

Please check the examination details below before entering your candidate information

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

Time 1 hour 15 minutes	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">Paper reference</td> <td style="font-size: 24px; font-weight: bold; padding: 2px 5px;">4CH1/2CR</td> </tr> </table>	Paper reference	4CH1/2CR
Paper reference	4CH1/2CR		

# Chemistry

**UNIT: 4CH1**

**PAPER: 2CR**

<b>You must have:</b> Calculator, ruler	Total Marks
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### 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/



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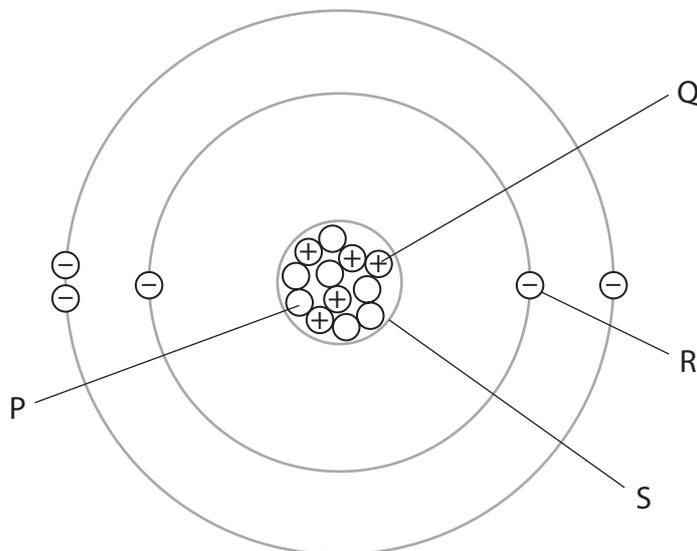
# The Periodic Table of the Elements

