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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 **4CH1/2CR**

Chemistry

Unit: 4CH1
PAPER: 2CR

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 ▶

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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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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 (a) Two substances are needed to cause iron to rust.

Name these two substances.

(2)

1 .....

2 .....

(b) The box gives the names of some substances.

calcium	copper	gold
iodine	methane	zinc

Use words from the box to answer these questions.

(i) Give the name of a non-metallic element.

(1)

.....

(ii) Give the name of a compound.

(1)

.....

(iii) Give the name of the metal that is lowest in the reactivity series.

(1)

.....

(Total for Question 1 = 5 marks)

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2 Crude oil is a mixture of hydrocarbons.

(a) This passage is about the industrial separation of crude oil.

Complete the passage by adding the missing words.

(3)

Crude oil is ..... to form vapour.

The vapour is passed through a ..... column.

The refinery gases are collected at the top of the column because they have low

....

(b) Bitumen is collected at the bottom of the column.

Give one use of bitumen.

(1)

.....

(c) One of the hydrocarbons in crude oil is an alkane with this structural formula.

$CH_3CH_2CH_2CH_2CH_3$

(i) Give the name of this alkane.

(1)

.....

(ii) Calculate the relative molecular mass (M_r) of this alkane.

(1)

M_r = ...

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(d) Catalytic cracking is used to convert long-chain alkanes into shorter-chain alkanes.

Give the name of the catalyst and the temperature used in catalytic cracking.

(2)

catalyst .....

temperature .....

(e) Catalytic cracking also produces alkenes.

Decane ($C_{10}H_{22}$) can undergo cracking to give C_4H_{10} and two different alkenes.

Complete the equation for this cracking process.

(2)

$C_{10}H_{22} \rightarrow C_4H_{10} +$ ..... $+$ .....

(Total for Question 2 = 10 marks)

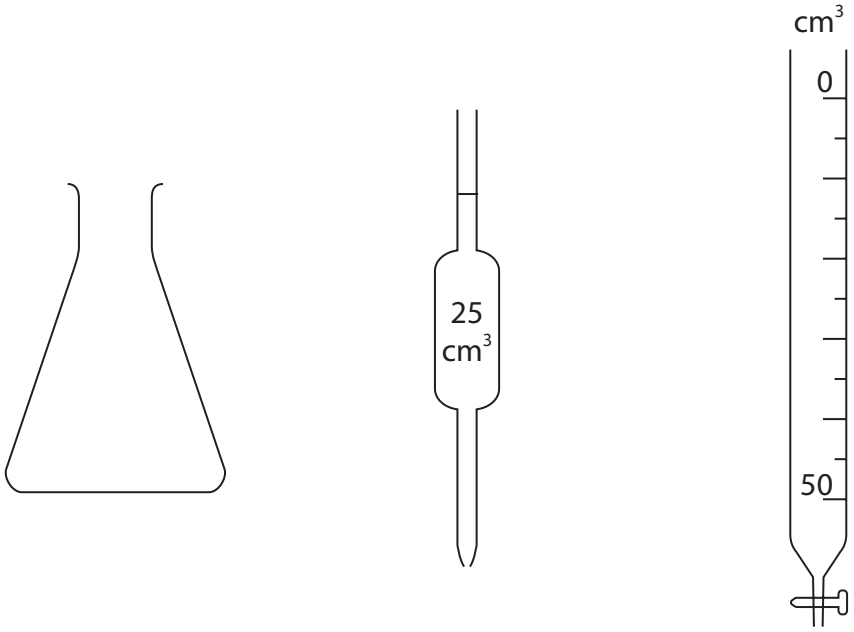
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3 A student does a titration to find the concentration of a solution of dilute sulfuric acid.

The student uses these solutions and this apparatus.

- dilute sulfuric acid
- potassium hydroxide solution of concentration 0.240 mol / dm^3
- methyl orange indicator



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(a) The student wants to find the volume of sulfuric acid needed to neutralise 25.0 cm^3 of the potassium hydroxide solution.

Describe how the student should do this titration.

Assume that all pieces of apparatus are clean and dry.

(6)

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(b) The student needs 15.00 cm^3 of sulfuric acid to neutralise 25.0 cm^3 of the potassium hydroxide solution.

