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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)

Tuesday 11 June 2024

Morning (Time: 1 hour 15 minutes)

Paper reference **4CH1/2CR**

Chemistry

UNIT: 4CH1

PAPER: 2CR

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 ▶

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P 7 3 4 2 6 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.

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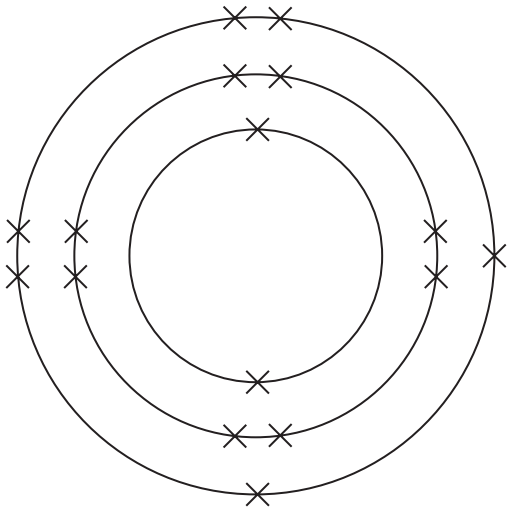
Answer ALL questions.

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 sulfur.

(a) The diagram represents the electronic configuration of an atom of sulfur.



(i) Which period of the Periodic Table contains sulfur?

(1)

☒ A 2

☒ **B** 3

☒ **C** 4

☒ **D** 6

(ii) What is the charge on a sulfide ion?

(1)

☒ A 1+

☒ **B** 2+

☒ **C** 1–

☒ **D** 2–

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(b) When a mixture of sulfur and zinc is heated to a high temperature a reaction occurs, forming the compound zinc sulfide, ZnS

(i) Give a reason why the mixture of sulfur and zinc needs heating before a reaction occurs.

(1)

.....

.....

(ii) Calculate the relative formula mass (M_r) of zinc sulfide.

[for Zn, $A_r = 65$ for S, $A_r = 32$]

(1)

M_r = ...

(Total for Question 1 = 4 marks)

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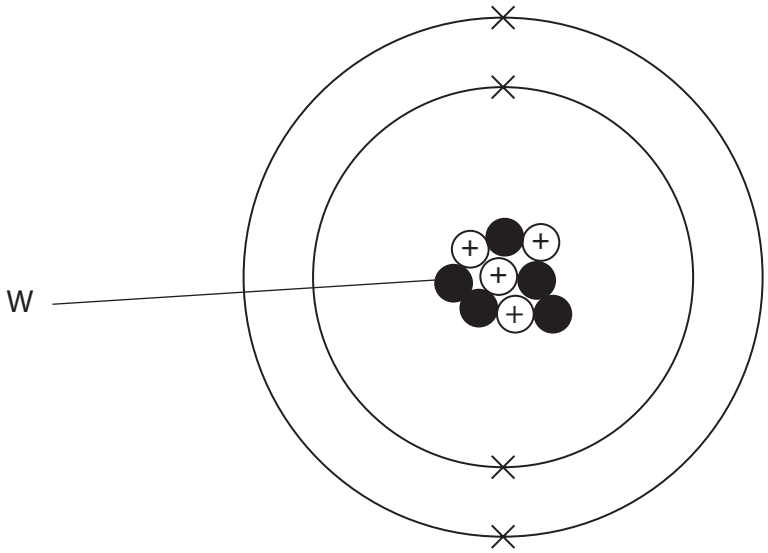
2 (a) The diagram represents an atom of an element.



(i) What is the name of the particle labelled W?

(1)

- ☒ A electron
- ☒ **B** ion
- ☒ **C** neutron
- ☒ **D** proton

(ii) What is the mass number of this atom?

(1)

- ☒ A 4
- ☒ **B** 5
- ☒ **C** 9
- ☒ **D** 13

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(b) These are the symbols for the two isotopes of lithium.

$^{6}_{3}Li$ $^{7}_{3}Li$

(i) In terms of sub-atomic particles, give one similarity and one difference between the two isotopes.

(2)

similarity

.....

.....

difference

.....

.....

(ii) A sample of lithium contains 7.5% of $^{6}_{3}Li$ and 92.5% of $^{7}_{3}Li$

Calculate the relative atomic mass (A_r) of this sample of lithium.

(2)

A_r = ...

