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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Friday 17 May 2024

Morning (Time: 2 hours)

Paper reference **4CH1/1C 4SD0/1C**

Chemistry

UNIT: 4CH1
Science (Double Award) 4CH1/4SD0
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.

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 ▶

P75820A

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P 7 5 8 2 0 A 0 1 2 4

Pearson

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.

P 7 5 8 2 0 A 0 2 2 4

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Answer ALL questions.

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 ☒.

1 The box gives the names of some substances.

bromine	chlorine	diamond	ethene
iodine	lithium	methane	water

(a) Complete the table by choosing a substance from the box that matches each description.

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

(5)

Description	Substance
a good conductor of electricity	
an element that is a liquid at room temperature	
a substance that can be used to form a polymer	
an element that forms a basic oxide	
a substance that has a giant covalent structure	

(b) Describe a test for chlorine.

(2)

.....

.....

.....

.....

(Total for Question 1 = 7 marks)

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2 This question is about the reactivities of metals.

(a) The table shows the reactions of four metals, P, Q, R and S, with water and with dilute hydrochloric acid.

The letters are not the symbols of the elements.

Metal	Reaction with water	Reaction with dilute hydrochloric acid
P	no reaction	no reaction
Q	very fast reaction	(not done)
R	no reaction	slow reaction
S	slow reaction	fast reaction

(i) Deduce the order of reactivity of the metals.

(1)

most reactive .....

.....

.....

least reactive .....

(ii) Give the letter of the metal that could be zinc.

(1)

.....

(iii) Give a word equation for the reaction between aluminium and hydrochloric acid.

(1)

.....

(iv) Give the name of a metal that could be P.

(1)

.....

(v) Give a reason why the reaction of Q with dilute hydrochloric acid is not done.

(1)

.....

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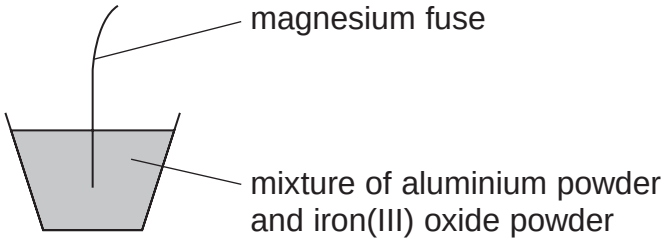
(b) The diagram shows the apparatus used to demonstrate the reaction between aluminium and iron(III) oxide.



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

This is the equation for the reaction.

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

(i) State what is meant by the term **exothermic**.

(1)

.....

.....

(ii) State why aluminium displaces iron.

(1)

.....

.....

(iii) Explain why this reaction is a redox reaction.

(2)

.....

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.....

.....

(Total for Question 2 = 9 marks)

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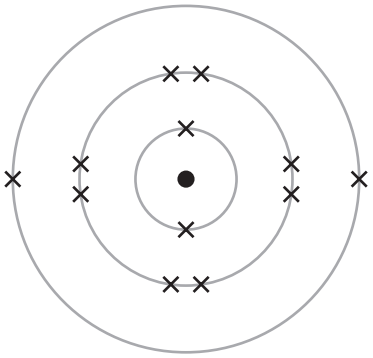
3 The diagram represents an atom of element Z.

Z is not the symbol of the element.



(a) (i) Give the number of the group to which element Z belongs.

(1)

.....

(ii) Give the number of the period to which element Z belongs.

(1)

.....

(iii) Give the formula of the compound that forms when Z reacts with fluorine.

(1)

.....

(b) One mole of Z contains 6.0×10^{23} atoms.

Calculate the number of electrons in one mole of atoms of element Z.

Give your answer in standard form.

(2)

number of electrons = ...

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(c) A sample of element Z contains three isotopes. The table shows the numbers of particles in the nucleus of each isotope and the percentage abundance of each isotope.

