

Write your name here

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Centre Number

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International GCSE**

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# Chemistry

**Unit: KCH0/4CH0**

**Science (Double Award) KSC0/4SC0**

**Paper: 1C**

Thursday 19 May 2016 – Morning

**Time: 2 hours**

Paper Reference

**KCH0/1C 4CH0/1C  
KSC0/1C 4SC0/1C**

**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.
- 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 ☒.

## Information

- The total mark for this paper is 120.
- 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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**PEARSON**

# THE PERIODIC TABLE

Period 1 2 3 4 5 6 7 0

Group

1	1	2	3	4	5	6	7	0																																																																																																																																																																																																														
1	7 Li Lithium 3	8 Be Beryllium 4	9 B Boron 5	10 C Carbon 6	11 N Nitrogen 7	12 O Oxygen 8	13 F Fluorine 9	14 Ne Neon 10	15 He Helium 2																																																																																																																																																																																																													
2	19 K Potassium 19	20 Ca Calcium 20	21 Sc Scandium 21	22 Ti Titanium 22	23 V Vanadium 23	24 Cr Chromium 24	25 Mn Manganese 25	26 Fe Iron 26	27 Co Cobalt 27	28 Ni Nickel 28	29 Cu Copper 29	30 Zn Zinc 30	31 Ga Gallium 31	32 Ge Germanium 32	33 As Arsenic 33	34 Se Selenium 34	35 Br Bromine 35	36 Kr Krypton 36																																																																																																																																																																																																				
3	39 Y Yttrium 39	40 Zr Zirconium 40	41 Nb Niobium 41	42 Mo Molybdenum 42	43 Tc Technetium 43	44 Ru Ruthenium 44	45 Rh Rhodium 45	46 Pd Palladium 46	47 Ag Silver 47	48 Cd Cadmium 48	49 In Indium 49	50 Sn Tin 50	51 Sb Antimony 51	52 Te Tellurium 52	53 I Iodine 53	54 Xe Xenon 54	55 Ba Barium 56	56 La Lanthanum 57	57 Ce Cerium 58	58 Pr Praseodymium 59	59 Nd Neodymium 60	60 Pm Promethium 61	61 Sm Samarium 62	62 Eu Europium 63	63 Gd Gadolinium 64	64 Tb Terbium 65	65 Dy Dysprosium 66	66 Ho Holmium 67	67 Er Erbium 68	68 Tm Thulium 69	69 Yb Ytterbium 70	70 Lu Lutetium 71	71 Hf Hafnium 72	72 Ta Tantalum 73	73 W Tungsten 74	74 Re Rhenium 75	75 Os Osmium 76	76 Ir Iridium 77	77 Pt Platinum 78	78 Au Gold 79	79 Hg Mercury 80	80 Tl Thallium 81	81 Pb Lead 82	82 Bi Bismuth 83	83 Po Polonium 84	84 At Astatine 85	85 Rn Radon 86																																																																																																																																																																							
4	87 Fr Francium 87	88 Ra Radium 88	89 Ac Actinium 89	90 Th Thorium 90	91 Pa Protactinium 91	92 U Uranium 92	93 Np Neptunium 93	94 Pu Plutonium 94	95 Am Americium 95	96 Cm Curium 96	97 Bk Berkelium 97	98 Cf Californium 98	99 Es Einsteinium 99	100 Fm Fermium 100	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103	104 Rf Rutherfordium 104	105 Db Dubnium 105	106 Sg Seaborgium 106	107 Bh Bohrium 107	108 Hs Hassium 108	109 Mt Meitnerium 109	110 Ds Darmstadtium 110	111 Rg Roentgenium 111	112 Cn Copernicium 112	113 Nh Nihonium 113	114 Fl Flerovium 114	115 Mc Moscovium 115	116 Lv Livermorium 116	117 Ts Tennessine 117	118 Og Oganesson 118	119 Uu Ununennium 119	120 Uub Unbibium 120	121 Uut Untrium 121	122 Uuq Unquadrium 122	123 Uup Unpentium 123	124 Uuq Unsexium 124	125 Uuh Unheptium 125	126 Uuo Unoctium 126	127 Uuq Unnonium 127	128 Uub Undecium 128	129 Uut Undecium 129	130 Uuq Untridecium 130	131 Uup Unquadecium 131	132 Uuh Unpentecium 132	133 Uuo Unsextecium 133	134 Uuh Unseptecium 134	135 Uuo Unoctecium 135	136 Uuh Unnonecium 136	137 Uuo