| 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** | |

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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. 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.*

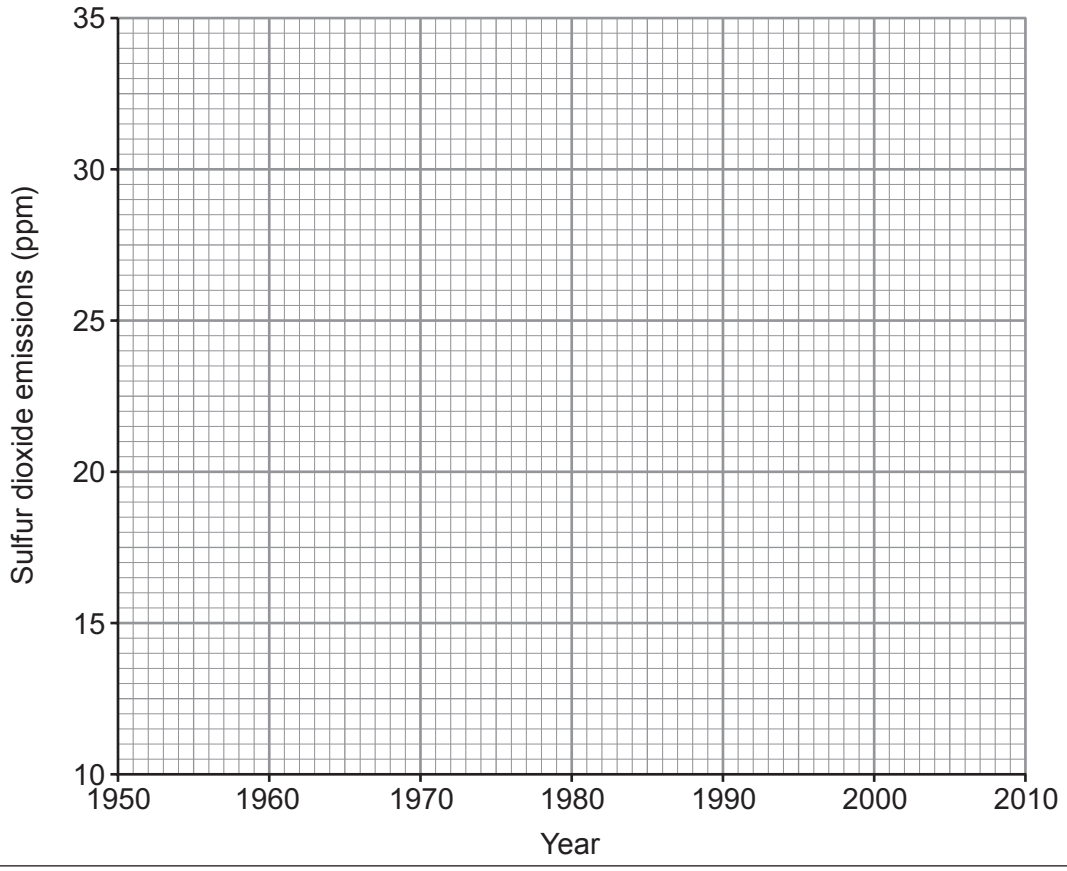
**1.** Burning fossil fuels containing sulfur causes sulfur dioxide, $SO_2$, to be released into the atmosphere.

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]

$SO_2$ + ☐ $H_2S$ ⟶ ☐ S + ☐ .....

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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.

$$\underset{\text{selenium dioxide}}{SeO_2} + 2NaOH \longrightarrow \underset{\text{sodium selenite}}{Na_2SeO_3} + H_2O$$

(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 = ..... %

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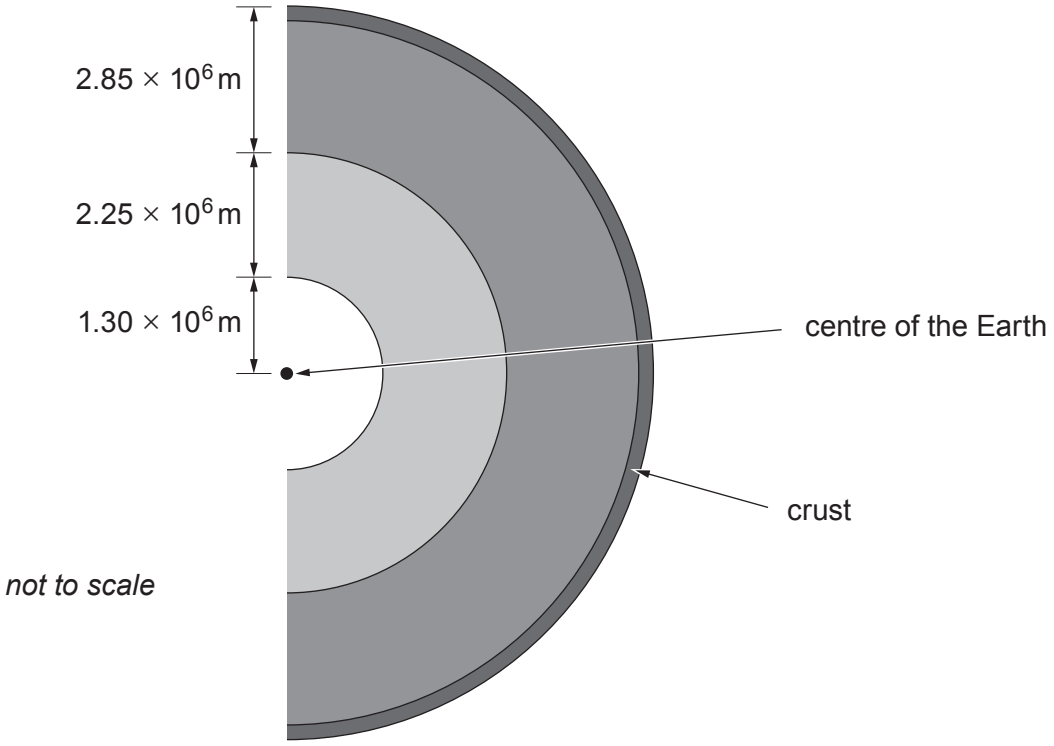
**4.** The Earth is almost spherical. The diagram shows a section of the layered structure of the Earth.




