Candidate Name	Centre Number					Candidate Number				

GCSE CHEMISTRY

COMPONENT 1

Concepts in Chemistry

FOUNDATION TIER

SAMPLE PAPER

(2 hours 15 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1	**9**	
2	**15**	
3	**11**	
4	**7**	
5	**12**	
6	**11**	
7	**8**	
8	**9**	
9	**8**	
10	**12**	
11	**10**	
12	**8**	
Total	**120**	

ADDITIONAL MATERIALS

In addition to this examination paper you will need:
- a calculator
- a ruler

INSTRUCTIONS TO CANDIDATES

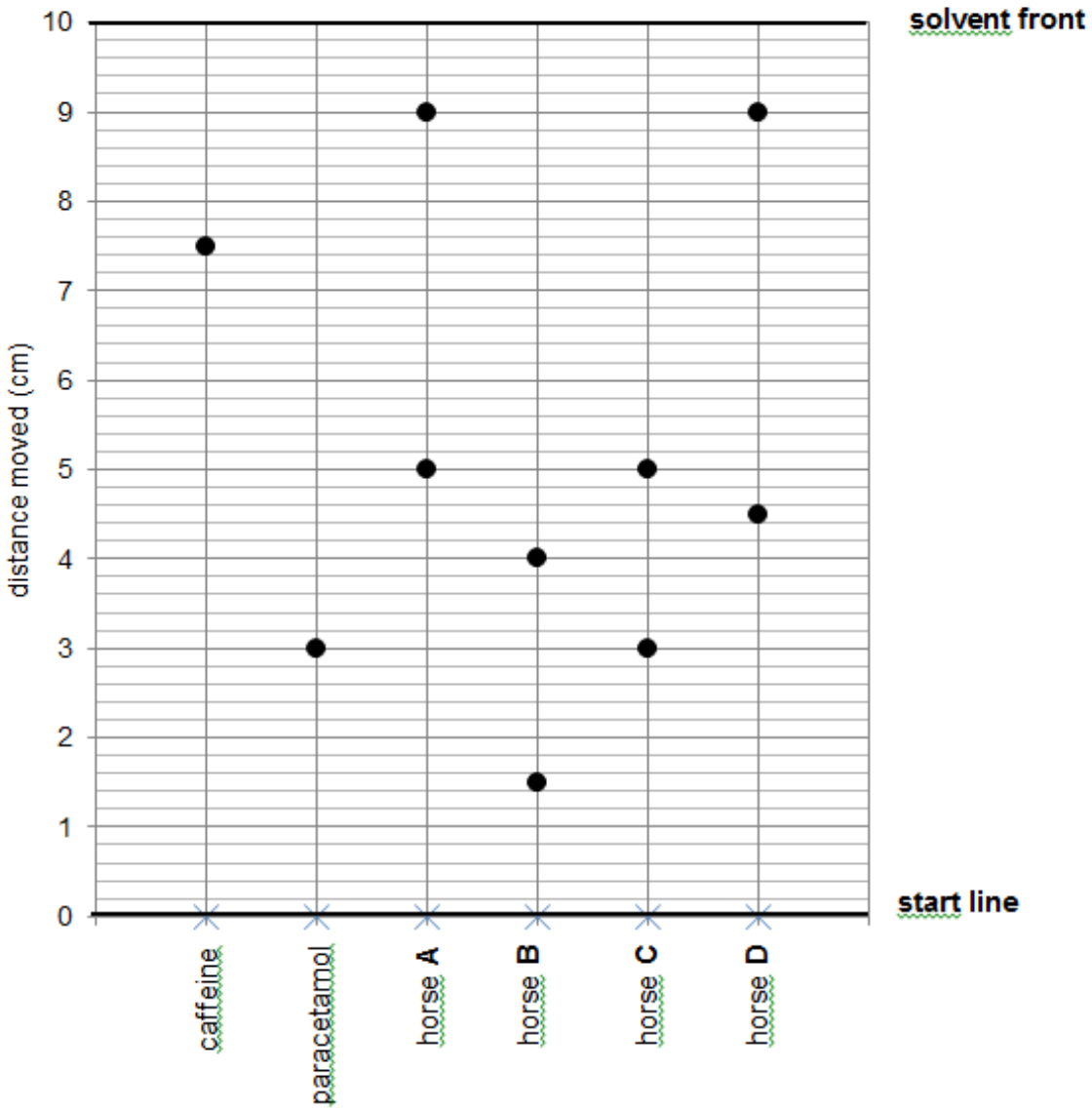
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **9**.

Answer **all** *questions*.

1. (a) Chromatography can be used to test if racehorses have been given drugs. Urine samples from four horses, **A–D**, were tested to find out whether they contained caffeine or paracetamol.
The following diagram shows the results obtained.



(i) Give the letter of the horse, **A**, **B**, **C** or **D**, that had been given paracetamol. [1]

……

(ii) Explain how the results show that none of the horses had been given caffeine. [1]

.....

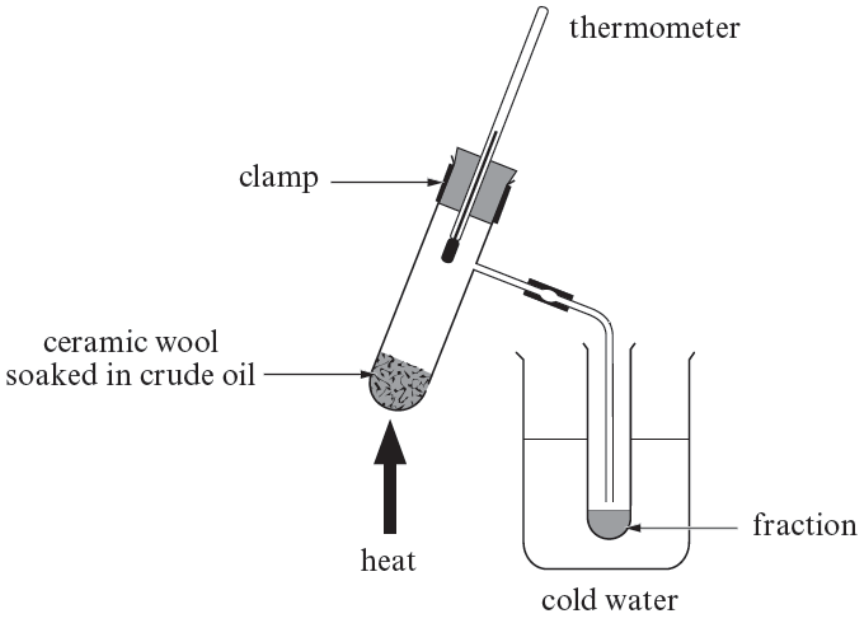
.....

(iii) The R_f value can be used to identify a substance. Use the following equation to calculate the R_f value of paracetamol. [2]

$$R_f = \frac{\text{distance moved by paracetamol}}{\text{distance moved by solvent}}$$

R_f = ……..

(b) The diagram below shows the laboratory apparatus used to separate crude oil into four fractions.



The table below shows properties of the four fractions collected.

Fraction	Boiling point range (°C)	Colour of fraction	Viscosity (how runny) at 20 °C	How it burns
1	20-100	colourless	runny	very easily with a clean flame
2	100-150	pale yellow	fairly runny	easily with a clean flame
3	150-200	yellow	quite thick	quite easily with a yellow flame and some smoke
4	200-250	dark yellow	thick	hard to burn and a very smoky flame

Use the information in the table to answer parts (i) and (ii).

(i) Give the number (**1**, **2**, **3** or **4**) of the fraction: [4]

I which is darkest in colour …….

II which is easiest to burn …….

III which is easiest to pour …….