Unquadecium 137	138 Uuh Unpentecium 138	139 Uuo Unsextecium 139	140 Uuh Unseptecium 140	141 Uuo Unoctecium 141	142 Uuh Unnonecium 142	143 Uuo Unquadecium 143	144 Uuh Unpentecium 144	145 Uuo Unsextecium 145	146 Uuh Unseptecium 146	147 Uuo Unoctecium 147	148 Uuh Unnonecium 148	149 Uuo Unquadecium 149	150 Uuh Unpentecium 150	151 Uuo Unsextecium 151	152 Uuh Unseptecium 152	153 Uuo Unoctecium 153	154 Uuh Unnonecium 154	155 Uuo Unquadecium 155	156 Uuh Unpentecium 156	157 Uuo Unsextecium 157	158 Uuh Unseptecium 158	159 Uuo Unoctecium 159	160 Uuh Unnonecium 160	161 Uuo Unquadecium 161	162 Uuh Unpentecium 162	163 Uuo Unsextecium 163	164 Uuh Unseptecium 164	165 Uuo Unoctecium 165	166 Uuh Unnonecium 166	167 Uuo Unquadecium 167	168 Uuh Unpentecium 168	169 Uuo Unsextecium 169	170 Uuh Unseptecium 170	171 Uuo Unoctecium 171	172 Uuh Unnonecium 172	173 Uuo Unquadecium 173	174 Uuh Unpentecium 174	175 Uuo Unsextecium 175	176 Uuh Unseptecium 176	177 Uuo Unoctecium 177	178 Uuh Unnonecium 178	179 Uuo Unquadecium 179	180 Uuh Unpentecium 180	181 Uuo Unsextecium 181	182 Uuh Unseptecium 182	183 Uuo Unoctecium 183	184 Uuh Unnonecium 184	185 Uuo Unquadecium 185	186 Uuh Unpentecium 186	187 Uuo Unsextecium 187	188 Uuh Unseptecium 188	189 Uuo Unoctecium 189	190 Uuh Unnonecium 190	191 Uuo Unquadecium 191	192 Uuh Unpentecium 192	193 Uuo Unsextecium 193	194 Uuh Unseptecium 194	195 Uuo Unoctecium 195	196 Uuh Unnonecium 196	197 Uuo Unquadecium 197	198 Uuh Unpentecium 198	199 Uuo Unsextecium 199	200 Uuh Unseptecium 200	201 Uuo Unoctecium 201	202 Uuh Unnonecium 202	203 Uuo Unquadecium 203	204 Uuh Unpentecium 204	205 Uuo Unsextecium 205	206 Uuh Unseptecium 206	207 Uuo Unoctecium 207	208 Uuh Unnonecium 208	209 Uuo Unquadecium 209	210 Uuh Unpentecium 210	211 Uuo Unsextecium 211	212 Uuh Unseptecium 212	213 Uuo Unoctecium 213	214 Uuh Unnonecium 214	215 Uuo Unquadecium 215	216 Uuh Unpentecium 216	217 Uuo Unsextecium 217	218 Uuh Unseptecium 218	219 Uuo Unoctecium 219	220 Uuh Unnonecium 220	221 Uuo Unquadecium 221	222 Uuh Unpentecium 222	223 Uuo Unsextecium 223	224 Uuh Unseptecium 224	225 Uuo Unoctecium 225	226 Uuh Unnonecium 226	227 Uuo Unquadecium 227	228 Uuh Unpentecium 228	229 Uuo Unsextecium 229	230 Uuh Unseptecium 230	231 Uuo Unoctecium 231	232 Uuh Unnonecium 232	233 Uuo Unquadecium 233	234 Uuh Unpentecium 234	235 Uuo Unsextecium 235	236 Uuh Unseptecium 236	237 Uuo Unoctecium 237	238 Uuh Unnonecium 238	239 Uuo Unquadecium 239	240 Uuh Unpentecium 240	241 Uuo Unsextecium 241	242 Uuh Unseptecium 242	243 Uuo Unoctecium 243	244 Uuh Unnonecium 244	245 Uuo Unquadecium 245	246 Uuh Unpentecium 246	247 Uuo Unsextecium 247	248 Uuh Unseptecium 248	249 Uuo Unoctecium 249	250 Uuh Unnonecium 250	251 Uuo Unquadecium 251	252 Uuh Unpentecium 252	253 Uuo Unsextecium 253	254 Uuh Unseptecium 254	255 Uuo Unoctecium 255	256 Uuh Unnonecium 256	257 Uuo Unquadecium 257	258 Uuh Unpentecium 258	259 Uuo Unsextecium 259	260 Uuh Unseptecium 260	261 Uuo Unoctecium 261	262 Uuh Unnonecium 262	263 Uuo Unquadecium 263	264 Uuh Unpentecium 264	265 Uuo Unsextecium 265	266 Uuh Unseptecium 266	267 Uuo Unoctecium 267	268 Uuh Unnonecium 268	269 Uuo Unquadecium 269	270 Uuh Unpentecium 270	271 Uuo Unsextecium 271	272 Uuh Unseptecium 272	273 Uuo Unoctecium 273	274 Uuh Unnonecium 274	275 Uuo Unquadecium 275	276 Uuh Unpentecium 276	277 Uuo Unsextecium 277	278 Uuh Unseptecium 278	279 Uuo Unoctecium 279	280 Uuh Unnonecium 280	281 Uuo Unquadecium 281	282 Uuh Unpentecium 282	283 Uuo Unsextecium 283	284 Uuh Unseptecium 284	285 Uuo Unoctecium 285	286 Uuh Unnonecium 286	287 Uuo Unquadecium 287	288 Uuh Unpentecium 288	289 Uuo Unsextecium 289	290 Uuh Unseptecium 290	291 Uuo Unoctecium 291	292 Uuh Unnonecium 292	293 Uuo Unquadecium 293	294 Uuh Unpentecium 294	295 Uuo Unsextecium 295	296 Uuh Unseptecium 296	297 Uuo Unoctecium 297	298 Uuh Unnonecium 298	299 Uuo Unquadecium 299	300 Uuh Unpentecium 300