1	2	3	4	5	6	7	0	
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	85 <b>Rb</b> rubidium 37	133 <b>Cs</b> caesium 55	4 <b>He</b> helium 2
23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	85 <b>Rb</b> rubidium 37	133 <b>Cs</b> caesium 55	4 <b>He</b> helium 2	20 <b>Ne</b> neon 10	19 <b>F</b> fluorine 9
11 <b>B</b> boron 5	12 <b>C</b> carbon 6	14 <b>N</b> nitrogen 7	16 <b>O</b> oxygen 8	27 <b>Co</b> cobalt 27	28 <b>Si</b> silicon 14	31 <b>P</b> phosphorus 15	32 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17
13 <b>Al</b> aluminium 13	14 <b>Si</b> silicon 14	15 <b>P</b> phosphorus 15	16 <b>S</b> sulfur 16	29 <b>Cu</b> copper 29	30 <b>Zn</b> zinc 30	33 <b>As</b> arsenic 33	34 <b>Se</b> selenium 34	35 <b>Br</b> bromine 35
13 <b>Al</b> aluminium 13	14 <b>Si</b> silicon 14	15 <b>P</b> phosphorus 15	16 <b>S</b> sulfur 16	29 <b>Cu</b> copper 29	30 <b>Zn</b> zinc 30	33 <b>As</b> arsenic 33	34 <b>Se</b> selenium 34	35 <b>Br</b> bromine 35
27 <b>Co</b> cobalt 27	28 <b>Si</b> silicon 14	31 <b>P</b> phosphorus 15	32 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	36 <b>Kr</b> krypton 36	70 <b>Ga</b> gallium 31	73 <b>Ge</b> germanium 32	75 <b>As</b> arsenic 33
26 <b>Fe</b> iron 26	25 <b>Mn</b> manganese 25	24 <b>Cr</b> chromium 24	23 <b>V</b> vanadium 23	22 <b>Ti</b> titanium 22	21 <b>Sc</b> scandium 21	49 <b>In</b> indium 49	50 <b>Sn</b> tin 50	51 <b>Sb</b> antimony 51
101 <b>Ru</b> ruthenium 44	103 <b>Rh</b> rhodium 45	106 <b>Pd</b> palladium 46	108 <b>Ag</b> silver 47	112 <b>Cd</b> cadmium 48	115 <b>In</b> indium 49	122 <b>Sb</b> antimony 51	127 <b>I</b> iodine 53	128 <b>Te</b> tellurium 52
108 <b>Hs</b> hassium 108	109 <b>Mt</b> meitnerium 109	110 <b>Ds</b> darmstadtium 110	111 <b>Rg</b> roentgenium 111	112 <b>Cd</b> cadmium 48	115 <b>In</b> indium 49	122 <b>Sb</b> antimony 51	127 <b>I</b> iodine 53	128 <b>Te</b> tellurium 52
107 <b>Bh</b> bohrium 107	106 <b>Sg</b> seaborgium 106	105 <b>Db</b> dubnium 105	104 <b>Rf</b> rutherfordium 104	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
105 <b>Db</b> dubnium 105	104 <b>Rf</b> rutherfordium 104	103 <b>Mc</b> moscovium 103	102 <b>Lv</b> livermorium 102	75 <b>Re</b> rhenium 75	77 <b>Ir</b> iridium 77	78 <b>Pt</b> platinum 78	79 <b>Au</b> gold 79	80 <b>Hg</b> mercury 80
104 <b>Rf</b> rutherfordium 104	103 <b>Mc</b> moscovium 103	102 <b>Lv</b> livermorium 102	101 <b>Ru</b> ruthenium 44	186 <b>Re</b> rhenium 75	190 <b>Os</b> osmium 76	192 <b>Ir</b> iridium 77	195 <b>Pt</b> platinum 78	197 <b>Au</b> gold 79
103 <b>Mc</b> moscovium 103	102 <b>Lv</b> livermorium 102	101 <b>Ru</b> ruthenium 44	100 <b>Lr</b> livermorium 100	186 <b>Re</b> rhenium 75	190 <b>Os</b> osmium 76	192 <b>Ir</b> iridium 77	195 <b>Pt</b> platinum 78	197 <b>Au</b> gold 79
102 <b>Lv</b> livermorium 102	101 <b>Ru</b> ruthenium 44	100 <b>Lr</b> livermorium 100	99 <b>Lr</b> livermorium 99	186 <b>Re</b> rhenium 75	190 <b>Os</b> osmium 76	192 <b>Ir</b> iridium 77	195 <b>Pt</b> platinum 78	197 <b>Au</b> gold 79
101 <b>Ru</b> ruthenium 44	98 <b>Tc</b> technetium 43	96 <b>Mo</b> molybdenum 42	93 <b>Nb</b> niobium 41	91 <b>Zr</b> zirconium 40	89 <b>Y</b> yttrium 39	139 <b>La*</b> lanthanum 57	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73
98 <b>Tc</b> technetium 43	96 <b>Mo</b> molybdenum 42	93 <b>Nb</b> niobium 41	91 <b>Zr</b> zirconium 40	89 <b>Y</b> yttrium 39	139 <b>La*</b> lanthanum 57	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74
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93 <b>Nb</b> niobium 41	91 <b>Zr</b> zirconium 40	89 <b>Y</b> yttrium 39	88 <b>Sr</b> strontium 38	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
91 <b>Zr</b> zirconium 40	89 <b>Y</b> yttrium 39	88 <b>Sr</b> strontium 38	87 <b>Fr</b> francium 87	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
89 <b>Y</b> yttrium 39	88 <b>Sr</b> strontium 38	87 <b>Fr</b> francium 87	86 <b>Rn</b> radon 86	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
88 <b>Sr</b> strontium 38	87 <b>Fr</b> francium 87	86 <b>Rn</b> radon 86	85 <b>At</b> astatine 85	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
87 <b>Fr</b> francium 87	86 <b>Rn</b> radon 86	85 <b>At</b> astatine 85	84 <b>Kr</b> krypton 36	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
86 <b>Rn</b> radon 86	85 <b>At</b> astatine 85	84 <b>Kr</b> krypton 36	83 <b>Po</b> polonium 84	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