Isotope	Number of protons	Number of neutrons	Percentage abundance
1	12	12	79.0
2	12	13	10.0
3	12	14	11.0

Use the information in the table to calculate the relative atomic mass (A_r) of element Z.

Give your answer to one decimal place.

(4)

A_r = ...

(d) Deduce the name of element Z.

(1)

.....

(Total for Question 3 = 10 marks)

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4 Caffeine is a stimulant found in coffee, tea and some soft drinks.

(a) The molecular formula of caffeine is $C_8H_{10}N_4O_2$

(i) Determine the number of atoms in one molecule of caffeine.

(1)

.....

(ii) Calculate the relative formula mass (M_r) of caffeine.

(2)

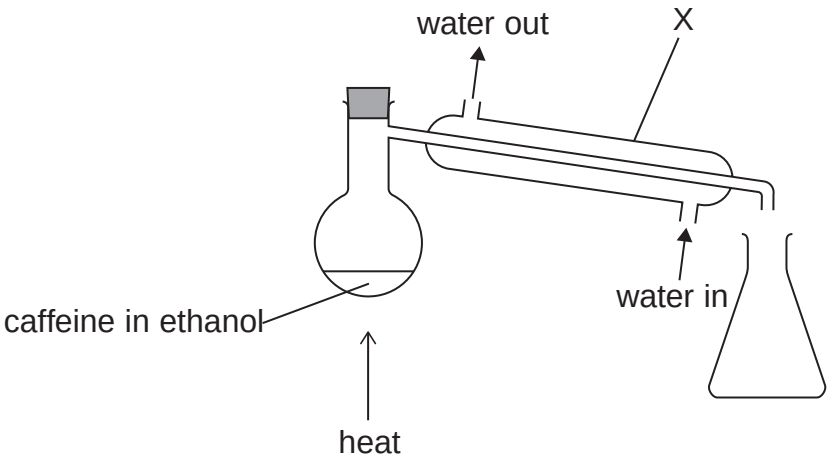
M_r = ...

(iii) Give the empirical formula for caffeine.

(1)

.....

(b) Ethanol can be obtained from a solution of caffeine in ethanol using this apparatus.



(i) Give the name of the method of separation shown in the diagram.

(1)

.....

(ii) Describe what happens to the ethanol vapour in apparatus X.

(2)

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(c) Calcium bromide is an ionic compound.

The table shows the formulae and melting points of caffeine and calcium bromide.

Name	Formula	Melting point in °C
caffeine	$C_8H_{10}N_4O_2$	235
calcium bromide	$CaBr_2$	730

The relative formula mass of calcium bromide is similar to the relative formula mass of caffeine.

Explain why calcium bromide has a much higher melting point than caffeine.

(5)

(Total for Question 4 = 12 marks)

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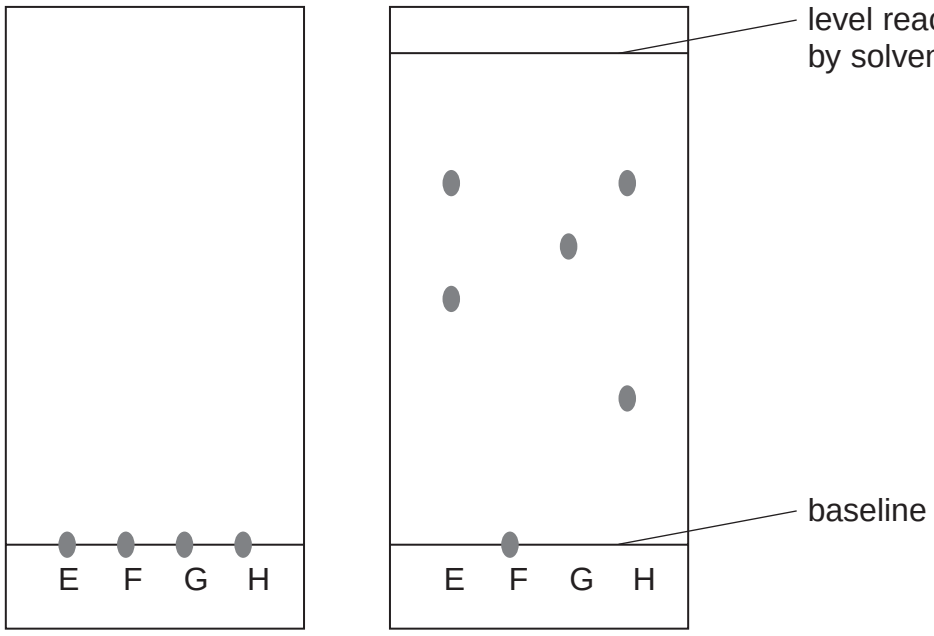
5 A student uses paper chromatography in an experiment to separate the dyes in four different felt tip pens, E, F, G and H.

