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|-------------------------------------------------------------------------------------------------|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Please check the examination details below before entering your candidate information           |  |                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                    |
| Candidate surname                                                                               |  | Other names                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Pearson Edexcel</b>                                                                          |  | Centre Number                                                                                                                                                                                                                                                                                                                                                                                                                              | Candidate Number                                                                                                                                                                                                                                                                                                                                                   |
| <b>International GCSE (9–1)</b>                                                                 |  | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> </div> | <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> </div> |
| <b>Thursday 9 January 2020</b>                                                                  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                    |
| Morning (Time: 2 hours)                                                                         |  | Paper Reference <b>4CH1/1C 4SD0/1C</b>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Chemistry</b><br><b>Unit: 4CH1</b><br><b>Science (Double Award) 4SD0</b><br><b>Paper: 1C</b> |  |                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                    |
| <b>You must have:</b><br>Calculator, ruler                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                            | Total Marks<br><div style="border: 1px solid black; width: 40px; height: 40px; margin: 0 auto;"></div>                                                                                                                                                                                                                                                             |

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- Show all the steps in any calculations and state the units.
- Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

### Information

- The total mark for this paper is 110.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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\* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

*The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.*

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**Answer ALL questions.**

1 This question is about gases in the atmosphere.

(a) The box gives the names of some gases in the atmosphere.

|       |                |        |          |        |
|-------|----------------|--------|----------|--------|
| argon | carbon dioxide | helium | nitrogen | oxygen |
|-------|----------------|--------|----------|--------|

Choose gases from the box to answer these questions.

Each gas may be used once, more than once or not at all.

(i) Identify a noble gas.

Argon

(1)

(ii) Identify a gas that makes up about 78% of the atmosphere.

Nitrogen

(1)

(iii) Identify a greenhouse gas.

Carbon dioxide

(1)

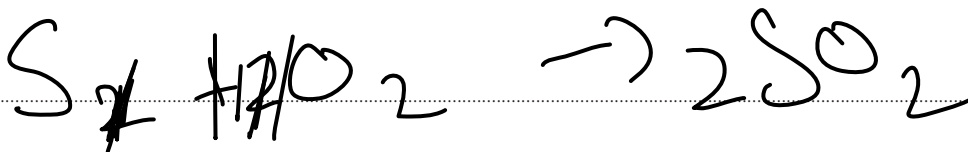
(iv) Identify a gas produced by the thermal decomposition of calcium carbonate.

~~CO<sub>2</sub>~~ Carbon dioxide

(1)

(b) Sulfur reacts with oxygen to produce sulfur dioxide gas.

(i) Write a chemical equation for this reaction.



(1)

(ii) State an environmental problem caused when sulfur dioxide gas dissolves in water in the atmosphere.

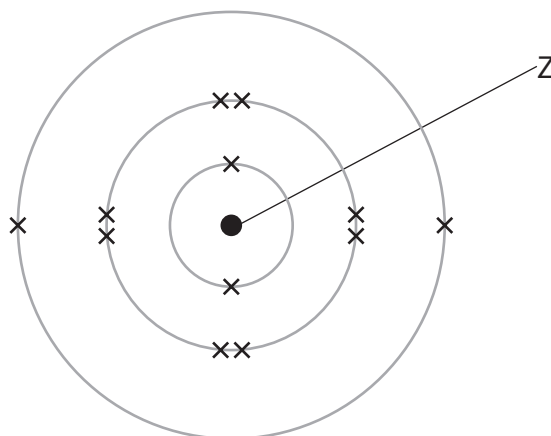
Acid rain

(1)

(Total for Question 1 = 6 marks)



2 The diagram shows the electronic configuration of an atom of an element.



(a) Complete the table by giving the missing information about this atom.

(5)

|                                                 |            |
|-------------------------------------------------|------------|
| name of the part of this atom labelled Z        | Nucleus ✓  |
| number of protons in this atom                  | 12 ✓       |
| number of the group that contains this element  | Group 2 ✓  |
| number of the period that contains this element | Period 3 ✓ |
| the charge on the ion formed from this atom     | +2 ✓       |

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(b) This element has three isotopes.