Key

Relative atomic mass
Symbol
Name
Atomic number

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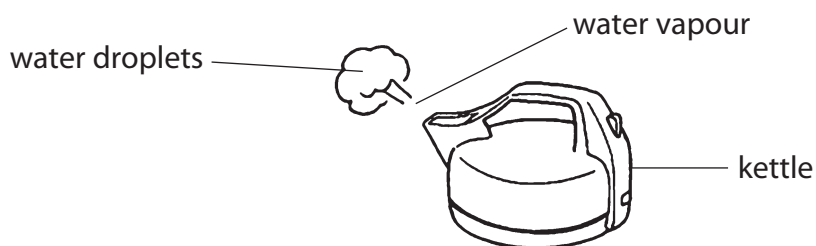
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**Answer ALL questions.**

**1** The diagram shows a kettle of boiling water.



As the water vapour cools it turns into droplets of liquid water.

(a) The change of state when water vapour changes into liquid water is described as (1)

- A** boiling
- B** condensation
- C** evaporation
- D** sublimation

(b) Describe what happens when water vapour cools to form liquid water.

Your answer should include the change in the energy, arrangement and movement of the particles.

(3)

change in energy .....

.....

change in arrangement .....

.....

change in movement .....

.....

.....

**(Total for Question 1 = 4 marks)**



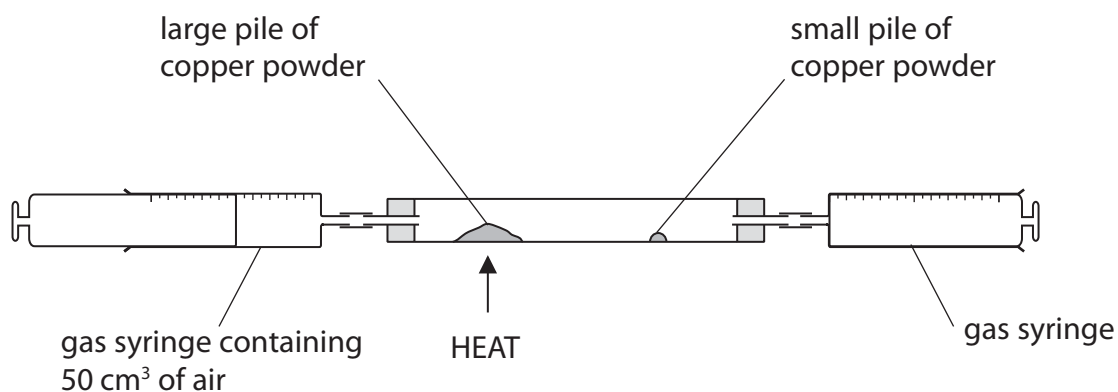
2 Air is a mixture of gases.  
The two main gases present are the elements nitrogen and oxygen.

(a) Another element that is present in air is (1)

- A argon
- B carbon dioxide
- C hydrogen
- D sulfur dioxide

(b) Give the formula of a compound that is found in unpolluted air. (1)

(c) This apparatus in the diagram is used to find the percentage of oxygen in air.



The large pile of copper powder is heated, and the air in the syringe is passed several times from one gas syringe to the other.

The large pile of copper powder turns black. The remaining gas is allowed to cool and its volume is measured.

(i) Explain why the large pile of copper turns black. (2)



(ii) Why is the gas allowed to cool before its volume is measured?

(1)

(iii) The small pile of copper powder is then heated and the remaining gas is passed several times over the hot copper. The copper does not turn black.

Suggest why the small pile of copper does not turn black.

(1)

(d) In another experiment, the total volume of air in the apparatus before heating is  $150 \text{ cm}^3$ . At the end of the experiment the volume of gas remaining is  $125 \text{ cm}^3$ .

Use this information to calculate the percentage of oxygen in this sample of air.

(2)

percentage of oxygen = .....%

**(Total for Question 2 = 8 marks)**

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3 A student wants to find out if the green colouring in grass is a mixture of dyes.

He uses a solvent to dissolve the green colouring from some grass.

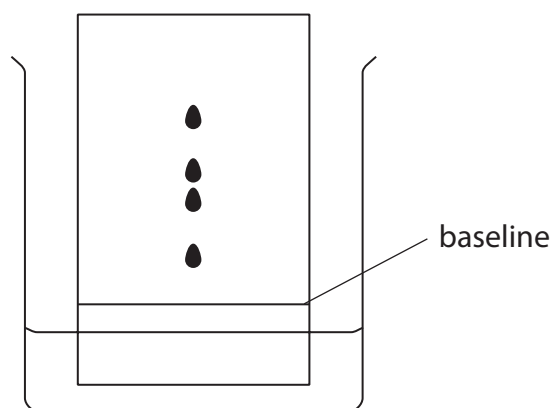
He then separates the solution of the green colouring from the remaining grass.

(a) Which of these methods is used to separate the solution of the green colouring from the remaining grass?

(1)

- A boiling
- B condensation
- C evaporation
- D filtration

(b) The student uses a dropping pipette to place a drop of the green solution onto a piece of chromatography paper and produces a chromatogram. The diagram shows his results.



(i) Add three more labels to the diagram to show

- the solvent
- the chromatography paper
- the original position of the spot of the green solution

(3)

(ii) Explain how many different dyes are present in the green colouring.

(1)

.....