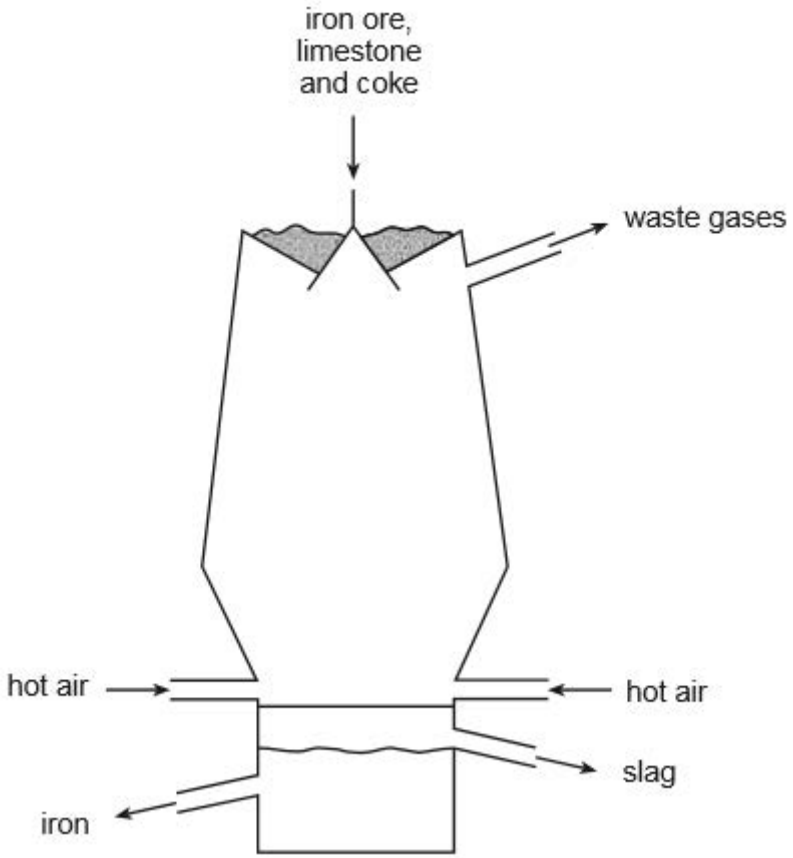
IV with the biggest boiling range ……..…

(ii) **Underline** the process industry uses to obtain fractions from crude oil. [1]

neutralisation **polymerisation** **cracking** **fractional distillation**

9

2. (a) Iron is extracted in the blast furnace. Iron ore, limestone, coke and hot air are the raw materials.



(i) Draw a line to link the raw material to its use in the blast furnace. [3]

Raw material	**Use**
iron ore	source of iron
limestone	act as a fuel
coke	remove impurities
hot air	source of oxygen

(ii) The symbol equation below shows one of the main reactions occurring in the furnace.

$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

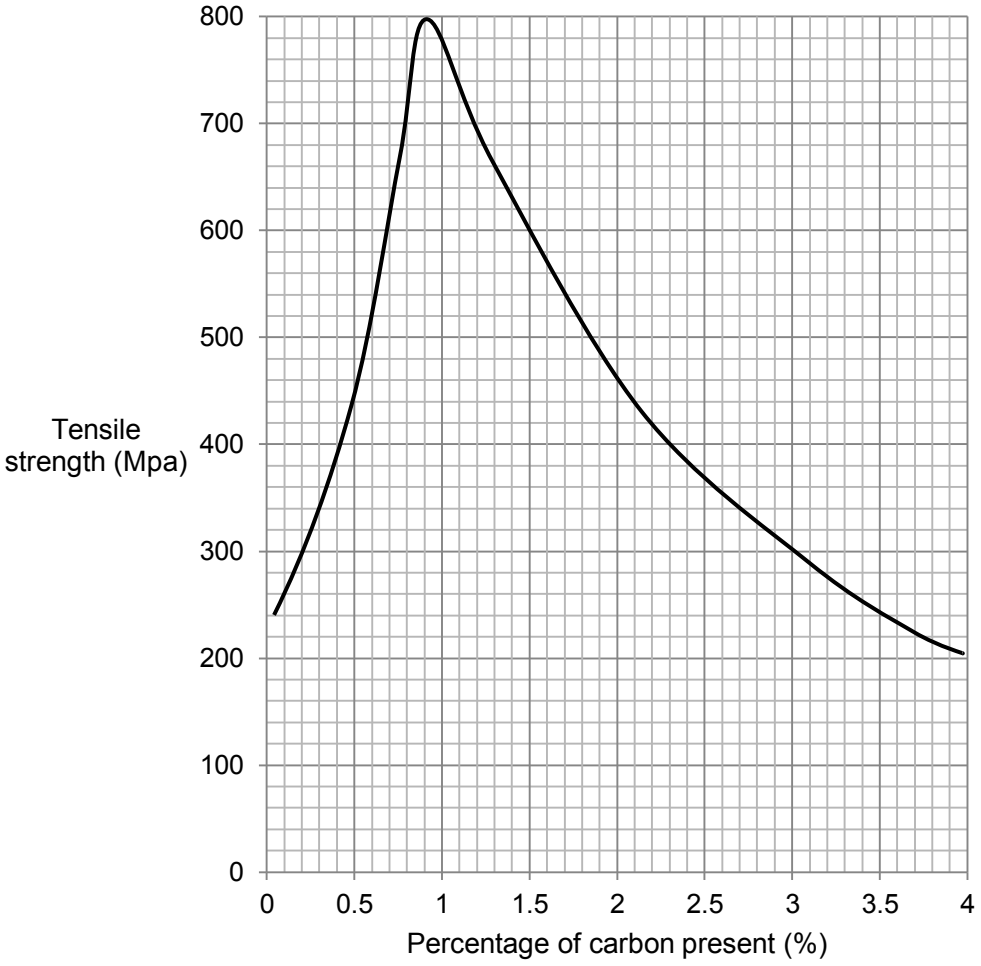
I Use the information above to complete the **word** equation for the reaction. [2]

Iron(III) oxide + carbon monoxide $\longrightarrow$ …….. + ……..……..

II Put a tick (✓) in the box next to the term used to describe the removal of oxygen from iron(III) oxide. [1]

reduction	☐	oxidation	☐
combustion	☐	decomposition	☐

(b) The graph below shows how the tensile strength of iron alloys changes with the percentage of carbon present.



(i) Describe how the tensile strength changes as the percentage of carbon present increases. [2]

.....

.....

(ii) The table below shows the percentage of carbon present in some iron alloys.

