Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel International GCSE (9–1)

Centre Number | Candidate Number

Thursday 9 January 2020

Morning (Time: 2 hours) | Paper Reference **4CH1/1C 4SD0/1C**

Chemistry

Unit: 4CH1

Science (Double Award) 4SD0

Paper: 1C

You must have:
Calculator, ruler

Total Marks

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 ▶

P59923A

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1/1/1/1/1/

P 5 9 9 2 3 A 0 1 2 8

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The Periodic Table of the Elements

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
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[98] 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	178 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	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** 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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GradeMax

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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.

(1)

Argon ✓

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

(1)

Nitrogen ✓

(iii) Identify a greenhouse gas.

(1)

Carbon dioxide ✓

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

(1) ✓

CO_2 Carbon dioxide

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

(i) Write a chemical equation for this reaction.

(1) -1

$S + 2O_2 \rightarrow 2SO_2$ ✓

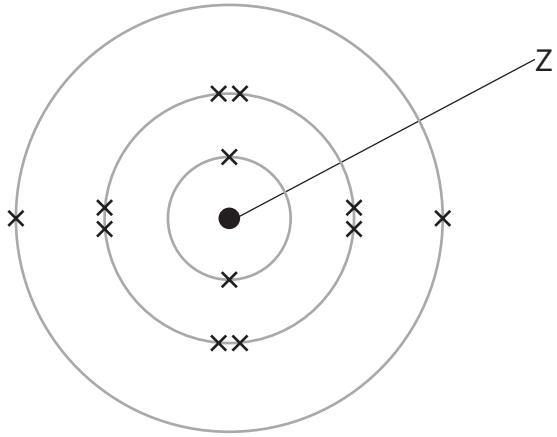
(ii) State an environmental problem caused when sulfur dioxide gas dissolves in water in the atmosphere.

(1)

Acid rain ✓

(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.

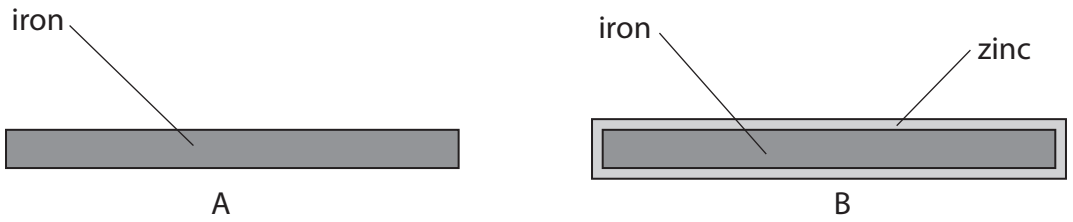
Give your answer to one decimal place.

(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.

(1)

Galvanising ✓

(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.

(1)

Rust ✓

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

(2)

1 ~~Air~~ Oxygen ✓

2 Water ✓

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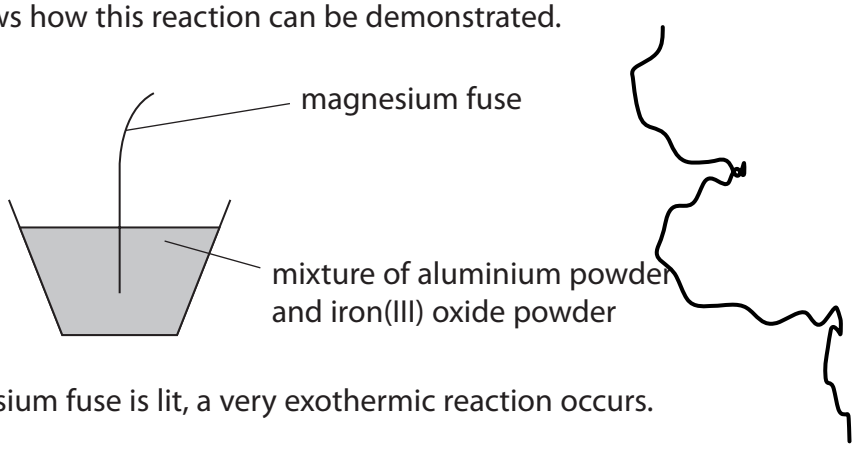
(c) Iron can be formed by reacting aluminium powder with iron(III) oxide.

