MODEL ANSWERS

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 14 May 2020

Morning (Time: 2 hours)

Paper Reference **4CH1/1CR 4SD0/1CR**

Chemistry

Unit: 4CH1

Science (Double Award) 4SD0

Paper: 1CR

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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P 6 2 0 4 6 A 0 1 2 8

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.

Answer ALL questions.

1 (a) The box gives some methods used in the separation of mixtures.

chromatography	crystallisation	evaporation
filtration	fractional distillation	simple distillation

Use words from the box to answer these questions.

(i) Identify the method used to obtain pure water from sea water.

(1)

Simple distillation

(ii) Identify the method used to separate the dyes in a food colouring.

(1)

Chromatography

(iii) Identify the method used to obtain ethanol from a mixture of ethanol and water.

(1)

fractional distillation.

(b) Complete the sentences by writing a suitable word in each blank space.

(3)

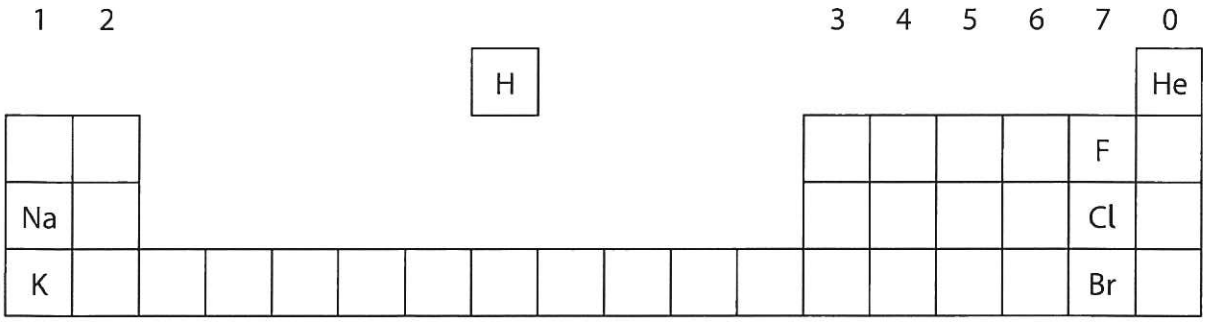
When salt is added to water and stirred until no more will dissolve, a saturated solution forms.

The salt is the Solute.

The water is the Solvent.

(Total for Question 1 = 6 marks)

2 The diagram shows the positions of some elements in the Periodic Table.



(a) Use symbols from this table to answer these questions.

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

(i) Give the symbol of a metal.

(1)

Na / K

(ii) Give the symbol of a noble gas.

(1)

He

(iii) Give the symbol of a liquid at room temperature.

(1)

Br

(iv) Give the symbols of the two elements in Period 3

(1)

Na and Cl

(b) Deduce the electronic configuration of Na

(1)

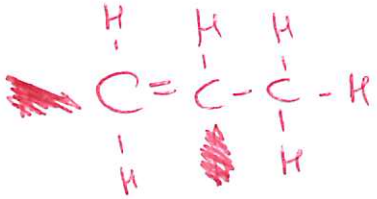
2.8.1

(Total for Question 2 = 5 marks)

3 This question is about alkenes and alkanes.

(a) Complete the table by giving the missing information about the alkene with the molecular formula C_3H_6

(4)

Molecular formula	C_3H_6
Name	~~Propene~~ Propene
Empirical formula	CH_2
General formula	C_nH_{2n}
Displayed formula	

(b) Alkenes are unsaturated compounds.

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

(1)

Contains a Carbon-Carbon double bond.

(ii) Describe a test to show that a compound is unsaturated.

(2)

Add bromine water, it will decolorise (orange to colourless) if an unsaturated compound is present.

(c) When the alkane methane reacts with chlorine, the products are chloromethane (CH_3Cl) and hydrogen chloride gas.

(i) Give a chemical equation for this reaction.

(1)

$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$

(ii) What is the name of this type of reaction?

(1)

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

(iii) State the condition needed for this reaction to occur.

(1)

UV light.

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(d) When ethane reacts with chlorine, one of the products of the reaction has the formula $C_2H_4Cl_2$

There are two isomers with this formula.

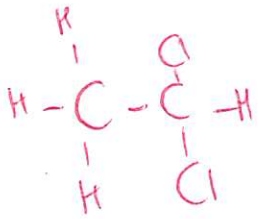
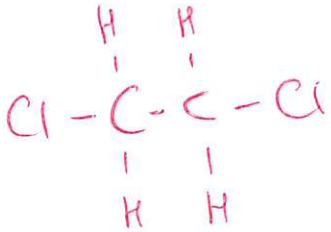
(i) State what is meant by the term **isomers**.