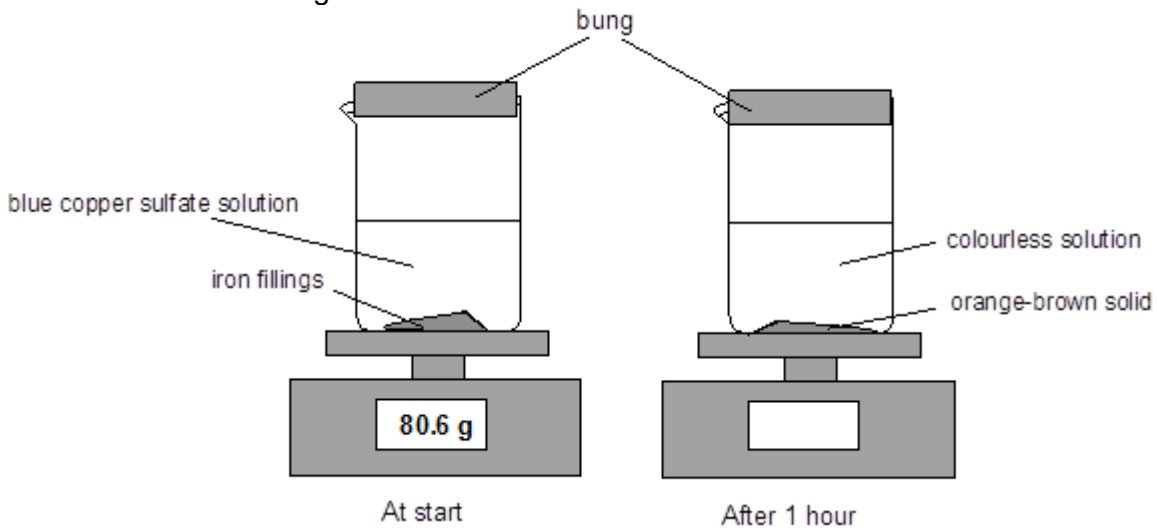
Alloy of iron	Percentage of carbon present in the alloy (%)
wrought iron	0.1
mild steel	0.3
high-carbon steel	0.9
cast iron	3.7

A steel with high tensile strength is needed in building the frame for a roof. Use the information in the table and the graph to name the alloy which has the **highest** tensile strength. [1]

.....

(c) A student was asked to investigate what happens when grey iron filings are added to copper(II) sulfate solution.

The apparatus was set up as shown below. The mass was recorded at the start and again after one hour.



(i) I Name this type of reaction. [1]

……..

II Explain why this reaction takes place. [2]

.....

.....

(ii) Complete the **balanced symbol** equation for the reaction taking place. [1]

$Fe + CuSO_4 \longrightarrow$ ..... + ...

(iii) Put a circle around the statement which describes the mass of the beaker and contents after 1 hour.

mass of beaker + contents < 80.6 g

mass of beaker + contents = 80.6 g

mass of beaker + contents > 80.6 g

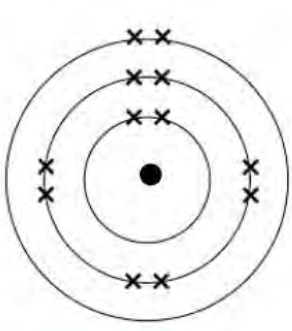
mass of beaker + contents = 40.3 g

Give a reason for your choice. [2]

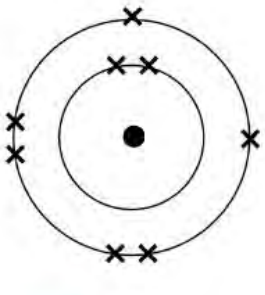
.....

15

3. (a) The diagrams below show the electronic structures of a magnesium atom and an oxygen atom.



magnesium atom



oxygen atom

Magnesium reacts with oxygen to form magnesium oxide.

State, in terms of electrons, what happens to magnesium and oxygen atoms during this reaction. [2]

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.....

.....

(b) The key below represents atoms of some elements.

nitrogen, N

hydrogen, H

oxygen, O

(i) Use the key to draw a diagram representing a molecule of ammonia, NH_3. [1]

(ii) Use the key to give the chemical formula for the compound represented by the following diagram. [1]

formula .....

(c) The box below shows the symbols and formulae for some gases.

CO_2	**O_2**	**He**	**CH_4**	**Ne**	**SO_2**

(i) Choose **two** elements from the box above.

..... and ..... [1]

(ii) Choose **two** compounds from the box above.

..... and ..... [1]

(d) (i) Give the **formulae** of the: [2]

positive ion in potassium chloride .....

negative ion in Na_2O .....

(ii) Give the chemical formula for magnesium hydroxide. [1]

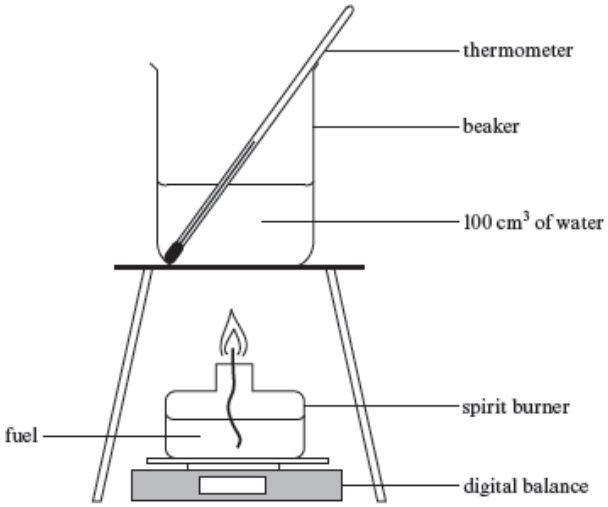
.....

(e) Sodium chlorate, $NaClO_3$, is used to bleach paper.
Calculate the relative formula mass (M_r) of sodium chlorate. [2]

M_r = ...

11

4. (a) Methanol and ethanol are both fuels. A group of students were asked to carry out an experiment to find out which was the better fuel. The apparatus they used is shown in the following diagram and their results are recorded in the table below.



	Methanol	Ethanol
Mass of spirit burner and fuel before heating (g)	140.5	136.8
Mass of spirit burner and fuel after heating (g)	140.0	136.3
Volume of water used (cm^3)	100	100
Temperature of water before heating (^oC)	20	21
Temperature of water after heating (^oC)	25	29

(i) State which is the better fuel and give a reason for your answer. [1]

.....

.....

(ii) Their teacher said that burning these amounts of fuels would have given off enough heat for the water to reach much higher temperatures.

Suggest **two** possible reasons why higher temperatures were not reached. [2]

.....

.....

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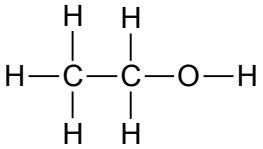
.....

(iii) Complete and balance the **symbol** equation for the combustion of methanol. [2]

$2CH_3OH + 3O_2 \longrightarrow$ ..... + ...

(b) (i) The following diagram shows the structural formula of ethanol.



Give the molecular formula of ethanol. ..... [1]

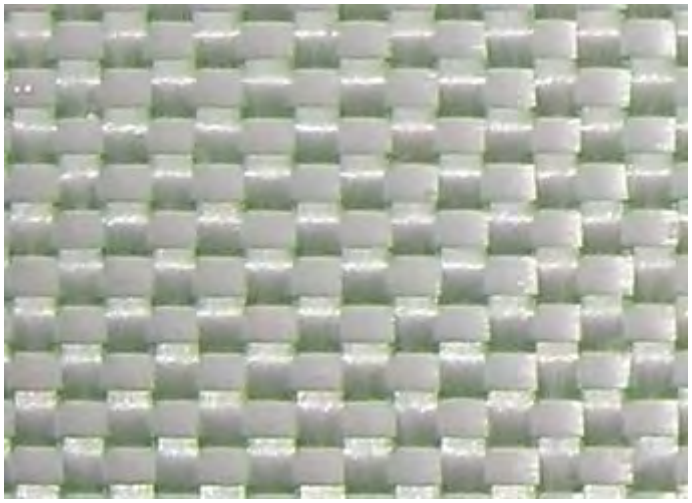
(ii) An alcohol contains three carbon atoms, eight hydrogen atoms and one oxygen atom. Draw the structural formula of an alcohol with this number of atoms. [1]

5. (a) Alloys and composites are synthetic materials produced for a huge range of uses.

State whether the statements listed below relate to alloys or composites. Circle your answer (alloy **or** composite) in each case. [2]

Statement	**Answer**	
a mixture of two or more elements of which at least one is a metal	alloy	composite
each component is easily recognised	alloy	composite
reinforced concrete	alloy	composite
bronze	alloy	composite

(b) A common example of a composite material is fiberglass. This is made by mixing glass fibres with a polymer resin such as epoxy resin.



