

Please check the examination details below before entering your candidate information

Candidate surname					Other names				
Centre Number				Candidate Number					
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**Pearson Edexcel International GCSE (9–1)**

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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Q:1/1/1/



  
Pearson

# The Periodic Table of the Elements

1	2	3	4	5	6	7	0										
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	11 <b>Na</b> sodium 11	12 <b>Mg</b> magnesium 12	13 <b>Al</b> aluminium 13	14 <b>N</b> nitrogen 7	15 <b>P</b> phosphorus 15	16 <b>S</b> sulfur 16	17 <b>Cl</b> chlorine 17	18 <b>Ar</b> argon 18								
19 <b>K</b> potassium 19	20 <b>Ca</b> calcium 20	21 <b>Sc</b> scandium 21	22 <b>Ti</b> titanium 22	23 <b>V</b> vanadium 23	24 <b>Cr</b> chromium 24	25 <b>Mn</b> manganese 25	26 <b>Fe</b> iron 26	27 <b>Co</b> cobalt 27	28 <b>Ni</b> nickel 28	29 <b>Cu</b> copper 29	30 <b>Zn</b> zinc 30	31 <b>Ga</b> gallium 31	32 <b>Ge</b> germanium 32	33 <b>As</b> arsenic 33	34 <b>Se</b> selenium 34	35 <b>Br</b> bromine 35	36 <b>Kr</b> krypton 36
37 <b>Rb</b> rubidium 37	38 <b>Sr</b> strontium 38	39 <b>Y</b> yttrium 39	40 <b>Zr</b> zirconium 40	41 <b>Nb</b> niobium 41	42 <b>Mo</b> molybdenum 42	43 <b>Tc</b> technetium [98]	44 <b>Ru</b> ruthenium 44	45 <b>Rh</b> rhodium 45	46 <b>Pd</b> palladium 46	47 <b>Ag</b> silver 47	48 <b>Cd</b> cadmium 48	49 <b>In</b> indium 49	50 <b>Sn</b> tin 50	51 <b>Sb</b> antimony 51	52 <b>Te</b> tellurium 52	53 <b>I</b> iodine 53	54 <b>Xe</b> xenon 54
55 <b>Cs</b> caesium 55	56 <b>Ba</b> barium 56	57 <b>La*</b> lanthanum 57	72 <b>Hf</b> hafnium 72	73 <b>Ta</b> tantalum 73	74 <b>W</b> tungsten 74	75 <b>Re</b> rhenium 75	76 <b>Os</b> osmium 76	77 <b>Ir</b> iridium 77	78 <b>Pt</b> platinum 78	79 <b>Au</b> gold 79	80 <b>Hg</b> mercury 80	81 <b>Tl</b> thallium 81	82 <b>Pb</b> lead 82	83 <b>Bi</b> bismuth 83	84 <b>Po</b> polonium [209]	85 <b>At</b> astatine [210]	86 <b>Rn</b> radon [222]
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

1	<b>H</b>	1
	hydrogen	

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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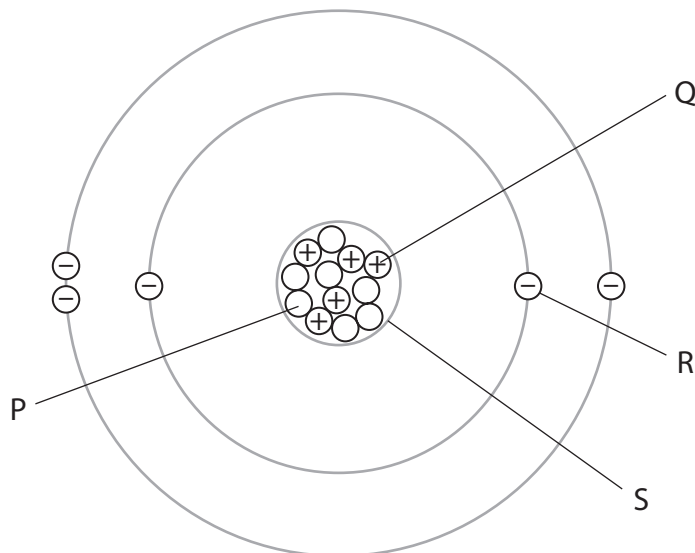
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**Answer ALL questions.**

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 The diagram shows the sub-atomic particles in an atom of an element.



- (a) (i) Give the name of each of the sub-atomic particles labelled P, Q and R.

(3)

P .....

Q .....

R .....

- (ii) Give the name of the part of the atom labelled S.

(1)

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- (b) Give the name of this element.

(1)

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**(Total for Question 1 = 5 marks)**

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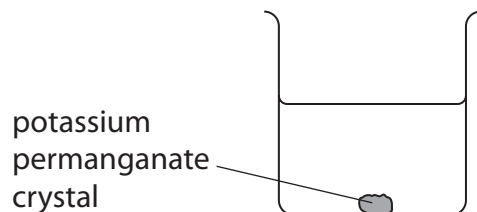
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P 7 0 9 4 8 A 0 3 2 0

2 A potassium permanganate crystal is placed in a beaker of water.



After several days a coloured solution forms.

