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, index 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

Answer **one** question.
Write your answers in the spaces provided.
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.

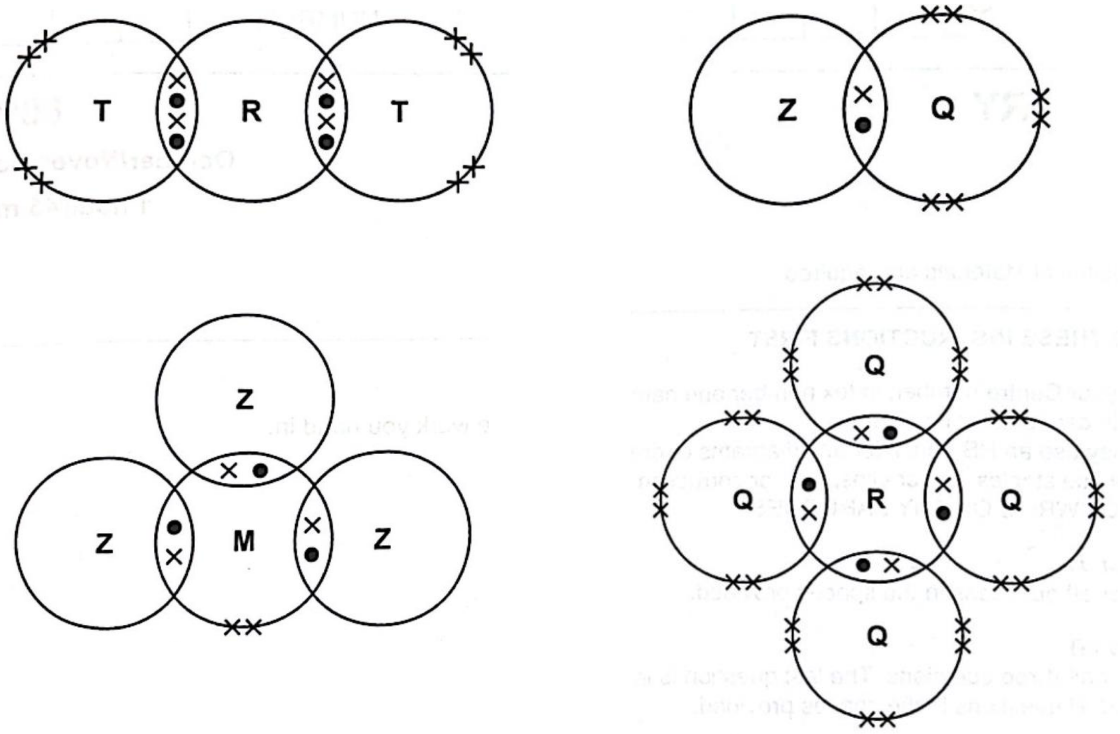
For Examiner's Use		
Section A		
Section B		
Deductions	Significant Figures	
	Units	

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]**

Q or Z

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

Z

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

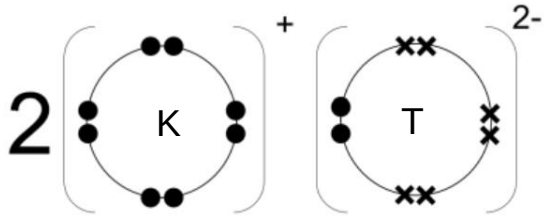
M or Q or R

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

M

(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.



Correct charge – [1], correct ratio – [1]

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

High mp/bp (✓) – **strong electrostatic FOA between oppositely charged ions (✓)** and hence **large amount of energy (✓)** to overcome.