85 <b>At</b> astatine 85	84 <b>Kr</b> krypton 36	83 <b>Po</b> polonium 84	82 <b>Pb</b> lead 82	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
84 <b>Kr</b> krypton 36	83 <b>Po</b> polonium 84	82 <b>Pb</b> lead 82	81 <b>Tl</b> thallium 81	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
83 <b>Po</b> polonium 84	82 <b>Pb</b> lead 82	81 <b>Tl</b> thallium 81	80 <b>Hg</b> mercury 80	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
82 <b>Pb</b> lead 82	81 <b>Tl</b> thallium 81	80 <b>Hg</b> mercury 80	79 <b>Au</b> gold 79	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
81 <b>Tl</b> thallium 81	80 <b>Hg</b> mercury 80	79 <b>Au</b> gold 79	78 <b>Pt</b> platinum 78	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
80 <b>Hg</b> mercury 80	79 <b>Au</b> gold 79	78 <b>Pt</b> platinum 78	77 <b>Ir</b> iridium 77	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
79 <b>Au</b> gold 79	78 <b>Pt</b> platinum 78	77 <b>Ir</b> iridium 77	76 <b>Os</b> osmium 76	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
78 <b>Pt</b> platinum 78	77 <b>Ir</b> iridium 77	76 <b>Os</b> osmium 76	75 <b>Re</b> rhenium 75	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
77 <b>Ir</b> iridium 77	76 <b>Os</b> osmium 76	75 <b>Re</b> rhenium 75	74 <b>W</b> tungsten 74	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
76 <b>Os</b> osmium 76	75 <b>Re</b> rhenium 75	74 <b>W</b> tungsten 74	73 <b>Nb</b> niobium 41	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
75 <b>Re</b> rhenium 75	74 <b>W</b> tungsten 74	73 <b>Nb</b> niobium 41	72 <b>Hf</b> hafnium 72	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
74 <b>W</b> tungsten 74	73 <b>Nb</b> niobium 41	72 <b>Hf</b> hafnium 72	71 <b>Lu*</b> lutetium 71	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
73 <b>Nb</b> niobium 41	72 <b>Hf</b> hafnium 72	71 <b>Lu*</b> lutetium 71	70 <b>Ga</b> gallium 31	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
72 <b>Hf</b> hafnium 72	71 <b>Lu*</b> lutetium 71	70 <b>Ga</b> gallium 31	69 <b>Tm</b> thulium 70	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
71 <b>Lu*</b> lutetium 71	70 <b>Ga</b> gallium 31	69 <b>Tm</b> thulium 70	68 <b>Er</b> erbium 68	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
70 <b>Ga</b> gallium 31	69 <b>Tm</b> thulium 70	68 <b>Er</b> erbium 68	67 <b>Tm</b> thulium 70	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
69 <b>Tm</b> thulium 70	68 <b>Er</b> erbium 68	67 <b>Tm</b> thulium 70	66 <b>Yb</b> ytterbium 69	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
68 <b>Er</b> erbium 68	67 <b>Tm</b> thulium 70	66 <b>Yb</b> ytterbium 69	65 <b>Lu*</b> lutetium 71	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
67 <b>Tm</b> thulium 70	66 <b>Yb</b> ytterbium 69	65 <b>Lu*</b> lutetium 71	64 <b>Tm</b> thulium 70	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
66 <b>Yb</b> ytterbium 69	65 <b>Lu*</b> lutetium 71	64 <b>Tm</b> thulium 70	63 <b>Sm</b> samarium 62	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
65 <b>Lu*</b> lutetium 71	64 <b>Tm</b> thulium 70	63 <b>Sm</b> samarium 62	62 <b>Eu</b> europium 63	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
64 <b>Tm</b> thulium 70	63 <b>Sm</b> samarium 62	62 <b>Eu</b> europium 63	61 <b>Gd</b> gadolinium 64	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
63 <b>Sm</b> samarium 62	62 <b>Eu</b> europium 63	61 <b>Gd</b> gadolinium 64	60 <b>Dy</b> dysprosium 66	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
62 <b>Eu</b> europium 63	61 <b>Gd</b> gadolinium 64	60 <b>Dy</b> dysprosium 66	59 <b>Ho</b> holmium 67	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
61 <b>Gd</b> gadolinium 64	60 <b>Dy</b> dysprosium 66	59 <b>Ho</b> holmium 67	58 <b>Er</b> erbium 68	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
60 <b>Dy</b> dysprosium 66	59 <b>Ho</b> holmium 67	58 <b>Er</b> erbium 68	57 <b>Lu*</b> lutetium 71	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
59 <b>Ho</b> holmium 67	58 <b>Er</b> erbium 68	57 <b>Lu*</b> lutetium 71	56 <b>Y</b> yttrium 39	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
58 <b>Er</b> erbium 68	57 <b>Lu*</b> lutetium 71	56 <b>Y</b> yttrium 39	55 <b>Mn</b> manganese 25	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
57 <b>Lu*</b> lutetium 71	56 <b>Y</b> yttrium 39	55 <b>Mn</b> manganese 25	54 <b>Ni</b> nickel 28	137 <b>Ba</b> barium 56	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75
56 <b>Y</b> yttrium 39	55 <b>Mn</b> manganese 25	54 <b>Ni</b> nickel 28	53 <b></b>					