Give **one** advantage of arranging the glass fibres as shown in the diagram above. [1]

.....

(c) The table below shows some properties of glass and epoxy resin.

Material	**Density (g/cm^3)**	**Strength (N/cm^2)**
glass	2.4	350 000
epoxy resin	1.5	6000

(i) A fibre glass panel contains 3 cm^3 of epoxy resin. Calculate the **mass** of the resin. [2]

Use the following equation:

mass = density × volume

mass = ... g

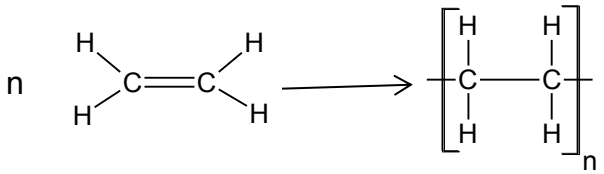
(ii) A force of 52.5 N just breaks a glass fibre. Calculate the cross-sectional area (csa) of the glass fibre. [2]

Use the following equation:

force = strength × csa

cross-sectional area (csa) = ... cm^2

(d) The equation below shows the formation of the plastic polythene from ethene.



ethene polyethene

Describe what happens to ethene molecules during the formation of polythene. [3]

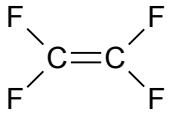
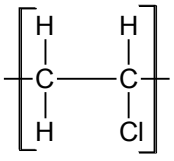
.....

.....

.....

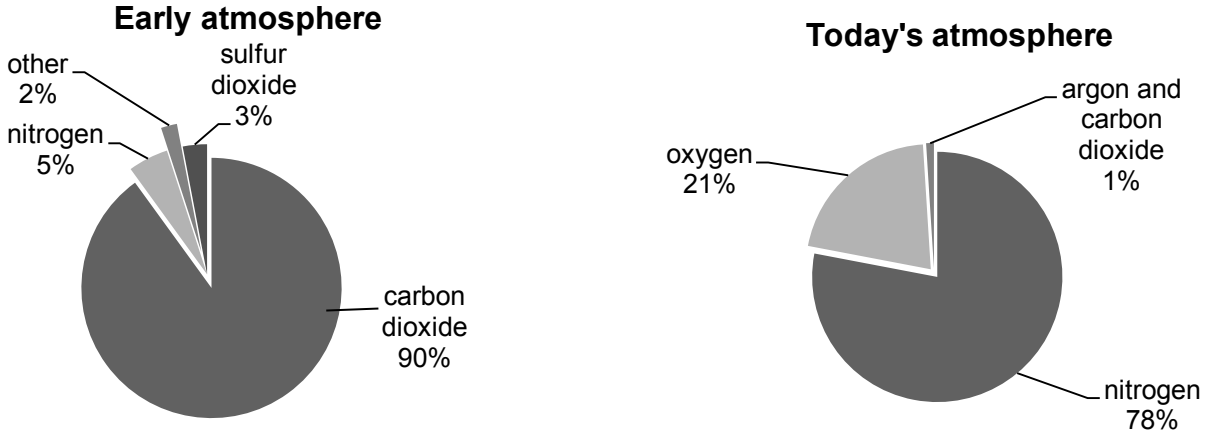
(e) The table below shows some information about monomers and the polymers that can be made from them.

Complete the table. [2]

Name of monomer	**Structural formula of monomer**	**Name of polymer**	**Repeating unit for the polymer**
tetrafluoroethene		polytetrafluoroethene PTFE	
vinylchloride (chloroethene)		polyvinylchloride PVC	

12

6. (a) The pie charts below show how the present day atmosphere on Earth compares with the early atmosphere formed billions of years ago.



(i) Use the information in the pie charts to describe how today's atmosphere is different from the early atmosphere. [3]

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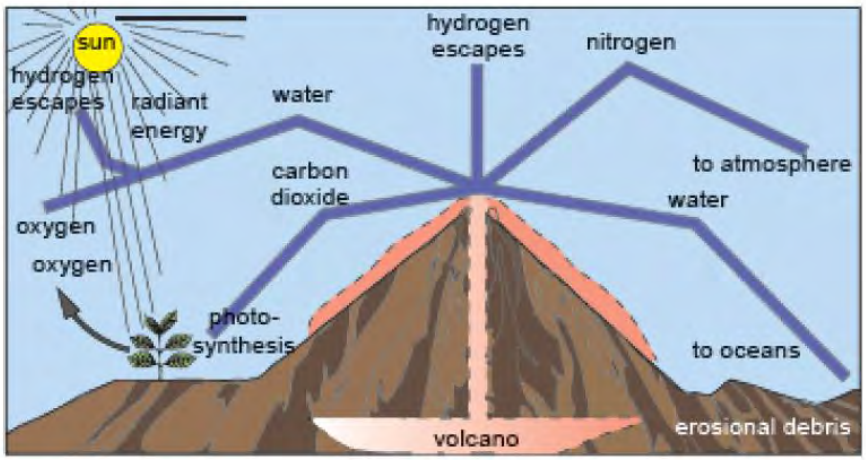
(ii) Use the information in the diagram to describe how volcanoes contributed to the appearance of oxygen in the atmosphere. [2]



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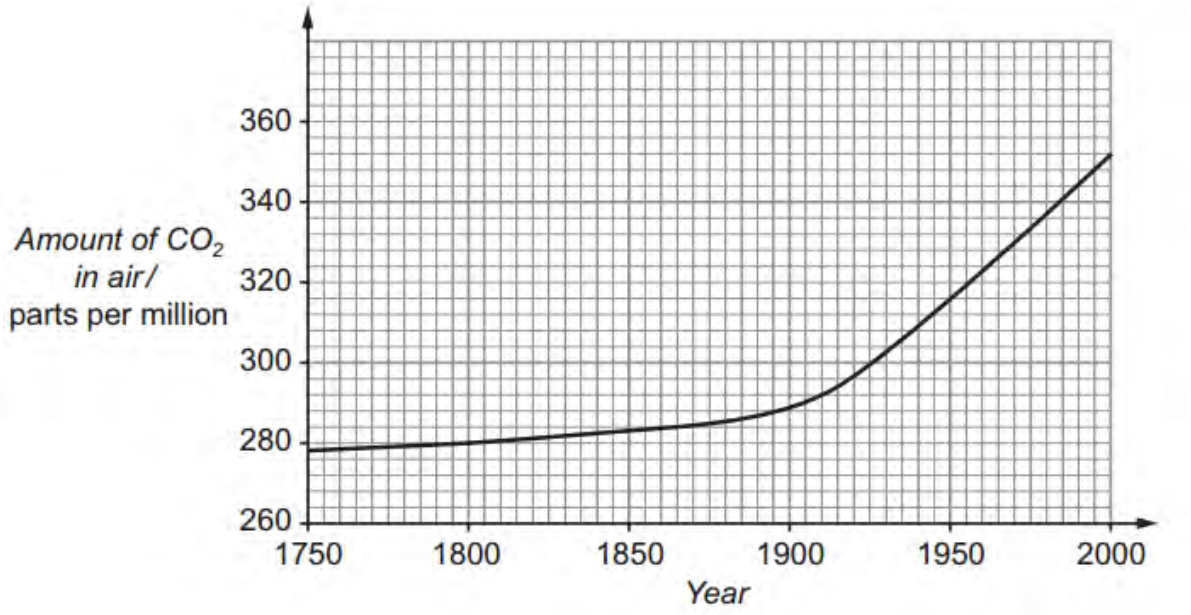
(b) The following graph shows how the concentration of carbon dioxide in the Earth's atmosphere changed between 1750 and the year 2000.