The table shows the mass number and percentage abundance of each isotope in a sample of this element.

| Mass number | Percentage abundance (%) |
|-------------|--------------------------|
| 24          | 79.2                     |
| 25          | 10.0                     |
| 26          | 10.8                     |

Calculate the relative atomic mass ( $A_r$ ) of this element.

Give your answer to one decimal place.

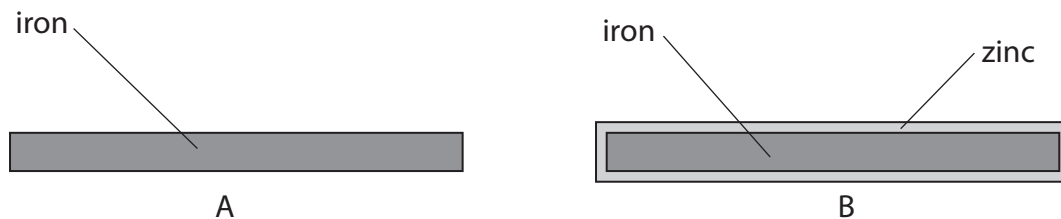
(3)

relative atomic mass = .....

(Total for Question 2 = 8 marks)



3 The diagram shows two samples of iron, A and B.



Sample B is coated with a thin layer of zinc.

(a) Name the process used to coat iron with zinc.

Galvanising ✓

(1)

(b) The two samples of iron are left outside for several weeks.

A brown solid containing hydrated iron(III) oxide forms on sample A.

(i) Give the common name for the brown solid.

Rust- ✓

(1)

(ii) Give the names of the two substances that react with the iron to form the brown solid.

(2)

1 Air ✓  
2 Water ✓

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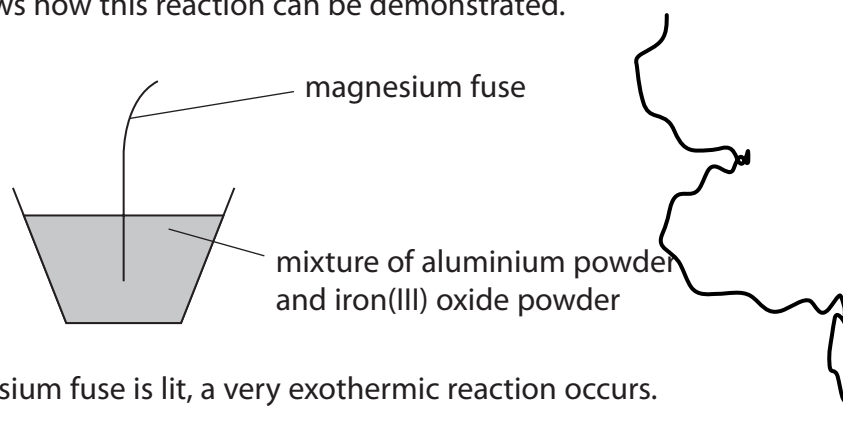
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(c) Iron can be formed by reacting aluminium powder with iron(III) oxide.

The diagram shows how this reaction can be demonstrated.

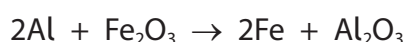


When the magnesium fuse is lit, a very exothermic reaction occurs.

(i) State the meaning of the term **exothermic**.

Heat is released to the surrounding.

(ii) The equation for the reaction between aluminium and iron(III) oxide is



Explain what this reaction shows about the relative reactivities of aluminium and iron.

The reaction shows that aluminium is more reactive than iron as it displaced it.

(iii) Explain why the reaction between aluminium and iron(III) oxide is a redox reaction.

It is called a redox reaction as both oxidation and reduction take place. Al is getting oxidised to  $\text{Al}_2\text{O}_3$  and  $\text{Fe}_2\text{O}_3$  is getting reduced to Fe.

(Total for Question 3 = 10 marks)



4 This question is about ionic compounds.

- (a) The table shows the formulae of some positive and negative ions, and the formulae of some compounds containing these ions.

|                    | $\text{Mg}^{2+}$           | $\text{Al}^{3+}$             | $(\text{NH}_4^+)_2\text{S}$                     |
|--------------------|----------------------------|------------------------------|-------------------------------------------------|
| $\text{S}^{2-}$    | $\text{MgS}$               | $\text{Al}_2\text{S}_3$      | <del><math>\text{S}(\text{NH}_4)_2</math></del> |
| $\text{NO}_3^-$    | $\text{Mg}(\text{NO}_3)_2$ | $\text{Al}(\text{NO}_3)_3$   | $\text{NH}_4\text{NO}_3$                        |
| $\text{CO}_3^{2-}$ | $\text{MgCO}_3$            | $\text{Al}_2(\text{CO}_3)_3$ | $(\text{NH}_4)_2\text{CO}_3$                    |

- (i) Complete the table by giving the three missing formulae.