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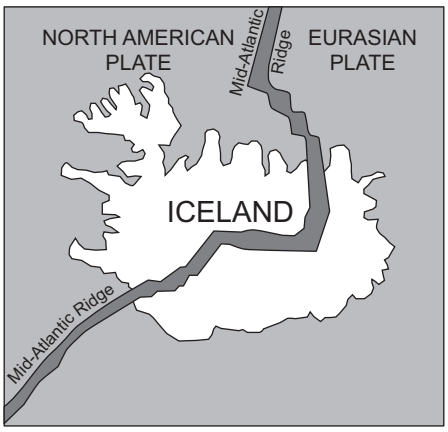
(ii) Iceland lies on the Mid-Atlantic Ridge which is formed at a constructive plate boundary. Explain the formation of the Mid-Atlantic Ridge. [2]

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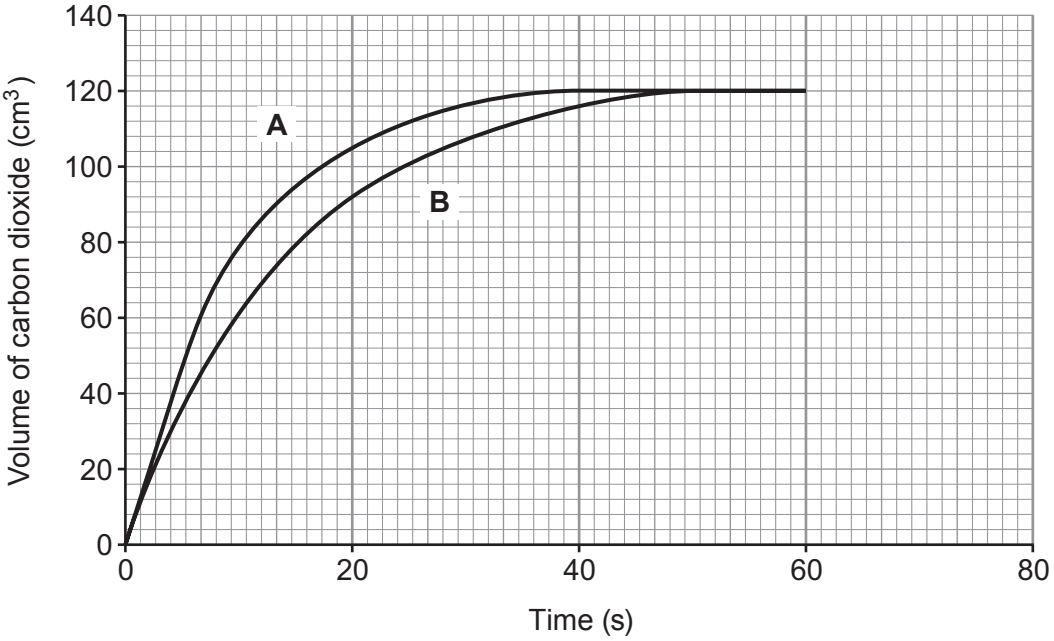
**5.** The rate of reaction between hydrochloric acid and calcium carbonate was studied. Two experiments, **A** and **B**, were carried out. The same concentration of acid and the same mass of calcium carbonate were used, with the acid in excess each time. The volume of gas produced was measured for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