The diagram shows the appearance of the paper before and after the experiment.



(a) (i) The chromatography paper is placed in a solvent. Explain why the spots on the baseline are placed above the level of the solvent.

(2)

(ii) Explain which two felt tip pens contain the same dye.

(2)

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(iii) The student thought that both F and G contained only one dye.

Explain why the student can only be certain about one of these dyes.

(2)

.....

.....

.....

.....

(b) Calculate the R_f value for the dye in G.

Show your working.

(3)

R_f value = ...

(Total for Question 5 = 9 marks)

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6 This question is about some Group 1 elements and their compounds.

(a) A teacher adds a small piece of sodium to a trough of water.

(i) Give two observations that are made when sodium reacts with water.

(2)

1 .....

2 .....

(ii) After the reaction has stopped, the teacher adds a few drops of phenolphthalein to the solution in the trough.

Explain the colour of the phenolphthalein after it is added to the solution.

(2)

.....

.....

.....

.....

(b) A student does a flame test to see if a white solid contains lithium ions.

They clean a platinum wire before using it for the flame test.

(i) Explain why the student needs to clean the platinum wire.

(2)

.....

.....

.....

.....

.....

(ii) What is the colour of the flame if the solid contains lithium ions?

(1)

☒ A lilac

☒ **B** orange

☒ **C** red

☒ **D** yellow

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(c) Potassium aluminium sulfate can be used in baking.

Anhydrous potassium aluminium sulfate has the formula $KAl(SO_4)_2$

(i) Give the formula of each ion in potassium aluminium sulfate.

(2)

potassium ion

.....

aluminium ion

.....

sulfate ion

.....

(ii) Potassium aluminium sulfate is normally found as a hydrated salt, with the formula $KAl(SO_4)_2.xH_2O$

When 23.7 g of the hydrated salt is heated to remove all the water, 12.9 g of the anhydrous salt is formed.

Calculate the value of x.

[for $KAl(SO_4)_2$, $M_r = 258$ for H_2O, $M_r = 18$]

(4)

x = ...

(Total for Question 6 = 13 marks)

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7 This question is about nitrogen and its compounds.

(a) What is the approximate percentage by volume of nitrogen in the atmosphere?

(1)

- ☒ A 1%
- ☒ **B** 20%
- ☒ **C** 70%
- ☒ **D** 80%

(b) Complete the dot-and-cross diagram for a molecule of nitrogen.

Show outer electrons only.

(2)

N N

(c) Nitrogen dioxide produced in car engines reacts with water vapour and oxygen in the atmosphere to form nitric acid.

(i) Give a chemical equation for this reaction.

(2)

.....

(ii) Nitric acid forms acid rain.

State one environmental effect of acid rain.

(1)

.....

.....

(d) Ammonium carbonate contains nitrogen.

(i) What is the formula of ammonium carbonate?

