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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

Monday 11 January 2021

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 ▶

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1/1/1/1/

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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 radius 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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Answer ALL questions.

1 This question is about states of matter.

(a) Use the words solid, liquid or gas to give the initial and final state of matter for each of the changes listed in the table.

The first one has been done for you.

(3)

Change	Initial state	Final state
melting	solid	liquid
sublimation		
condensing		
evaporation		

(b) Particles in a solid are closely packed, arranged in a regular pattern and vibrate about fixed positions.

Describe the arrangement and movement of the particles in a gas.

(3)

(Total for Question 1 = 6 marks)

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2 The table gives the melting and boiling points of four pure substances, W, X, Y and Z.

	Melting point in °C	Boiling point in °C
W	–7	60
X	660	2500
Y	180	1330
Z	115	445

Use data from the table to answer the questions.

(a) (i) Which substance is a gas at 100 °C?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(ii) Which substance is a liquid for the largest range of temperature?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(iii) Which substance is a liquid at 1000 °C and a gas at 2000 °C?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

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(b) Substance Y does not conduct electricity when solid but does conduct electricity when molten.

Give the type of bonding in substance Y.

(1)

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(c) Suggest how the melting point of a pure substance changes when an impurity is added.

(1)

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(Total for Question 2 = 5 marks)

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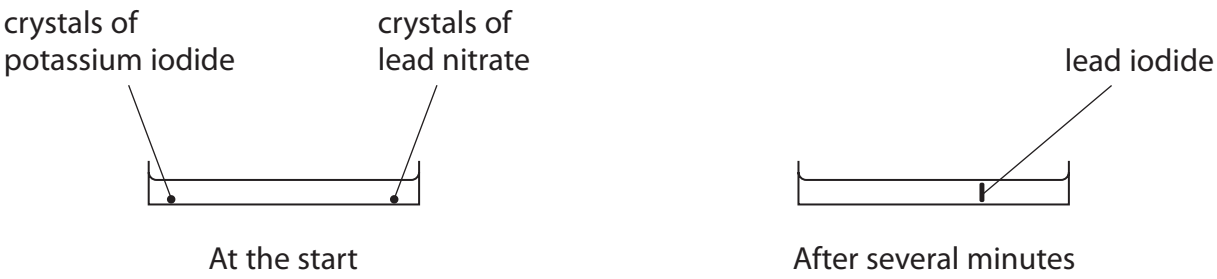
3 Lead nitrate and potassium iodide react to form the insoluble solid lead iodide.

Crystals of lead nitrate and potassium iodide are placed at opposite ends of a container of water.

Solid lead iodide forms after several minutes.

The diagram shows the container at the start and after several minutes.



(a) Name the two processes that occur before the solid lead iodide forms.

(2)

1 .....

2 .....

(b) Explain why solid lead iodide takes less time to form when the reaction is repeated using water at a higher temperature.

(2)

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(c) The formula for lead nitrate is $Pb(NO_3)_2$

(i) Give the number of different elements in lead nitrate.

(1)

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(ii) Give the charge on the lead ion in $Pb(NO_3)_2$

(1)

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(d) Complete the chemical equation for the reaction between lead nitrate and potassium iodide.

(1)

$Pb(NO_3)_2(aq)$ + ... $KI(aq) \rightarrow PbI_2(s)$ + ... $KNO_3(aq)$

(Total for Question 3 = 7 marks)

