Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2024

CHEMISTRY
Paper 2

6092/02
23 August 2024
1 hr 45 mins

READ THESE INSTRUCTIONS FIRST

Candidates answer on the Question Paper.
No Additional Materials are required.
Write your name, register number and class in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph.
Do not use staples, paper clips, and glue or correction fluid.

Section A (70 Marks)
Answer **all** questions
Write your answers in the spaces provided.

Section B (10 Marks)
Answer **one** question.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 23.

The use of an approved scientific calculator is expected, where appropriate.

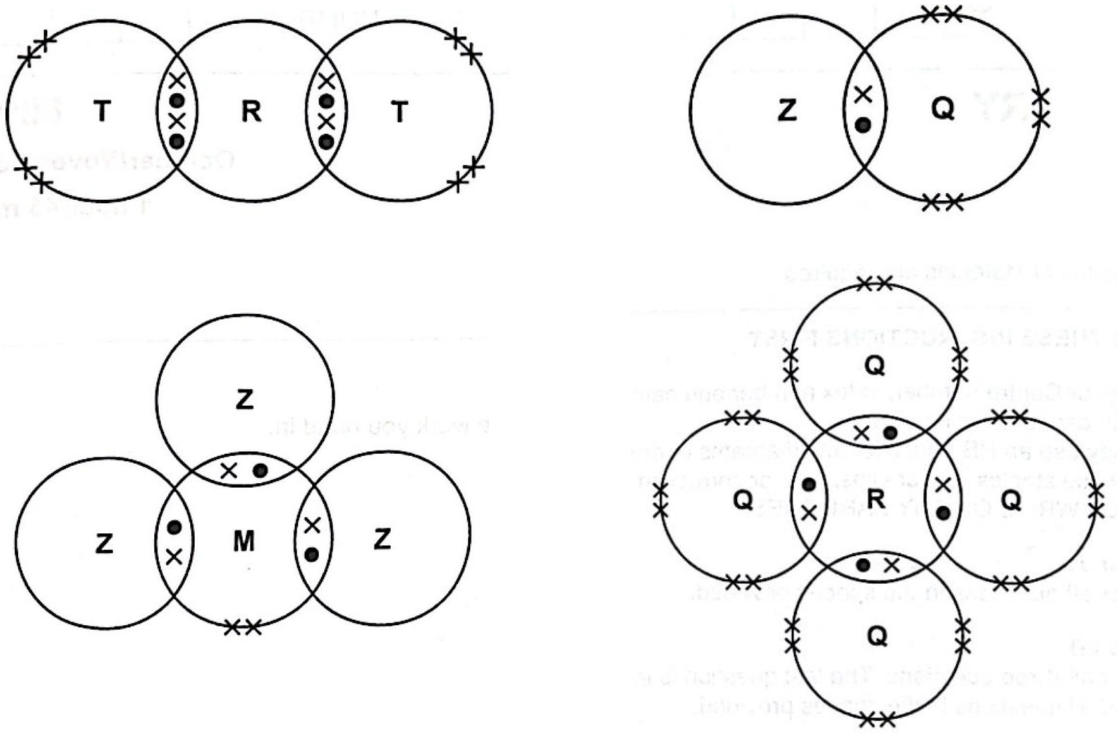
For Examiner's Use		
Section A		
Section B		
Deductions	Significant Figures	
	Units	
Total		**80**

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 70.

A1 The figure below shows 'dot-and-cross' diagrams for molecules that contain elements from the first two periods of the Periodic Table. The elements are represented by the letters **M**, **Q**, **R**, **T** and **Z**.

Each diagram shows outer electrons only.



Use the letters **M**, **Q**, **R**, **T** and **Z** to answer the questions below.

(a) Which element can form an ion with a charge of 1-? **[1]**

_____

(b) Which element can lose, gain and share electrons? **[1]**

_____

(c) Which element can form an acidic oxide? **[1]**

_____

(d) Which element forms a triple covalent bond? **[1]**

_____

(e) **(i)** Potassium reacts with element **T** to form a compound. **[2]**

Draw a dot-and-cross diagram of the compound formed between potassium and element **T**. Show only the valence electrons.

