Name: …… Register no: ……..… Class: ……..….

NGEE ANN SECONDARY SCHOOL NA

PRELIMINARY EXAMINATION

SCIENCE **5105/04**

Paper 4 Chemistry

2 August 2024

Candidates answer on the Question Paper. **Papers 3 and 4: 1 hour 15 minutes**

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

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

The use of an approved scientific calculator is expected, where appropriate.
In calculations, you should show all the steps in your working, giving your answer at each stage.
You are advised to spend no longer than 30 minutes on Paper 3.
You may proceed to answer Paper 4 as soon as you have completed Paper 3.
A copy of the Periodic Table is printed on page 2.

At the end of the examination hand in your answers to Paper 3 and Paper 4 separately.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use

Section	Marks
Paper 3	/20
Paper 4 – Section A	/22
Paper 4 – Section B	/8
Total	/50

Check by student: _____ Date: _____

This document consists of **13** printed pages and **1** blank pages.

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}.

Section A

Answer **all** questions.

1. Choose from the substances listed to answer the questions.

NH_4Cl

Na_2CO_3

Al_2O_3

CH_3Cl

K_3PO_4

Each substance may be used once, more than once or not at all.

Identify the substance which

(a) reacts with both acid and alkali to form salt and water.

…… [1]

(b) contains a total of eight atoms.

…… [1]

(c) reacts with aqueous sodium hydroxide to produce a gas which turns moist red litmus paper blue.

…… [1]

[Total: 3 marks]

2. A student measures accurately a fixed volume of 25.0 cm^3 of a known concentration of dilute hydrochloric acid into a glass beaker. She measures the initial temperature of the hydrochloric acid. She then adds 30.0 cm^3 of excess potassium hydroxide into the acid and stirs. The final temperature of the mixture is recorded.

(a) State the type of apparatus or instrument that the student used to measure the following quantities:

25.0 cm^3 of dilute hydrochloric acid ……..

30.0 cm^3 of potassium hydroxide …….

temperature of the solutions ……..

[2]

(b) Figure 2.1 shows initial and final temperatures recorded.

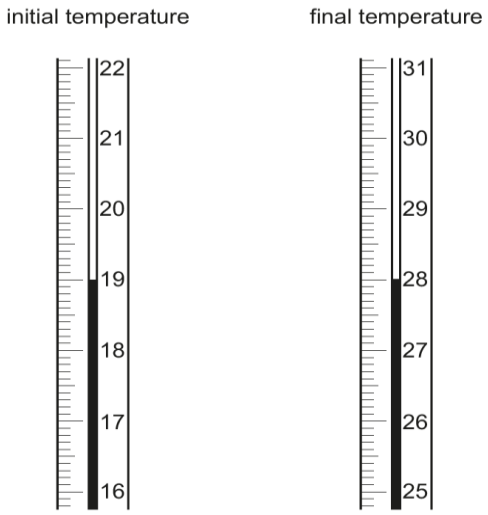


Fig. 2.1

Use the information provided in Fig. 2.1 to complete Table 2.1.
Indicate whether the temperature change is a positive (+) or negative (–) value.
The initial temperature has been recorded in the table. [2]

initial temperature / ^oC	19.0
final temperature / ^oC	
temperature change / ^oC (final temperature – initial temperature)	

Table 2.1

(c) Write an ionic equation, including state symbols, for the reaction of dilute hydrochloric acid and aqueous potassium hydroxide.

…… [1]

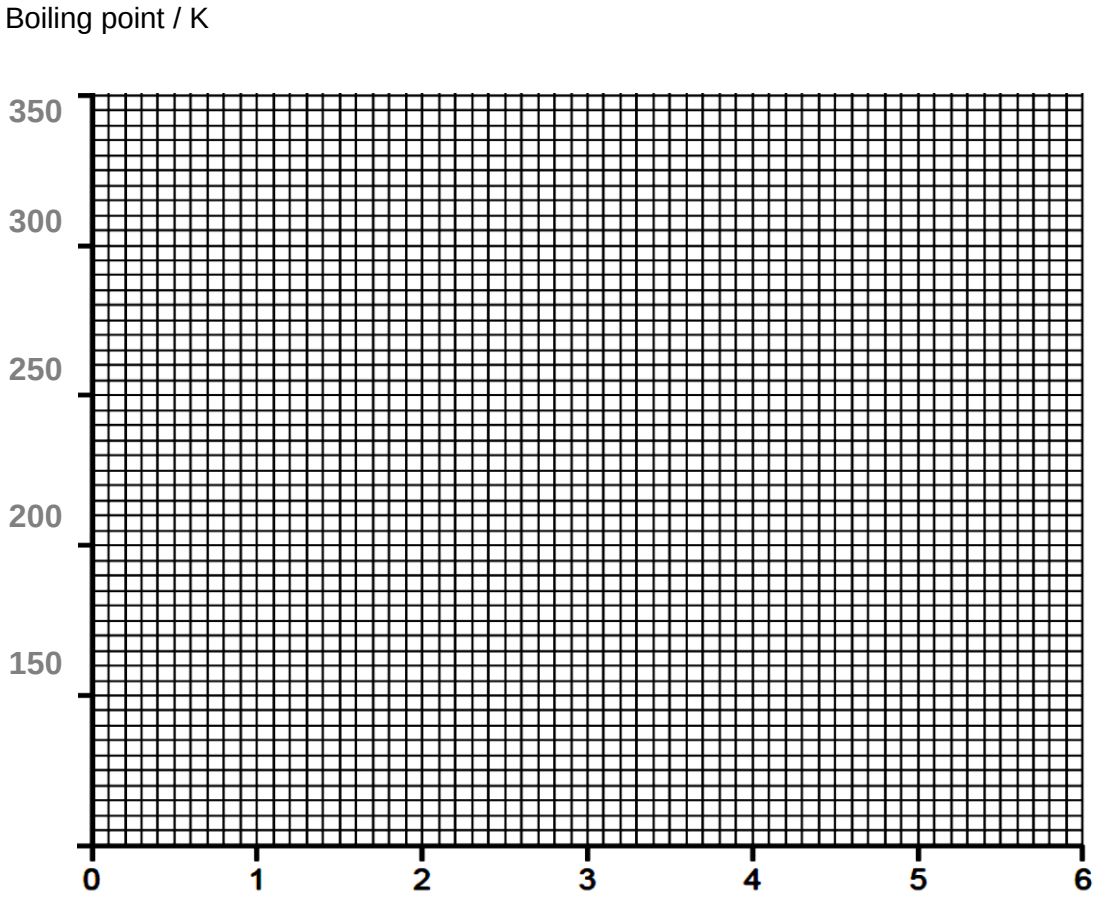
[Total: 5 marks]