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**.

(1)

Heat is released to the surrounding.

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

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

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

(2)

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.

(3)

It is called a redox reaction as both oxidation and reduction take place. Al is getting oxidised to Al_2O_3 and Fe_2O_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.

	Mg^{2+}	Al^{3+}	NH_4^+
S^{2-}	MgS	Al_2S_3	$(NH_4)_2S$
NO_3^-	$Mg(NO_3)_2$	$Al(NO_3)_3$	NH_4NO_3
CO_3^{2-}	$MgCO_3$	$Al_2(CO_3)_3$	$(NH_4)_2CO_3$

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

(3)

(ii) Give the name of the compound with the formula NH_4NO_3.

(1)

Ammonium Nitrate

(b) Sodium oxide, Na_2O, 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 2 two oppositively charged ions, usually a metal and a non-metal.

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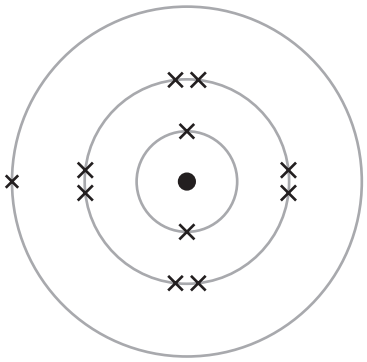
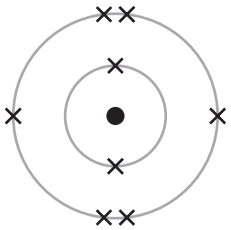
(ii) The diagram shows the arrangement of the electrons in a sodium atom and in an oxygen atom.

sodium atom



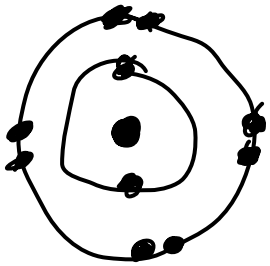
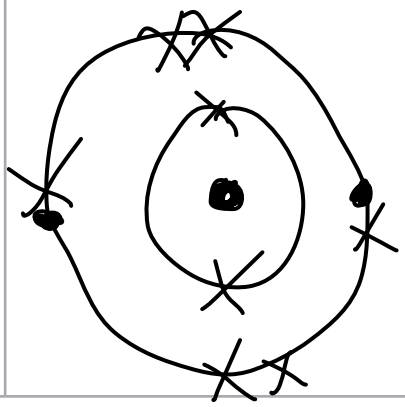
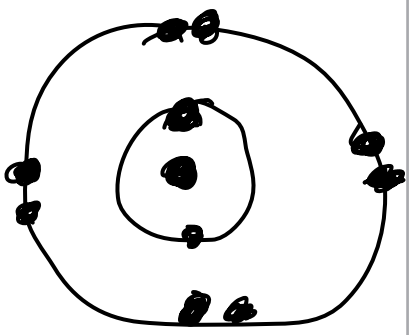
oxygen atom