(2)

Compounds with the same molecular formula but different displayed formulae.

(ii) Draw the displayed formulae of the two isomers with the formula $C_2H_4Cl_2$

(2)

isomer 1	isomer 2
	

(Total for Question 3 = 14 marks)

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4 A solution of hydrogen peroxide decomposes when a catalyst of manganese(IV) oxide is added.

The products of the reaction are water and oxygen.

(a) Complete the chemical equation for this reaction.

(1)

2 H_2O_2 → 2 H_2O + 1 O_2

(b) Give a test for oxygen.

(1)

If oxygen is present, a glowing splint will relight.

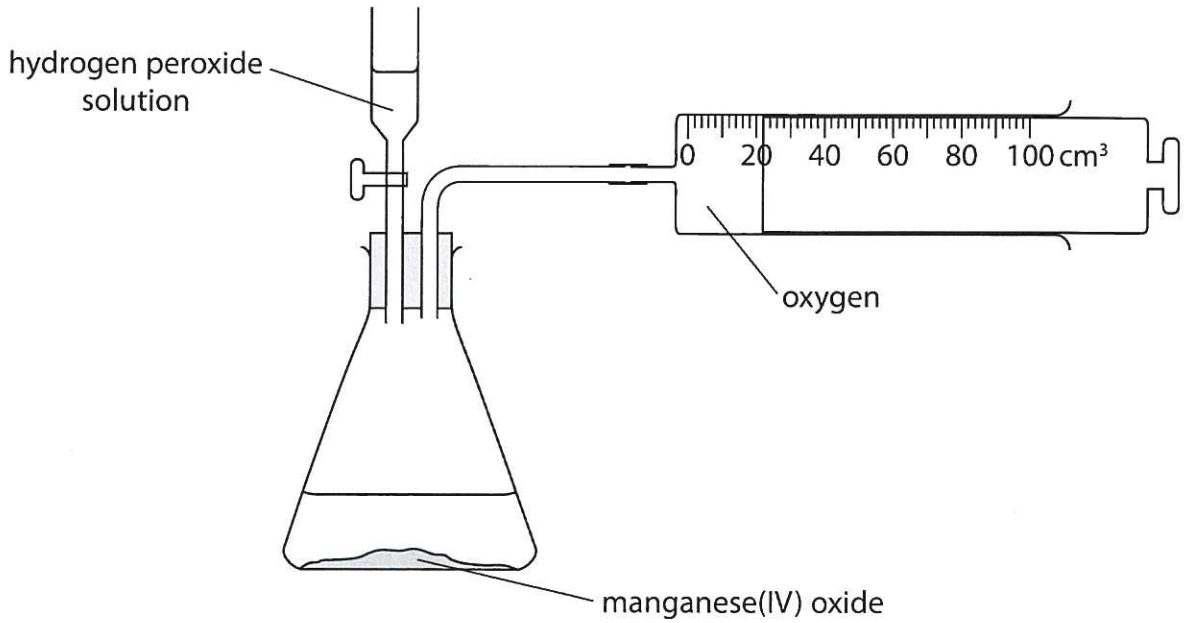
(c) State the reason for adding a catalyst.

(1)

To increase the rate of reaction.

(d) A student investigates how changing the concentration of the hydrogen peroxide solution affects the rate of this reaction.

She uses this apparatus.



The student records the volume of oxygen that collects every 2 minutes for 16 minutes.

The table shows her results.

Time in minutes	0	2	4	6	8	10	12	14	16
Volume of oxygen in cm³	0	22	38	50	55	69	76	80	80

(i) Plot the student's results on the grid.