(a) Give the names of the two processes that cause the coloured solution to form.

(2)

1 .....

2 .....

(b) The formula of potassium permanganate is  $\text{KMnO}_4$

(i) How many different types of atom are in  $\text{KMnO}_4$ ?

(1)

A 3

B 4

C 6

D 7

(ii) Calculate the relative formula mass ( $M_r$ ) of  $\text{KMnO}_4$

(1)

$M_r =$  .....

(c) Potassium permanganate can be used as an oxidising agent.

State what is meant by the term **oxidising agent**.

(1)

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**(Total for Question 2 = 5 marks)**



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3 This question is about alkanes.

(a) (i) Which of these is the **molecular** formula of an alkane?

(1)

- A  $C_2H_5$
- B  $C_4H_{10}$
- C  $CH_2CH_2$
- D  $CH_3CH_2CH_3$

(ii) Which of these has the same empirical formula and molecular formula?

(1)

- A  $CH_2$
- B  $C_2H_6$
- C  $C_3H_8$
- D  $C_4H_{10}$

(b) In the presence of ultraviolet radiation, methane reacts with bromine to form bromomethane and hydrogen bromide.

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

(1)

(ii) Give a chemical equation for this reaction.

(1)

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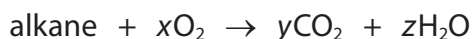
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- (c) One mole of an alkane burns completely in oxygen.

The equation represents the reaction.



The numbers  $x$ ,  $y$  and  $z$  are used to balance the equation.

- (i) The complete combustion of one mole of the alkane produces 220 g of carbon dioxide and 108 g of water.

Calculate the values of  $y$  and  $z$ .

$$[M_r \text{ of } \text{CO}_2 = 44 \quad M_r \text{ of } \text{H}_2\text{O} = 18]$$

(2)

$$y = \dots\dots\dots$$

$$z = \dots\dots\dots$$

- (ii) Determine the molecular formula of the alkane and the value of  $x$ .

(2)

$$\text{molecular formula} = \dots\dots\dots$$

$$x = \dots\dots\dots$$

- (d) When an alkane burns in a limited supply of air, incomplete combustion occurs.

Explain why incomplete combustion of an alkane could be harmful to humans.

(2)

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**(Total for Question 3 = 10 marks)**

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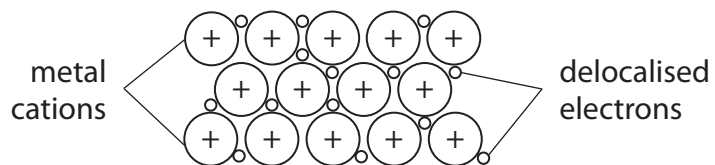


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4 (a) The diagram represents the structure of copper metal.



Explain three properties of copper that make it a suitable metal to use in electrical wiring.

(5)

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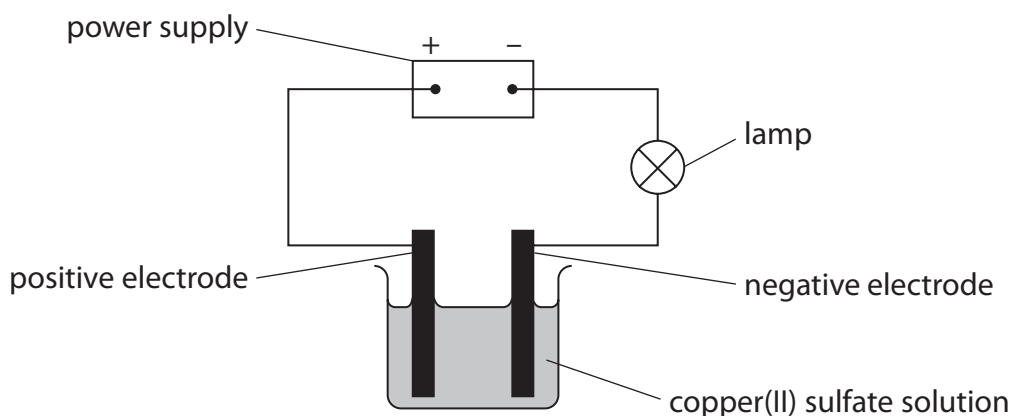
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- (b) The diagram shows the electrolysis of copper(II) sulfate solution, using graphite electrodes.



Copper forms at the negative electrode and oxygen forms at the positive electrode.

- (i) Give the formula of the copper ion and the formula of the sulfate ion in copper(II) sulfate.

(1)

copper ion

sulfate ion

- (ii) State what would be seen at the positive electrode.

(1)

- (iii) Give a test for oxygen.

(1)



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

(2)

(v) Suggest why the copper(II) sulfate solution contains some  $\text{OH}^-$  ions.