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

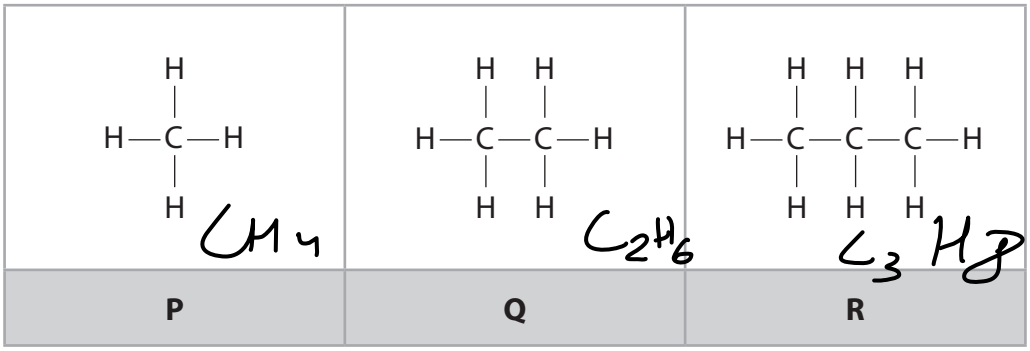
Include the charges on the ions.

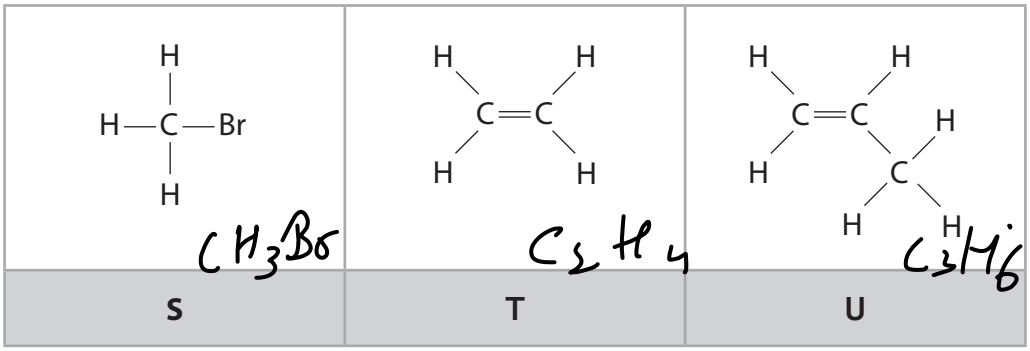
(3)

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.

(1)

S

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

(1)

T, U

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

(1)

U

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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.

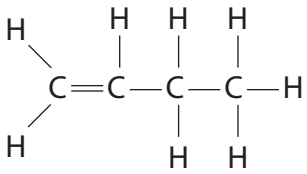
Give two characteristics of a homologous series.

(2)

1

2

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



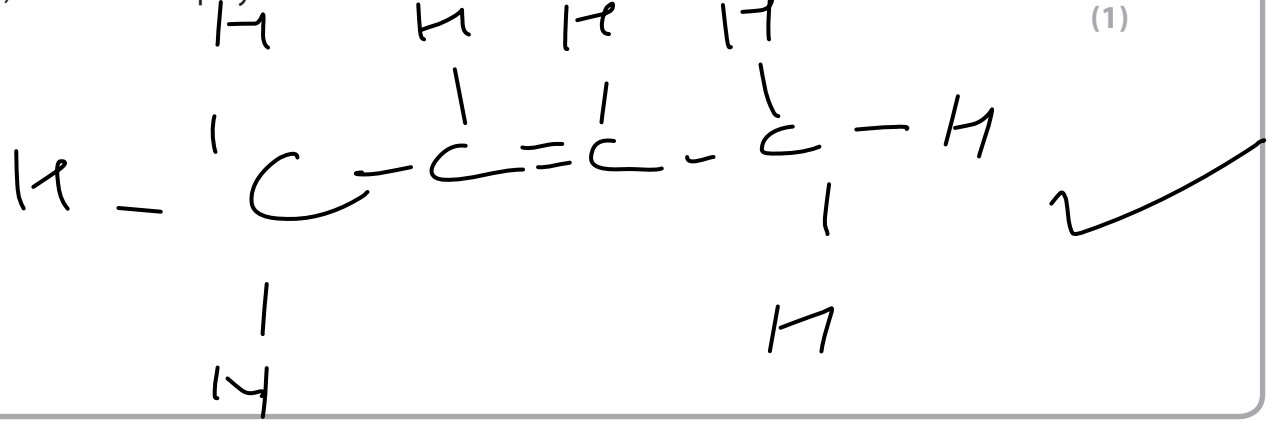
(i) Give the name of alkene V.

