Please check the examination details below before entering your candidate information			
Candidate surname		Other names	
Centre Number Candidate No	umber		
Pearson Edexcel Inter	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 ▶







# The Periodic Table of the Elements

0 <b>He</b> 4 2 2	20 <b>Ne</b> neon 10	40 <b>Ar</b> argon 18	84 <b>Kr</b> krypton 36	131 <b>Xe</b> xenon 54
7	19 <b>F</b> fluorine 9	35.5 CI chlorine 17	80 <b>Br</b> bromine 35	127 
O	16 <b>O</b> oxygen 8	32 <b>S</b> sulfur 16	79 <b>Se</b> selenium 34	128 <b>Te</b> tellurium 52
2	14 <b>N</b> nitrogen 7	31 P phosphorus 15	75 <b>As</b> arsenic 33	122 <b>Sb</b> antimony 51
4	12 <b>C</b> carbon 6	28 <b>Si</b> silicon 14	73 <b>Ge</b> germanium 32	119 <b>Sn</b> th 50
က	11 <b>B</b> boron 5	27 <b>Al</b> aluminium 13	70 <b>Ga</b> gallium 31	115 <b>In</b> indium 49
·			65 <b>Zn</b> zinc 30	112 <b>Cd</b> cadmium 48
			63.5 <b>Cu</b> copper 29	108 <b>Ag</b> silver 47
			59 <b>Ni</b> nickel 28	106 <b>Pd</b> palladium 46
			59 <b>Co</b> cobalt 27	103 <b>Rh</b> rhodium 45
T hydrogen			56 <b>Fe</b> iron 26	101 <b>Ru</b> ruthenium 44
			55 Mn manganese 25	[98] <b>Tc</b> technetium 43
	mass <b>bol</b> number		52 <b>Cr</b> chromium 24	96 <b>Mo</b> molybdenum 42
Key	relative atomic mass <b>atomic symbol</b> name atomic (proton) number		51 V vanadium 23	93 <b>Nb</b> niobium 41
	relati <b>atc</b> atomic		48 <b>Ti</b> titanium 22	91 <b>Zr</b> zirconium 40
			45 Sc scandium 21	89 <b>Y</b> yttrium 39
2	9 <b>Be</b> beryllium 4	24 <b>Mg</b> magnesium 12	40 <b>Ca</b> calcium 20	88 Sr strontium 38
<b>←</b>	7 Li Iffhium 3	23 <b>Na</b> sodium 11	39 <b>K</b> potassium 19	85 <b>Rb</b> rubidium 37

0	84 krypto 36	13' <b>Xe</b> xenol 54	[22] <b>Rn</b> rador 86	fully		
11	80 <b>Br</b> bromine 35	127 	[210] <b>At</b> astatine 85	Elements with atomic numbers 112–116 have been reported but not fully authenticated		
10	79 <b>Se</b> selenium 34	128 <b>Te</b> tellurium 52	[209] <b>Po</b> polonium 84	ave been rep 1		
13	75 <b>As</b> arsenic 33	122 <b>Sb</b> antimony 51	209 <b>Bi</b> bismuth 83	s 112–116 he authenticated		
+	73 <b>Ge</b> germanium 32	119 <b>Sn</b> tin 50	207 <b>Pb</b> lead 82	omic numbers		
13	70 <b>Ga</b> gallium 31	115 In indium 49	204 <b>T</b> thallium 81	nents with atc		
	65 <b>Zn</b> zinc 30	112 <b>Cd</b> cadmium 48	201 <b>Hg</b> mercury 80	Elem		
	63.5 <b>Cu</b> copper 29	108 <b>Ag</b> silver 47	197 <b>Au</b> gold 79	Rg roentgenium 111		
	59 <b>Ni</b> nickel 28	106 <b>Pd</b> palladium 46	195 <b>Pt</b> platinum 78	[271] <b>Ds</b> damstadtium 110		
	59 <b>Co</b> cobatt 27	103 <b>Rh</b> rhodium 45	192 <b>Ir</b> iridium 77	[268]		
	56 Fe iron 26	101 <b>Ru</b> ruthenium 44	190 <b>0s</b> osmium 76	[277] <b>Hs</b> hassium 108		
	55 <b>Mn</b> manganese 25	[98] <b>Tc</b> technetium 43	186 <b>Re</b> rhenium 75	[264] <b>Bh</b> bohrium 107		
	52 Cr chromium 24	96 <b>Mo</b> molybdenum 42	184 <b>W</b> tungsten 74	[266] Sg seaborgium 106		
	51 V vanadium 23	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	[262] <b>Db</b> dubnium 105		
	48 <b>Ti</b> titanium 22	91 <b>Zr</b> zirconium 40	178 <b>Hf</b> hafnium 72	[261] <b>Rf</b> rutherfordium 104		
	45 Sc scandium 21	89 <b>Y</b> yttrium 39	139 <b>La*</b> lanthanum 57	[227] <b>Ac*</b> actinium 89		
71	40 <b>Ca</b> calcium 20	88 Sr strontium 38	137 <b>Ba</b> barium 56	[226] <b>Ra</b> radium 88		
-	39 <b>K</b> potassium 19	85 <b>Rb</b> rubidium 37	133 <b>Cs</b> caesium 55	[223] <b>Fr</b> francium 87		

**Rn** radon 86

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

<sup>\*</sup> The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.