(ii) State one physical property of the above compound and explain the reason for the physical property. **[2]**

_____

_____

[Total: 8 marks]

A2 The table below shows information about the preparation of pure samples of some solid salts. **[5]**

Complete the table by filling in the missing information. Include state symbols with the formulae.

formulae of salt	formulae of reagent 1	formulae of reagent 2	method of preparation
$CaCO_3$ (s)			_____
Ag_2SO_4 (s)		H_2SO_4 (aq)	Adding excess solid to acid evaporation and crystallisation
NH_4NO_3 (s)	HNO_3 (aq)		_____ evaporation and crystallisation

[Total: 5 marks]

A3 Nitrogen dioxide is an acidic oxide. It dissolves in water to form two acids, nitric acid and nitrous acid, HNO_2 in a single reaction.

(a) (i) Write a balanced chemical equation for the above reaction. **[1]**

_____

(ii) Disproportionation is a reaction when the same substance is oxidised and reduced in the same reaction. **[2]**
Explain why the reaction in **(a)(i)** is a disproportionation reaction.

_____

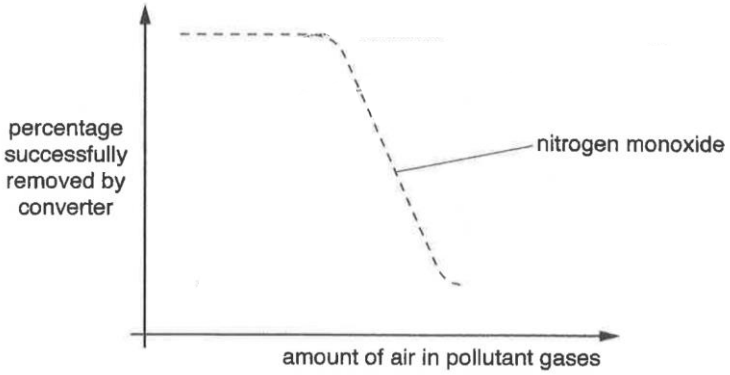
_____

_____

(b) One of the main sources of nitrogen monoxide, NO is from the combustion engines of vehicles.

(i) State how nitrogen monoxide, NO is formed in combustion engines of vehicles. **[2]**

(ii) Hence, explain with the aid of a chemical equation how nitrogen monoxide is removed by catalytic converters fitted in cars. **[2]**

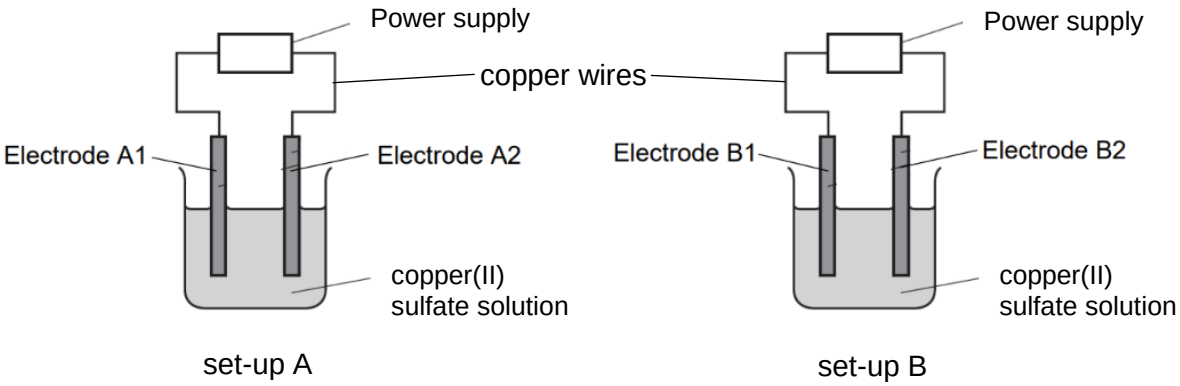


The amount of air in the pollutant gases that enter the catalytic converter affects the reactions in the converter.
The graph shows the percentage of nitrogen monoxide that the catalytic converter successfully **removed.**

(iii) Using the equation in **(ii)** and the graph above, explain why the percentage of nitrogen monoxide successfully removed by catalytic converter decreases as the amount of air increases. **[2]**

[Total: 9 marks]

A4 A student electrolysed aqueous copper(II) sulfate using two sets-ups shown below.
The electrodes used in each set-up are made of the same material.
However, the electrodes used in set-ups A and B are made of different materials.