OR

Good electrical conductor (✓) in **aqueous/molten (✓)** state – **ions are mobile (✓)** to conduct electricity

OR

Poor electrical conductor (✓) in **solid (✓)** state – **ions are in fixed positions (✓)** and cannot conduct electricity

3 (✓) – [2], 1 – 2 (✓) – [1]
Allow ecf if the properties match the dot and cross diagram

[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 any formulae.

formulae of salt	formulae of reagent 1	formulae of reagent 2	method of preparation
$CaCO_3$ (s)	**$Ca(NO_3)_2$, $CaCl_2$ (must be aqueous) (✓)**	**Group I/ammonium carbonate (aq) (✓)**	**Precipitation (✓)**
Ag_2SO_4 (s)	**Ag_2CO_3 (s)/ Ag_2O (s), AgOH (s) (✓)**	H_2SO_4 (aq)	Adding excess solid to acid evaporation and crystallisation
NH_4NO_3 (s)	HNO_3 (aq)	**NH_3 (aq) (✓)**	**Titration (✓)** evaporation and crystallisation

6(✓) – [5], 5(✓) – [4], 3 – 4 (✓) – [3], 2 (✓) – [2], 1 (✓) – [1]
Formula and state symbols must be correct to be given (✓).

[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]**

$2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

(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.

NO_2 is oxidised as the O.S of N increases from +4 to +5 in HNO_3. **[1]**

NO_2 is reduced as the O.S of N decreases from +4 to +3 in HNO_2 **[1]**

(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]**

Oxides of nitrogen are formed at **high temperatures (✓)** when **large amount of energy (✓)** is absorbed to break the **N-N triple bonds (✓)** in N_2.

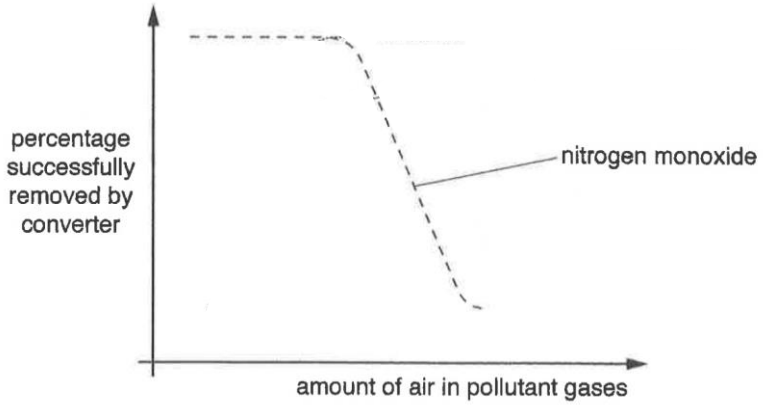
3 (✓) – [2]; 1 – 2 (✓) – [1]

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

Oxides of nitrogen **react with carbon monoxide to form nitrogen gas and carbon dioxide. [1]**

$2NO + 2CO \rightarrow N_2 + 2CO_2$ [1]

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.**



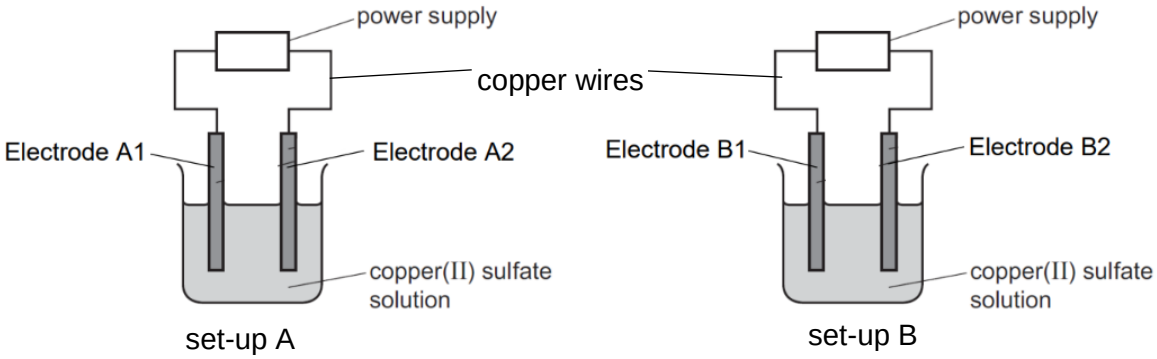
(iii) Using the equation in **(ii)** and the graph above, explain why the percentage of nitrogen monoxide successfully removed by catalytic converter decreases as the amount of air increases. **[2]**

As amount of air increases, carbon monoxide will react with **more oxygen** to **form carbon dioxide [1]**.