(1)

**(Total for Question 4 = 11 marks)**

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P 7 0 9 4 8 A 0 1 1 2 0

5 This question is about alcohols, carboxylic acids and esters.

(a) Ethanol can be manufactured by the fermentation of a solution of glucose.

(i) Write a word equation for this reaction.

(1)

(ii) State the substance that needs to be added for the reaction to occur.

(1)

(iii) State two conditions needed for this reaction.

(2)

1

2

(b) In the presence of an acid catalyst, ethanoic acid is heated with butanol to form an ester.

(i) Which of these is the formula of the ester?

(1)

**A**  $\text{CH}_3\text{COOC}_3\text{H}_7$

**B**  $\text{CH}_3\text{COOC}_4\text{H}_9$

**C**  $\text{C}_2\text{H}_5\text{COOC}_4\text{H}_9$

**D**  $\text{C}_3\text{H}_7\text{COOC}_2\text{H}_5$

(ii) State how you would know that an ester has formed.

(1)

(iii) Give one use of an ester.

(1)

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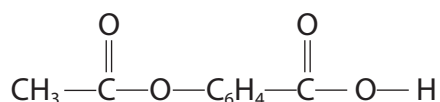
(c) Aspirin is a compound used to reduce pain.

Aspirin contains a carboxylic acid functional group and an ester functional group.

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

(1)

(ii) This is the structural formula of aspirin.



Draw a circle around the carboxylic acid functional group.

(1)

(iii) Aspirin has this percentage composition by mass.

C = 60.00%      H = 4.44%      O = 35.56%

Show by calculation that the empirical formula of aspirin is  $\text{C}_9\text{H}_8\text{O}_4$

(3)

(Total for Question 5 = 12 marks)



**6** A student uses this method to do a titration.

- use a measuring cylinder to obtain  $25\text{ cm}^3$  of sodium hydroxide solution
- transfer the solution to a conical flask
- add a few drops of universal indicator to the flask
- fill a burette with dilute sulfuric acid and record the initial burette reading
- add the acid to the flask, swirling the flask continuously
- add the acid slowly near the end-point
- record the final burette reading at the end-point

The student repeats the titration until at least two concordant results are obtained.

(a) State what is meant by concordant results.

(1)

(b) Explain two improvements to the student's method so that more accurate results are obtained.

(4)

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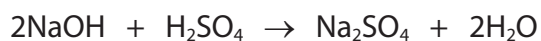


(c) The student makes the improvements and repeats the titration.

The sulfuric acid has a concentration of  $0.600 \text{ mol/dm}^3$ .

The sodium hydroxide solution has a concentration of  $1.50 \text{ mol/dm}^3$ .

This is the equation for the reaction.



Calculate the volume, in  $\text{cm}^3$ , of sulfuric acid that the student needs to completely react with  $25.0 \text{ cm}^3$  of the sodium hydroxide solution.

(3)

volume of sulfuric acid = .....  $\text{cm}^3$

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(d) The student plans to obtain pure dry crystals of hydrated sodium sulfate.

They add the calculated volume of sulfuric acid to  $25.0 \text{ cm}^3$  of the sodium hydroxide solution to form sodium sulfate solution.

Describe what the student should do to obtain pure dry crystals of hydrated sodium sulfate from the solution.

(4)

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**(Total for Question 6 = 12 marks)**





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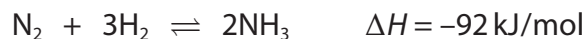
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7 In the presence of an iron catalyst, nitrogen reacts with hydrogen to form ammonia.

The reaction conditions used are a temperature of 450 °C and a pressure of 200 atmospheres.

This is the equation for the reaction.



(a) (i) State what the symbol  $\rightleftharpoons$  represents.

(1)

(ii) Give the reason for using a catalyst.

(1)

(b) (i) The reaction mixture is kept at a pressure of 200 atmospheres, but the temperature is increased to 550 °C.

Explain the effect of this change on the yield of ammonia at equilibrium.

(2)

(ii) The reaction mixture is kept at a temperature of 450 °C, but the pressure is increased to 300 atmospheres.

Explain the effect of this change on the yield of ammonia at equilibrium.

(2)

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(c) Draw an energy level diagram for the reaction between nitrogen and hydrogen.

Include the reactants, products and  $\Delta H$  in your diagram.

(3)

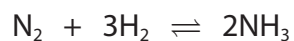
energy



QUESTION 7 CONTINUES ON NEXT PAGE



- (d) At the start of the reaction,  $48 \text{ dm}^3$  of nitrogen is added to  $120 \text{ dm}^3$  of hydrogen at rtp.



[molar volume of any gas at rtp =  $24 \text{ dm}^3$ ]

- (i) Show by calculation that the nitrogen is in excess.

(3)

- (ii) The yield of ammonia at equilibrium is 20%.

Calculate the volume, in  $\text{dm}^3$ , of ammonia formed from  $120 \text{ dm}^3$  of hydrogen.

(3)

volume of ammonia = .....  $\text{dm}^3$

(Total for Question 7 = 15 marks)

**TOTAL FOR PAPER = 70 MARKS**