(3)

- (ii) Give the name of the compound with the formula  $\text{NH}_4\text{NO}_3$ .

(1)

Ammonium Nitrate

- (b) Sodium oxide,  $\text{Na}_2\text{O}$ , is an ionic compound.

The sodium and oxide ions are held together by ionic bonds.

- (i) State the meaning of the term **ionic bond**.

(2)

A bond between two oppositely charged ions, usually a metal and a non-metal.

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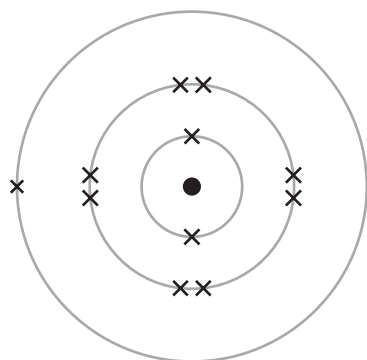
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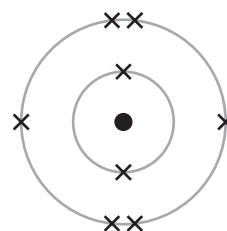


- (ii) The diagram shows the arrangement of the electrons in a sodium atom and in an oxygen atom.

sodium atom



oxygen atom

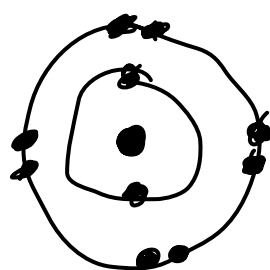


Draw diagrams in the boxes to show the arrangement of the electrons in the ions of sodium oxide.

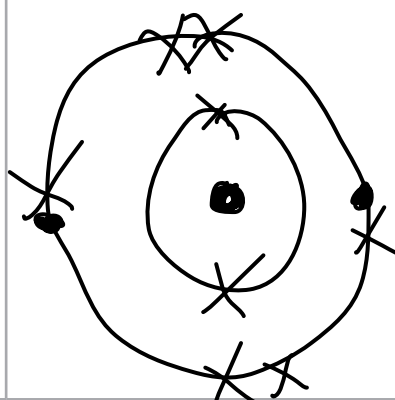
Include the charges on the ions.

(3)