# **Answer ALL questions.**

Some questions must be answered with a cross in a box  $\boxtimes$ . If you change your mind about an answer, put a line through the box  $\boxtimes$  and then mark your new answer with a cross  $\boxtimes$ .

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

Name these two substances.

(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)



(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<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>3</sub>

(i) Give the name of this alkane.

(1)

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

(1)

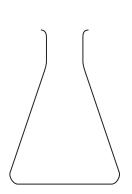
 $M_{\rm r} = \dots$ 

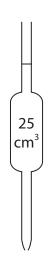
(d) Catalytic cracking is used to convert long-chain alkanes into shorter-chain alkanes	s.
Give the name of the catalyst and the temperature used in catalytic cracking.	(2)
catalyst	
temperature	
(e) Catalytic cracking also produces alkenes.	
Decane ( $C_{10}H_{22}$ ) can undergo cracking to give $C_4H_{10}$ and two different alkenes.	
Complete the equation for this cracking process.	
	(2)
$C_{10}H_{22} \rightarrow C_4H_{10} + \dots + \dots + \dots$	
(Total for Question 2 = 10 ma	arks)

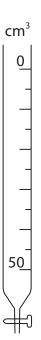
**3** A student does a titration to find the concentration of a solution of dilute sulfuric acid.

The student uses these solutions and this apparatus.

- dilute sulfuric acid
- potassium hydroxide solution of concentration 0.240 mol/dm³
- methyl orange indicator







(a)	(a) The student wants to find the volume of sulfuric acid needed to neutralise 25.0 cm <sup>3</sup> of the potassium hydroxide solution.		
	Describe how the student should do this titration.		
	Assume that all pieces of apparatus are clean and dry.	(6)	



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

This is the equation for the reaction.

$$2KOH + H2SO4 \rightarrow K2SO4 + 2H2O$$

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

(2)

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

(1)

amount of 
$$H_2SO_4 =$$
 ..... mol

(iii) Calculate the concentration, in mol/dm³, of the sulfuric acid.

(2)

concentration of sulfuric acid = ...... mol/dm<sup>3</sup>

(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	CH₃COOH
name	
	CH <sub>2</sub> O
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)

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



(c	) Alcohols	and carboxylic acids can be heated together to form esters.	
(C	/ Alcohols	and carboxylic acids can be ficated together to form esters.	
		e why it is better to heat the mixture using a water bath rather than ctly with a Bunsen burner flame.	
			(1)
	(ii) An e	ster has the structural formula CH <sub>3</sub> CH <sub>2</sub> COOCH <sub>3</sub>	
	Whic	ch of these is the name of this ester?	
			(1)
	$\boxtimes$	A ethyl methanoate	
	$\boxtimes$	<b>B</b> methyl ethanoate	
	$\boxtimes$	C methyl propanoate	

(Total for Question 4 = 8 marks)

**D** propyl methanoate

- **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<sup>3</sup>, of sulfur dioxide gas that can be produced at rtp.

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

 $[1 \text{ tonne} = 10^6 \text{ g}]$ 

Give your answer in standard form.

(3)

 $maximum\ volume = ..... dm^3$ 



(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)

$$+$$
  $\rightarrow$   $H_2S_2O_7$ 

$$H_2S_2O_7 + \dots \rightarrow \dots$$



(d) Sulfuric acid reacts with ammonia to form ammonium sulfate, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>

Calculate the percentage by mass of nitrogen in ammonium sulfate.

$$[M_r \text{ of } (NH_4)_2SO_4 = 132]$$

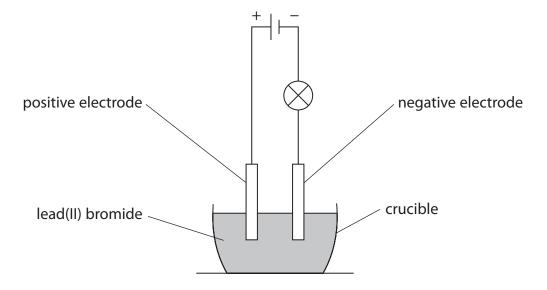
(2)

percentage = ..... %

(Total for Question 5 = 12 marks)

6	A teacher prepares the insoluble salt lead(II) bromide (PbBr <sub>2</sub> ) 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)

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



Explain why th	ne lamp does	not light when	n 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)



(ii) Explain how bromide ions in the molten lead(II) bromide become bromine molecules at the positive electrode.	(4)
	(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 ma	rks)



7 The reaction between hydrogen and chlorine is exothermic.

This is the equation for the reaction.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$
  $\Delta H = -184 \text{ kJ}$ 

(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	Н—Н	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)

Defented	annahita an anah kacamatan 1997 di		
Keter to bond-k	oreaking and bond-making in yo	ur answer.	(3)
	eaction profile diagram to show	the position of the products the	
enthalpy chang	e ( $\Delta H$ ) and the activation energy		
enthalpy chang			(4)
enthalpy chang	je ( $\Delta H$ ) and the activation energy		(4)
			(4)
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