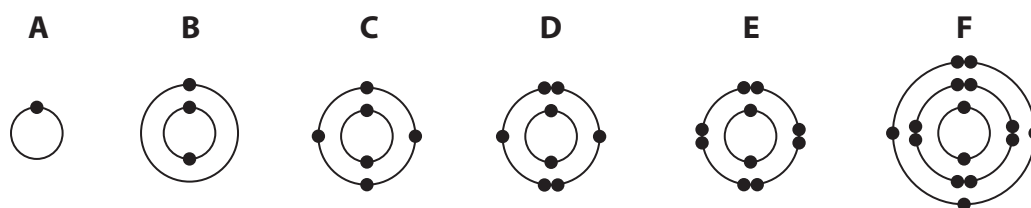
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**(Total for Question 3 = 5 marks)**



4 The diagram shows the electronic configurations of six different atoms.



(a) You may use the Periodic Table on page 2 to help you answer this question. Answer each part by writing one of the letters A, B, C, D, E or F in the box provided.

You may use each letter once, more than once or not at all.

Give the letter that represents an atom

(6)

(i) of a noble gas

(ii) that contains three protons

(iii) of phosphorus

(iv) of an element in Group 4 of the Periodic Table

(v) of an element in Period 3 of the Periodic Table

(vi) with a full outer shell of electrons

(b) Atoms of A and D combine to form a compound containing covalent bonds.

(i) Complete the sentence to describe a covalent bond.

(2)

A covalent bond is the electrostatic attraction between a pair of .....

and the ..... of two atoms.

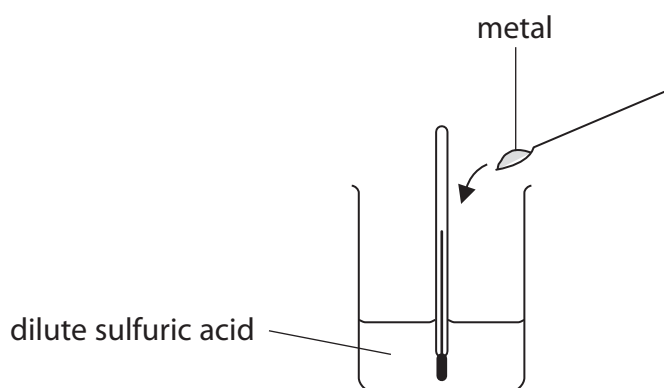
(ii) Suggest, with reference to electronic configurations, the most likely formula of the compound formed between atoms of A and D.

(1)

(Total for Question 4 = 9 marks)



- 5 A student uses this apparatus to investigate the temperature changes that take place when certain metals are added to dilute sulfuric acid.



This is the student's method:

- use the five metals aluminium, copper, iron, magnesium and zinc
  - add the same amount of each metal separately to 25 cm<sup>3</sup> of acid
  - in each case the acid is in excess
  - stir the mixture and record the highest temperature reached
- (a) Use the diagrams of the thermometer in the table to record the highest temperature reached in each experiment.

Record all temperatures to the nearest 0.5 °C.

(3)

	Metal				
	aluminium	copper	iron	magnesium	zinc
Thermometer					
Highest temperature in °C					





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(b) (i) In each experiment the initial temperature of the acid is 25 °C.

Which metal produces the largest temperature rise?

(1)

(ii) Explain the result obtained with copper.

(1)

(c) The same amount of magnesium is added to 50cm<sup>3</sup> of dilute sulfuric acid.

Explain the effect this would have on the temperature change observed.

(2)

**(Total for Question 5 = 7 marks)**



6 This question is about hydrogen ( $\text{H}_2$ ) and water.

(a) Hydrogen is a gas at room temperature. It exists as simple molecules.

(i) Draw a dot and cross diagram to show the arrangement of the electrons in a hydrogen molecule.

(1)

(ii) Explain why hydrogen has a very low boiling point.

(2)

.....

.....

.....

.....

(b) The symbols for the three isotopes of hydrogen are



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

(2)

.....

.....

.....

.....

(ii) Complete the table to show the number of protons, neutrons and electrons in each of the three isotopes of hydrogen.

(3)

	Isotope		
	${}^1\text{H}$	${}^2\text{H}$	${}^3\text{H}$
number of protons			
number of neutrons			
number of electrons			



(c) When hydrogen burns in oxygen, heat energy is transferred to the surroundings.

(i) State the name given to a reaction in which heat energy is transferred to the surroundings.

(1)

(ii) Write a chemical equation to represent the reaction that takes place when hydrogen burns in oxygen.

(2)

(iii) Describe a chemical test to show that the product is water.

(2)

(iv) Describe a physical test to show that the product is pure water.

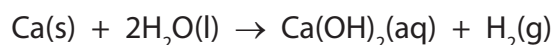
(2)

**(Total for Question 6 = 15 marks)**



7 This question is about the reactions of calcium and some calcium compounds.

(a) Calcium reacts with cold water. The equation for the reaction is



(i) State two observations that are made when calcium reacts with water.

(2)

1 .....