(i) Describe the change in the pattern shown in the graph before and after 1900.
Explain what caused the change. [3]

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(ii) Explain how the change in concentration of carbon dioxide is believed by most scientists to be causing sea levels to rise. [3]

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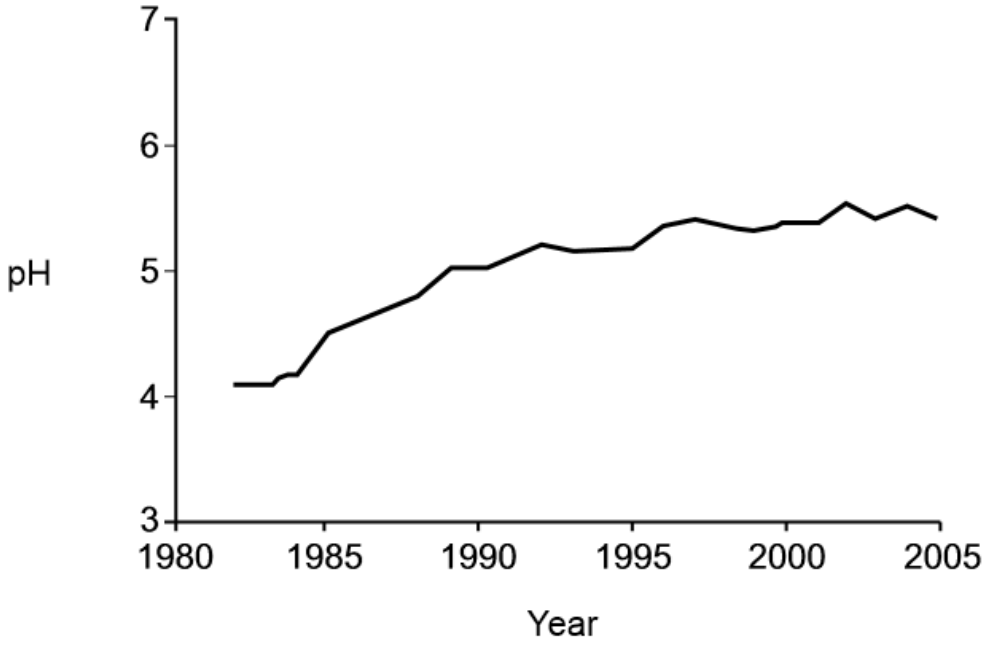
11

7. (a) Some sulfur dioxide is produced when fossil fuels are burnt. One of the major consequences of sulfur dioxide emission is the formation of acid rain. Acid rain causes the pH in lakes and reservoirs to decrease.

The graph below shows how the pH of a reservoir changed between 1982 and 2005.



(i) Describe how the pH **and** the acidity changed between 1982 and 2005. [2]

pH .....

Acidity .....

(ii) The reservoir is in a remote part of the country and difficult to reach. pH readings were taken daily and used to produce the graph above.

pH meter

A

datalogger and pH sensor

B

pH paper

C

litmus paper

D

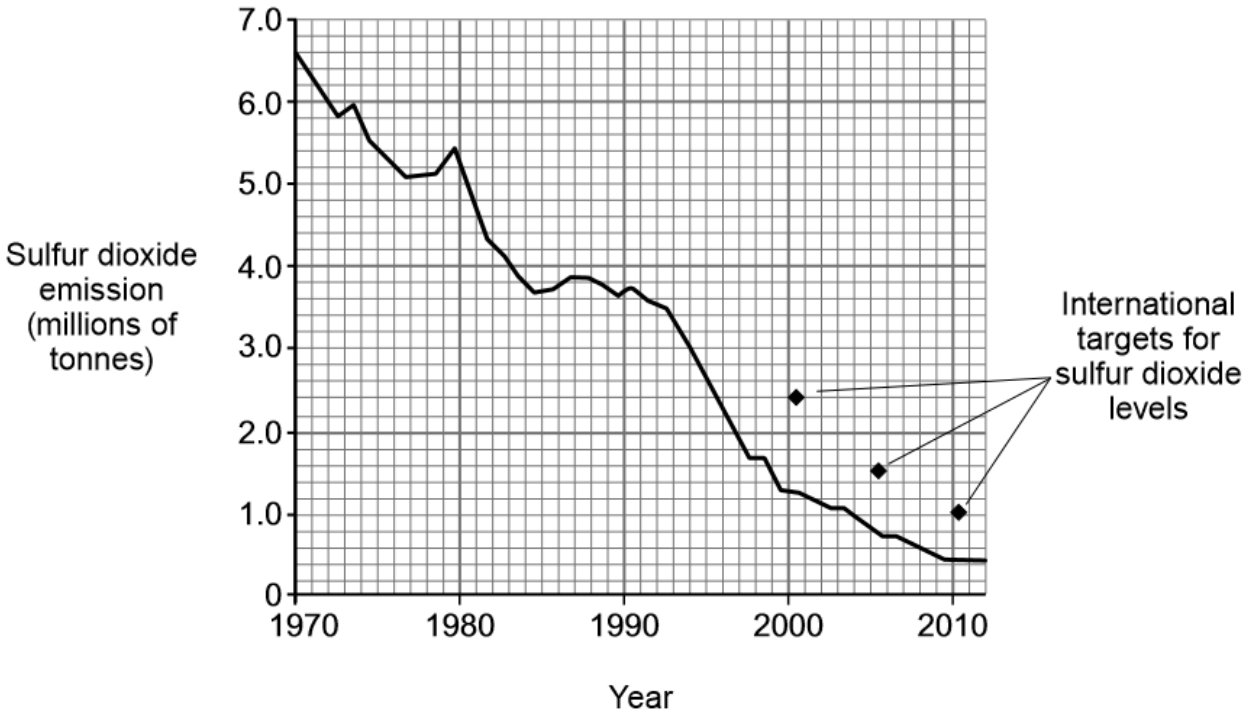
Give the **letter** of the equipment above that you would choose to record and store the pH of the reservoir several times a day. Give a reason for your choice. [2]

Letter .....

Reason …….....

…….....

(b) The graph below shows the total annual sulfur dioxide emissions in the UK between 1970 and 2012. International targets for sulfur dioxide levels are also shown (♦).



(i) Use the information to give **two** conclusions relating to sulfur dioxide emissions in the UK between 2000 and 2012. [2]

.....

.....

(ii) The generation of electricity in power stations is the main source of sulfur dioxide.

Suggest an explanation for the small peak in sulfur dioxide emissions in 1979. [2]

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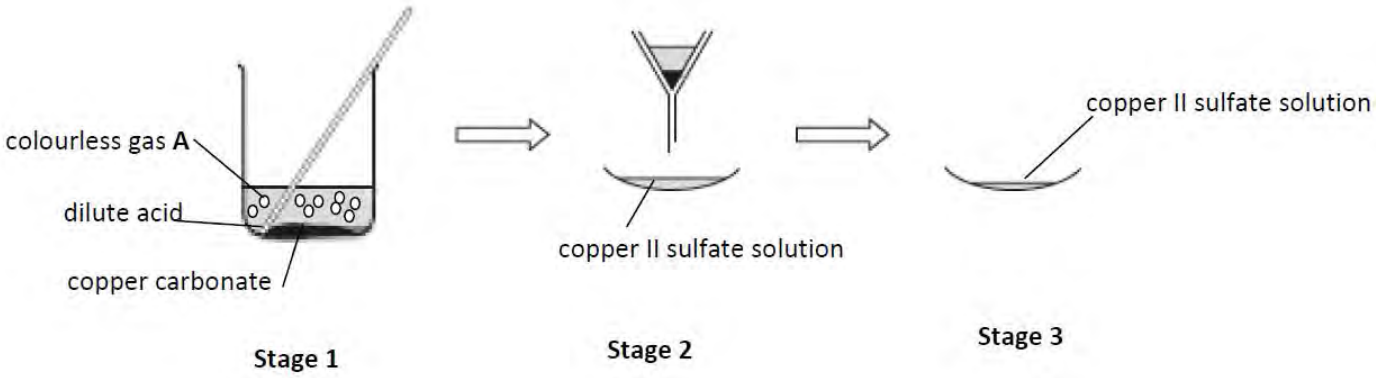
.....