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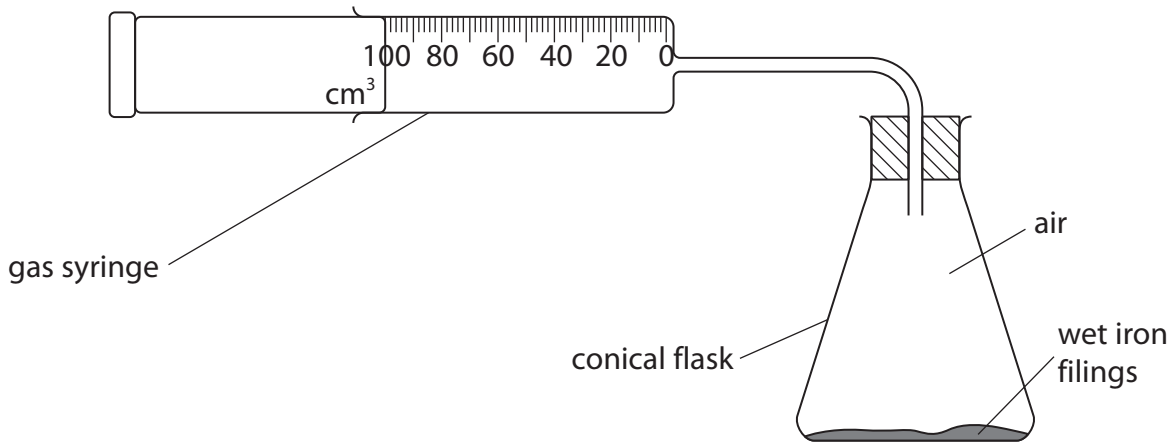
4 This question is about rusting.

(a) When iron rusts, it reacts with oxygen in the air.

A student uses the rusting of iron to find the percentage of oxygen in a sample of air.

The diagram shows the apparatus.



These are the student's results.

volume of air in conical flask and connecting tube = 265 cm^3

volume of air in gas syringe at start = 100 cm^3

volume of air in gas syringe at end = 25 cm^3

Calculate the percentage of oxygen in the sample of air using the student's results.

(3)

percentage of oxygen = ... %

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(b) (i) Cars are painted to prevent the iron in car bodies from rusting.

Explain how painting prevents the iron in car bodies from rusting.

(2)

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(ii) Some car manufacturers use paint containing tiny particles of zinc.

Explain how particles of zinc prevent iron in car bodies from rusting even when this paint is scratched.

(2)

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(Total for Question 4 = 7 marks)

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5 This question is about the separation of mixtures.

(a) The box gives some methods used to separate mixtures.

crystallisation	filtration	fractional distillation	simple distillation

Complete the table by giving the correct method from the box for each separation.

Each method can be used once, more than once or not at all.

(4)

Separation	Method
insoluble solid from a liquid	
pure water from a solution	
liquid from a mixture of liquids with different boiling points	
soluble solid from a solution	

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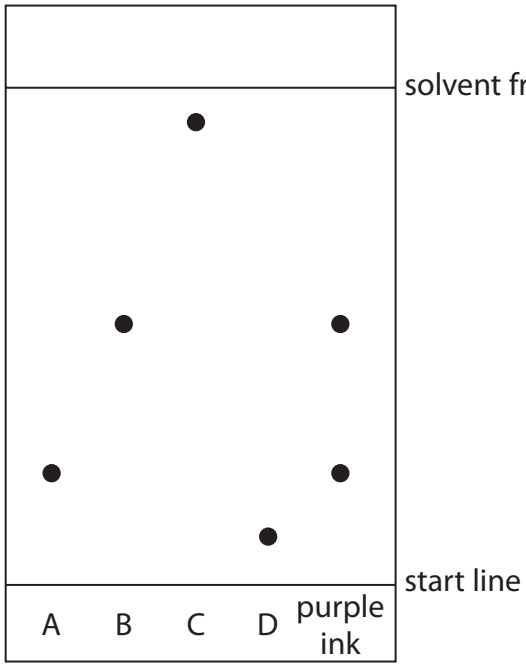
(b) A student uses chromatography to analyse the composition of purple ink.

The diagram shows the student's chromatogram at the end of the experiment.



(i) Explain which dyes are contained in the purple ink.

(2)

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(ii) Explain which dye is least soluble in the solvent.