Lesser CO present to react with NO [1] and hence lesser NO will be successfully removed from catalytic converter.

[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 **electrons**

(ii) copper(II) sulfate solution **Ions** **both (✓) to get [1]**

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

Set-up A: **A1** Set-up B: **B1** **both (✓) to get [1]** **[1]**

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

Copper(II) ions gain electrons OR are **discharged/reduced preferentially** to form **copper solid. [1]**

Cu^{2+} (aq) + 2e → Cu (s) [1]

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

Half-equation at A2: **$4OH^-$ (aq) → $2H_2O$ (l) + O_2 (g) + 4e** **[1]**

Half-equation at B2: **Cu (s) → Cu^{2+} (aq) + 2e** **[1]**

(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]**

Cu^{2+} and OH^- ions are preferentially discharged, leaving behind **H^+ ions [1]** and hence

pH of solution will become acidic/pH will decrease from pH 7 to below 7 [1].

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

(i) Set-up A: **carbon/graphite**

(ii) Set-up B: **copper** **both (✓) to get [1]**

[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]**

No. of moles of acid = 0.10 x $\frac{100}{1000}$ = 0.0100 mol

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

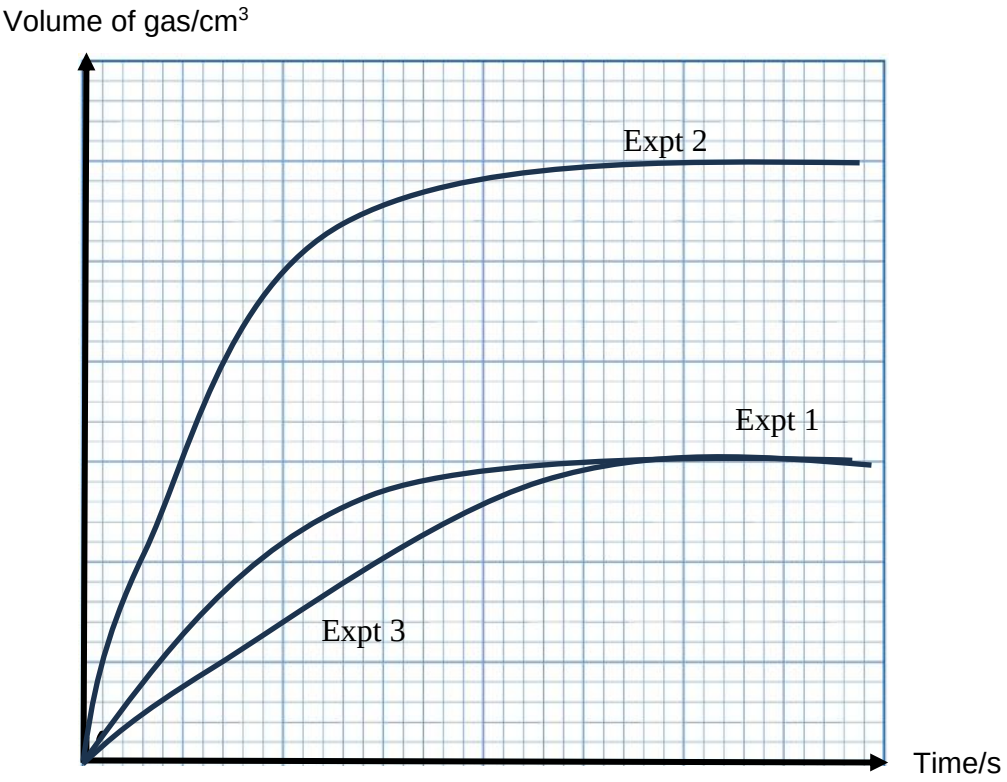
$2HCl + Zn \rightarrow ZnCl_2 + H_2$
No. of moles of H_2 = 0.0100 ÷ 2 = 0.005 mole [1]