He recorded the following observations in the two set-ups.

set-up A	set-up B
mass of electrode A1 increased	mass of electrode B1 increased
mass of electrode A2 remained the same	mass of electrode B2 decreased
effervescence observed at electrode A2 blue copper(II) sulfate solution fades in colour.	no effervescence observed at B2. blue copper(II) sulfate solution remains unchanged.

(a) Name the particles which transfer charges through the: **[1]**

(i) copper wires _____

(ii) copper(II) sulfate solution _____

(b) State which electrode is the cathode in each set-up.

Set-up A: _____ Set-up B: _____ **[1]**

(c) Explain, with an appropriate equation, the increase in mass at electrodes at A1 and B1. **[2]**

_____

_____

(d) Write the half-equations of the reactions taking place at Electrode A2 and Electrode B2. **[2]**

Half-equation at A2: _____

Half-equation at B2: _____

(e) Describe how the electrolyte of set-up A would change by the end of experiment in terms of its pH and explain why. **[2]**

_____

_____

(f) Suggest the materials that are used to make the electrodes in: **[1]**

(i) Set-up A: _____

(ii) Set-up B: _____

[Total: 9 marks]

A5 The table below shows four different experiments that were conducted with various concentrations and volumes of three different acids that reacted with excess zinc.

experiment	acid	concentration of acid in mol/dm^3	Volume of acid in cm^3
1	hydrochloric acid	0.10	100
2	hydrochloric acid	0.20	100
3	ethanoic acid	0.10	100
4	sulfuric acid	M	N

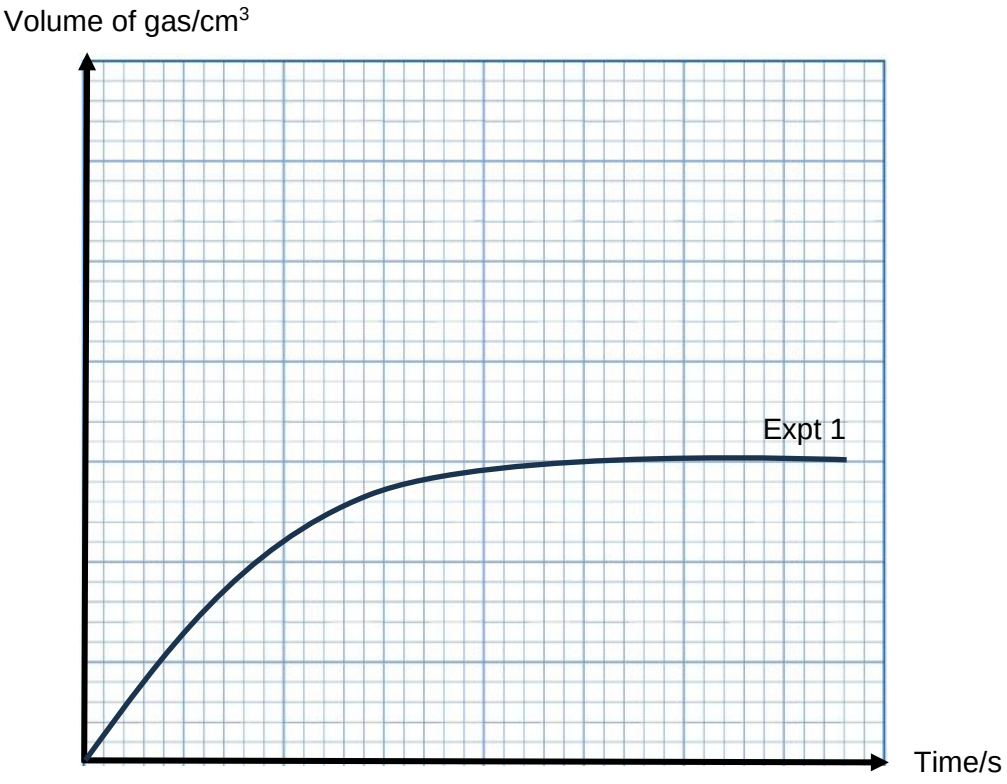
(a) The chemical equation between zinc and hydrochloric acid is shown below.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