(Total for Question 2 = 6 marks)

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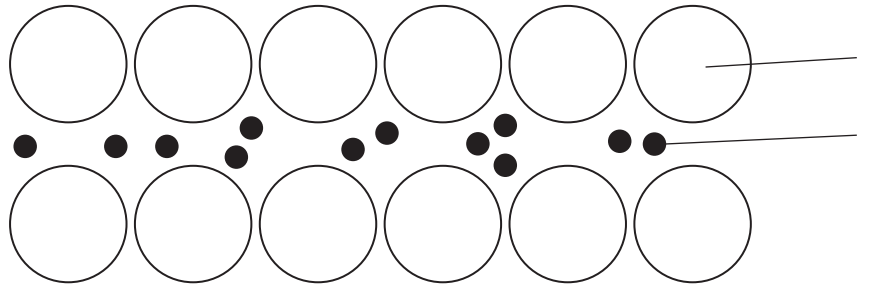
3 This question is about magnesium metal and its compounds.

(a) (i) The diagram represents the structure of magnesium.

Complete the diagram by adding the labels.

(2)



(ii) Explain why magnesium is malleable.

(2)

(b) Magnesium burns in oxygen gas to form solid magnesium oxide.

(i) Complete the chemical equation for the reaction by balancing the equation and adding the state symbols.

(2)

.....Mg(s) + O_2(.....) → .....MgO(.....)

(ii) Give a reason why magnesium is oxidised in this reaction.

(1)

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(c) A student uses this method to make a solution of magnesium chloride.

Step 1 measure 25 cm^3 of dilute hydrochloric acid into a beaker

Step 2 add magnesium powder a little at a time

Step 3 keep adding magnesium powder until it is in excess

Step 4 remove the excess magnesium powder by filtration

This is the equation for the reaction.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(i) Give a reason why the student uses magnesium powder rather than magnesium ribbon.

(1)

.....

.....

(ii) Give a reason why the student adds an excess of magnesium in step 3.

(1)

.....

.....

(iii) Calculate the minimum mass of magnesium needed to react with 25.0 cm^3 of 2.00 mol / dm^3 hydrochloric acid.

[for Mg, A_r = 24]

(3)

mass = ... g

(Total for Question 3 = 12 marks)

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4 This question is about the manufacture of ethanol by the fermentation of glucose.

(a) Fermentation needs to be done in the absence of air.

Give **two** other conditions needed for fermentation.

(2)

1 .....

2 .....

(b) Explain why fermentation needs to be done in the absence of air.

(2)

.....

.....

.....

.....

(c) (i) Complete the equation for fermentation.

(1)

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2\,\text{.....}$$

(ii) A mixture containing 500 mol of glucose is fermented.

A mass of 5750 g of ethanol is obtained.

Calculate the percentage yield.

[for ethanol, $M_r = 46$]

(3)

percentage yield = ... %

(Total for Question 4 = 8 marks)

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5 Sodium sulfate can be prepared by the reaction between sodium hydroxide solution and sodium hydrogensulfate ($NaHSO_4$) solution.

This is the equation for the reaction.

$$NaOH(aq) + NaHSO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$$

Sodium hydrogensulfate solution is acidic.

A student adds 25.0 cm^3 of sodium hydroxide solution to a conical flask and adds two drops of indicator.

The student does a titration.

(a) (i) Name a piece of apparatus that should be used to add 25.0 cm^3 of sodium hydroxide solution to the conical flask.

(1)

.....

(ii) Describe the method the student should use to find the accurate volume of sodium hydrogensulfate solution needed to neutralise the 25.0 cm^3 of sodium hydroxide solution.

(5)

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(b) The student repeats the titration without the indicator and forms a solution of sodium sulfate.

Describe how the student can obtain pure, dry crystals of hydrated sodium sulfate from the solution.

(4)