Volume of gas = 0.005 x 24 dm^3 = 0.120 dm^3/ 120 cm^3 [1]

No ECF with (ii)

(iii) The graph below shows the graph for Experiment 1. Label the volume of gas found in **(a)(ii)** in the axes below. **[1]**
Hence, sketch the graph for Experiment 2 and label it as **Expt 2**.

Faster speed and twice the yield [1]



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

$2CH_3COOH + Zn \rightarrow Zn(CH_3COO)_2$ or $(CH_3COO)_2Zn + H_2$

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

Slower speed **[1]**
Same yield **[1]**

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

Speed of reaction is slower/Graph is less steep than Expt 1 as **ethanoic acid is a weak acid (✓) that dissociates partially in water(✓)** to form **lower concentration of H^+ ions. (✓)**

Frequency of effective collisions is lower (✓) and hence speed is slower.
4 (✓) – [2]; 2 – 3 (✓) – [1] , 1 (✓) – [0]

Volume of gas formed is the same as Expt 1 as the **number of moles of acid used or concentration and volume of acid remains unchanged [1].**

(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: **0.10 mol/dm^3** (2dp as per table) **[1]** N: **100 cm^3** **[1]**
Number of moles of acid must be 0.01 mol.
No units needed.

[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]**

- Has a relatively **low density** of 2.99 g/cm^3;
- Has a relatively **low melting point** of 419℃.
- **Does not have variable oxidation states/forms only Zn^{2+}** (only forms one chloride / oxide)
- **Does not form coloured compounds** since zinc chloride is white.

Any 2 – [2]

Note : Do not accept zinc has only one charge / has a lower bp or mp than transition metals

(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.

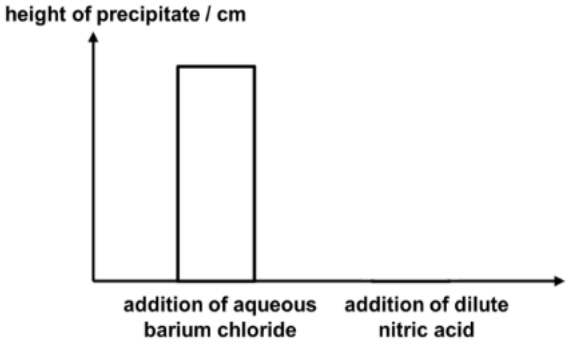
Add **aqueous ammonia (✓)** into the solution; **[1]**

If zinc ions are present, a **white precipitate (✓)** will form; ppt **dissolves in excess aqueous ammonia. (✓) [1]**

(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.

Don't agree with student.
Upon adding of barium chloride, ppt formed could be due to sulfate or carbonate ions. (✓)

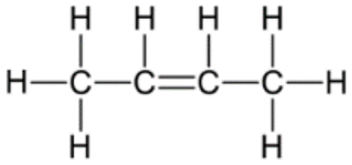
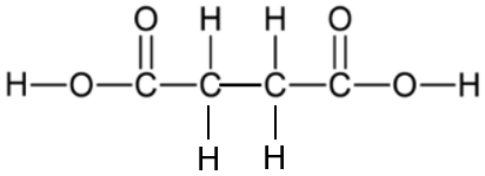
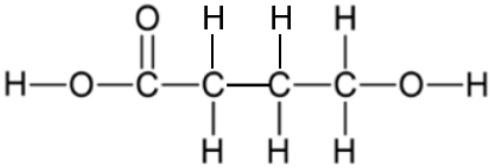
Height of ppt decreases/ppt dissolves upon adding nitric acid (✓) and this means that the **ppt reacted with nitric acid. (✓)**