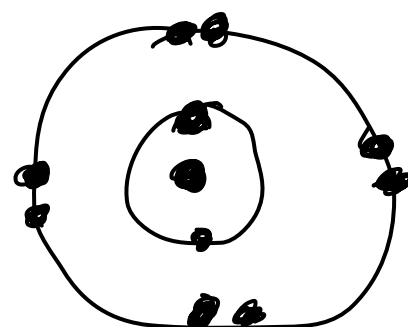
sodium ion



oxide ion



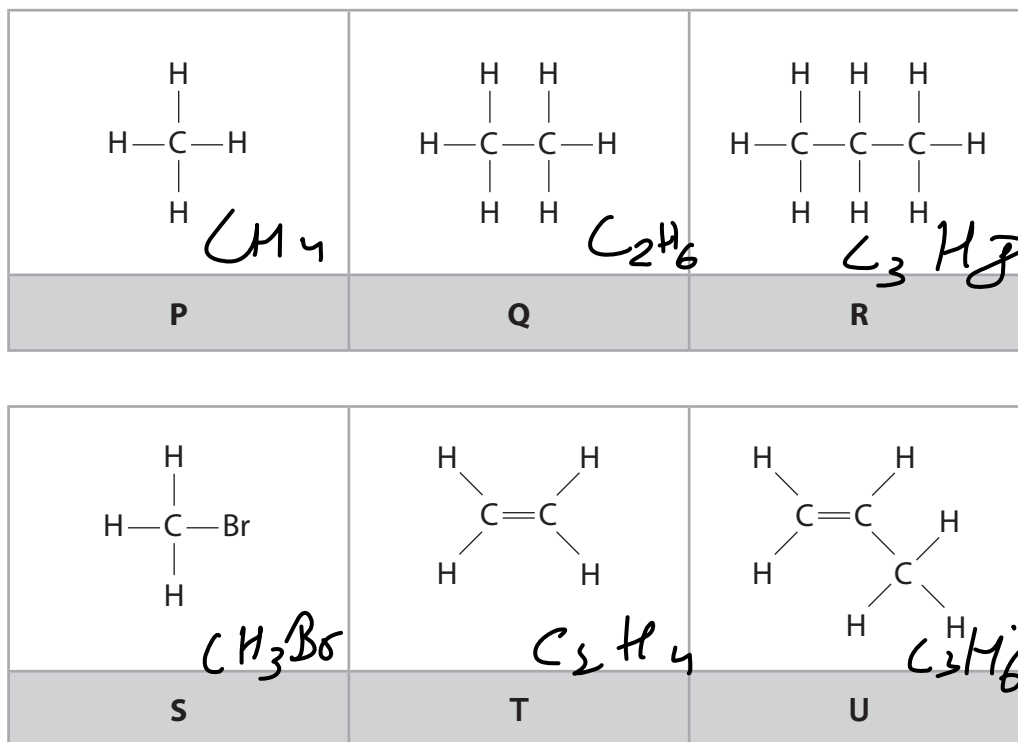
sodium ion



(Total for Question 4 = 9 marks)



5 The boxes show the displayed formulae of six organic compounds, P, Q, R, S, T and U.



(a) Use the letters P, Q, R, S, T and U to answer these questions.

Each letter may be used once, more than once or not at all.

(i) Give the letter of the compound that is **not** a hydrocarbon.

*S*

(1)

(ii) Give the letters of the two compounds that have the same empirical formula.

*T, U*

(1)

(iii) Give the letter of the compound that is used to manufacture poly(propene).

*U*

(1)

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(b) Describe a test that can be used to distinguish between compounds Q and T. (3)

test

Add bromine water

result with compound Q

No reaction occurs

result with compound T

Bromine water turns from brown to colorless

(c) Compounds P, Q and R are members of the same homologous series.

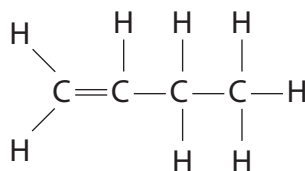
Give two characteristics of a homologous series.

(2)

1

2

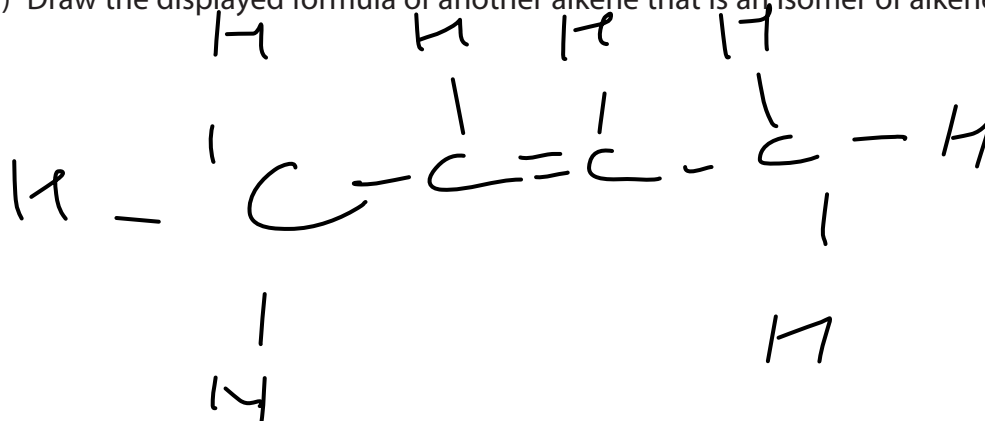
(d) This is the displayed formula of an alkene, V.