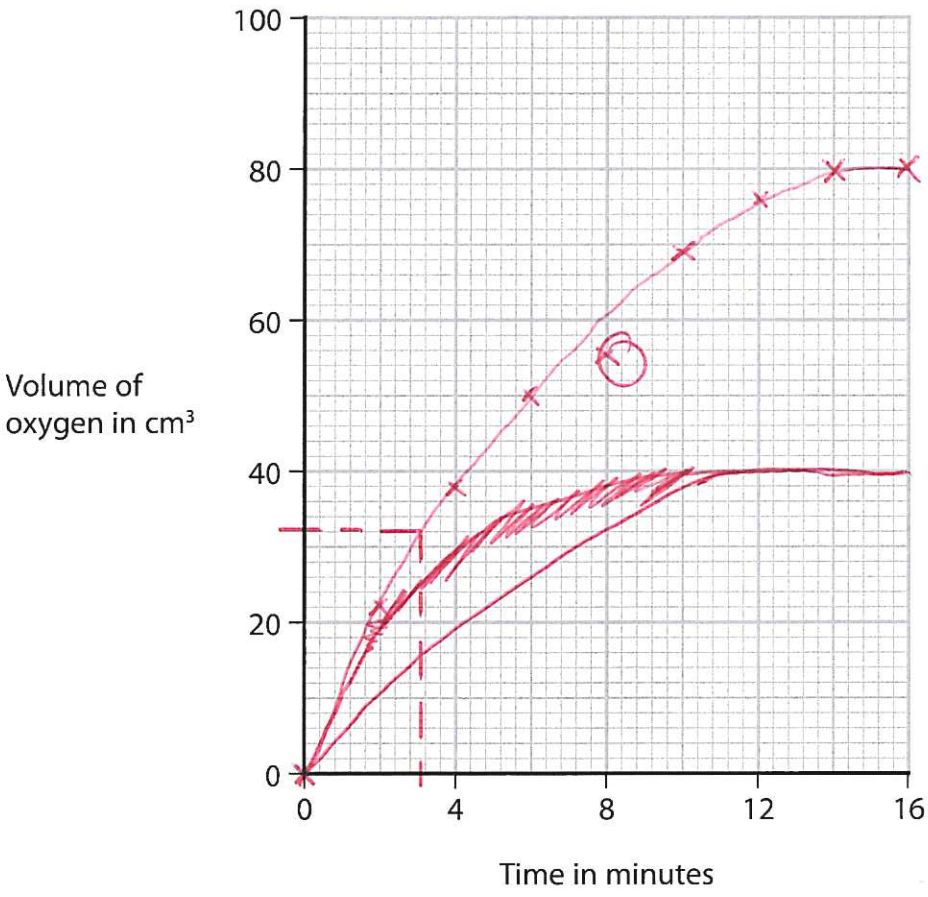
(1)

(ii) Draw a circle on the grid around the anomalous result.

(1)

(iii) Draw a curve of best fit through the points, ignoring the anomalous result.

(1)



(iv) Suggest a mistake that the student might have made to cause the anomalous result.

(1)

The reading was taken before 8 minutes had passed.

(v) Determine the volume of oxygen collected during the first 3 minutes.

Show on your graph how you obtain your answer.

(2)

volume of oxygen = 32 cm^3

(e) The student repeats the experiment using hydrogen peroxide solution of half the concentration of the original solution.

She keeps the volume of the hydrogen peroxide solution and all other conditions the same.

(i) Draw on the grid the curve you would expect the student to obtain.

(2)

(ii) Explain how using hydrogen peroxide solution of half the concentration affects the rate of the reaction.

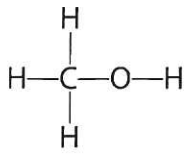
Refer to particle collision theory in your answer.

(3)

The reaction is slower as there are fewer particles of reactant per unit volume So there are less frequent collisions.

(Total for Question 4 = 14 marks)

5 (a) The diagram shows the displayed formula of the organic compound methanol, CH_3OH



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

(1)

6

(ii) State why methanol is not a hydrocarbon.

(1)

It Contains Oxygen, not only Carbon and hydrogen.

(b) The atoms in methanol are held together by covalent bonds.

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

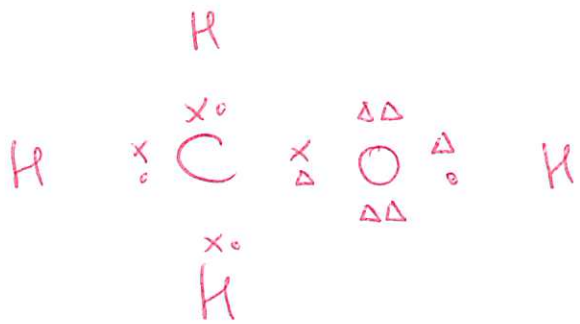
(2)

The Strong electrostatic attraction of the nuclei of the two bonded atoms and the pair of electrons shared between them.

(ii) Draw a dot-and-cross diagram to show the bonding in a molecule of methanol.