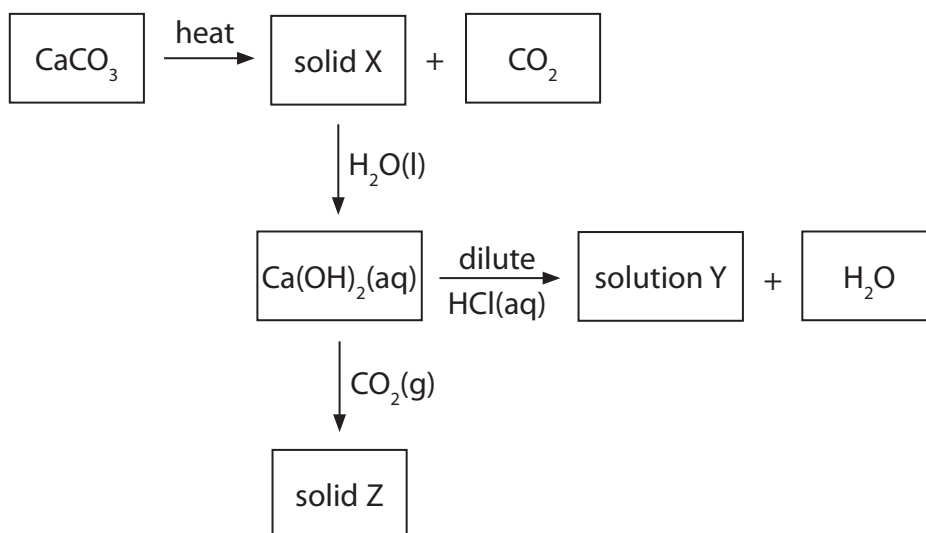
2 .....

(ii) Explain a possible value for the pH of the solution formed.

(2)

(b) The diagram shows some reactions involving calcium compounds.

Identify solid X, solution Y and solid Z.



(3)

solid X .....

solution Y .....

solid Z .....

(Total for Question 7 = 7 marks)



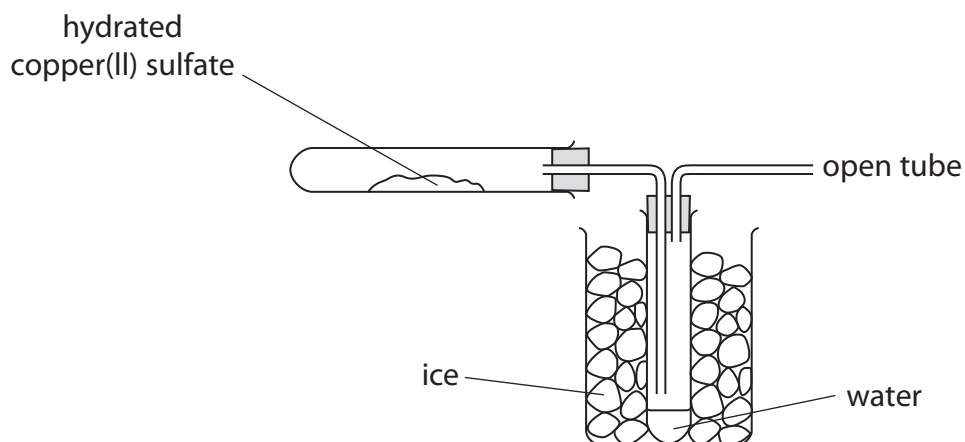
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8 The apparatus in the diagram is used to heat a sample of hydrated copper(II) sulfate crystals,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

The equation for the reaction that takes place is



(a) Draw an arrow on the diagram to show where heat is applied. (1)

(b) What is the purpose of the ice? (1)

(c) Calculate the maximum mass of water that could be collected when a sample of hydrated copper(II) sulfate of mass 2.50 g is heated. [ $M_r$  of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is 250] (3)

mass of water = ..... g

**(Total for Question 8 = 5 marks)**



- 9 A student investigates the reaction of aqueous sodium hydroxide with two different aqueous solutions of hydrochloric acid, solution X and solution Y.

She carries out two experiments.

*Experiment 1*

- Using a measuring cylinder, she pours  $20 \text{ cm}^3$  of aqueous sodium hydroxide into a conical flask and records its temperature.
- Using a burette, she adds  $5 \text{ cm}^3$  of solution X to the conical flask.
- She stirs the mixture with the thermometer and records the temperature.
- She adds further  $5 \text{ cm}^3$  volumes of solution X and stirs with the thermometer.
- She records the temperature after each addition of solution X.
- She stops when a total of  $40 \text{ cm}^3$  of solution X has been added.

*Experiment 2*

- She empties the burette and rinses it first with water and then with solution Y. She then fills the burette with solution Y.
- She repeats the experiment using solution Y.

The table shows the results she obtains in Experiment 1.

Experiment 1 – Solution X	
Volume in $\text{cm}^3$ of solution X added	Temperature in $^\circ\text{C}$
0	23.0
5	27.0
10	31.0
15	32.2
20	30.6
25	28.9
30	27.3
35	25.6
40	24.0