(i) Give the name of alkene V. (1)

~~butene~~ but-1-ene

(ii) Draw the displayed formula of another alkene that is an isomer of alkene V. (1)



(e) An organic compound has the percentage composition by mass

C = 36.36%

H = 6.06%

F = 57.58%

(i) Show that the empirical formula of the compound is  $\text{CH}_2\text{F}$

(2)

$$\begin{array}{r}
 36.36 \\
 \hline
 12 \\
 \hline
 3.03 \\
 \hline
 1
 \end{array}
 \quad
 \begin{array}{r}
 6.06 \\
 \hline
 1 \\
 \hline
 6.062 \\
 \hline
 3.031 \\
 \hline
 2
 \end{array}
 \quad
 \begin{array}{r}
 57.68 \\
 \hline
 19 \\
 \hline
 3.037 \\
 \hline
 3.031 \\
 \hline
 1
 \end{array}$$

(ii) The relative molecular mass ( $M_r$ ) of the compound is 66.

Determine the molecular formula of the compound.

$$\text{C H}_2 \text{F} = 12 + 2 + 19 = 33^{(2)}$$

$$(\text{CH}_2\text{F}) \times 2 = \text{C}_2\text{H}_4\text{F}_2 = 24 + 4 + 38 = 66$$

molecular formula =  $\text{C}_2\text{H}_4\text{F}_2$

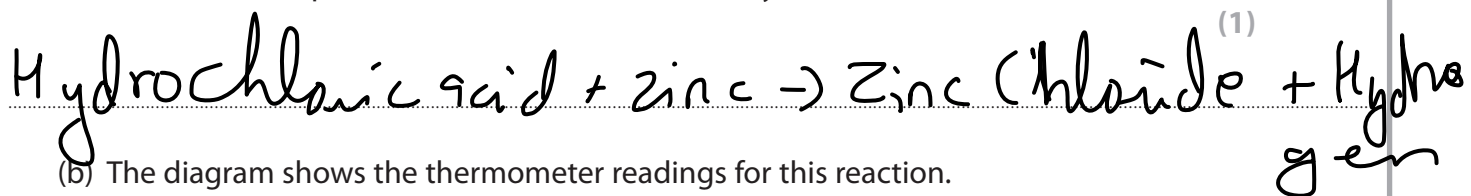
(Total for Question 5 = 14 marks)



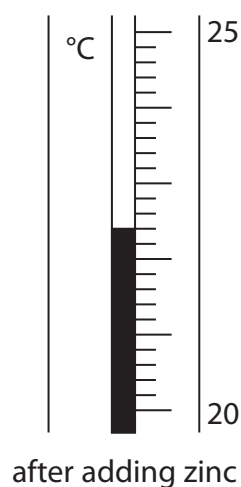
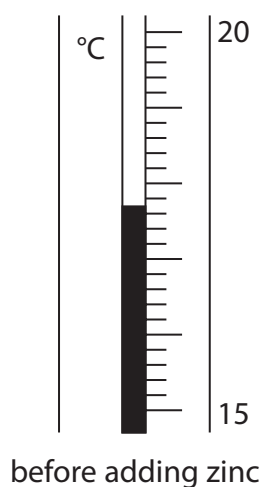
6 A student uses this method to investigate the reaction of dilute hydrochloric acid with zinc.

- pour some dilute hydrochloric acid into a glass beaker
- record the initial temperature of the acid
- add a piece of zinc and stir the mixture
- record the temperature of the mixture after one minute

(a) Write a word equation for the reaction of dilute hydrochloric acid with zinc.



(b) The diagram shows the thermometer readings for this reaction.



Complete the table, giving all values to the nearest 0.1°C.

|                                      |      |
|--------------------------------------|------|
| temperature in °C after adding zinc  | 22.4 |
| temperature in °C before adding zinc | 17.7 |
| temperature change in °C             | 4.7  |

(3)



(c) Another student repeats the method using five different metals to compare their reactivity.

(i) This student uses a polystyrene cup instead of a glass beaker.

Explain why a polystyrene cup is better than a glass beaker in this investigation.

As less heat is released into the polystyrene cup as it does not absorb it, giving a ~~better~~ more accurate ~~of the~~ value. (2)

(ii) Give three factors that the student should keep constant in this investigation.

- The moles of metals (3)
- 1 The mass of metals
  - 2 The concentration of HCl
  - 3 The volume of hydrochloric acid

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(d) The table shows some of the student's results.

| Metal added | Observation        | Temperature change in °C |
|-------------|--------------------|--------------------------|
| copper      | no bubbling        | 0.0                      |
| iron        | slow bubbling      |                          |
| magnesium   | rapid bubbling     | 8.7                      |
| tin         | very slow bubbling | 1.4                      |
| zinc        | moderate bubbling  | 5.1                      |

(i) State why there is no temperature change for copper.