(2)

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(c) A different chromatography experiment is set up.

A spot of food colouring is placed on the start line.

A food dye in the colouring has an R_f value of 0.72

The distance between the start line and the solvent front is 120 mm.

Calculate the distance the food dye moves from the start line.

(2)

distance = ... mm

(Total for Question 5 = 10 marks)

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6 This question is about salts.

(a) When solutions of salts are mixed together, precipitates sometimes form.

The insoluble salt barium carbonate forms as a precipitate when solutions of the soluble salts ammonium carbonate and barium chloride react together.

When solutions of the soluble salts potassium chloride and magnesium sulfate are mixed, no precipitate forms.

Complete the table to show the results of mixing solutions of some soluble salts.

(3)

	ammonium carbonate solution	**magnesium sulfate solution**
barium chloride solution	precipitate of barium carbonate	
potassium chloride solution		no precipitate
calcium chloride solution		precipitate of calcium sulfate

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(b) A student has four unlabelled beakers, each containing a colourless solution of a different salt.

The four solutions are

- potassium carbonate
- potassium chloride
- potassium iodide
- sodium chloride

Describe a method to identify each solution.

Do not refer to safety in your answer.

(6)

(Total for Question 6 = 9 marks)

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7 This question is about lithium oxide.

(a) The diagram shows the electron configurations of an atom of lithium and an atom of oxygen.



lithium oxygen

Describe the changes in electronic configuration when lithium and oxygen react to form lithium oxide, Li_2O

(3)

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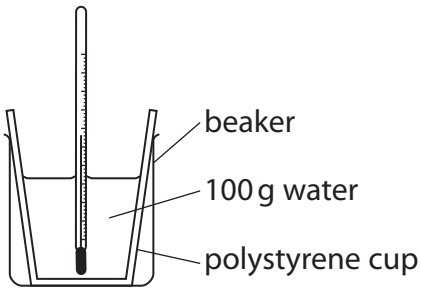
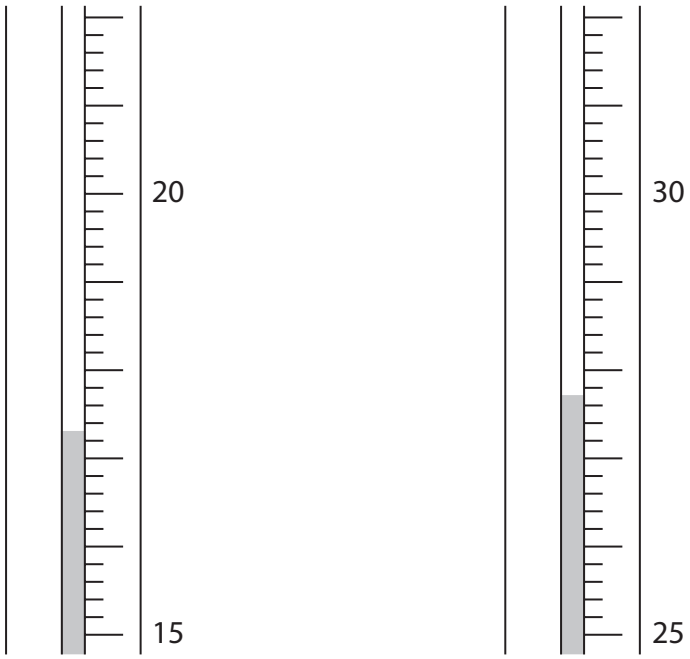
(b) Lithium oxide reacts with water to form lithium hydroxide as the only product.
A scientist uses this apparatus to measure the temperature change of the reaction.



This is the scientist's method.

- pour 100 g of water into a polystyrene cup
- record the temperature of the water
- add the lithium oxide and stir the mixture
- record the maximum temperature reached

The diagram shows the thermometer readings before and after adding the lithium oxide.