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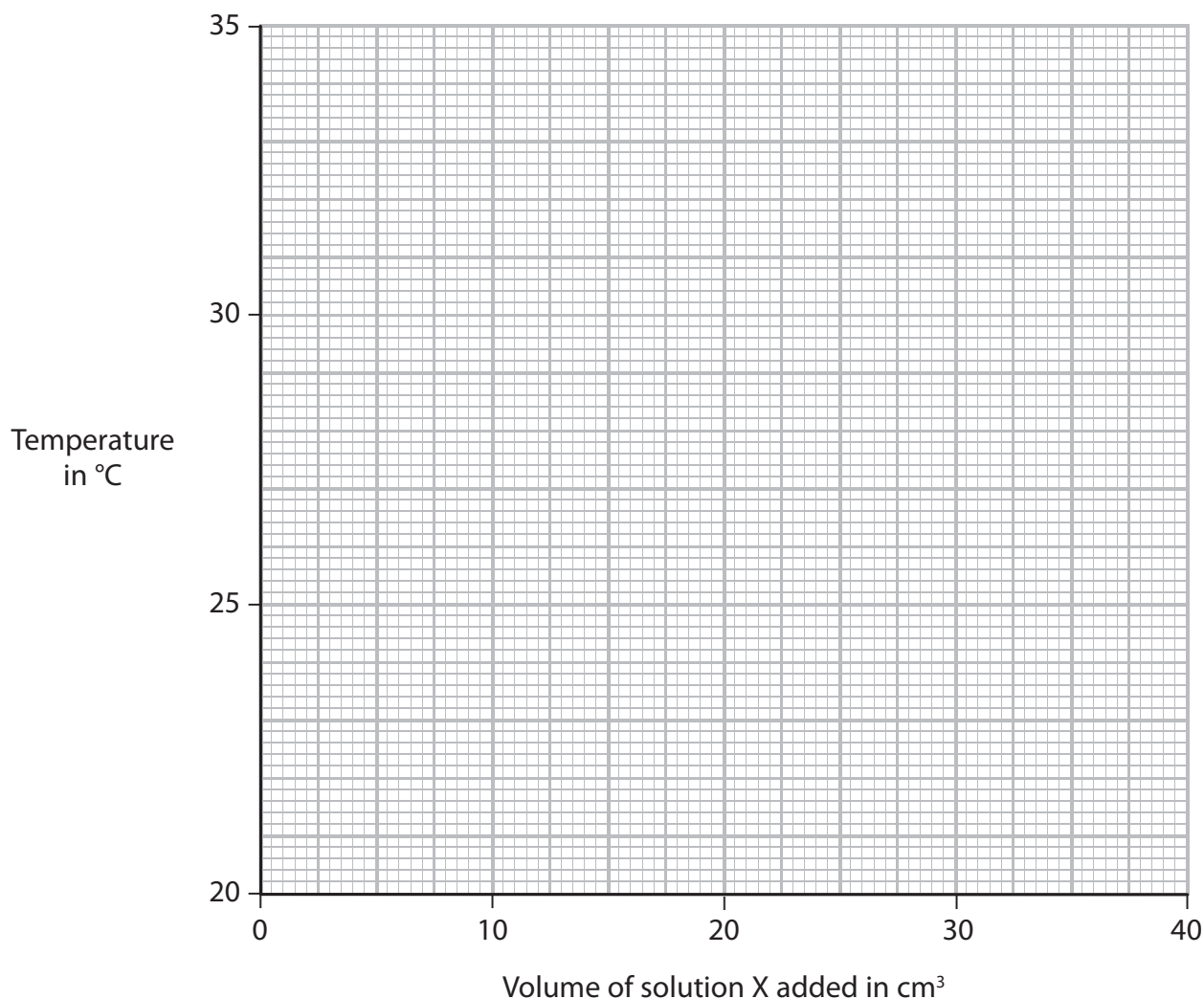
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- (a) Plot the results for Experiment 1 on the grid.  
Draw a straight line of best fit through the first three points and a second straight line of best fit through the last six points.

Make sure that the two straight lines cross.

(4)



- (b) (i) Use the graph to determine the volume of solution X that will produce the maximum temperature rise when added to 20 cm<sup>3</sup> of the aqueous sodium hydroxide.

(1)

volume of solution X = ..... cm<sup>3</sup>

- (ii) Use the graph to determine the maximum temperature rise.

(1)

maximum temperature rise = ..... °C



P 4 5 7 2 8 A 0 1 5 2 8

(c) Why did the student rinse the burette first with water, and then with solution Y, before performing Experiment 2?

(2)

water .....

.....

solution Y .....

.....

(d) The maximum temperature rise in Experiment 2 was less than that in Experiment 1. Suggest a reason why.

(1)

.....

.....

.....

**(Total for Question 9 = 9 marks)**





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10 This question is about hydrochloric acid.

(a) Dilute hydrochloric acid,  $\text{HCl}(\text{aq})$ , reacts with many metals.

A student observes the reaction of dilute hydrochloric acid with four metals, P, Q, R and S. She uses the same amount of metal in each case.

The table shows her observations.

Metal	Observations
P	very few bubbles produced very slowly
Q	many bubbles produced very quickly
R	many bubbles produced quickly
S	few bubbles produced slowly

(i) Use the information in the table to place the four metals in order of reactivity.

Place the most reactive first.

(2)

most reactive

least reactive

(ii) Give the names of the two products formed when magnesium reacts with dilute hydrochloric acid.

(2)

Product 1 .....

Product 2 .....

(b) Describe a test to show that dilute hydrochloric acid contains chloride ions.

(2)

.....

.....

.....

.....