8

8. (a) One method of preparing dry copper(II) sulfate crystals is by reacting a carbonate with a dilute acid. The information below shows the stages a pupil follows to make copper(II) sulfate crystals.



(i) Name the acid used in the process. [1]

.....

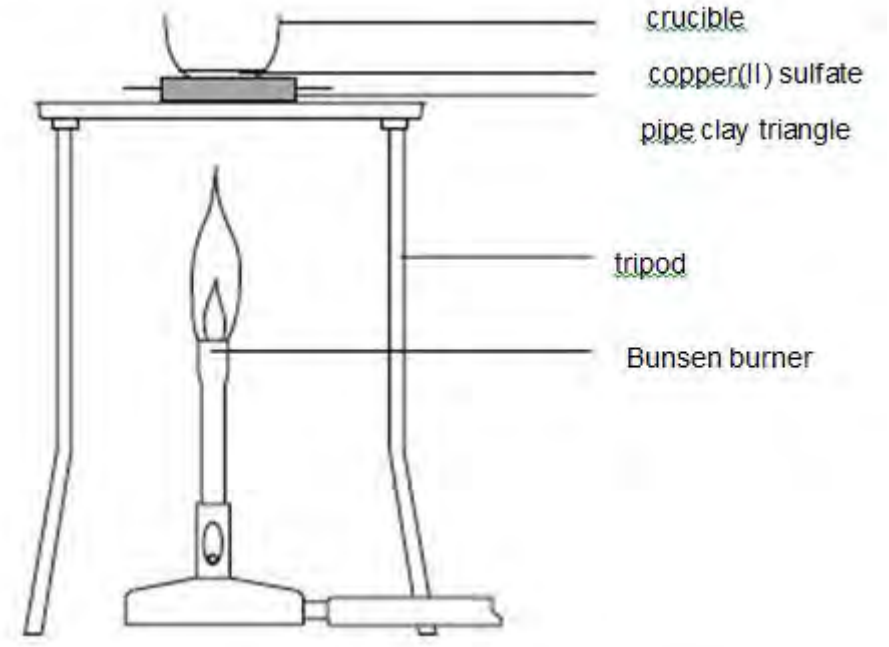
(ii) Name gas **A** formed in stage 1. [1]

.....

(iii) Name the substance removed during stage 3. [1]

.....

(b) The blue colour of hydrated copper(II) sulfate crystals is due to the presence of water molecules. These water molecules can be removed by gently heating to form white anhydrous copper(II) sulfate powder using the apparatus shown below.



6.25 g of blue hydrated copper(II) sulfate was gently heated in a crucible until the mass remaining was a constant 4.00 g.

(i) Calculate the mass of water removed during heating. [1]

mass of water = ... g

(ii) Use the equation below to calculate the percentage of water in the blue copper(II) sulfate. [2]

$$\text{percentage of water in blue copper(II) sulfate} = \frac{\text{mass of water}}{\text{mass of blue copper(II) sulfate}} \times 100$$

percentage of water = ... %

(iii) The equation below represents the reaction taking place.

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

State and explain what you would expect to **see** if water were added to the white anhydrous copper(II) sulfate powder. [3]

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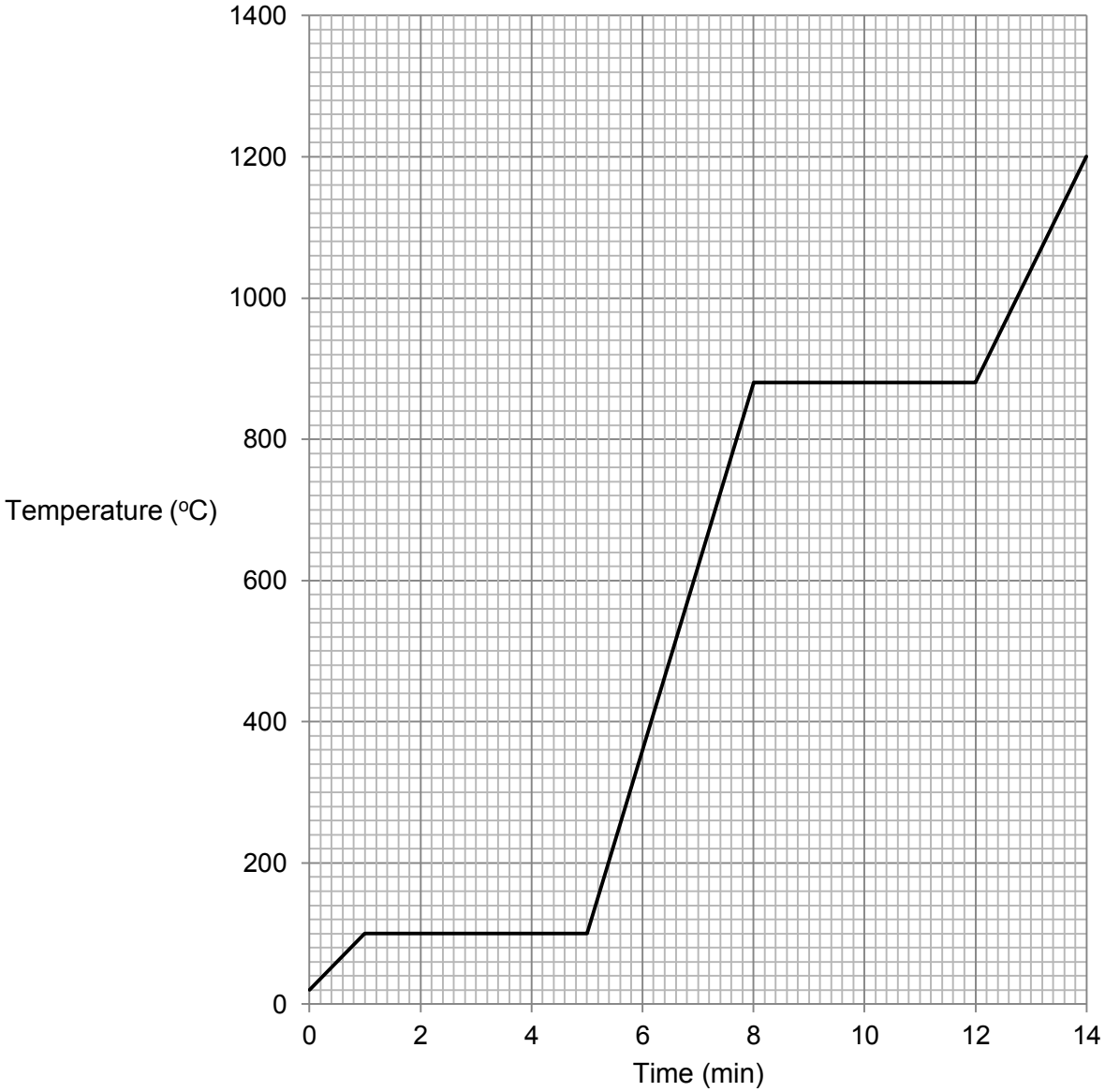
9

9. A small amount of an element, which is **not** a giant molecule, was heated and its temperature was recorded over a period of 12 minutes. At room temperature the element is a solid. The results are shown on the grid below.