(1)

- ☒ A NH_3CO_3
- ☒ **B** $(NH_3)_2CO_3$
- ☒ **C** NH_4CO_3
- ☒ **D** $(NH_4)_2CO_3$

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(ii) A technician finds an unlabelled bottle on a shelf that could be ammonium carbonate solution.

Describe tests that the technician should do to confirm that the solution contains ammonium ions and carbonate ions.

(6)

(Total for Question 7 = 13 marks)

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8 This question is about hydrocarbons.

(a) The molecular formula C_4H_8 represents all the isomers of an alkene.

(i) Explain what is meant by the term **isomers**.

(2)

.....

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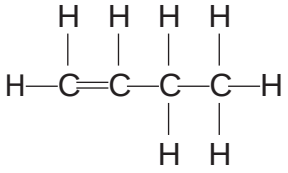
(ii) The displayed formula of one of the isomers of the alkene is shown.



Draw displayed formulae for two other alkene isomers with the molecular formula C_4H_8

(2)

alkene isomer 1	alkene isomer 2

(b) But-1-ene reacts with bromine to form a compound with molecular formula $C_4H_8Br_2$

What is the name given to this type of reaction?

(1)

- ☒ A addition
- ☐ **B** combustion
- ☐ **C** decomposition
- ☐ **D** substitution

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(c) The alkene C_3H_6 can be polymerised to form the polymer poly(propene).

(i) Draw the repeat unit of poly(propene).

(1)

(ii) These are two methods for disposing of polymers such as poly(propene).

method 1 burying them in landfill sites

method 2 burning them to release heat energy

State one environmental problem linked to each of these methods of disposal.

(2)

method 1

.....

.....

method 2

.....

.....

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(d) Complete combustion of one mole of an alkane produces 396 g of carbon dioxide and 180 g of water.

This is the equation for the reaction.

$$\text{alkane} + xO_2 \rightarrow yCO_2 + zH_2O$$

Calculate the values of x, y and z.

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

(3)

x = ...

y = ...

z = ...

(e) In a petrol engine, incomplete combustion occurs because there is a limited supply of oxygen.

(i) Petrol contains octane, C_8H_{18}

Complete the equation for this reaction, including state symbols.

(2)

$C_8H_{18}(l)$ + ...O_2(.....) → .....CO(.....) + 3C(.....) + ...H_2O(.....)

(ii) Explain one problem for humans caused by a product of this incomplete combustion.

(2)

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(Total for Question 8 = 15 marks)

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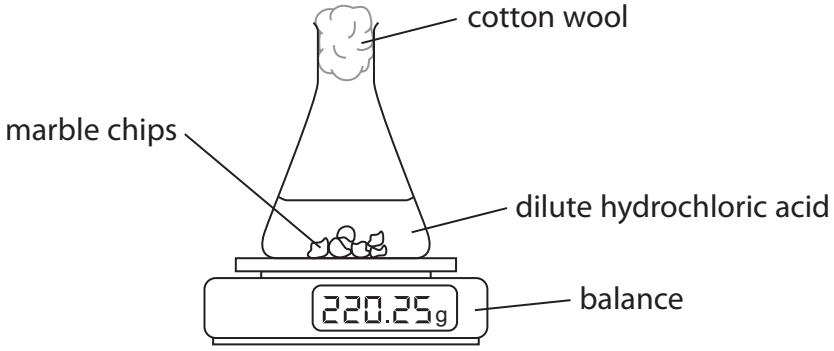
9 A student uses this apparatus to investigate the rate of reaction between marble chips and dilute hydrochloric acid.



This is the equation for the reaction.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

(a) During the reaction the reading on the balance decreases because mass is lost from the flask.

(i) State why mass is lost from the flask.

(1)

.....

.....

(ii) State the purpose of the cotton wool.

(1)

.....

.....