As it did not react (1)

(ii) Predict the temperature change for iron.

(1)

temperature change = 2.5 °C

(iii) Deduce the order of reactivity of the five metals.

(1)

most reactive

Magnesium

zinc

Iron

tin

least reactive

Copper

(Total for Question 6 = 12 marks)



7 This question is about some of the halogens and their compounds.

(a) (i) Which element is a liquid at room temperature?

- ☐ A astatine
- ☒ B bromine
- ☐ C chlorine
- ☐ D iodine

(ii) Which element has the palest colour?

- ☐ A astatine
- ☐ B bromine
- ☒ C chlorine
- ☐ D iodine

(iii) Which element is the least reactive?

- ☒ A astatine
- ☐ B bromine
- ☐ C chlorine
- ☐ D iodine

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(b) A teacher uses displacement reactions to demonstrate the reactivities of some halogens.

She adds solutions of chlorine, bromine and iodine separately to three different sodium halide solutions.

The table shows some of the teacher's results.

|                   | sodium chloride       | sodium bromide        | sodium iodide         |
|-------------------|-----------------------|-----------------------|-----------------------|
| chlorine solution | not done              | solution turns orange | Solution turns orange |
| bromine solution  | solution stays orange | not done              | solution turns brown  |
| iodine solution   | Solution stays orange | solution stays brown  | not done              |

A change in colour of the solution indicates that a reaction has occurred.

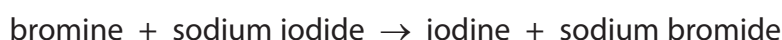
(i) Complete the table by predicting the missing results.

(2)

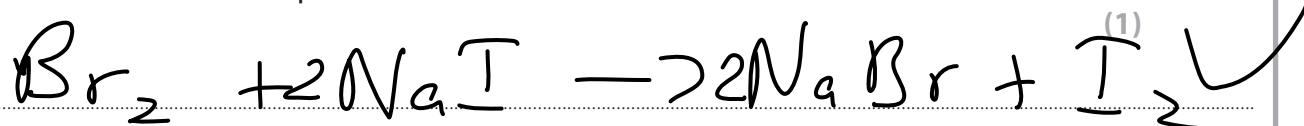
(ii) State why the teacher does not add bromine solution to sodium bromide solution.

As ~~not~~ no reaction since they both contain the same element.

(iii) The word equation for the reaction of bromine with sodium iodide is



Write a chemical equation for this reaction.



(c) A technician sees an unlabelled bottle containing a liquid.

He knows that the liquid is a solution of one of these compounds.

- copper(II) chloride
- copper(II) bromide
- iron(II) chloride
- iron(II) bromide

Describe chemical tests that the technician could use to identify the compound in the solution.

The technician can add aq.  $\text{NaOH}$  to the solution to test for  $\text{Fe}^{2+}$  and  $\text{Cu}^{2+}$  ions. If the solution contains  $\text{Fe}^{2+}$  ions a green ppt should form which is soluble in excess. If it contains  $\text{Cu}^{2+}$  ions then a blue ppt will form which is also insoluble in excess.

To test for  $\text{Cl}^-$  and  $\text{Br}^-$  ions, first add dil. nitric acid followed by silver nitrate solution. The nitric acid removes any carbonate and sulphide ions. If the solution contains  $\text{Cl}^-$  ions, a white ppt is formed. If it contains  $\text{Br}^-$  then a cream ppt forms.

(Total for Question 7 = 13 marks)



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P 5 9 9 2 3 A 0 1 9 2 8

8 (a) Carbon dioxide changes directly from a solid to a gas without becoming a liquid.

(i) Give the name of the change of state from solid to gas.

(1)

Sublimation

(ii) Describe the test for carbon dioxide gas.

(2)

Pass through lime water.  
It turns milky. After a while if  $\text{CO}_2$  is still being passed it will turn colorless.

(b) Carbon dioxide is a simple molecular covalent substance.

Explain why carbon dioxide turns from a solid to a gas at a very low temperature.

(2)

Since it is a simple covalent structure. It has very weak intermolecular forces of attraction which require very little energy to break.