(i) Give the melting point and boiling point of the element. [1]

melting point = ..……..°C boiling point = ……..…°C

(ii) State whether the element is a metal or a non-metal. Give the reason for your choice. [1]

……...……...……

……...……...……

……...……...……

(b) Describe and explain, using particle theory, the changes that occur to the element when it is heated over the period of the first **12** minutes. [6 QER]

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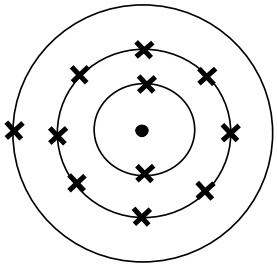
10. (a) Complete the following table that shows information about atoms of some elements. [5]

Element	Symbol	Number of protons	Number of neutrons	Number of electrons
beryllium	$^{9}_{4}Be$	4	5	4
fluorine	$^{19}_{9}F$	9	……	……
calcium	……..	20	20	……
argon	$^{40}_{18}Ar$	…….	22	18

(b) The diagram below shows the electronic structure of an element in the Periodic Table.



Using X to represent an electron, draw a similar diagram to show the electronic structure of the element which:

(i) lies directly **below** this element in the Periodic Table; [1]

(ii) lies directly to the **right** of this element in the Periodic Table. [1]

(c) The diagram below shows the early form of the Periodic Table developed by Mendeleev.

I	II	III	IV	V	VI	VII			
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5	VIII		
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Ti 204	Pb 207	Bi 209					
			Th 232		U 238				

(i) State what information Mendeleev used to arrange the elements. [2]

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(ii) Describe and explain the differences between Period 4 of Mendeleev's table and that of the modern table. [3]

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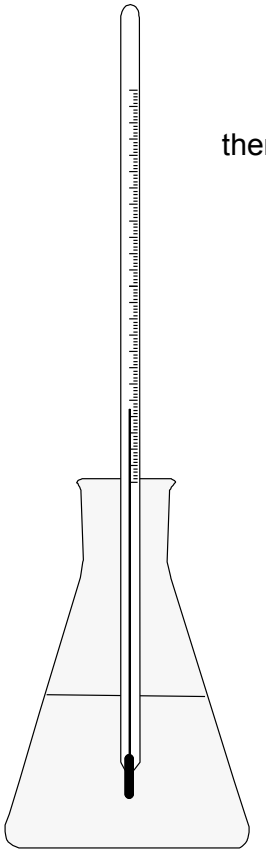
12

11. A pupil investigated how the temperature changes when dilute hydrochloric acid reacts with dilute sodium hydroxide solution.

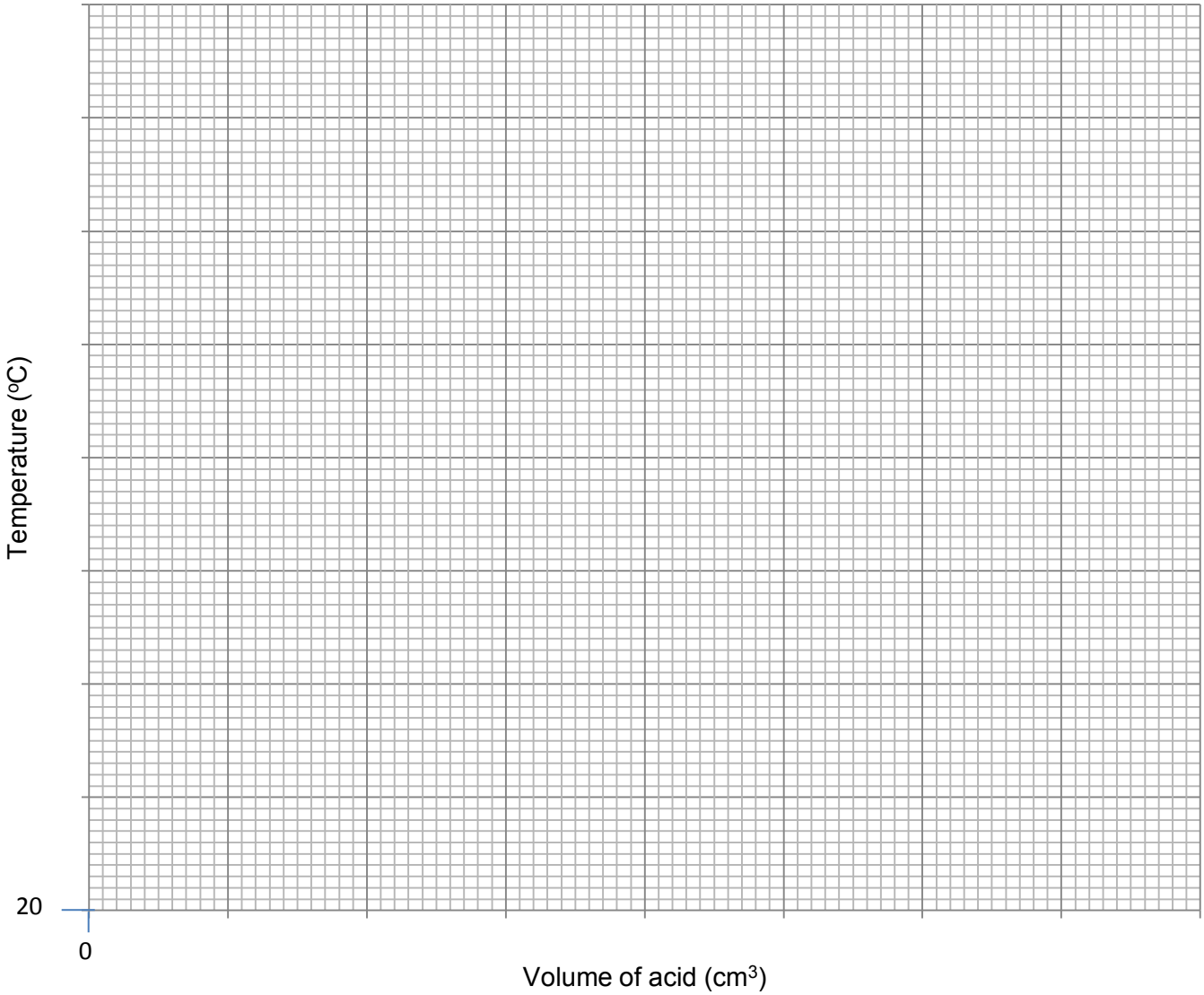


(a) 80 cm^3 of dilute acid was added, 10 cm^3 at a time, to 25 cm^3 of alkali in a conical flask. The highest temperature reached was recorded each time.

The table below shows the results obtained.