**(Total for Question 10 = 6 marks)**



11 The table shows the displayed formulae of four hydrocarbons, W, X, Y and Z.

<b>W</b>	<b>X</b>
<pre>       H   H   H                     H-C-C-C-H                       H   H   H           </pre>	<pre>       H   H   H   H                         H-C-C-C-C-H                           H   H   H   H           </pre>
<b>Y</b>	<b>Z</b>
<pre>           H                     H-C-H                       H   H                         H-C-C-C-H                               H   H   H           </pre>	<pre>           H   H            \ /             C            / \         H   C   H          \ / \ /           C=C          / \ \ /         H   H   H           </pre>

(a) Give the name of hydrocarbon W. (1)

(b) Give the molecular formula for hydrocarbon X. (1)

(c) Which of the hydrocarbons belong to the same homologous series of compounds? (1)

(d) Give the empirical formula of hydrocarbon Z. (1)

(e) Z is an unsaturated hydrocarbon.  
Explain what is meant by the term **unsaturated hydrocarbon**. (3)

unsaturated .....

hydrocarbon .....



- (f) (i) The substitution reaction between W and bromine is similar to the reaction between methane and bromine.

Suggest the displayed formula for a possible product of the reaction between W and bromine.

(1)

- (ii) State the condition required for this reaction to take place.

(1)

**(Total for Question 11 = 9 marks)**

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12 Titanium is a metal that can be extracted from its ore in a three-stage process.

- stage 1 titanium ore is converted into titanium dioxide,  $\text{TiO}_2$
- stage 2 titanium dioxide is then converted into titanium chloride,  $\text{TiCl}_4$
- stage 3 titanium chloride is converted into titanium, Ti

(a) A titanium ore contains the composition by mass

$$\text{Fe} = 36.8\% \quad \text{Ti} = 31.6\% \quad \text{O} = 31.6\%$$

Show by calculation that the empirical formula of this ore is  $\text{FeTiO}_3$

(3)

(b) The equation for the conversion of titanium dioxide into titanium chloride is



Explain which element has been oxidised in this reaction.

(2)

.....

.....

.....

.....



(c) In stage 3

- titanium chloride vapour is passed through molten magnesium in an atmosphere of argon
- the products are allowed to cool to form a solid mixture of titanium and magnesium chloride
- this mixture is crushed into a powder and then added to water to dissolve the magnesium chloride

(i) Write a chemical equation for the reaction between titanium chloride and magnesium.

(2)

(ii) Suggest why this reaction cannot be successfully carried out in an atmosphere of air.

(1)

(iii) Suggest why the mixture is crushed into a powder before it is added to water.

(1)

(d) (i) Describe the bonding in titanium metal.

(2)

(ii) Explain why titanium conducts electricity.

(1)

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

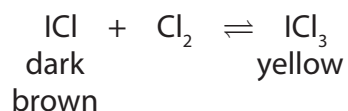


**13** Iodine reacts with chlorine to form iodine monochloride, ICl

(a) Write a chemical equation for this reaction.

(1)

(b) Iodine monochloride reacts reversibly with chlorine to form iodine trichloride.



The reaction mixture is allowed to reach a state of dynamic equilibrium.

(i) One feature of a reaction that is in dynamic equilibrium is that both the forward reaction and the backward reaction occur simultaneously.

Give two other features of a reaction that is in dynamic equilibrium.

(2)

1 .....

.....

2 .....

.....

(ii) When the equilibrium mixture is heated, it becomes darker brown in colour.

Explain whether the backward reaction is exothermic or endothermic.

(2)

.....

.....

.....

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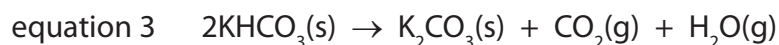
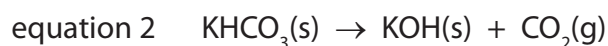
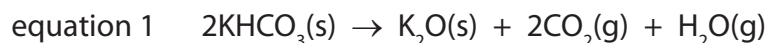
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**(Total for Question 13 = 5 marks)**



14 Potassium hydrogencarbonate ( $\text{KHCO}_3$ ) decomposes on heating.

Three possible equations for the decomposition are



When 8.00 g of potassium hydrogencarbonate is heated until it is fully decomposed, 5.52 g of solid is formed.

(a) Complete the table by calculating the amount, in moles, of each solid.

(2)

Solid	$M_r$ of solid	Mass of solid in g	Amount of solid in mol
$\text{KHCO}_3$	100	8.00	
$\text{K}_2\text{O}$	94	5.52	
KOH	56	5.52	
$\text{K}_2\text{CO}_3$	138	5.52	

(b) Use the information in the table to explain which equation, 1, 2 or 3, represents the decomposition of potassium hydrogencarbonate.

(2)

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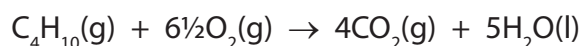
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(Total for Question 14 = 4 marks)

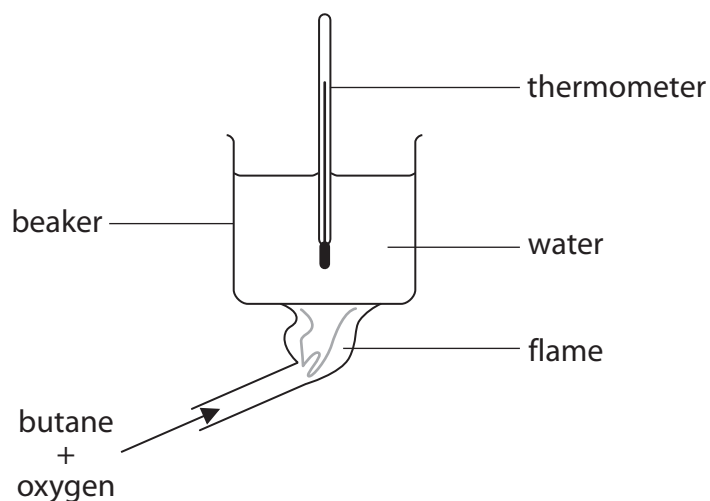


15 Butane ( $C_4H_{10}$ ) is a gas at room temperature and pressure.

The equation for the complete combustion of butane is



Butane is used in an experiment to determine its  $\Delta H$  of combustion.