Hence the **ppt could be $BaCO_3$** which reacted with acid since **$BaSO_4$ (✓) cannot react with acid.**

4 (✓) – [3]; 2 – 3 (✓) – [2], 0 – 1 (✓) – [1]

[Total: 7 marks]

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

organic compound	structure of compound
W	
X	
Y	

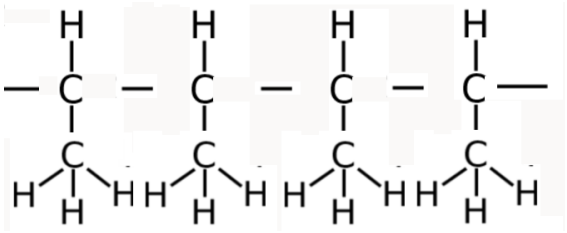
(a) (i) State the compound that can undergo addition polymerisation and condensation polymerisation on its own respectively. **[2]**

Addition polymerisation: **W**

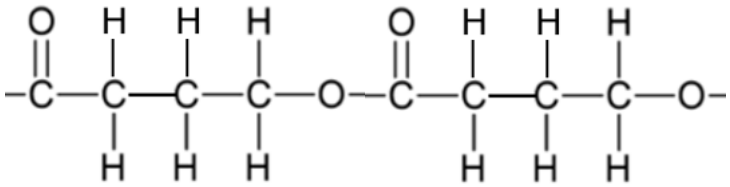
Condensation polymerisation: **Y**

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

Addition Polymer:



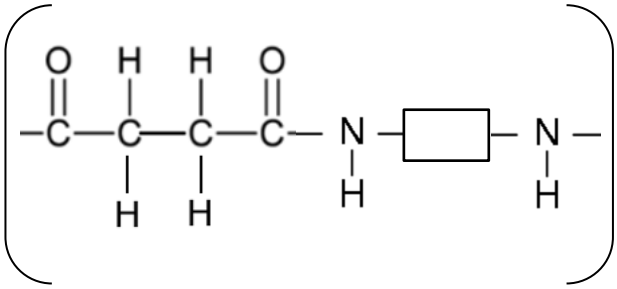
Condensation Polymer:



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

Draw any di-ol or di-amine
(all bonds must be correct and can accept a shape to represent alkyl group)

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



n

Note : Repeat unit is not accepted.

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

water

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

Heat in (reflux) **(✓)** both compounds with **aqueous acidified potassium manganate(VII) (✓)**.

Purple solution decolourises with Y (✓) but not with X.

3(✓) – [2]; 1 – 2 (✓) – [1]

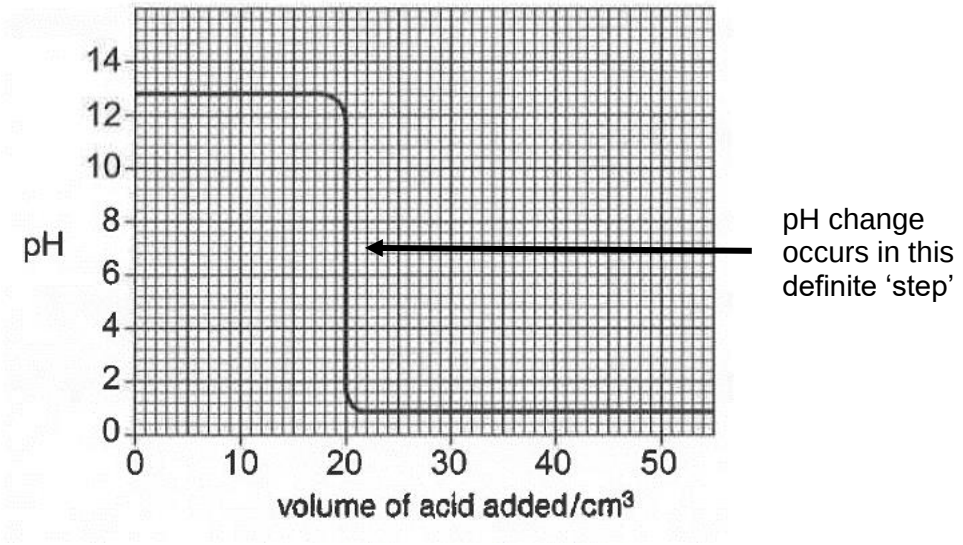
(ii) Name a reagent that can be used to differentiate organic compound W from compounds X and Y. **[1]**