(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 CH_2F

(2)

$\frac{36.36}{12}$ $\frac{6.06}{1}$ $\frac{57.68}{19}$

3.03 : 6.062 : 3.037

3.03 / 3.03 : 3.03 / 3.03 : 3.03 / 3.03

1 : 2 : 1

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

Determine the molecular formula of the compound.

(2)

$CH_2F = 12 + 2 + 19 = 33$

$(CH_2F)_2 = C_2H_4F_2 = 24 + 4 + 38 = 66$

molecular formula = $C_2H_4F_2$

(Total for Question 5 = 14 marks)

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

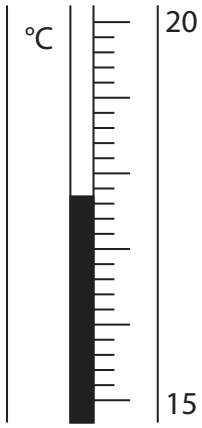
- pour some dilute hydrochloric acid into a glass beaker
- record the initial temperature of the acid
- add a piece of zinc and stir the mixture
- record the temperature of the mixture after one minute

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

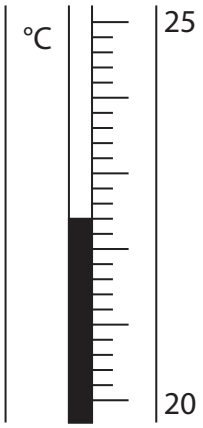
(1)

Hydrochloric acid + zinc → Zinc Chloride + Hydrogen

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



before adding zinc



after adding zinc

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

(3)

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

(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.

(2)

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

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

(3)

1 The moles 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.

(1)

As it did not react

(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

(1)

(ii) Which element has the palest colour?

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

(1)

(iii) Which element is the least reactive?

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

(1)

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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.

(1)

As no reaction since they both contain the same element

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

bromine + sodium iodide → iodine + sodium bromide

Write a chemical equation for this reaction.

(1)

$Br_2 + 2NaI \rightarrow 2NaBr + I_2$

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(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.

(6)

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

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

(Total for Question 7 = 13 marks)

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

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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 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)

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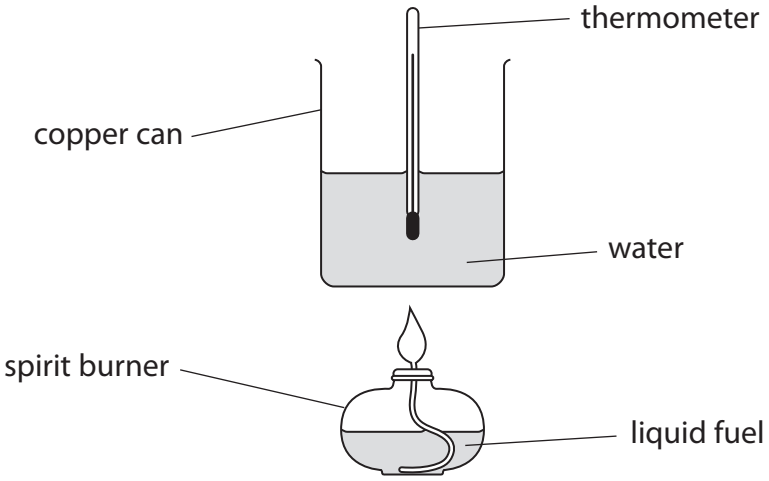
9 A student uses this apparatus to investigate the heat energy released when a liquid fuel is burned.



This is the student's method.

- measure the mass of the spirit burner and fuel
- add 100 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 °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.