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(c) Diamond and graphite are both giant covalent substances made up of carbon atoms.

- diamonds are used in cutting tools
- graphite is used in pencils to make marks on paper

Explain, with reference to structure and bonding, why each substance is suitable for its particular use.

(6)

(Total for Question 8 = 11 marks)



P 5 9 9 2 3 A 0 2 1 2 8

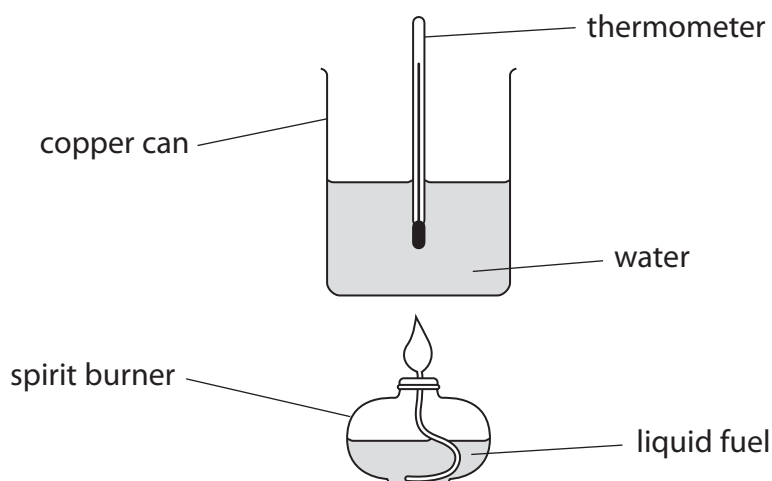
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- 9 A student uses this apparatus to investigate the heat energy released when a liquid fuel is burned.



This is the student's method.

- measure the mass of the spirit burner and fuel
- add  $100\text{ cm}^3$  of water to the copper can
- record the temperature of the water
- use the spirit burner to heat the water until the temperature rises by  $30^\circ\text{C}$
- immediately measure the new mass of the spirit burner and fuel

- (a) Suggest why the student measures the mass of the spirit burner and fuel immediately after heating the water.

~~So that no more fuel~~ To get the most accurate recording as it could evaporate. (1)

- (b) When the fuel is burned, the student notices that a black solid forms on the bottom of the copper can.

- (i) Identify the black solid.

~~Carbon~~ <sup>(11)</sup> Copper Oxide (1)

- (ii) Explain why the black solid forms.

Copper reacts with oxygen in the air. (2)



- (c) (i) Show that the heat energy change,  $Q$ , to raise the temperature of  $100\text{ cm}^3$  of water by  $30^\circ\text{C}$  is approximately 13 kJ.

[mass of  $1.0\text{ cm}^3$  of water = 1.0 g]

[ $c$  for water =  $4.2\text{ J/g/}^\circ\text{C}$ ]

(3)

- (ii) The student burns 0.96 g of methanol,  $\text{CH}_3\text{OH}$

Calculate the molar enthalpy change,  $\Delta H$ , in kJ/mol, for the combustion of methanol.

Include a sign in your answer.

[ $M_r$  of methanol = 32]

(3)

$\Delta H = \dots\dots\dots$  kJ/mol

- (d) The table shows data book values for the molar enthalpy change,  $\Delta H$ , for the combustion of some alcohols with different numbers of carbon atoms per molecule.