Aqueous bromine (Note : bromine gas and bromine water are not accepted)

[Total: 10 marks]

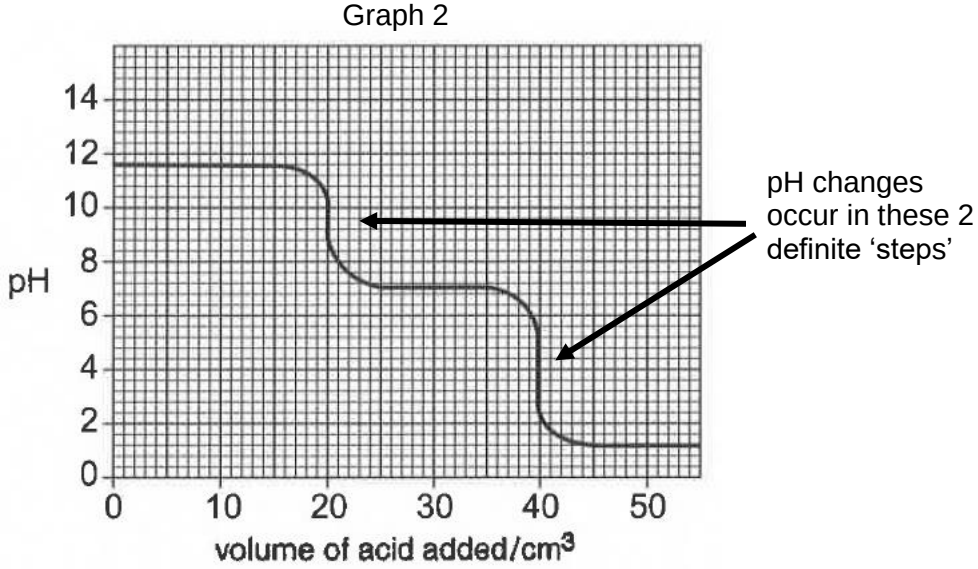
A8 A pH probe attached to a computer measures pH changes during some titration experiments.
In experiment 1, 0.1 mol/dm^3 of hydrochloric acid was added from a burette to 25.0 cm^3 of dilute sodium hydroxide. The pH probe measured the pH during the experiment.
Graph 1 shows the results.

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

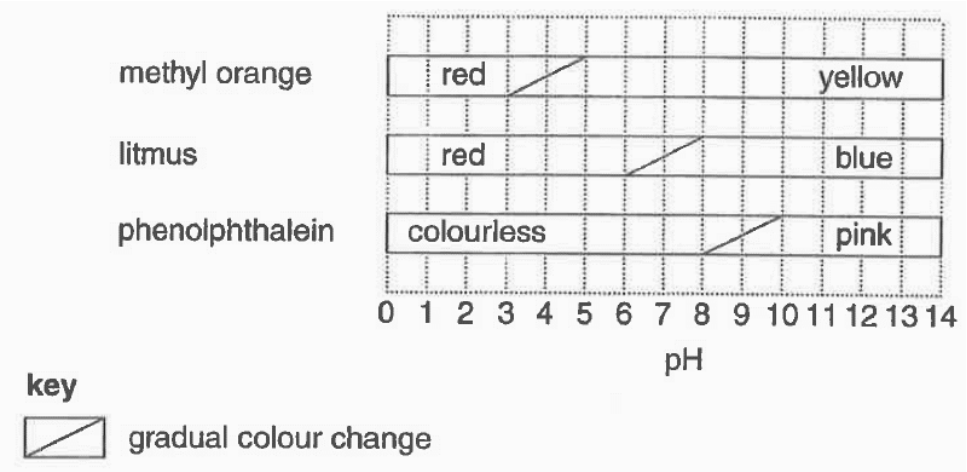


The reaction between sodium carbonate and hydrochloric acid happens in two stages.