(i) Find the number of moles of hydrochloric acid that reacted in Experiment 1. **[1]**

(ii) Hence, find the volume of gas that is evolved in Experiment 1. **[2]**

(iii) The graph below shows the graph for Experiment 1. **[1]**
Hence, sketch the graph for Experiment 2 and label it as **Expt 2**.



(b) **(i)** Write an equation to show the chemical reaction between ethanoic acid and zinc. **[1]**

(ii) Hence, sketch the graph for Experiment 3 in the same axes in **(a)(iii)** and label it as **Expt 3**. **[2]**

(iii) Explain the shape of your graph. **[3]**

(c) Suggest values for M and N in the table above so that Experiment 4 can have the same graph as Experiment 2. **[2]**

M: _____ N: _____

[Total: 12 marks]

A6 Zinc is a transition metal found in Period 4 of the Periodic Table.
Some properties of zinc are shown in the table below.

	zinc
electronic configuration	2.8.18.2
melting point/ºC	419
density/ g/dm^3	2.99
formula of metal oxide	ZnO
colour of metal chloride	white

It is noted that zinc only forms one oxide and one chloride.

(a) Using the information from the table, suggest two reasons why zinc is not considered a typical transition metal. **[2]**

(b) A student is given an unknown colourless solution T.

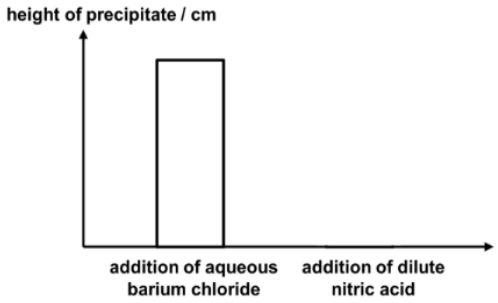
(i) Describe a chemical test that would confirm that solution T contains zinc ions. **[2]**

Include any observations that you might see.

(ii) To identify the anion present, the student carried out the following test:

step number	procedure
1	Add aqueous barium chloride to a test tube containing solution T.
2	Measure the height of precipitate formed after 5 minutes.
3	Add excess dilute nitric acid to the above mixture.
4	Measure the height of the precipitate formed after 5 minutes.

The results obtained are shown in a graph below.

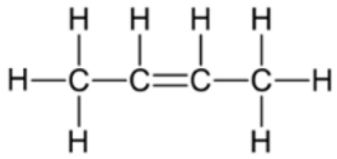
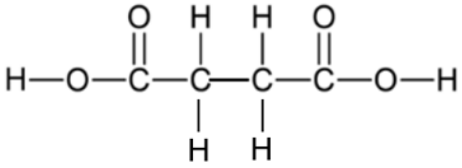
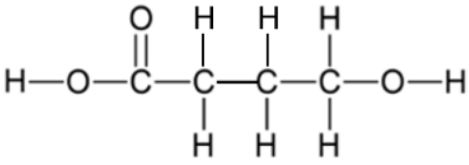


Based on the graph above, the student concluded that the anion is sulfate ion, but not carbonate ion. **[3]**
Do you agree with the student?

Explain your answer with reference to the graph.