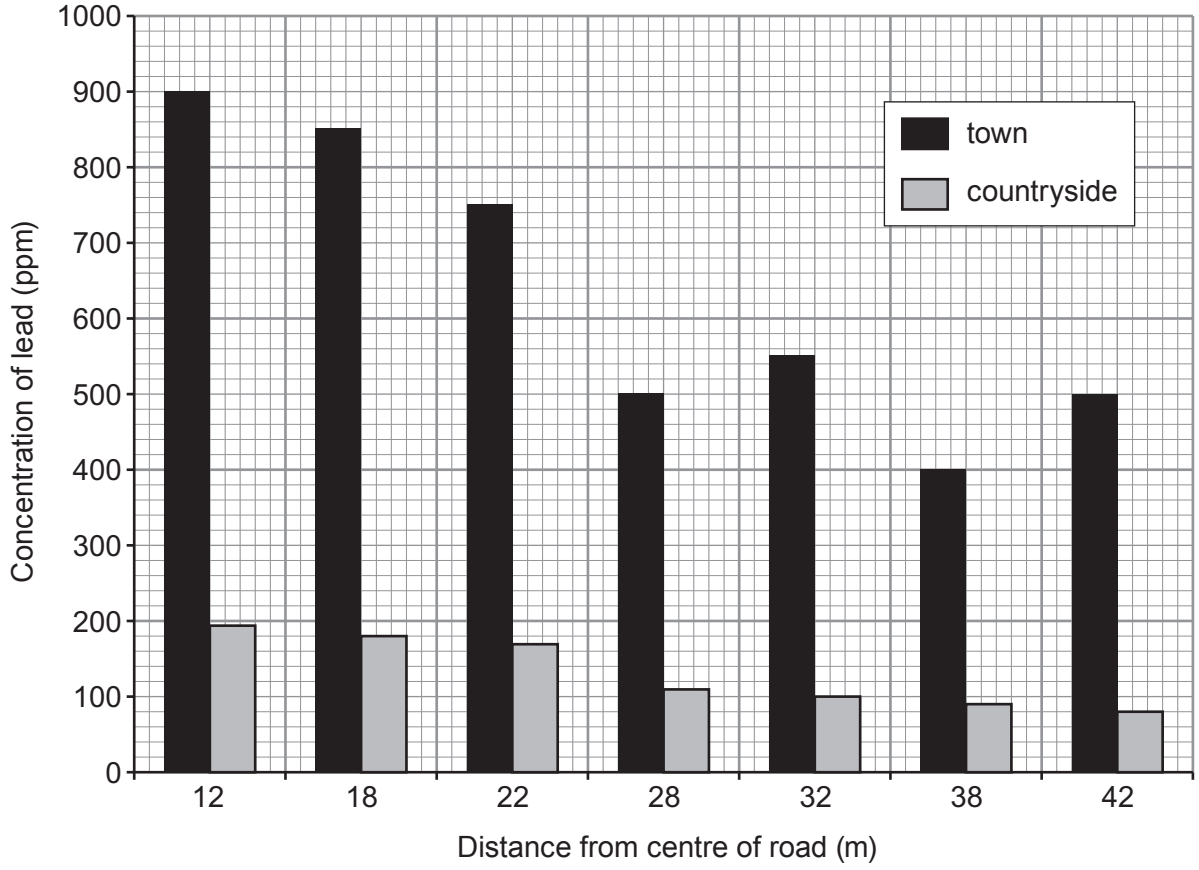

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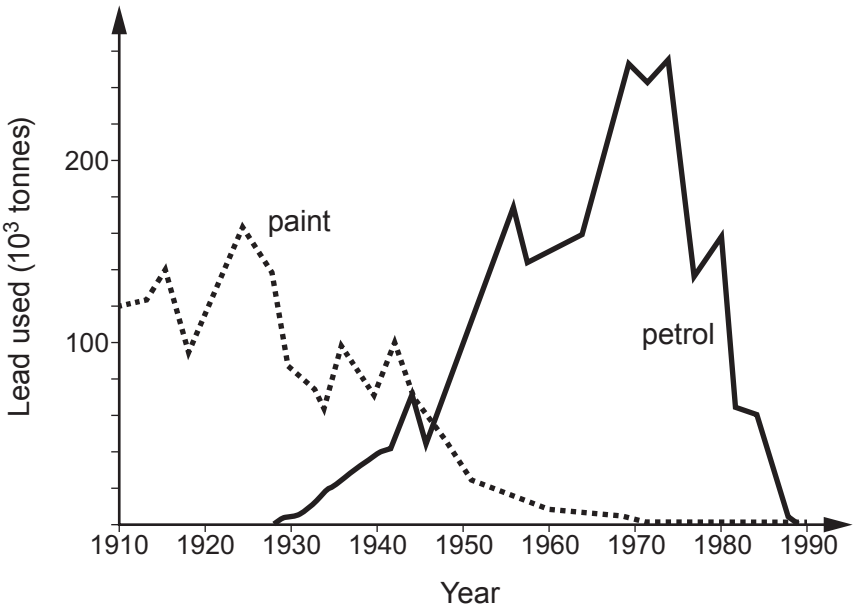
**Figure 2**




*(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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(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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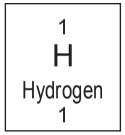
## FORMULAE FOR SOME COMMON IONS

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | 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