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

(2)

temperature in °C after adding the lithium oxide	
temperature in °C before adding the lithium oxide	17.3
temperature rise in °C	

(ii) Calculate the heat energy change in the reaction.

Give your answer to two significant figures.

[c = 4.2 J / g / °C]

(4)

heat energy change = ... J

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(iii) In another experiment the scientist obtains these results.

amount of lithium oxide in mol	0.0580
heat energy change in J	5210

Calculate the molar enthalpy change (ΔH) in kJ / mol.

Include a sign in your answer.

(3)

ΔH = ... kJ / mol

(iv) Give a reason why the scientist does the experiment in a polystyrene cup.

(1)

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(Total for Question 7 = 13 marks)

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8 This question is about the halogens.

(a) The table gives some information about the halogens.

Complete the table by predicting the physical state of astatine at room temperature and the colour of astatine.

(2)

Halogen	Physical state at room temperature	Colour
fluorine	gas	yellow
chlorine	gas	pale green
bromine	liquid	red-brown
iodine	solid	grey
astatine		

(b) Bromine has two isotopes with mass numbers 79 and 81

(i) The relative percentages of each isotope in a sample of bromine are

bromine-79 = 51.0% bromine-81 = 49.0%

Calculate the relative atomic mass of this sample of bromine.

Give your answer to one decimal place.

(3)

relative atomic mass = ...

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(ii) Give a reason why both isotopes of bromine have the same chemical properties.

(1)

.....

.....

(c) A student investigates the reactivity of some halogens.

She uses these solutions of halogens and their halides.

- bromine, chlorine and iodine
- sodium bromide, sodium chloride and sodium iodide

She adds each halogen solution to each halide solution.

The table shows her results.

	Sodium bromide	**Sodium chloride**	**Sodium iodide**
Bromine	no reaction	no reaction	reaction occurs
Chlorine	reaction occurs	no reaction	reaction occurs
Iodine	no reaction	no reaction	no reaction

(i) Explain how these results show the order of reactivity of bromine, chlorine and iodine.

(3)

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(ii) Suggest why the student does not need to add bromine solution to sodium bromide solution.

(1)

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(iii) The ionic equation for the reaction between bromine and sodium iodide is

$$Br_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Br^-(aq)$$

Explain why this is a redox reaction.

(2)

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(Total for Question 8 = 12 marks)

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9 Propane is a hydrocarbon with the formula C_3H_8

(a) State why propane is a hydrocarbon.

(2)

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(b) (i) Name the poisonous gas that forms when propane is burned in a limited supply of air.

(1)

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(ii) State why this gas is poisonous to humans.

(1)

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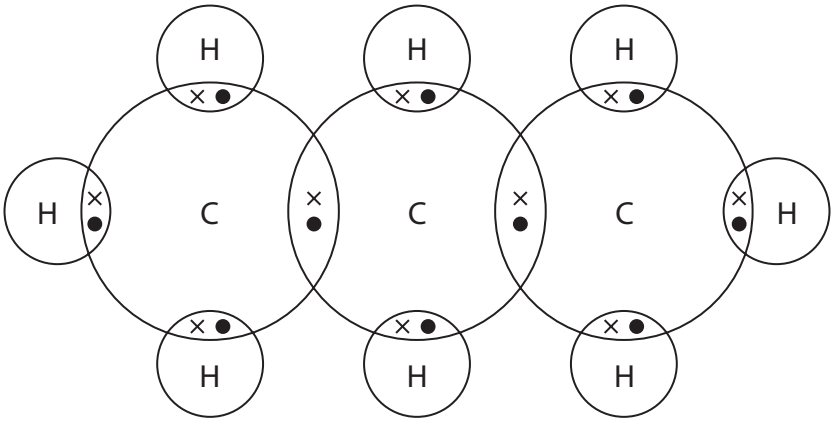
(c) The diagram represents a molecule of propane.



Describe the forces of attraction between the atoms in a molecule of propane.