(a) State what the symbol  $\Delta H$  represents.

(1)

(b) The table shows the results of the experiment.

mass of water heated	200 g
mass of butane burned	0.725 g
initial temperature of water	20.2 °C
final temperature of water	43.7 °C

Use this equation to calculate the heat produced when 0.725 g of butane is burned in this experiment.

$$\text{heat produced (in J)} = \text{mass of water (in g)} \times 4.2 \times \text{temperature rise of water (in } ^\circ\text{C)}$$

(3)

heat produced = ..... J





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(c) A student uses the value from part (b) to calculate  $\Delta H$  for the combustion of butane. He calculates it as  $-1580 \text{ kJ/mol}$ . He has not made a mistake in his calculation. A data book value is  $-2887 \text{ kJ/mol}$ .

(i) What is the significance of the negative sign for  $\Delta H$ ? (1)

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(ii) The student notices that at the end of the experiment the bottom of the beaker is covered in black soot (carbon). Suggest how this soot is formed. (1)

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(iii) Explain how the formation of the soot may account for the difference between the value of  $\Delta H$  from the experiment and the value of  $\Delta H$  in the data book. (1)

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(iv) Suggest one other reason why the two  $\Delta H$  values are different. (1)

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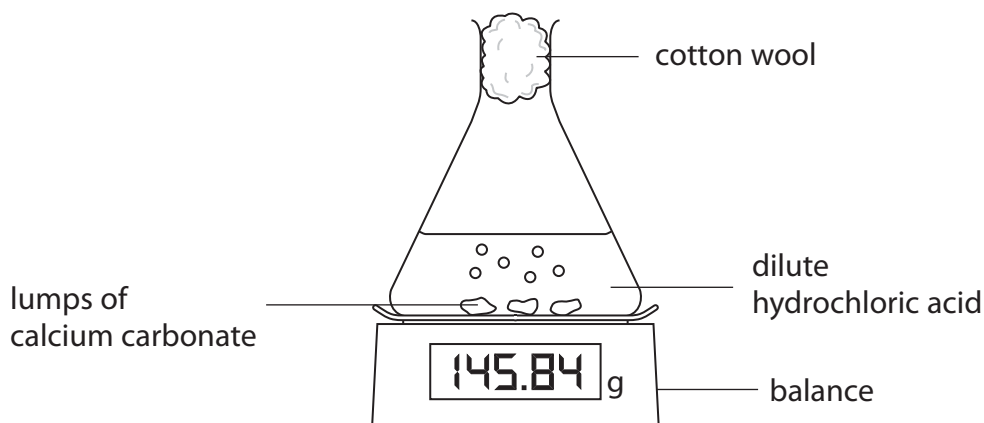
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**(Total for Question 15 = 8 marks)**

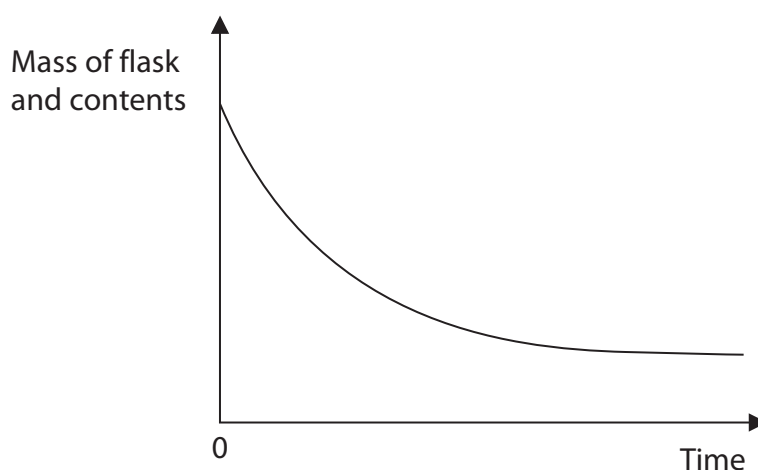


16 The diagram shows the apparatus used to investigate the rate of reaction between calcium carbonate and an excess of dilute hydrochloric acid.



The mass of the flask and contents is measured at regular time intervals.

The graph shows the results obtained.



(a) What is the purpose of the cotton wool in the neck of the flask? (1)

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(b) Explain why the mass of the flask and contents decreases with time. (1)

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(c) (i) The experiment is repeated using

- the same mass of identical calcium carbonate lumps
- the same volume of hydrochloric acid but of a higher concentration

Sketch on the graph the curve that would be produced.

(2)

(ii) Explain, using the particle collision theory, how the rate of reaction changes with an increase in concentration of hydrochloric acid.

(3)

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**(Total for Question 16 = 7 marks)**

**TOTAL FOR PAPER = 120 MARKS**



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