is the soft water, the temporary hard water or the permanent hard water. Give a reason for your choice. [2]

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(b) (i) Permanent hard water can be softened by ion exchange. Explain how ion exchange works. [2]

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(ii) Explain why the resin in ion exchange stops working after continued use. [1]

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(c) A litre bottle of mineral water contains 184 mg of dissolved calcium sulfate, $CaSO_4$. Calculate the number of moles of calcium sulfate present.

Give your answer to **three** significant figures.

1 mg = 0.001 g [2]

A_r(Ca) = 40 A_r(S) = 32 A_r(O) = 16

Moles of calcium sulfate = ... mol

11

8. The most common understanding of the term 'heavy metal' is a metallic element which is toxic and has a high density, atomic number and relative atomic mass. The definitions used vary depending on the context. In metallurgy, for example, a heavy metal is defined on the basis of density, whereas in physics the distinguishing factor is atomic number. A chemist would likely be more concerned with chemical behaviour. More specific definitions have been published but none of these have been widely accepted.

Despite this lack of agreement, the term is widely used in science. Heavy metals are sometimes defined as metals with a density greater than 5 g / cm^3. They are often highly toxic or damaging to the environment. Chromium, arsenic, cadmium, mercury and lead have the greatest potential to cause harm on account of their extensive use.

Heavy metals are dangerous because they tend to bio-accumulate. Bio-accumulation occurs when the toxic chemical is taken into the body faster than it can be excreted. Lead can have an adverse impact on mental development in infants and children. Lead may also be a factor in behavioural problems. Heavy metal poisoning could result, for instance, from drinking-water contamination.

Lead is the most prevalent heavy metal contaminant. As a component of tetraethyl lead, $(CH_3CH_2)_4Pb$, it was used extensively in 'leaded petrol' from the 1930s-1970s. Although the use of leaded petrol has been phased out, soils next to roads can have high lead concentrations – see **Figure 1**. Lead-based paints were another early source of lead pollution but their use is now banned in the UK. **Figure 2** opposite shows how the amount of lead used in paint and petrol in the USA changed over the 20th century.