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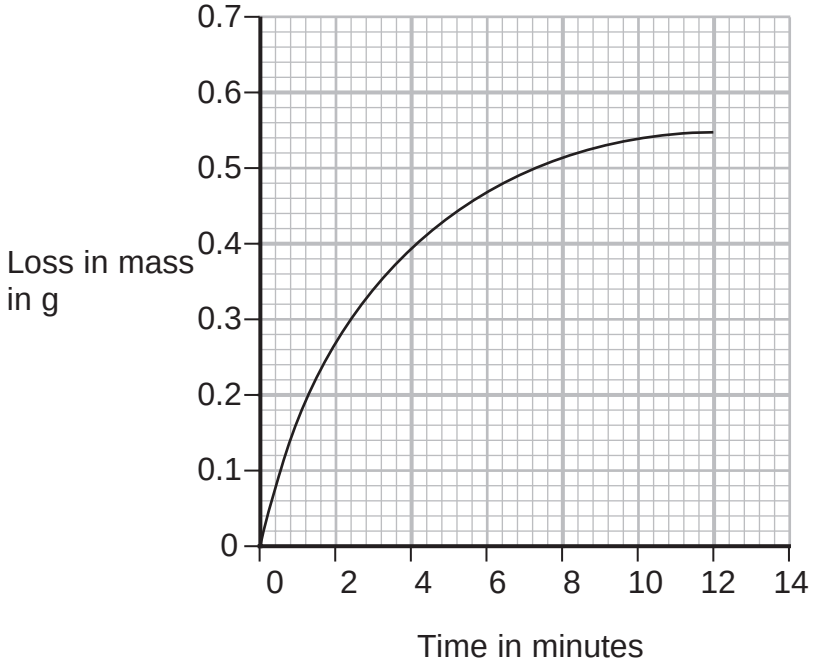
(b) This is a graph of the student's results.



(i) Explain the shape of the graph.

You should assume that the marble chips are in excess.

(4)

(ii) On the grid, draw the curve you would expect to obtain if the student uses the same volume of hydrochloric acid but with half the concentration.

Assume that all other conditions are kept the same.

(2)

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(c) The student repeats the experiment using the same mass of smaller marble chips.

Explain, using particle collision theory, how using smaller marble chips would affect the rate of this reaction.

Assume that all other conditions are kept the same as in the initial experiment.

(3)

(Total for Question 9 = 11 marks)

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10 A student investigates the reaction between magnesium and nitric acid.

The student uses this method.

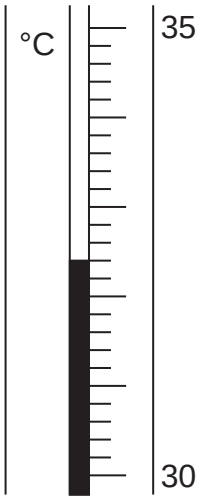
- add 40 cm^3 of dilute nitric acid to a glass beaker
- record the temperature of the acid
- find the mass of a strip of magnesium ribbon
- add the magnesium ribbon to the nitric acid
- when all the magnesium has reacted, record the highest temperature reached

(a) Complete the chemical equation for this reaction.

(1)

$Mg + 2HNO_3 \rightarrow$ ..... + ...

(b) The thermometer shows the highest temperature reached.



Complete the table by giving the temperatures to the nearest 0.1°C

(2)

starting temperature of the acid in °C	
highest temperature reached in °C	
temperature rise in °C	16.4

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(c) (i) Show that the heat energy change (Q) for this reaction is about 2800 J.

[for 1.0 cm^3 of solution, mass = 1.0 g]

[for the solution, c = 4.2 J/g/°C]

(2)

(ii) The mass of magnesium used by the student was 0.12 g.

Calculate the value of the enthalpy change (ΔH), in kJ/mol, for the magnesium reacting with nitric acid.

Give your answer to two significant figures, including a sign in your answer.

(4)

ΔH = ... kJ/mol

(d) Explain why using a polystyrene cup, instead of a glass beaker, would give a more accurate result.

(2)

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(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 110 MARKS

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