**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)

.....

- (b) Give the name of this element.

(1)

.....

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

.....

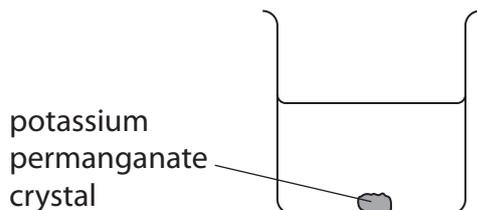
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2 A potassium permanganate crystal is placed in a beaker of water.



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)

.....

.....

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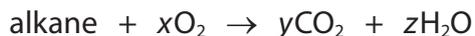
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- (c) One mole of an alkane burns completely in oxygen.

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)

.....

.....

.....

.....

(Total for Question 3 = 10 marks)

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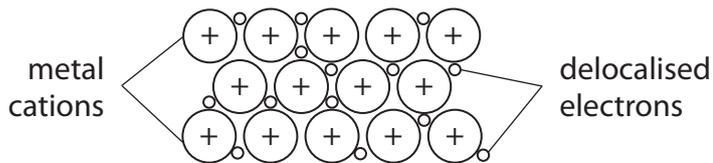


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4 (a) The diagram represents the structure of copper metal.



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

(5)

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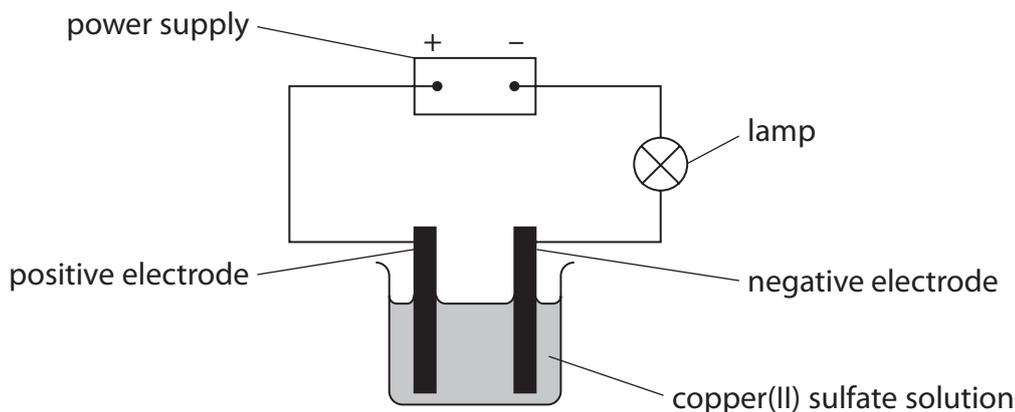
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(b) The diagram shows the electrolysis of copper(II) sulfate solution, using graphite electrodes.



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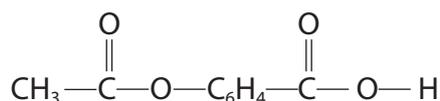
(c) Aspirin is a compound used to reduce pain.

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.

$$\text{C} = 60.00\% \quad \text{H} = 4.44\% \quad \text{O} = 35.56\%$$

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)



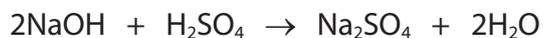


(c) The student makes the improvements and repeats the titration.

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)

(Total for Question 6 = 12 marks)

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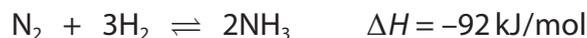
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7 In the presence of an iron catalyst, nitrogen reacts with hydrogen to form ammonia.

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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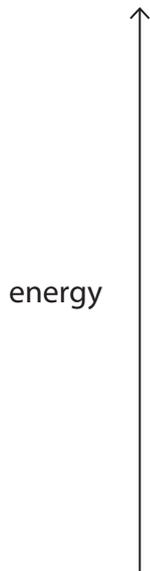
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- (c) Draw an energy level diagram for the reaction between nitrogen and hydrogen.  
Include the reactants, products and  $\Delta H$  in your diagram.

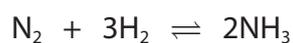
(3)



QUESTION 7 CONTINUES ON NEXT PAGE



- (d) At the start of the reaction, 48 dm<sup>3</sup> of nitrogen is added to 120 dm<sup>3</sup> of hydrogen at rtp.



[molar volume of any gas at rtp = 24 dm<sup>3</sup>]

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

(3)

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

Calculate the volume, in dm<sup>3</sup>, of ammonia formed from 120 dm<sup>3</sup> of hydrogen.

(3)

volume of ammonia = ..... dm<sup>3</sup>

**(Total for Question 7 = 15 marks)**

**TOTAL FOR PAPER = 70 MARKS**