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.

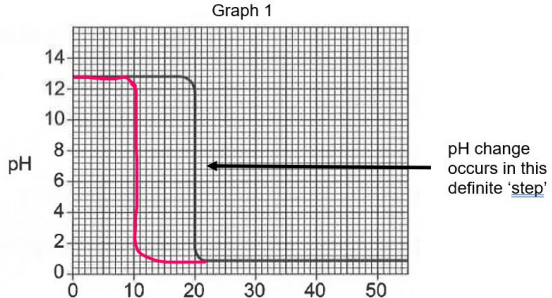
(a) Use the information to calculate the concentration of sodium hydroxide used in Experiment 1. **[2]**

No. of moles of acid = 0.1 x $\frac{20}{1000}$ = 0.002 mol **[1]**
No. of moles of NaOH = 0.002 mol
Concentration of NaOH = 0.002 ÷ $\frac{25.0}{1000}$ = 0.08/ 0.0800 mol/dm^3 **[1]**

(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]**

The starting pH of sodium hydroxide is at pH 12.4 while the starting pH of sodium carbonate is 11.6/starting pH of sodium hydroxide in Expt 1 is higher than that of sodium carbonate in Expt 2. [1]

One definite step/one pH drop in Experiment 1 but there are two definite steps/two pH drops in Experiment 2. [1]

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

Sodium chloride, NaC*l*

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

Vertical portion of graph range pH 8.4 – 10.4

(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]**

The **definite step for stage 1 in Experiment 2 occurs between pH 8 – 10 (✓)**, **Phenolphthalein (✓) is a suitable indicator as the colour change for the indicator is also between pH 8 – 10 (✓)** which coincides with the definite step.

3 (✓) – [2]; 1 – 2 (✓) – [1]

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

$NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

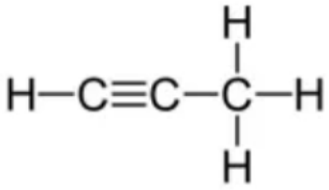
[Total: 10 marks]

Section B (10 Marks)

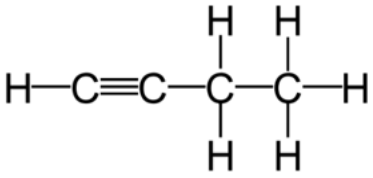
Answer only ONE question in this section.

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.

-C≡C- , C_2H_2

(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]**

35ºC – 45ºC inclusive [1],
fractional distillation [1]

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

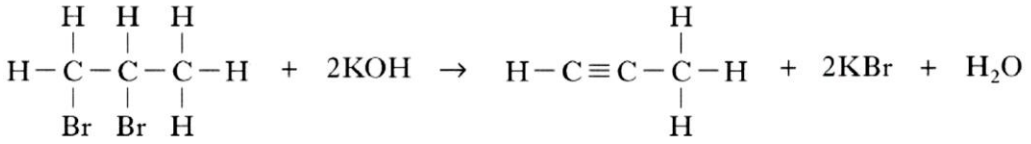
Boiling points increase (✓) down the table as the **molecular mass/molecular size /number of carbon atoms increase**. **(✓)**

Strength of intermolecular forces of attractions increases. (✓)

Higher amount of heat energy (✓) required to overcome the IMFOA

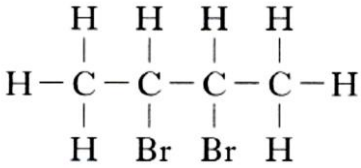
4 (✓) – [2]; 2 – 3 (✓) – [1]; 1 (✓) – [0]