(2)

(d) Propane can be produced by cracking.

An equation for cracking is

$$C_{13}H_{28} \rightarrow C_3H_8 + 2C_3H_6 + 2C_2H_4$$

Explain why cracking is an important process in the oil industry.

(3)

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(e) Propane reacts with bromine in the presence of ultraviolet radiation.

(i) Complete the equation for this reaction.

(2)

$C_3H_8 + Br_2 \rightarrow$ ..... + ...

(ii) Give the name of this type of reaction.

(1)

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(Total for Question 9 = 12 marks)

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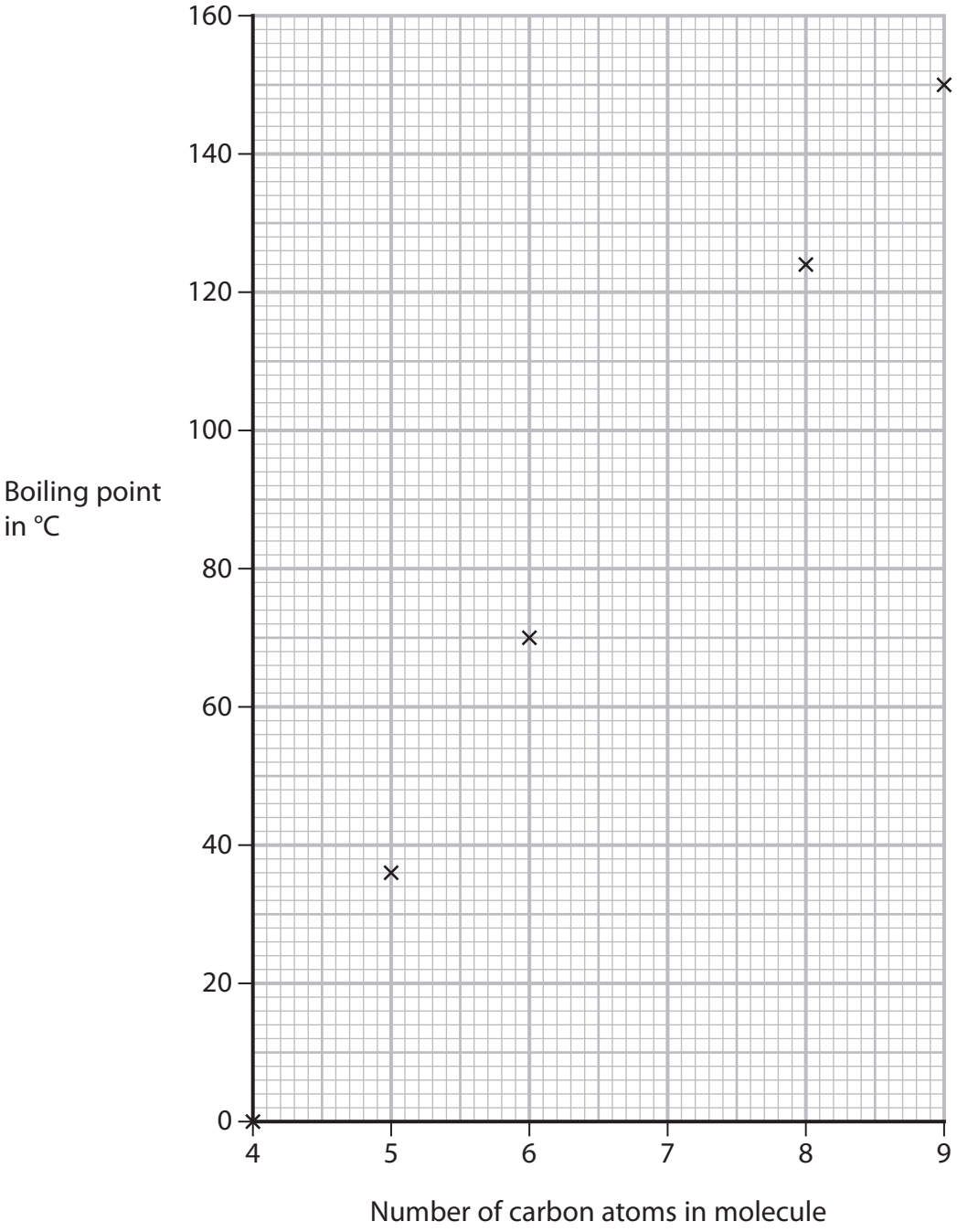
10 This question is about alkanes.