Volume of acid added (cm^3)	**Temperature (°C)**
0	21.0
10	22.8
20	24.2
30	25.4
40	26.4
50	27.0
60	26.7
70	26.2
80	25.6

(i) Use the grid provided on the next page to plot the volume of acid added against temperature.
Add a suitable line. [4]



(ii) Describe and explain the shape of the graph in relation to the chemical reaction taking place. [3]

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(b) (i) Apart from measuring the change in temperature, state a different method that could be used to show the stages of this reaction. [1]

……

(ii) Explain how your new method would show the stages of the reaction. [2]

……

……

10

12. (a) The electrolysis of water can be used to form hydrogen on an industrial scale. The overall equation for the electrolysis of water is:

$$2H_2O \longrightarrow 2H_2 + O_2$$

(i) Using the formula below calculate the atom economy for the production of hydrogen. [2]

$A_r(H) = 1$ $A_r(O) = 16$

$$\% \text{ atom economy} = \frac{\text{mass of desired product x100}}{\text{total mass of all reactant(s)}}$$

atom economy = …….. %

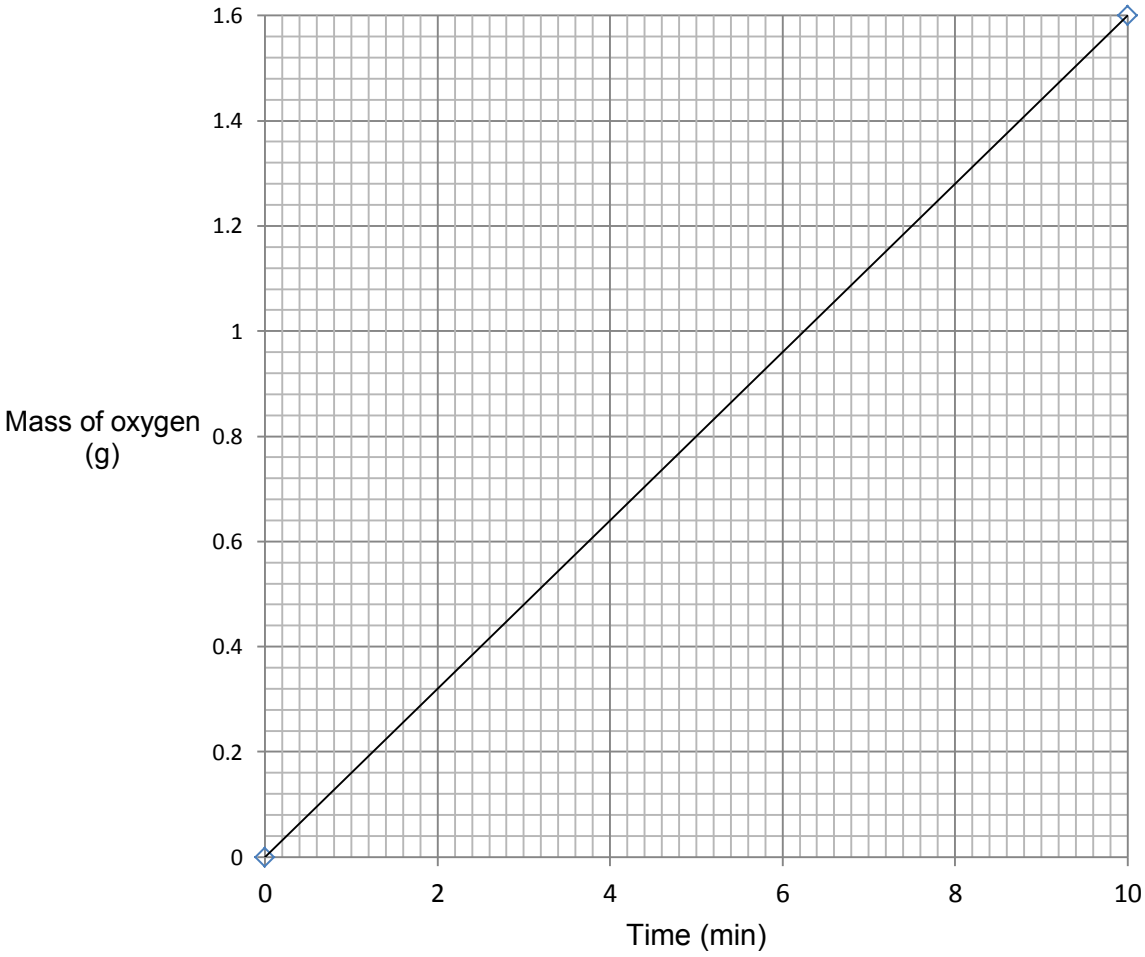
(ii) Explain how the atom economy calculated in a(i) supports the reason for not using the electrolysis of water as the main method for the industrial preparation of hydrogen. [2]

……

……

……

(b) The graph below shows the total mass of oxygen formed over 10 minutes.



Draw a second line on the grid to show the mass of **hydrogen** that you would expect to be collected during the same 10 minutes. [2]

(c) Use **only** information from the table below to explain **two** advantages of using hydrogen as a fuel for cars. [2]

Raw material	water
Extraction method	electrolysis
Combustion product(s)	water
State at room temperature and pressure	gas
Storage	thick steel containers

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8

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
Aluminium	Al^{3+}	Bromide	Br^{-}
Ammonium	NH_4^{+}	Carbonate	CO_3^{2-}
Barium	Ba^{2+}	Chloride	Cl^{-}
Calcium	Ca^{2+}	Fluoride	F^{-}
Copper(II)	Cu^{2+}	Hydroxide	OH^{-}
Hydrogen	H^{+}	Iodide	I^{-}
Iron(II)	Fe^{2+}	Nitrate	NO_3^{-}
Iron(III)	Fe^{3+}	Oxide	O^{2-}
Lithium	Li^{+}	Sulfate	SO_4^{2-}
Magnesium	Mg^{2+}		
Nickel	Ni^{2+}		
Potassium	K^{+}		
Silver	Ag^{+}		
Sodium	Na^{+}		
Zinc	Zn^{2+}		

THE PERIODIC TABLE

Key: A_r = relative atomic mass; Symbol; Name; Z = atomic number

Group 1–2: s Block; d Block; Groups 3–0: p Block

Period	1	2											3	4	5	6	7	0
1	1.01 H Hydrogen 1																	4.00 He Helium 2
2	6.94 Li Lithium 3	9.01 Be Beryllium 4											10.8 B Boron 5	12.0 C Carbon 6	14.0 N Nitrogen 7	16.0 O Oxygen 8	19.0 F Fluorine 9	20.2 Ne Neon 10
3	23.0 Na Sodium 11	24.3 Mg Magnesium 12											27.0 Al Aluminium 13	28.1 Si Silicon 14	31.0 P Phosphorus 15	32.1 S Sulfur 16	35.5 Cl Chlorine 17	40.0 Ar Argon 18
4	39.1 K Potassium 19	40.1 Ca Calcium 20	45.0 Sc Scandium 21	47.9 Ti Titanium 22	50.9 V Vanadium 23	52.0 Cr Chromium 24	54.9 Mn Manganese 25	55.8 Fe Iron 26	58.9 Co Cobalt 27	58.7 Ni Nickel 28	63.5 Cu Copper 29	65.4 Zn Zinc 30	69.7 Ga Gallium 31	72.6 Ge Germanium 32	74.9 As Arsenic 33	79.0 Se Selenium 34	79.9 Br Bromine 35	83.8 Kr Krypton 36
5	85.5 Rb Rubidium 37	87.6 Sr Strontium 38	88.9 Y Yttrium 39	91.2 Zr Zirconium 40	92.9 Nb Niobium 41	95.9 Mo Molybdenum 42	98.9 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
6	133 Cs Caesium 55	137 Ba Barium 56	139 La ‣ Lanthanum 57	179 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	(210) Po Polonium 84	(210) At Astatine 85	(222) Rn Radon 86
7	(223) Fr Francium 87	(226) Ra Radium 88	(227) Ac ‣‣ Actinium 89															

f Block

‣ Lanthanoid elements	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	(147) Pm Promethium 61	150 Sm Samarium 62	(153) Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
‣‣ Actinoid elements	232 Th Thorium 90	(231) Pa Protactinium 91	238 U Uranium 92	(237) Np Neptunium 93	(242) Pu Plutonium 94	(243) Am Americium 95	(247) Cm Curium 96	(245) Bk Berkelium 97	(251) Cf Californium 98	(254) Es Einsteinium 99	(253) Fm Fermium 100	(256) Md Mendelevium 101	(254) No Nobelium 102	(257) Lr Lawrencium 103