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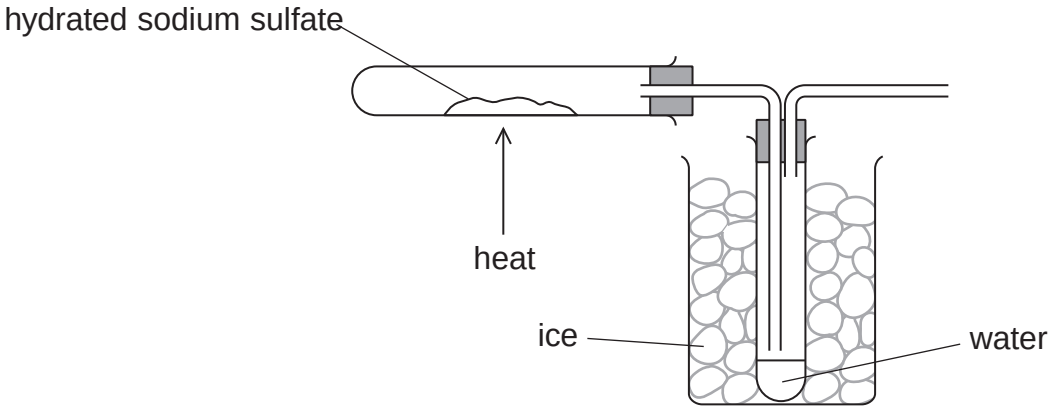
(c) Crystals of hydrated sodium sulfate decompose when heated.

This is the equation for the decomposition.

$$Na_2SO_4.xH_2O \rightarrow Na_2SO_4 + xH_2O$$

A student uses this apparatus to find the value of x.



The student heats the crystals until the decomposition is complete.

The table shows the student's results.

mass of empty test tube in g	25.12
mass of test tube and $Na_2SO_4.xH_2O$ in g	31.56
mass of test tube and Na_2SO_4 in g	27.96

Use the results to calculate the value of x.

[for Na_2SO_4, $M_r = 142$ for H_2O, $M_r = 18$]

(4)

value of x = ...

(Total for Question 5 = 14 marks)

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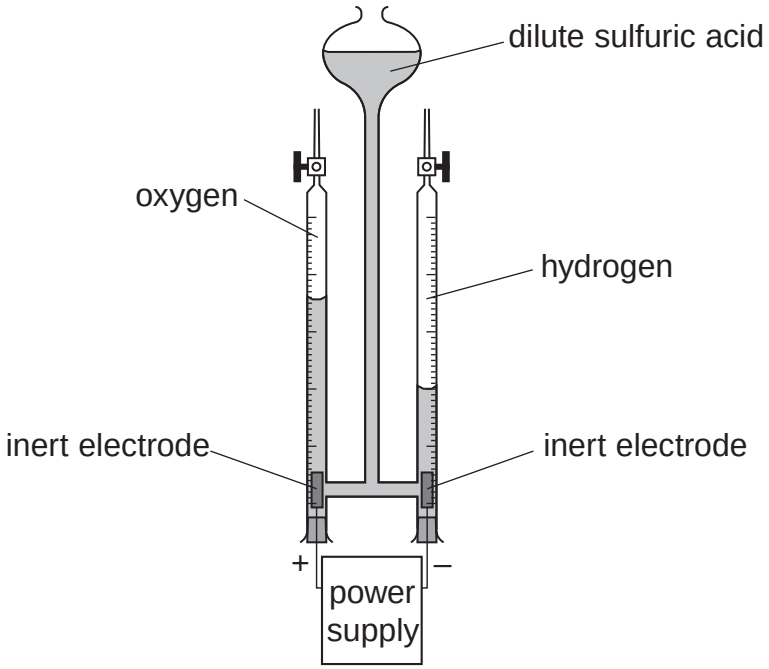
6 This question is about electrolysis.

(a) This apparatus is used to collect the gases produced when an electric current passes through dilute sulfuric acid.



(i) Name a suitable material for the inert electrodes.

(1)

.....

(ii) Give a test to show that the gas produced at the positive electrode is oxygen.

(1)

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.....

(iii) Give a test to show that the gas produced at the negative electrode is hydrogen.

(1)

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(iv) Give an ionic half-equation for the formation of hydrogen at the negative electrode.

(1)

.....

(v) The oxygen gas in the tube has a volume of 17.8 cm^3 at rtp.

Calculate the mass, in grams, of oxygen gas in the tube.

Give your answer to 3 significant figures.