This is the equation for the reaction.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

(i) Calculate the amount, in moles, of KOH in 25.0 cm^3 of potassium hydroxide solution of concentration 0.240 mol / dm^3.

(2)

amount of KOH = ... mol

(ii) Calculate the amount, in moles, of H_2SO_4 in 15.00 cm^3 of the sulfuric acid.

(1)

amount of H_2SO_4 = ... mol

(iii) Calculate the concentration, in mol / dm^3, of the sulfuric acid.

(2)

concentration of sulfuric acid = ... mol / dm^3

(Total for Question 3 = 11 marks)

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4 This question is about alcohols, carboxylic acids and their reactions.

(a) The boxes give some information about a carboxylic acid.

Complete the boxes by giving the missing information.

(3)

structural formula	CH_3COOH
name	
	CH_2O
displayed formula	

(b) Ethanol can be oxidised to produce a carboxylic acid.

(i) Give the names of the two reagents used in this oxidation reaction.

(2)

1 .....

2 .....

(ii) Which of these colour changes occurs during the reaction?

(1)

- ☒ **A** green to orange
- ☒ **B** orange to green
- ☒ **C** red to yellow
- ☒ **D** yellow to red

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(c) Alcohols and carboxylic acids can be heated together to form esters.

(i) State why it is better to heat the mixture using a water bath rather than directly with a Bunsen burner flame.

(1)

.....

.....

(ii) An ester has the structural formula $CH_3CH_2COOCH_3$

Which of these is the name of this ester?

(1)

☒ **A** ethyl methanoate

☒ **B** methyl ethanoate

☒ **C** methyl propanoate

☒ **D** propyl methanoate

(Total for Question 4 = 8 marks)

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5 This question is about three stages in the manufacture of sulfuric acid.

(a) In stage 1, sulfur is burned in oxygen to form sulfur dioxide gas.

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

(i) State one environmental problem caused by the release of sulfur dioxide into the atmosphere.

(1)

.....

.....

(ii) A mass of 6.4 tonnes of sulfur is burned to produce sulfur dioxide gas.

Calculate the maximum volume, in dm^3, of sulfur dioxide gas that can be produced at rtp.

[molar volume of sulfur dioxide gas at rtp = $24\,dm^3$]

[1 tonne = 10^6 g]

Give your answer in standard form.

(3)

maximum volume = ... dm^3

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(b) In stage 2, sulfur dioxide is reacted with oxygen to form sulfur trioxide gas.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The yield of sulfur trioxide is approximately 98%.

(i) A catalyst is used in this reaction.

Explain how a catalyst increases the rate of a reaction.

(2)

.....

.....

.....

.....

(ii) The temperature is kept constant.

Give a reason why increasing the pressure would increase the yield of sulfur trioxide.

(1)

.....

.....

(iii) Suggest why it is not necessary to increase the pressure in stage 2.

(1)

.....

.....

.....

(c) In stage 3, the sulfur trioxide is reacted with concentrated sulfuric acid to form a liquid called oleum, $H_2S_2O_7$

The oleum is then added to water to form concentrated sulfuric acid.

Complete the chemical equations for these two reactions.

(2)

..... + ... → $H_2S_2O_7$

$H_2S_2O_7$ + ... → .....

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(d) Sulfuric acid reacts with ammonia to form ammonium sulfate, $(NH_4)_2SO_4$

Calculate the percentage by mass of nitrogen in ammonium sulfate.

[M_r of $(NH_4)_2SO_4$ = 132]

(2)

percentage = ... %

(Total for Question 5 = 12 marks)