Figure 1

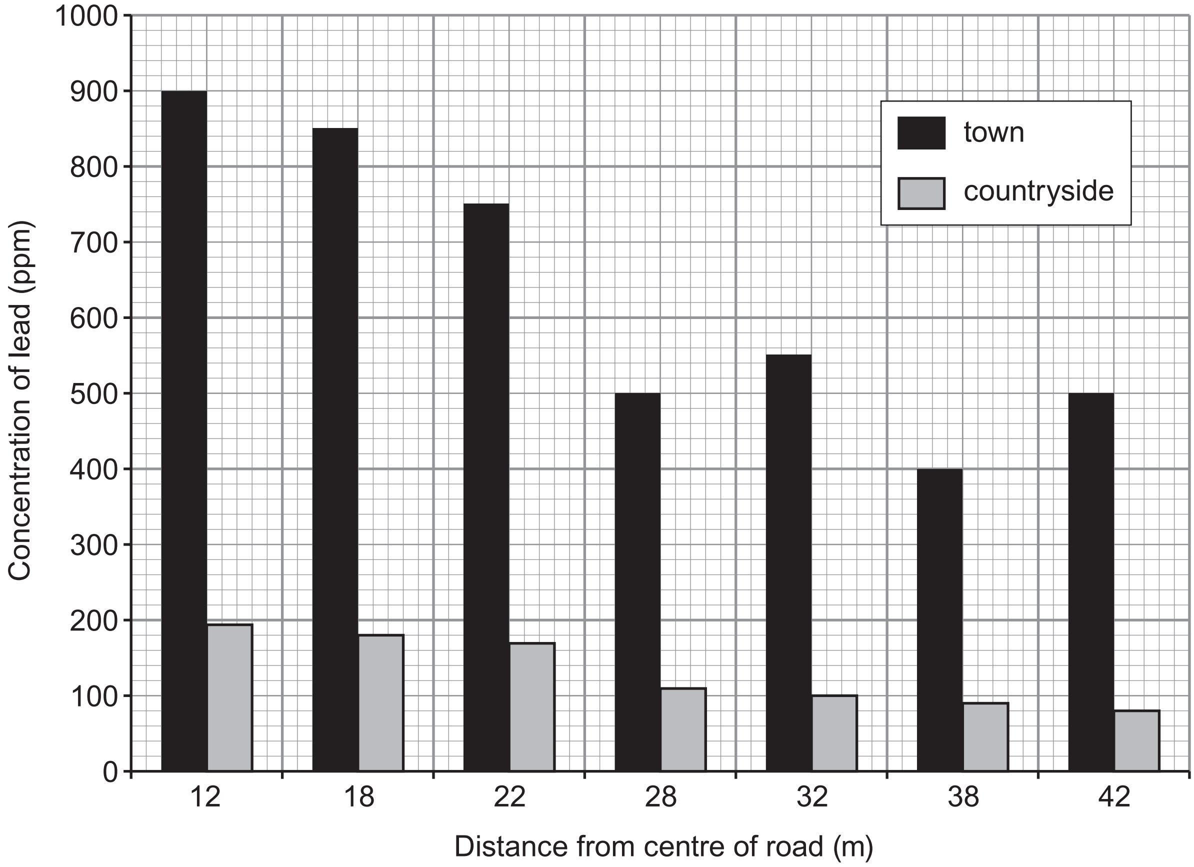

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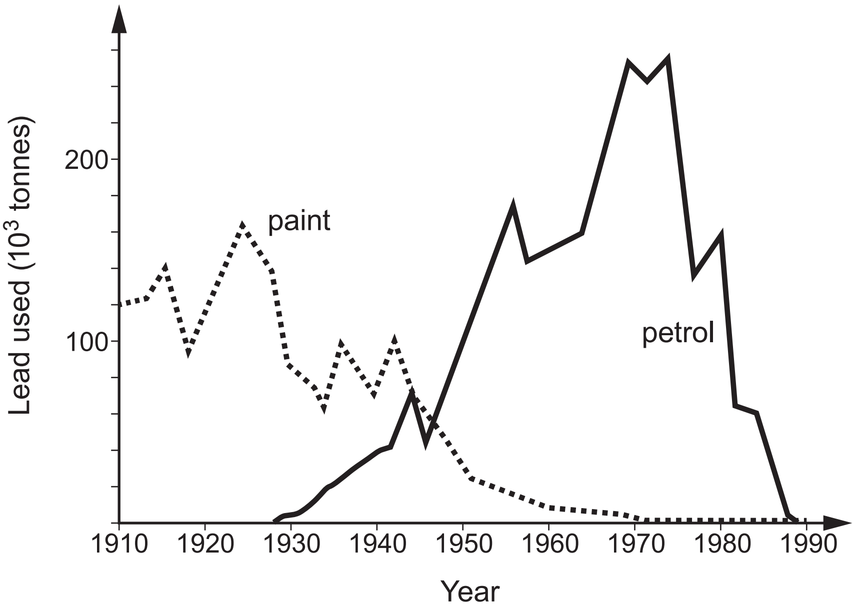
Figure 2



(a) (i) Put a tick (✓) in the box next to the statement which **best** describes why a single definition of a 'heavy metal' is not accepted by all scientists. [1]

metallurgists, physicists and chemists do not trust each other ☐

metallurgists, physicists and chemists are not concerned with the fact that heavy metals are toxic ☐

metallurgists, physicists and chemists are concerned with different properties of heavy metals ☐

metallurgists, physicists and chemists study different heavy metals ☐

(ii) Since the 1970s the use of lead water pipes has been prohibited across Europe. Explain why this is the case. [1]

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Examiner only

(iii) Put a tick (✓) in the box next to the **two** statements which describe the conclusions that can be drawn from the data in **Figure 1**. [2]

lead contamination in road-side soil decreases in towns and in the countryside as the distance from the centre of the road increases ☐

the decrease in lead contamination between 12 m and 42 m from the centre of the road is greater in towns than in the countryside ☐

lead contamination in road-side soil at all distances is much greater in towns than in the countryside ☐

lead contamination in road-side soil decreases between 12 m and 42 m from the centre of the road in the countryside ☐

there is approximately 50 % more lead contamination in road-side soil in towns compared to the countryside between 12 m and 28 m from the centre of the road ☐

there is an overall decrease of nearly 70 % in the lead contamination of road-side soil in towns between 12 m and 42 m from the centre of the road ☐

(iv) In the mid-1970s the use of lead in paints and the manufacture of cars that used leaded petrol was banned. Put a tick (✓) in the box next to the statement which **best** describes what happened after the ban. [1]

paint and petrol were lead-free by the mid-1970s anyway ☐

paint and petrol were not lead-free until 1980 ☐

the use of lead-based paint and leaded petrol increased until 1980 before decreasing ☐

it took 15 years for paint and petrol to become lead-free ☐

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(b) (i) Lead can form a number of oxides with different formulae. Red lead, Pb_3O_4, is used to make batteries. It is manufactured by reacting lead carbonate with oxygen. Carbon dioxide is also produced.

Balance the equation for this reaction. [1]

$$\square\, PbCO_3 + O_2 \longrightarrow \square\, Pb_3O_4 + \square\, CO_2$$

(ii) 11.36 g of a lead oxide contains 10.18 g of lead. Calculate the empirical formula of this oxide. [3]

$A_r(Pb) = 207$ $A_r(O) = 16$

Empirical formula ....

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END OF PAPER

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+}		

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

A_r	relative atomic mass
Symbol	
Name	
Z	atomic number