Show only the outer electrons of each atom.

(2)



(c) Another organic compound has the percentage composition by mass

C = 38.7% H = 9.7% O = 51.6%

(i) Calculate the empirical formula of this compound.

(3)

	C	H	O
Mass	38.7	9.7	51.6
A_r	12	1	16
=	3.225 :	9.7 :	3.225
Smallest	3.225	3.225	3.225
=	1 :	3 :	1

∴ Empirical formula = CH_3O

empirical formula = CH_3O

(ii) The relative molecular mass (M_r) of the compound is 62

Determine the molecular formula of the compound.

(2)

$\frac{62}{12+3+16} = 2$

∴ Molecular formula = $C_2H_6O_2$

molecular formula = $C_2H_6O_2$

(Total for Question 5 = 11 marks)

6 This question is about elements in Group 7 of the Periodic Table and their compounds.

(a) (i) Give the name of this group of elements.

(1)

Halogens

(ii) State the colour of chlorine gas.

(1)

Pale green

(iii) Give a test for chlorine gas.

(2)

Chlorine gas bleaches damp red litmus paper.

(b) Give a test to show that a solution contains iodide ions.

(3)

test Add dilute nitric acid then Silver nitrate Solution to the unknown Solution.

result A pale yellow precipitate forms, showing iodide ions are present.

(c) A student compares the reactivity of the elements bromine, chlorine and iodine.

He mixes these pairs of solutions and observes the reactions that occur.

- chlorine solution and potassium bromide solution
- bromine solution and potassium iodide solution

Explain how the reactions can be used to show the order of reactivity of the three elements.

Include the colour change that the student would observe in each reaction.

(6)

When Solutions of Chlorine and potassium bromide are mixed together, the Solution turns orange as Chlorine displaces bromine so Chlorine is more reactive than bromine.

When Solutions of bromine and potassium iodide are mixed together, the Solution turns brown as bromine displaces iodine so bromine is more reactive than iodine.

Hence:

Least reactive		Most reactive
iodine	bromine	Chlorine

(Total for Question 6 = 13 marks)

7 A student uses the reaction between zinc and dilute sulfuric acid to prepare some zinc sulfate crystals.

(a) (i) Complete the equation for this reaction by giving the correct state symbols.

(1)

Zn (s) + H_2SO_4 (aq) → $ZnSO_4$ (aq) + H_2 (g)

(ii) State what would be observed during this reaction.

(1)

fizzing

(b) The student adds excess zinc to a beaker of dilute sulfuric acid.

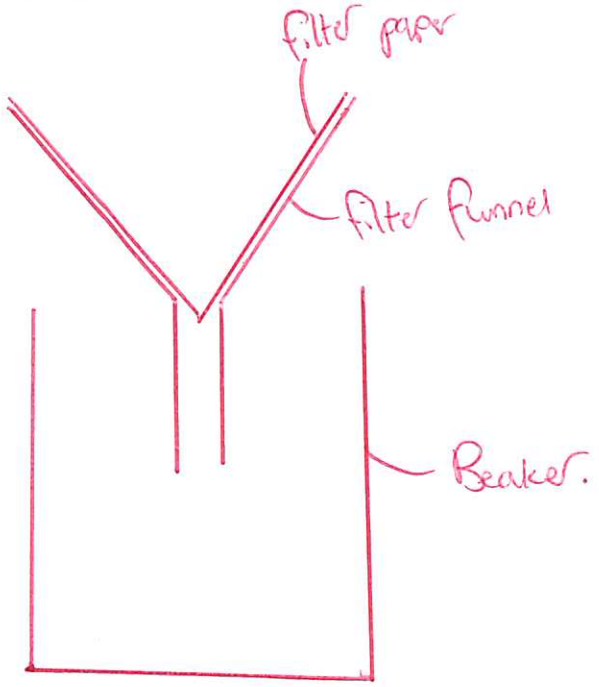
(i) Explain why it is necessary to add excess zinc.

(2)

This ensures that all of the acid reacts, ensuring the solution is pure zinc sulphate.

(ii) Draw a diagram of the apparatus the student should use to remove the unreacted zinc and collect the zinc sulfate solution.

(2)



(c) The student obtains a pure, dry sample of zinc sulfate crystals.

The formula of zinc sulfate crystals is $ZnSO_4.7H_2O$

(i) Calculate the relative molecular mass (M_r) of zinc sulfate crystals.

(2)

$Mr = 65 + 32 + 4(16) + 7(2(1) + 16)$

$= 287$

$M_r =$ 287

(ii) The student uses 0.0200 mol of dilute sulfuric acid in her preparation.

Show that the maximum mass of zinc sulfate crystals that the student could obtain is about 6 g.

(2)

$n(ZnSO_4.7H_2O) = 0.02 mol$

$m(ZnSO_4.7H_2O) = Mr \times mol$

$= 287 \times 0.02$

$= 5.74 g$

(iii) The student obtains a mass of 4.28 g of zinc sulfate crystals.

Calculate the percentage yield of the zinc sulfate crystals.

Give your answer to three significant figures.

(3)

$\%\ yield = \frac{4.28}{5.74} \times 100$

$= 74.6\%$

percentage yield = 74.6 %

(Total for Question 7 = 13 marks)

8 (a) A piece of magnesium ribbon is ignited and placed in a gas jar of oxygen.

The equation for the reaction is

$$2Mg + O_2 \rightarrow 2MgO$$

(i) Give two observations that would be made in this reaction.

(2)

1 White flame

2 White solid formed.

(ii) State why this is an oxidation reaction.

(1)

Magnesium gains oxygen, So it is oxidised.

(b) A second piece of magnesium ribbon is ignited and placed in a gas jar of carbon dioxide.

A very exothermic reaction occurs, forming magnesium oxide and carbon.

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

(1)

Releases thermal energy.

(ii) Give the chemical equation for this reaction.

(1)

$2Mg + CO_2 \rightarrow 2MgO + C$

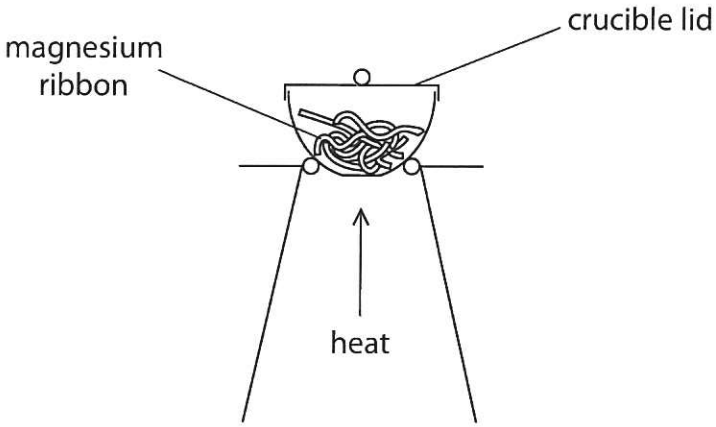
(iii) A fire starts in a warehouse where magnesium is stored.

Suggest why it would **not** be suitable to use a carbon dioxide fire extinguisher to put out this fire.

(1)

The Carbon dioxide wouldn't put out the fire, but lots of heat would be released.

(c) A student uses this apparatus to find the mass of magnesium oxide that forms when a known mass of magnesium is heated.



This is his method.

- find the mass of the crucible and lid
- place some magnesium ribbon in the crucible
- find the mass of the crucible, lid and magnesium
- heat the crucible with the lid on for a few minutes
- find the mass of the crucible, lid and magnesium oxide

Using this method, the mass of magnesium oxide formed is less than expected.

Explain two changes that the student should make to his method to obtain a mass of magnesium oxide closer to the expected mass.

(4)

1 Lift and replace the lid, to allow oxygen to enter the Crucible.

2 Reheat and reweigh to a constant mass, ensuring all magnesium has reacted.

(Total for Question 8 = 10 marks)

9 This question is about some compounds of the elements in Group 4 of the Periodic Table.

(a) When carbon dioxide dissolves in water, a weak acid forms.

(i) Which of these could be the pH of this weak acid?

(1)

- ☐ **A** 1
- ☒ **B** 5
- ☐ **C** 7
- ☐ **D** 9

(ii) Which of these is a correct statement about acids?

(1)

- ☐ **A** acids contain OH^- ions
- ☐ **B** acids are electron donors
- ☐ **C** acids are proton acceptors
- ☒ **D** acids are proton donors

(b) When lead(II) carbonate is heated, lead(II) oxide and carbon dioxide form.

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

(1)

Thermal de Composition.

(ii) Complete the equation for this reaction.

(1)

$PbCO_3 \rightarrow$ PbO + CO_2

(c) Silicon dioxide, SiO_2, and silicon(IV) chloride, $SiCl_4$, are both covalently bonded compounds.