(a) The graph shows the boiling points of several unbranched alkanes.



(i) Draw a curve of best fit.

(1)

(ii) Use the graph to find the boiling point of the alkane with 7 carbon atoms in its molecule.

Show on the graph how you obtain your answer.

(2)

boiling point = ... °C

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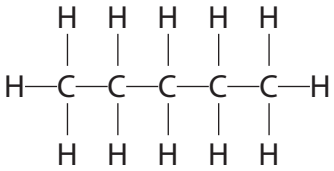
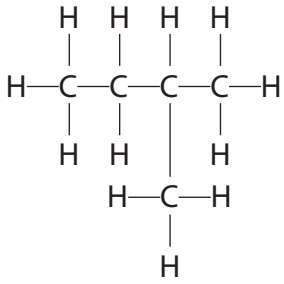
(iii) Explain the trend shown by the graph.

(3)

(b) The diagram represents two isomers with the formula C_5H_{12}





Explain why these compounds are isomers.

(2)

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(c) (i) An alkane contains 82.8% carbon and 17.2% hydrogen by mass.

Show by calculation that the empirical formula of this alkane is C_2H_5

(2)

(ii) Deduce the molecular formula of this alkane.

(1)

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(d) The equation for the complete combustion of one mole of an alkane can be represented by

$$\text{alkane} + ZO_2 \rightarrow XCO_2 + YH_2O$$

Complete combustion of one mole of the alkane produces 308 g of carbon dioxide and 144 g of water.

X, Y and Z are the numbers used to balance the equation.

Calculate the values of X, Y and Z.

[M_r of $CO_2 = 44$, M_r of $H_2O = 18$]

(3)

X = ...

Y = ...

Z = ...

(Total for Question 10 = 14 marks)

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11 This question is about reactions that form gases.

(a) Hydrogen peroxide decomposes to form water and oxygen.

The equation for the reaction is

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

25.0 cm^3 of hydrogen peroxide solution are poured into a conical flask and 1.00 g of solid manganese(IV) oxide is added.

Bubbles of oxygen gas are formed.

(i) Give the test for oxygen gas.

(1)

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(ii) Describe a method to show that solid manganese(IV) oxide is a catalyst in this reaction and not a reactant.

(3)