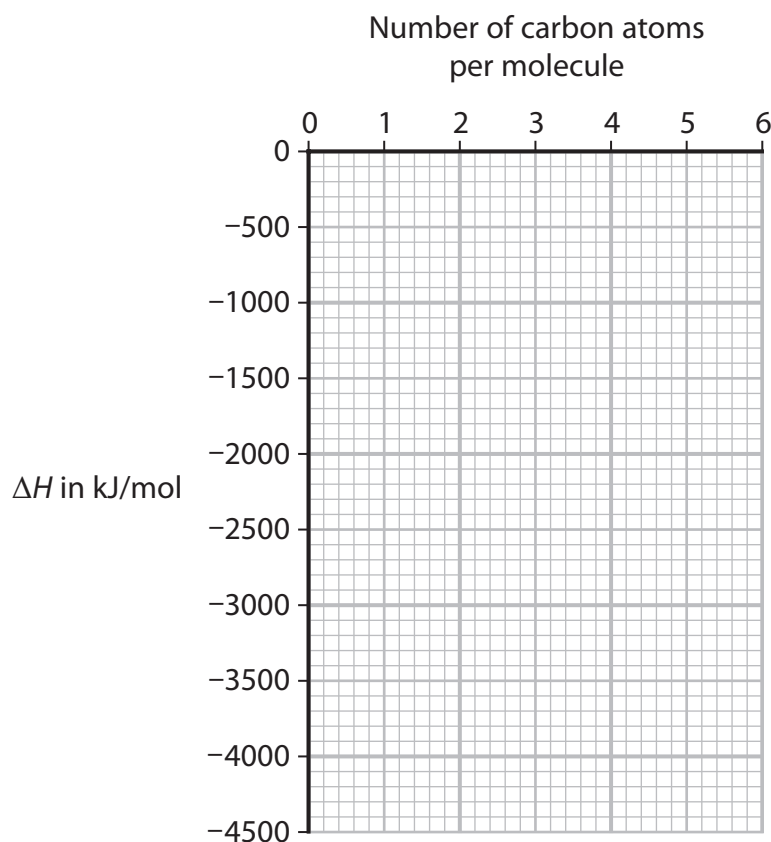
| Number of carbon atoms per molecule           | 1    | 2     | 3     | 4     | 5     |
|-----------------------------------------------|------|-------|-------|-------|-------|
| Molar enthalpy change, $\Delta H$ , in kJ/mol | -730 | -1370 | -2020 | -2680 | -3320 |



- (i) Plot the data values from the table on the grid.

Draw a straight line of best fit.

(2)



- (ii) Deduce the value of  $\Delta H$  for an alcohol with six carbon atoms per molecule.

Show on the graph how you obtained your answer.

(2)

$\Delta H = \dots\dots\dots$  kJ/mol

- (iii) State the relationship between  $\Delta H$  and the number of carbon atoms per molecule.

(1)

(Total for Question 9 = 15 marks)



**10** Nitric acid ( $\text{HNO}_3$ ) is used in the production of fertilisers.

Nitric acid is manufactured in three stages.

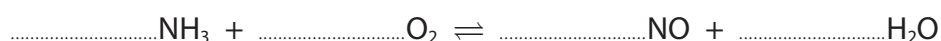
Stage 1 ammonia reacts with oxygen in the presence of a platinum catalyst to produce nitrogen monoxide gas,  $\text{NO}$ , and water.

Stage 2 nitrogen monoxide gas reacts with more oxygen to produce nitrogen dioxide gas,  $\text{NO}_2$ .

Stage 3 nitrogen dioxide gas reacts with water to produce nitric acid and more nitrogen monoxide gas.

(a) (i) Complete the chemical equation for the reaction in stage 1.

(1)



(ii) Give the meaning of the symbol  $\rightleftharpoons$

(1)

(iii) State the purpose of the platinum catalyst.

(1)

(b) Give a chemical equation for the reaction of nitrogen monoxide and oxygen in stage 2.

(1)

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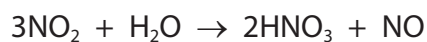


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- (c) (i) The equation for the reaction in stage 3 is



Calculate the maximum mass, in tonnes, of nitric acid that could be produced in this reaction from 11.5 tonnes of nitrogen dioxide.

[1 tonne =  $1.0 \times 10^6\text{g}$ ]

(4)

mass of nitric acid = ..... tonnes

- (ii) Suggest what use can be made of the nitrogen monoxide gas formed in stage 3.

(1)

.....

.....

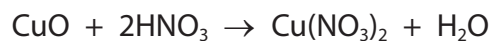
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**QUESTION 10 CONTINUES ON NEXT PAGE**



(d) When copper(II) oxide reacts with dilute nitric acid, copper(II) nitrate is produced.

The equation for the reaction is



0.200 mol of nitric acid reacts with excess copper(II) oxide.

A mass of 15.3 g of copper(II) nitrate is produced.

Calculate the percentage yield of copper(II) nitrate.

[ $M_r$  of copper(II) nitrate = 187.5]

(3)

percentage yield = ..... %

(Total for Question 10 = 12 marks)

**TOTAL FOR PAPER = 110 MARKS**