[Total: 7 marks]

A7 The structures of three organic compounds are given in the table below.

organic compound	structure of compound
W	
X	
Y	

(a) (i) State the compound that can undergo addition polymerisation and condensation polymerisation on its own respectively. **[2]**

Addition polymerisation: _____

Condensation polymerisation: _____

(ii) Draw two repeat units of the respective addition and condensation polymer. **[2]**

Addition Polymer:

Condensation Polymer:

(b) **(i)** Draw the structural formula of a simple molecule that can combine with X to undergo condensation polymerisation. **[1]**

(ii) Hence. draw the structure of the polymer formed. **[1]**

(iii) Name the small molecule that is formed as a by-product. **[1]**

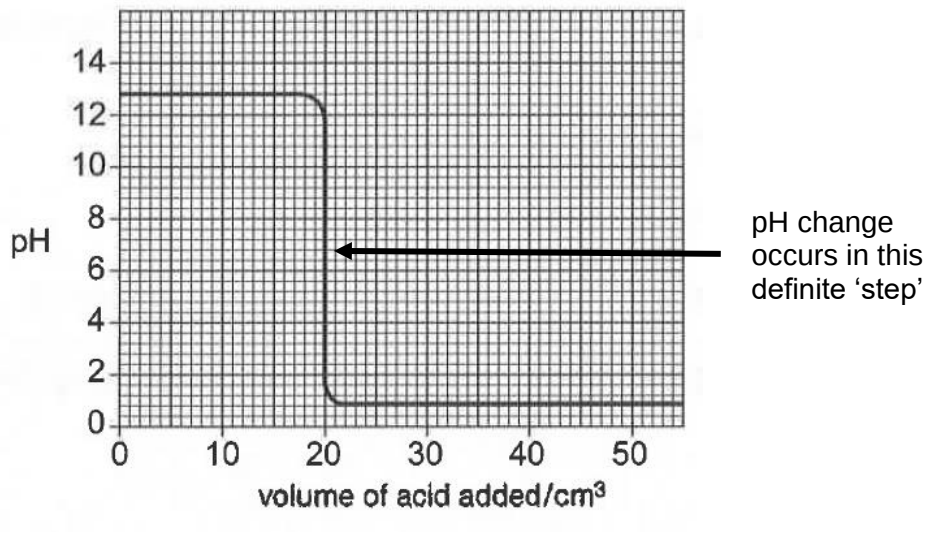
(c) **(i)** Describe a test that can be used to differentiate between organic compounds X and Y. **[2]**

(ii) Name a reagent that can be used to differentiate organic compound W from compounds X and Y. **[1]**

[Total: 10 marks]

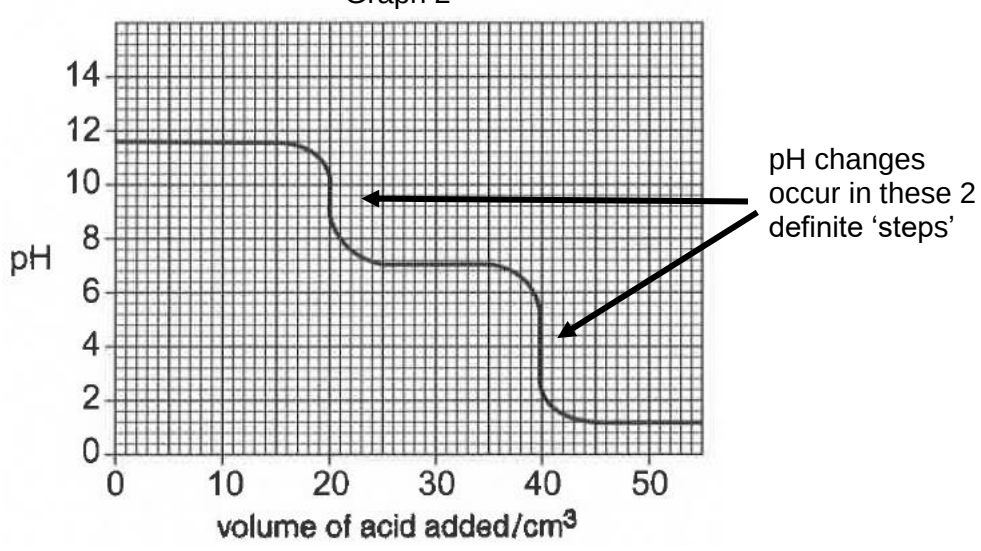
A8 A pH probe attached to a computer measures pH changes during some titration experiments.
In experiment 1, 0.1 mol/dm^3 of hydrochloric acid was added from a burette to 25.0 cm^3 of dilute sodium hydroxide. The pH probe measured the pH during the experiment.
Graph 1 shows the results.