[for O_2 at rtp, molar volume = 24 000 cm^3]

(3)

mass of oxygen = ... g

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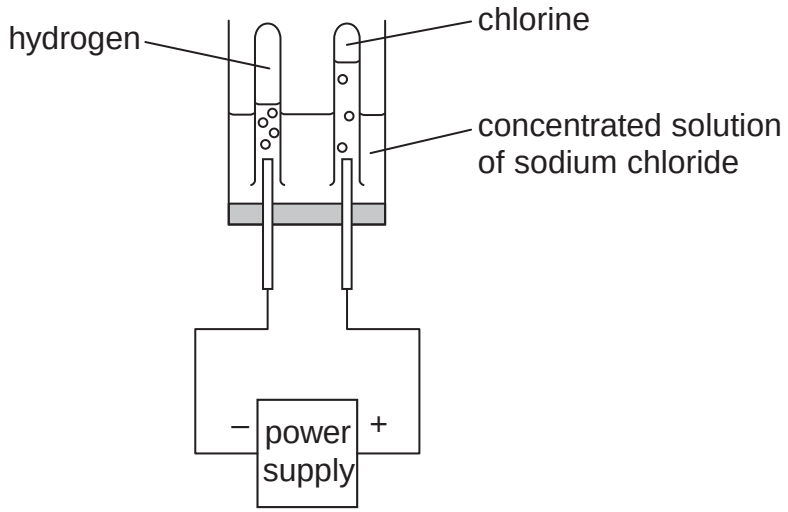
(b) This apparatus is used to electrolyse a concentrated solution of sodium chloride.



(i) Give a reason why sodium chloride solution conducts electricity.

(1)

.....

.....

(ii) The positive ions in the solution are H^+ and Na^+.

Give a reason why hydrogen forms at the negative electrode rather than sodium.

(1)

.....

.....

(iii) A sample of the solution is taken from near the negative electrode. The sample is tested with universal indicator.

Explain the final colour of the universal indicator.

(2)

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(Total for Question 6 = 11 marks)

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7 Gaseous ethanol is manufactured by reacting ethene gas with steam.

This is the equation for the reaction.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

(a) (i) The pressure on an equilibrium mixture of the three gases is decreased. All the other conditions are kept the same.

Predict the effect of this change on the yield of ethanol at equilibrium, giving a reason for your answer.

(2)

.....

.....

.....

.....

(ii) Predict the effect of adding a catalyst on the yield of ethanol at equilibrium, giving a reason for your answer.

(2)

.....

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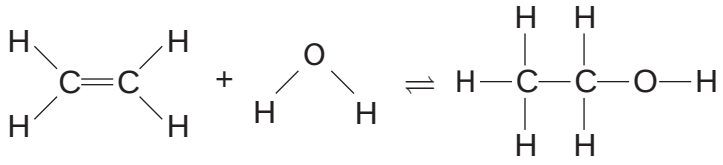
(b) The equation shows the displayed formulae for the reactants and products.



The table gives the bond energies.

Bond	Bond energy in kJ / mol
C—H	414
C═C	614
O—H	463
C—C	346
C—O	358

(i) Using the data in the table and the equation, show that the enthalpy change, ΔH, is approximately –40 kJ / mol.

(3)

(ii) Explain, in terms of bonds broken and bonds made, why this reaction is exothermic.

(2)

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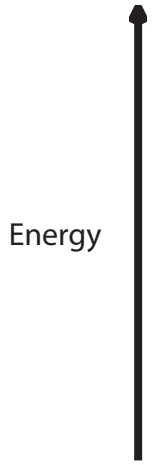
(iii) Draw an energy level diagram for the reaction between ethene and steam.

Label the enthalpy change, ΔH.

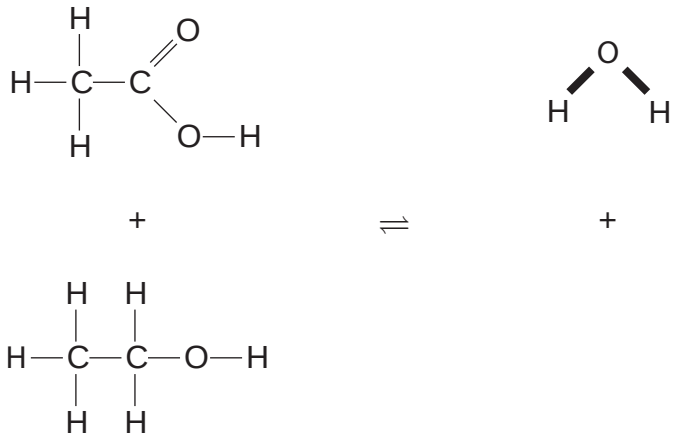
(3)



(c) Ethanoic acid reacts with ethanol to form ester A and water.

(i) Complete the equation by adding the displayed formula of ester A.

(2)



ester A

(ii) Give the name of ester A.

(1)

.....

(Total for Question 7 = 15 marks)

TOTAL FOR PAPER = 70 MARKS

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