(1)

~~So that no more than~~ To get the most accurate recording as it could evaporate.

(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.

(1)

~~Carbon~~ ~~Copper~~ Copper (II) oxide

(ii) Explain why the black solid forms.

(2)

Copper reacts with oxygen in the air.

(c) (i) Show that the heat energy change, Q, to raise the temperature of 100 cm^3 of water by 30 °C is approximately 13 kJ.

[mass of 1.0 cm^3 of water = 1.0 g]

[c for water = 4.2 J/g/°C]

(3)

(ii) The student burns 0.96 g of methanol, CH_3OH

Calculate the molar enthalpy change, ΔH, in kJ/mol, for the combustion of methanol.

Include a sign in your answer.

[M_r of methanol = 32]

(3)

ΔH = ... kJ/mol

(d) The table shows data book values for the molar enthalpy change, ΔH, 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, ΔH, in kJ/mol	−730	−1370	−2020	−2680	−3320

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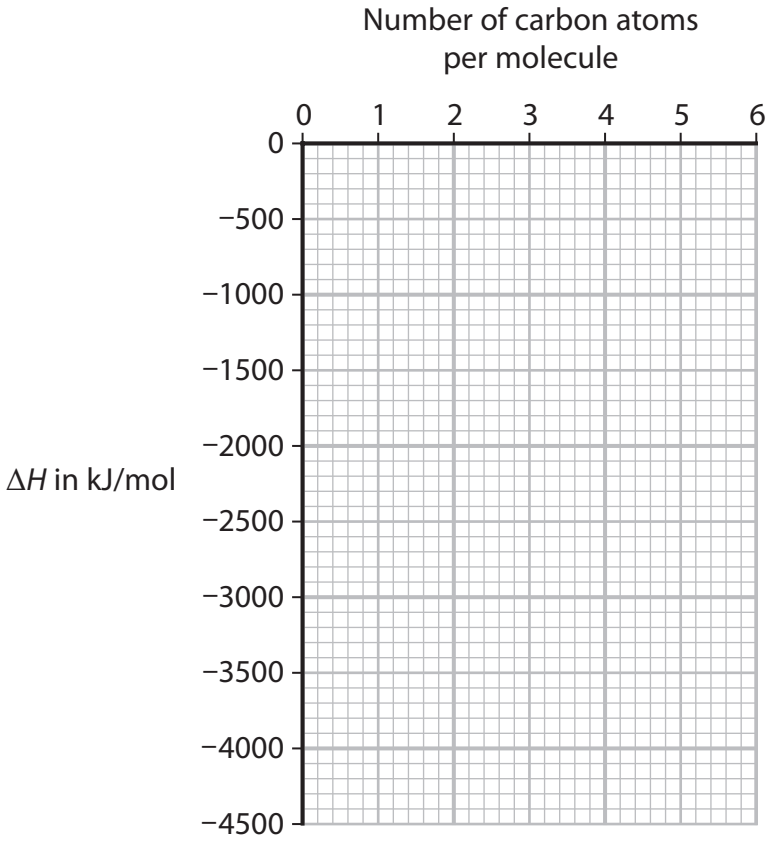
(i) Plot the data values from the table on the grid.

Draw a straight line of best fit.

(2)



(ii) Deduce the value of ΔH for an alcohol with six carbon atoms per molecule.

Show on the graph how you obtained your answer.

(2)

ΔH = ... kJ/mol

(iii) State the relationship between ΔH and the number of carbon atoms per molecule.

(1)

.....

.....

(Total for Question 9 = 15 marks)

10 Nitric acid (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, NO, and water.

Stage 2 nitrogen monoxide gas reacts with more oxygen to produce nitrogen dioxide gas, 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)

.....NH_3 + ...O_2 $\rightleftharpoons$ .....NO + ...H_2O

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

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$

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 = 1.0×10^6g]

(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

$$CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$$

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

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