Graph 1



In experiment 2, 0.1 mol/dm^3 hydrochloric acid was added from a burette to 25.0 cm^3 of dilute sodium carbonate.
Graph 2 shows the results.

Graph 2

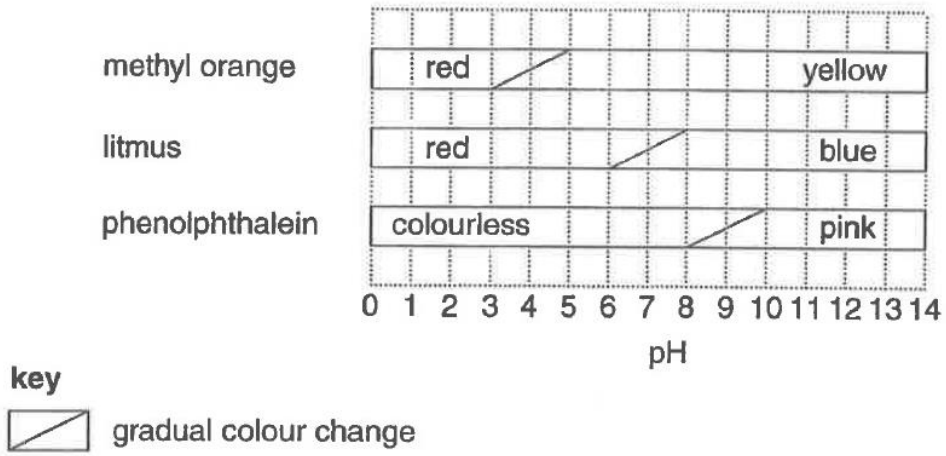


The reaction between sodium carbonate and hydrochloric acid happens in two stages.

Stage 1: Sodium carbonate reacts with dilute hydrochloric acid to form sodium hydrogencarbonate and a neutral salt.

Stage 2: Sodium hydrogencarbonate undergoes a further reaction with hydrochloric acid.
An indicator can be used to see when a pH change happens in the definite 'step'.

The diagram shows the colours of some indicators at different pH values. In between the colours, most indicators change colour over a range of pH values.



The best indicator for a titration gives a distinct colour change when a 'definite step' occurs.

In Experiment 1, it is found that all three indicators are suitable to give an accurate titration volume.

(a) Use the information to calculate the concentration of sodium hydroxide used in Experiment 1. **[2]**

(b) A third experiment was carried out. A solution of the sodium hydroxide of the same concentration as that used in Experiment 1 was used. **[1]**

In this experiment, hydrochloric acid of a concentration of 0.20 mol/dm^3 was used.

Using the axes for Graph 1 above, sketch the graph you would expect from this experiment and label it **Experiment 3**.

(c) Identify two differences between the pH graphs for Experiment 1 and 2. **[2]**

(d) **(i)** Identify the neutral salt formed in Stage 1 of Experiment 2 **[1]**

(ii) Based on Graph 2, suggest the pH of sodium hydrogencarbonate. **[1]**

(iii) Using the information from Graph 2, state and explain the indicator that is suitable to find the titration volume for Stage 1 in Experiment 2. **[2]**

(iv) Write a chemical equation for the reaction in Stage 2 of Experiment 2. **[1]**

_____

[Total: 10 marks]

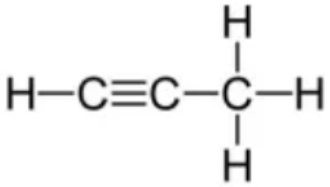
Section B (10 Marks)

Answer only ONE question in this section.

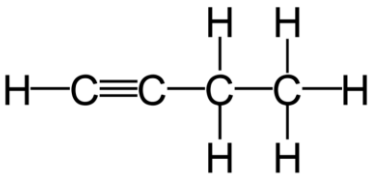
EITHER

B9 Alkynes are a homologous series of hydrocarbons.