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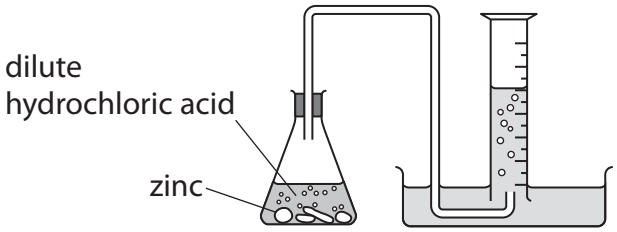
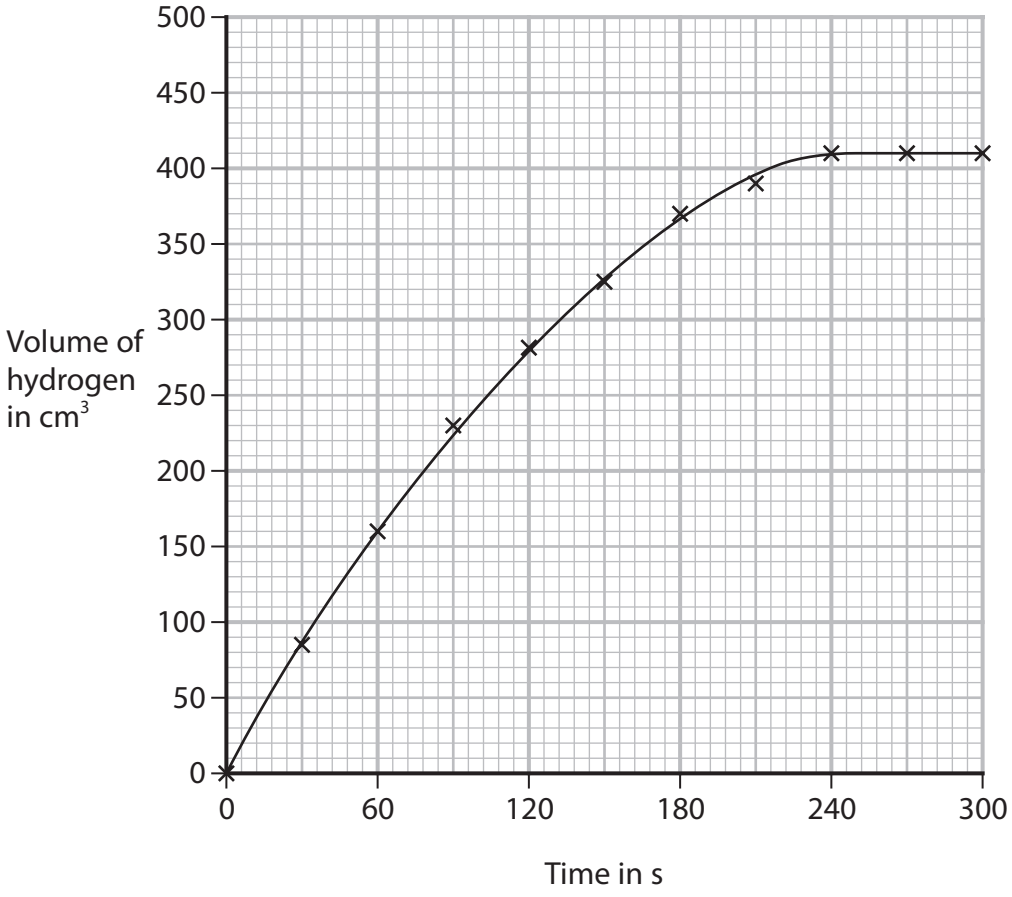
(b) A student uses this apparatus to investigate the rate of the reaction between zinc and an excess of dilute hydrochloric acid.



This is the student's method.

- pour 50 cm^3 of dilute hydrochloric acid into a conical flask
- add about 1.2 g of zinc lumps
- record the volume of hydrogen gas collected every 30 s until no more hydrogen is collected

The graph shows the student's results.



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(i) Calculate the mean (average) rate of reaction, in cm^3/s, in the first 120 s.

(2)

mean rate = ... cm^3/s

(ii) The equation for the reaction between zinc and hydrochloric acid is

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Use this equation and the particle collision theory to explain why the rate of reaction is greatest at the start of the reaction.

(3)

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(iii) The student repeats the experiment at a higher temperature but keeps all other conditions the same.

On the grid, draw the curve you would expect to see in this experiment.

(2)

Question continues on next page

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(iv) Explain why the rate of reaction is greater if the same mass of zinc powder is used instead of zinc lumps. All other conditions are kept the same.

(2)

(c) In another experiment, the student adds 0.55 g of zinc to a solution containing 2.50×10^{-2} moles of hydrochloric acid.

Use the equation to show that hydrochloric acid is in excess.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

[A_r of Zn = 65]

(2)

(Total for Question 11 = 15 marks)

TOTAL FOR PAPER = 110 MARKS

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