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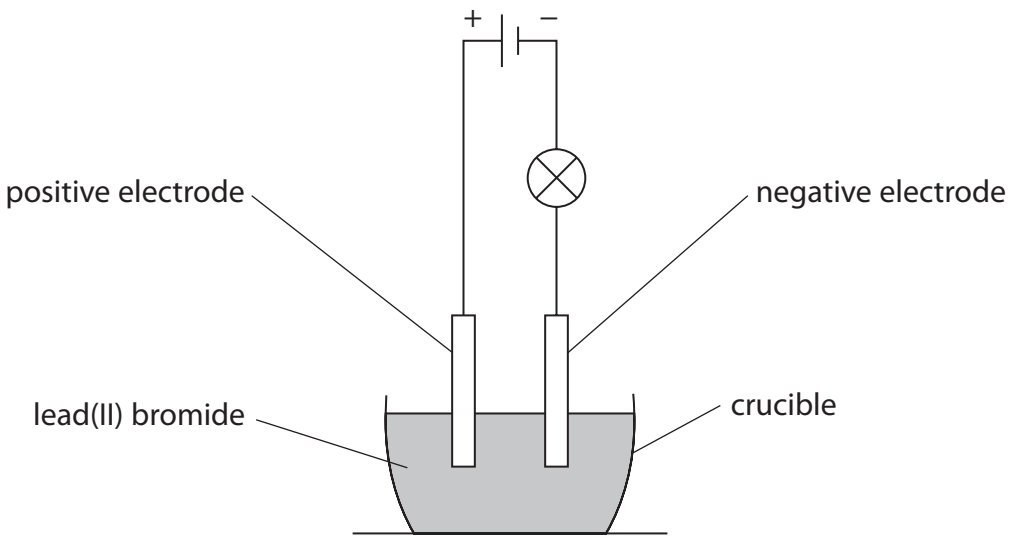
6 A teacher prepares the insoluble salt lead(II) bromide ($PbBr_2$) by mixing solutions of lead(II) nitrate and sodium bromide.

(a) Describe what the teacher should do next to obtain a pure, dry sample of lead(II) bromide.

(3)

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(b) The teacher then sets up a circuit in a fume cupboard using the pure, dry sample of lead(II) bromide.



Explain why the lamp does not light when the lead(II) bromide is solid.

(2)

.....

.....

.....

.....

(c) The teacher heats the lead(II) bromide.

When the lead(II) bromide is molten, the lamp lights and bromine forms at the positive electrode.

(i) State what observation would be made at the positive electrode.

(1)

.....

.....

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(ii) Explain how bromide ions in the molten lead(II) bromide become bromine molecules at the positive electrode.

(4)

(d) Write an ionic half-equation for the reaction that occurs at the negative electrode.

Include state symbols in your equation.

(2)

(Total for Question 6 = 12 marks)

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7 The reaction between hydrogen and chlorine is exothermic.

This is the equation for the reaction.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \Delta H = -184\,kJ$$

(a) State the meaning of the term **exothermic**.

(1)

.....

.....

(b) The table gives the bond energies for the H—H and H—Cl bonds.

Bond	H—H	H—Cl
Bond energy in kJ / mol	436	431

Use the equation and information from the table to calculate the bond energy of the Cl—Cl bond.

(4)

bond energy = ... kJ / mol

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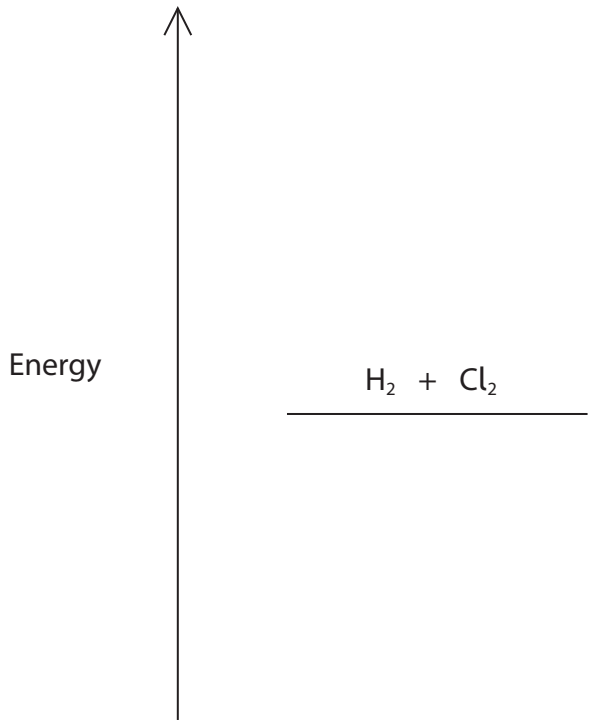
(c) Explain why this reaction is exothermic.

Refer to bond-breaking and bond-making in your answer.

(3)

(d) Complete the reaction profile diagram to show the position of the products, the enthalpy change (ΔH) and the activation energy (E_a) for the reaction.

(4)



(Total for Question 7 = 12 marks)

TOTAL FOR PAPER = 70 MARKS

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