The structural formulae of two members of this series are shown below.



propyne



butyne

(a) What is the functional group of this homologous series? **[1]**

Deduce the molecular formula of the first member of this homologous series.

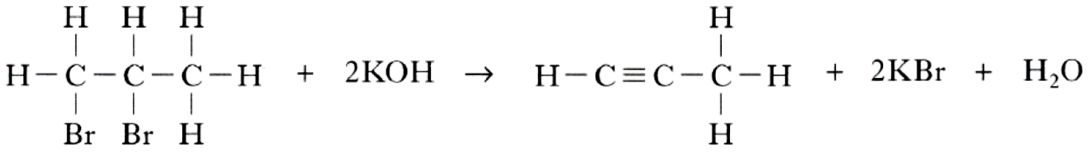
(b) The boiling points of four consecutive members of the alkyne series are shown in the table.

name of alkyne	boiling point/ºC
propyne	-23.2
butyne	8.1
pentyne	
hexyne	71.2
heptyne	100

(i) Predict the boiling point of pentyne and suggest a method to separate a mixture of pentyne and hexyne. **[2]**

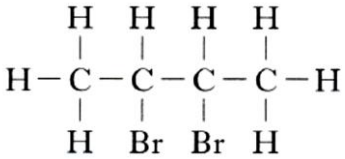
(ii) State and explain the trend of the boiling points down the table. **[2]**

(c) Alkynes can be prepared by reacting a dibromoalkane with potassium hydroxide solution. An equation for the reaction is shown.



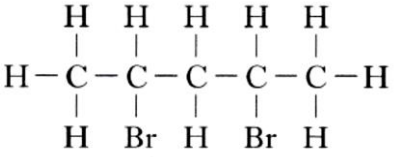
dibromoalkane propyne

Another dibromoalkane shown below also reacts with potassium hydroxide solution.



(i) Draw the full structural formula of the alkyne formed. **[1]**

(ii) Predict whether the dibromoalkane shown below forms an alkyne when it is added to potassium hydroxide solution. Explain your answer. **[2]**



(d) Pentyne is also a member of the alkyne homologous series with 5 carbon atoms. **[2]**

Draw the full structural formulae of two isomers of pentyne.

[Total: 10 marks]

OR

B9 Fluorine, chlorine, bromine and iodine are elements found in Group 17 of the Periodic Table. Some trends that can be observed as we go down Group 17 are atomic radius and ionic radius.

Table 1 below shows the atomic and ionic radii of halogens.

halogen	atomic radius/ nm	ionic (X^-) radius/ nm
F	0.071	0.133
C*l*	0.099	0.181
Br	0.114	0.196
I	M	0.220

Table 1

Electron affinity, shown in Table 2 below, is a measure of the attraction between the incoming electron and the nucleus. The first electron affinity is the energy change when 1 mole of gaseous atoms gain an electron to form 1 mole of gaseous ions. The reaction can be shown in an equation below:

$$X\ (g) + e^- \rightarrow X^-\ (g)$$

Table 2 shows the first electron affinities of Group 17 elements.

halogen	first electron affinity/ (kJ/mol)
F	-328
C*l*	-349
Br	-324
I	-295

Table 2

(a) **(i)** Use the information in Table 2 to sketch an energy profile diagram when a fluorine atom gains an electron to form a fluoride ion. **[3]**

Label E_a and ΔH in your energy profile diagram.

(ii) From Table 2, state the general trend observed in the first electron affinities going down Group 17. **[1]**

(b) **(i)** Using Table 1, suggest why the atomic size of the atoms increases down the group and hence use this knowledge to explain the pattern described in **(a)(ii)**. **[2]**

(ii) Suggest a value for the atomic radius for iodine, I. **[1]**

M = _____

(c) A sample of chlorine gas is bubbled into aqueous sodium iodide.

(i) What will be observed in this reaction? **[1]**

(ii) Explain your observations. **[2]**

Support your answer with a suitable ionic equation.

_____

_____

_____

[Total: 10 marks]

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.