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

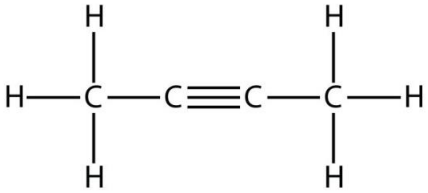


dibromoalkane propyne

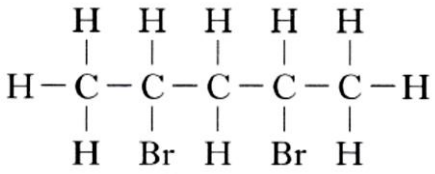
Another dibromoalkane shown below also reacts with potassium hydroxide solution.



(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]**

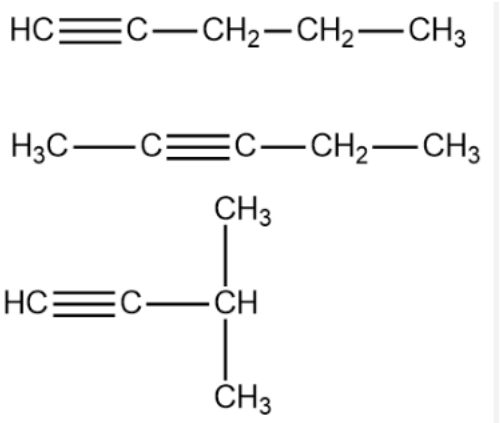


It will not form an alkyne as the **two bromine atoms are not on consecutive carbon atoms/ two carbon atoms that are side by side [1]**

unable to remove a Br_2 molecule/ 2 bromine atoms [1] to form the C-C triple bond.

(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.



Any acceptable structural formula

[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.

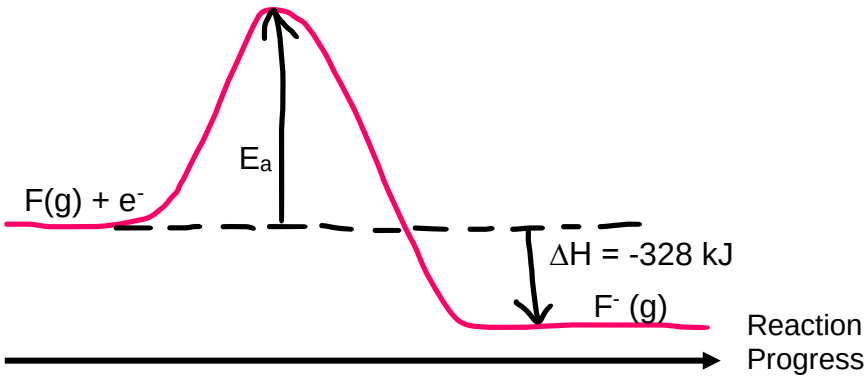
Halogen	first electron affinity/ (kJ/mol)
F	-328
C*l*	-349
Br	-324
I	-295

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.

Energy



E_a and ΔH – [1], exothermic – [1], reactants and products – [1]

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

The electron affinities decrease/less exothermic down the group [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]**

Atomic radius increases /number of electron shells increase down the group. **[1]**
The **attractions between the nucleus and the incoming/valence electron decreases** when an atom gains electrons. **[1]**

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

M = **0.130 – 0.140 [1]**

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

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

Colourless solution turns brown/reddish brown/ black ppt forms. [1]

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

Support your answer with a suitable ionic equation.

Chlorine is **more reactive than iodine (✓)** and hence it **displaces iodine (✓)** from sodium iodide. **[1]**

Cl_2 (g) + $2I^-$ (aq) → $2Cl^-$ (aq) + I_2 (aq/s) [1]

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2 (✓) for 1 mark

Max [1]mark with no ionic equation

[Total: 10 marks]

13	14	15	16	17	18
					2 He helium 4
5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
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
31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –