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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)

Time 1 hour 15 minutes

Paper reference **4CH1/2C**

Chemistry

Unit: 4CH1
PAPER: 2C

January 2022

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 70.
- 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 ▶

P70702A

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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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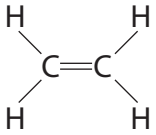
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Answer ALL questions.

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 This question is about the unsaturated hydrocarbon, ethene.

The displayed formula of ethene is



(a) (i) State the meaning of the term **hydrocarbon**.

(2)

.....

.....

.....

.....

(ii) Give the reason why ethene is described as unsaturated.

(1)

.....

.....

(b) Ethene is bubbled through bromine water until there is no further colour change.

Which of these is the appearance of the solution formed?

(1)

☒ **A** colourless

☒ **B** orange

☒ **C** purple

☒ **D** red

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(c) Ethanol is produced industrially by the reaction between ethene and steam.

The equation for the reaction is

$$CH_2CH_2(g) + H_2O(g) \rightarrow CH_3CH_2OH(l)$$

(i) State the temperature and pressure used in this reaction.

(2)

temperature

.....

pressure

.....

(ii) Give the **molecular** formula of ethanol.

(1)

.....

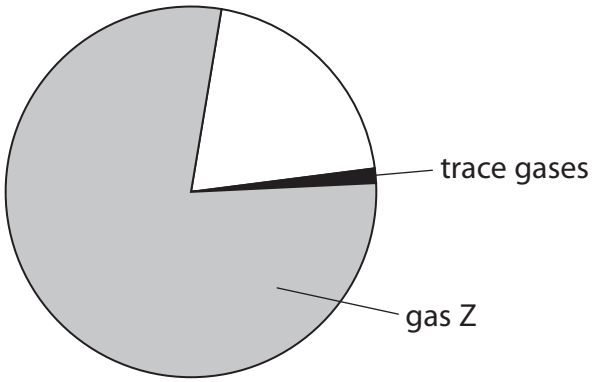
(Total for Question 1 = 7 marks)

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2 This question is about gases in the air.

The pie chart represents the percentages of gases in dry, unpolluted air.

Gases with percentages of less than 1% in air are called trace gases.



(a) (i) Which of these is gas Z?

(1)

- ☒ **A** hydrogen
- ☒ **B** methane
- ☒ **C** neon
- ☒ **D** nitrogen

(ii) Which of these is the approximate percentage of oxygen in dry, unpolluted air?

(1)

- ☒ **A** 0.04%
- ☒ **B** 0.9%
- ☒ **C** 21%
- ☒ **D** 35%

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(b) One of the trace gases is carbon dioxide.

(i) Identify **two** reactions that produce carbon dioxide by placing a tick (✓) in two boxes.

(2)

cracking an alkane	
complete combustion of an alkane	
reaction between magnesium and hydrochloric acid	
rusting of iron	
thermal decomposition of copper(II) carbonate	

(ii) Name an environmental problem that is caused by the percentage of carbon dioxide increasing in the atmosphere.

(1)

.....

(iii) Name the trace gas with the highest percentage in dry, unpolluted air.

(1)

.....

(c) Rainwater is acidic because carbon dioxide dissolves in water to form carbonic acid.

Acid rain is more acidic than rainwater because acidic pollutant gases also dissolve in water.

(i) Give the name of the acid that forms when nitrogen dioxide dissolves in water.

(1)

.....

(ii) Name another pollutant gas that also forms acid rain.

(1)

.....

(Total for Question 2 = 8 marks)

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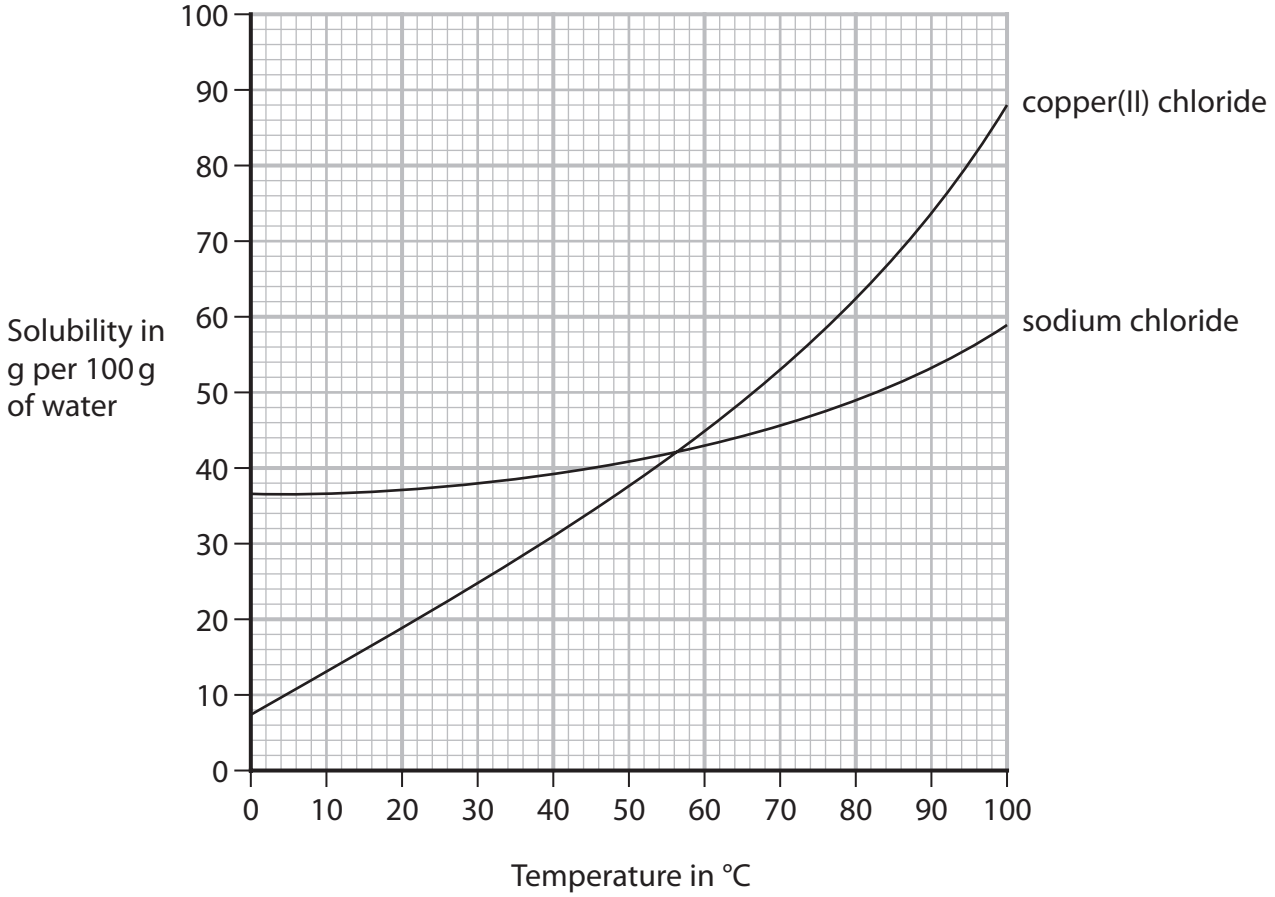
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3 This question is about solubility.

(a) The graph shows the solubilities of copper(II) chloride and sodium chloride at different temperatures.



(i) Determine the temperature at which copper(II) chloride and sodium chloride have the same solubility.

Show on the graph how you obtained your answer.

(2)

temperature = ... °C

(ii) A saturated solution of copper(II) chloride in 100 g of water is cooled from 40 °C to 10 °C.

Determine the mass, in grams, of copper(II) chloride that crystallises.

(2)

mass of copper(II) chloride = ... g

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(b) A student uses this method to determine the solubility of potassium chloride in water at room temperature.

- record the mass of an empty evaporating basin
- pour some saturated potassium chloride solution into the evaporating basin
- record the mass of the evaporating basin and saturated potassium chloride solution
- heat the evaporating basin to remove all the water
- record the mass of the evaporating basin and the dry potassium chloride

The table shows the student's results.

	Mass in grams
evaporating basin	58.1
evaporating basin and saturated potassium chloride solution	78.2
evaporating basin and dry potassium chloride	63.2

(i) Calculate the mass of dry potassium chloride obtained.

(1)

mass = ... g

(ii) Calculate the mass of water removed.

(1)

mass = ... g

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(iii) Calculate the solubility of potassium chloride in grams per 100 grams of water.

(2)

solubility = ... g per 100 g of water

(iv) Suggest why the student's method is **not** suitable for determining the solubility of hydrated copper(II) sulfate.

(1)

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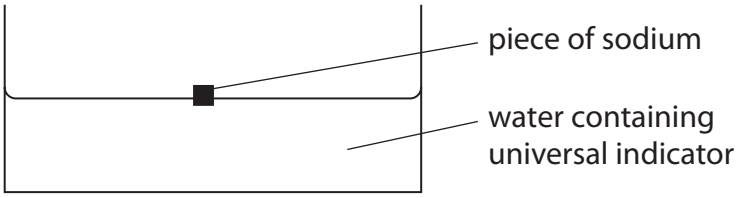
(Total for Question 3 = 9 marks)

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4 This question is about the reactions of Group 1 metals with water.

(a) A teacher adds a piece of sodium to some water containing universal indicator.



The equation for this reaction is

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

The sodium floats on the surface of the water and the universal indicator changes colour because an alkaline solution is formed.

(i) Give two other observations.

(2)

1 .....

.....

2 .....

.....

(ii) Give the final colour of the universal indicator.

(1)

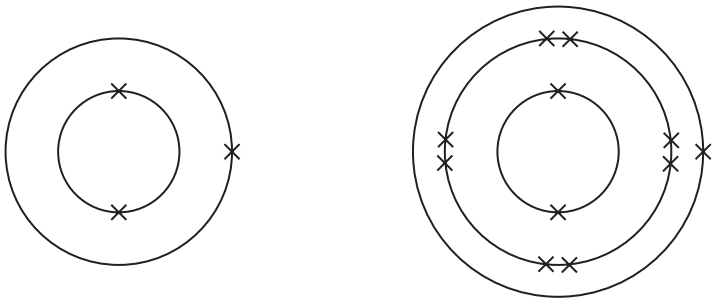
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(b) The diagram represents an atom of lithium and an atom of sodium.



lithium sodium

(i) Give a reason why lithium and sodium have similar reactions with water.

(1)

.....

.....

(ii) Explain why lithium is less reactive than sodium.

(3)

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(c) The teacher adds 0.150 g of lithium to an excess of water and collects the hydrogen gas produced.

The equation for the reaction is

$$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$$

The teacher collects 254 cm^3 of hydrogen gas at room temperature and pressure (rtp).

Show by calculation that 1 mol of hydrogen gas has a volume of approximately 24 000 cm^3 at rtp.

(4)

(Total for Question 4 = 11 marks)

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5 Hydrogen peroxide solution decomposes to give water and oxygen gas.

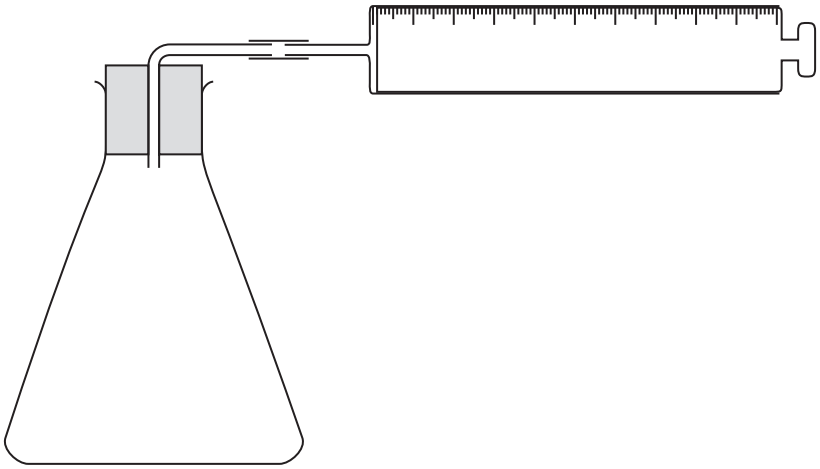
The equation for this reaction is

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(a) Three different solids are catalysts for the decomposition of hydrogen peroxide solution.

A student is given hydrogen peroxide solution and a sample of each of the solid catalysts.

The student has a timer, a measuring cylinder, a balance and the apparatus shown in the diagram.



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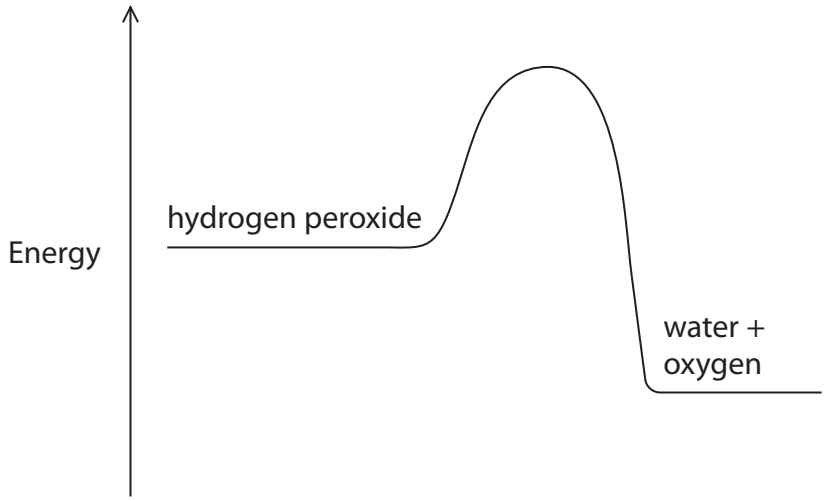
Describe a method the student could use to find which of the three solids is the most effective catalyst for the decomposition of hydrogen peroxide solution.

(5)

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(b) The diagram shows the reaction profile for the decomposition of hydrogen peroxide without a catalyst.



(i) Label the diagram to show the activation energy (E_a) and the enthalpy change (ΔH) for this reaction.

(2)

(ii) On the diagram, draw a curve to show the reaction profile for the same reaction when a catalyst is used.

(1)

(Total for Question 5 = 8 marks)

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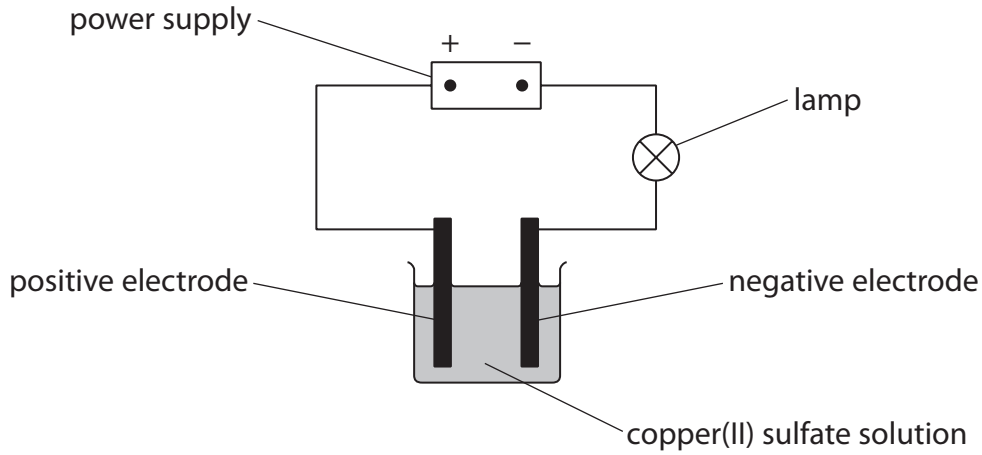
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6 This question is about the electrolysis of copper(II) sulfate solution.

(a) The diagram shows the apparatus used for the electrolysis.



A student records the total increase in mass of the negative electrode every minute for 8 minutes.

The table shows the results.

Time in minutes	Total increase in mass of the negative electrode in grams
0	0.00
1	0.15
2	0.27
3	0.34
4	0.39
5	0.41
6	0.42
7	0.42
8	0.42

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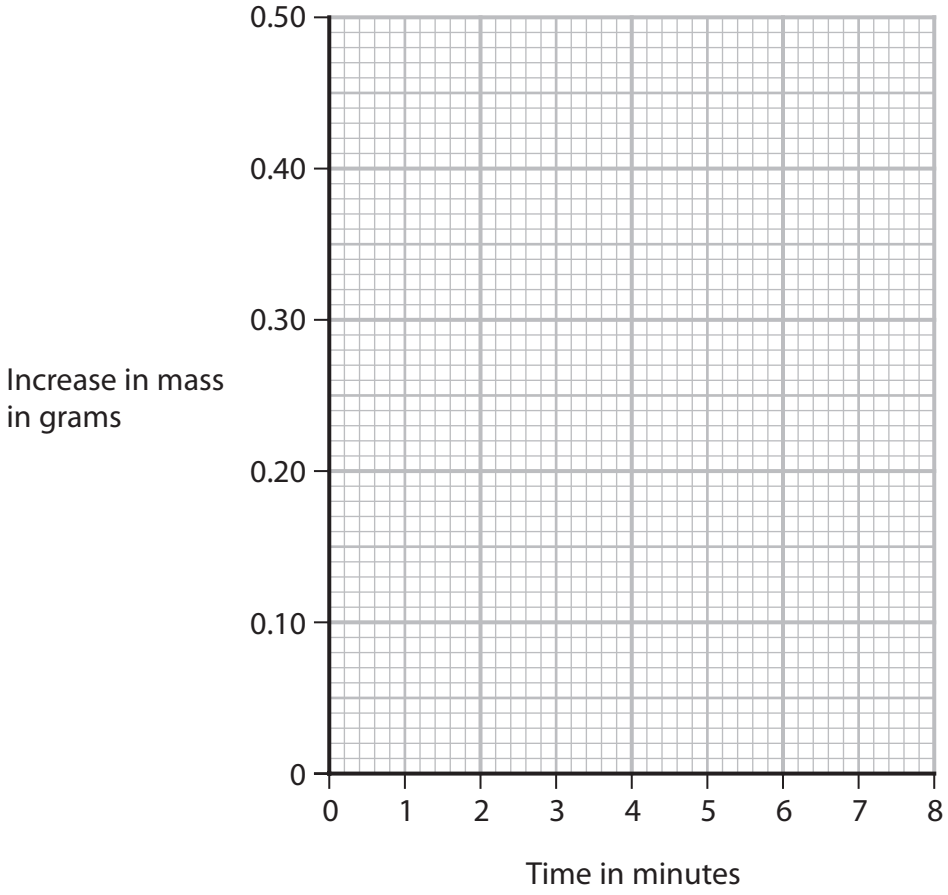
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(i) Plot the student's results.

(1)

(ii) Draw a curve of best fit.

(1)



(iii) Explain the shape of the graph.

(2)

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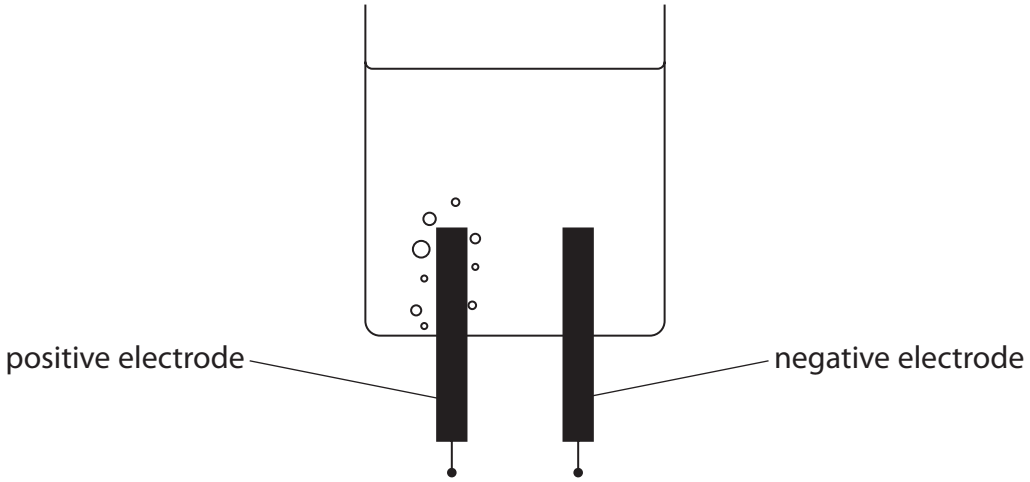
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(b) The product at the positive electrode is oxygen gas.

(i) The student repeats the electrolysis using different apparatus.



Describe how the student should collect a sample of pure oxygen at the positive electrode.

(2)

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(ii) Give an ionic half-equation for the formation of oxygen.

(2)

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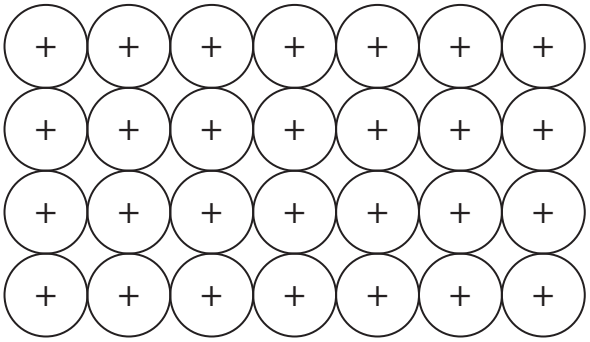
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(c) The wire used to connect the power supply to the electrodes is made of copper metal.

The diagram shows the arrangement of the ions in a metal.





(i) Metals that are malleable can also be stretched to form long, thin wires.

Suggest why metals can be stretched to form wires.

(2)

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(ii) Explain why metals conduct electricity.

(2)

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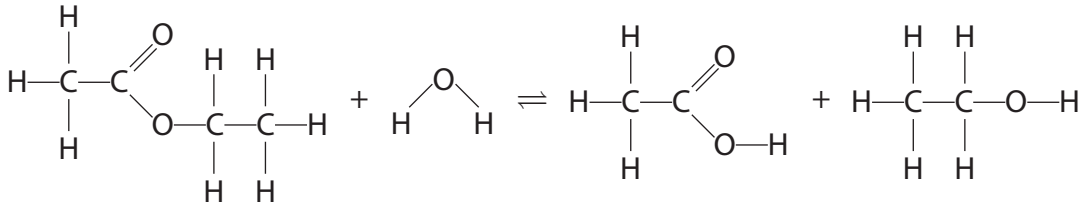
(Total for Question 6 = 12 marks)

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7 This question is about esters.

Ester A reacts with water to form ethanoic acid and ethanol.

The displayed formulae of the reactants and products are shown in this equation



ester A

The molar enthalpy change (ΔH) for the reaction is 0 kJ/mol.

(a) (i) Draw a ring around the functional group in ester A.

(1)

(ii) Give the name of ester A.

(1)

.....

(iii) Describe a chemical test, other than using an indicator, to show that the reaction mixture contains ethanoic acid.

(2)

.....

.....

.....

.....

(b) Explain why the molar enthalpy change (ΔH) for the reaction between ester A and water is 0 kJ/mol.

In your answer, refer to the bonds broken and the bonds formed.

(2)

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(c) A mixture of ester A and water is left in a sealed container until the reaction mixture reaches dynamic equilibrium.

(i) Describe what is meant by dynamic equilibrium.

(2)

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.....

.....

.....

(ii) Explain why adding a catalyst does not change the position of equilibrium.

(2)

.....

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.....

(d) The ethanoic acid produced in the reaction is completely neutralised by 22.75 cm^3 of 0.150 mol/dm^3 barium hydroxide solution.

The equation for the neutralisation reaction is

$$2CH_3COOH + Ba(OH)_2 \rightarrow Ba(CH_3COO)_2 + 2H_2O$$

Calculate the amount, in moles, of ethanoic acid neutralised.

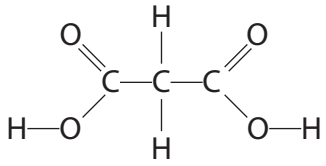
Give your answer to 3 significant figures.

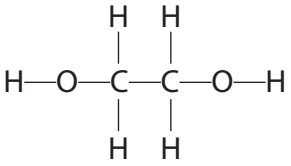
(3)

amount = ... mol

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(e) The structures of two organic compounds are shown.





These compounds react together to form a polymer.

Give the repeat unit of the polymer formed.

(2)

(Total for Question 7 = 15 marks)

TOTAL FOR PAPER = 70 MARKS

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