The table shows the melting and boiling points of these two compounds, and the physical state of silicon dioxide at room temperature.

Compound	Melting point in °C	Boiling point in °C	Physical state at room temperature
SiO_2	1710	2230	solid
$SiCl_4$	–69	58	Liquid.

(i) Complete the table by giving the physical state of silicon(IV) chloride at room temperature.

(1)

(ii) Explain, in terms of structure and bonding, why silicon dioxide has a much higher melting point than silicon(IV) chloride.

(6)

Silicon dioxide has a giant Covalent Structure with many Strong Covalent bonds between the atoms which require large amounts of energy to break and high temperatures.

$SiCl_4$ has a Simple Molecular Structure with weak intermolecular forces which requires less energy and lower temperatures to overcome.

Hence, Silicon dioxide has a much higher melting point than $SiCl_4$.

(Total for Question 9 = 11 marks)

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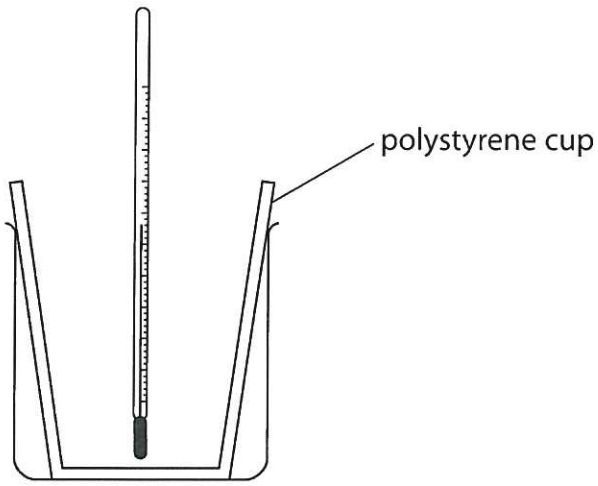
10 A student uses this apparatus to investigate the reaction between potassium hydroxide solution and dilute hydrochloric acid.



This is her method.

- pour 25 cm^3 of potassium hydroxide solution into a polystyrene cup and record the temperature of the solution
- pour 25 cm^3 of dilute hydrochloric acid into a measuring cylinder and record the temperature of the acid
- add the acid to the polystyrene cup and stir the mixture
- record the highest temperature reached

(a) (i) Give a word equation for the reaction between potassium hydroxide and hydrochloric acid.

(1)

Potassium hydroxide + Hydrochloric acid → Potassium chloride + water.

(ii) Explain why the student needs to stir the mixture.

(2)

This mixes the two solutions together, ensuring more reactant particles come into contact with each other.

It also ensures the solution is at the same temperature throughout.

(b) The table gives the temperatures of the solutions before the student mixes them.

potassium hydroxide solution	17.8 °C
dilute hydrochloric acid	18.4 °C

Calculate the mean (average) temperature of the two solutions.

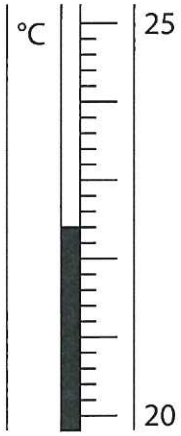
(2)

$\frac{17.8 + 18.4}{2} = 18.1\ ^{o}C$

mean temperature = 18.1 °C

(c) The student repeats the experiment on a different day, using 25 cm^3 of potassium hydroxide solution and 25 cm^3 of dilute hydrochloric acid.

The thermometer shows the highest temperature reached at the **end** of the experiment.



(i) Complete the table by giving the missing information.

Give both temperatures to the nearest 0.1 °C.

(2)

mean temperature at start in °C	17.2
temperature at end in °C	22.4
temperature rise in °C	5.2

(ii) Show that the heat energy change, Q, in the student's experiment is about 1100 J.

[for the mixture, c = 4.2 J/g/°C]

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

(3)

$Q = mc\Delta T$

$= 50(4.2)(5.2)$

$= 1092\ J = 1100\ J$ (2 sig fig)

(iii) The student uses 0.020 mol of potassium hydroxide in his experiment.

Calculate the enthalpy change (ΔH) in kJ/mol, for 1.0 mol of potassium hydroxide.

Include a sign in your answer.

(3)

$\Delta H = -\dfrac{1092 \times 10^{-3}}{0.02}$

$= -54.6\ kJ\,mol^{-1}$

$\Delta H =$ -54.6 kJ/mol

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 110 MARKS

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