3. Table 3.1 shows the boiling points in Kelvin of five alkenes, **A**, **B**, **C**, **D** and **E**.

Hydrocarbon	**A**	**B**	**C**	**D**	**E**
Number of carbon atoms per molecule	2	3	4	5	6
Boiling point / K	160		267	303	337

Table 3.1

(a) Plot a graph of boiling point against number of carbon atoms for these alkenes, marking each point with a cross (x).
Draw a best-fit line for the points plotted. [2]



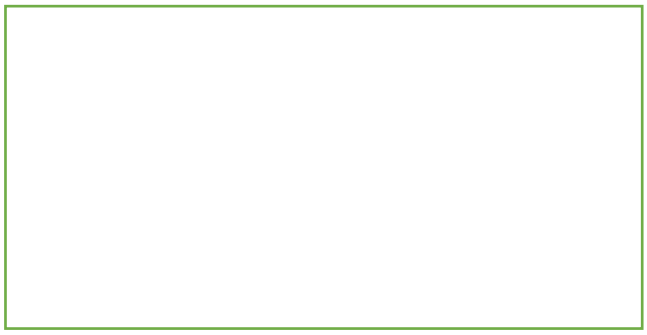
(b) From the graph, find the boiling point of alkene **B**.

…… [1]

(c) **(i)** Alkene **A** was reacted with aqueous bromine. State an observation made during this reaction.

…… [1]

(ii) Draw the full structural formula of the product obtained when alkene **A** reacts with bromine. [1]



(d) Propene can be produced by cracking long chain alkanes.
Pentadecane, $C_{15}H_{32}$, is cracked to produce a hydrocarbon, **R,** and propene respectively. The reaction is shown in the chemical equation below.

$$C_{15}H_{32} \longrightarrow \mathbf{R} + 2C_3H_6$$

Write the molecular formula of **R**.

……..…… [1]

[Total: 6 marks]

4. **(a)** Describe in terms of arrangement and movement, how chlorine molecules behave differently when chlorine is above its boiling point and when it is below its melting point.

above boiling point: ……

...…….....

below melting point: ……..…...

…….. [2]

(b) A sample of chlorine gas contains two different isotopes of chlorine atoms. Each chlorine atom can become a chloride ion.

Complete the table to describe the composition of the chlorine atom and the chloride ion.

particle	number of		
	protons	neutrons	electrons
a chlorine atom, $^{37}_{17}Cl$	17		
a chloride ion, $^{35}_{17}Cl^-$	17		

[1]

In an experiment, 6.5 g of zinc granules and excess dilute hydrochloric acid are allowed to react together in a beaker to produce zinc chloride solution and a gas.

(c) Write a balanced chemical reaction for the reaction between zinc and dilute hydrochloric acid.

…… [1]

(d) Calculate the number of moles of zinc that has reacted.

Number of moles of zinc = …… [1]

(e) The experiment was repeated using aluminium metal and dilute hydrochloric acid. It was found that 0.05 moles of aluminium chloride, $AlCl_3$, was produced during the experiment.
Calculate the mass of aluminium chloride, $AlCl_3$, produced.
[Relative atomic masses, A_r : Al, 27; Cl, 35.5]

Mass of $AlCl_3$ produced = …… [2]

(f) In another similar experiment, excess zinc granules was used instead of dilute hydrochloric acid. How can the excess zinc granules be removed from the reaction mixture at the end of the reaction?

…… [1]

[Total: 8 marks]

Section B

Answer **one** question from this section.

5. (a) Lithium reacts with sulfur to form lithium sulfide. Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons for the compound lithium sulfide.

[2]

(b) Give one similarity and one difference in physical property between the elements lithium and sulfur.

Similarity: …….....

……..…

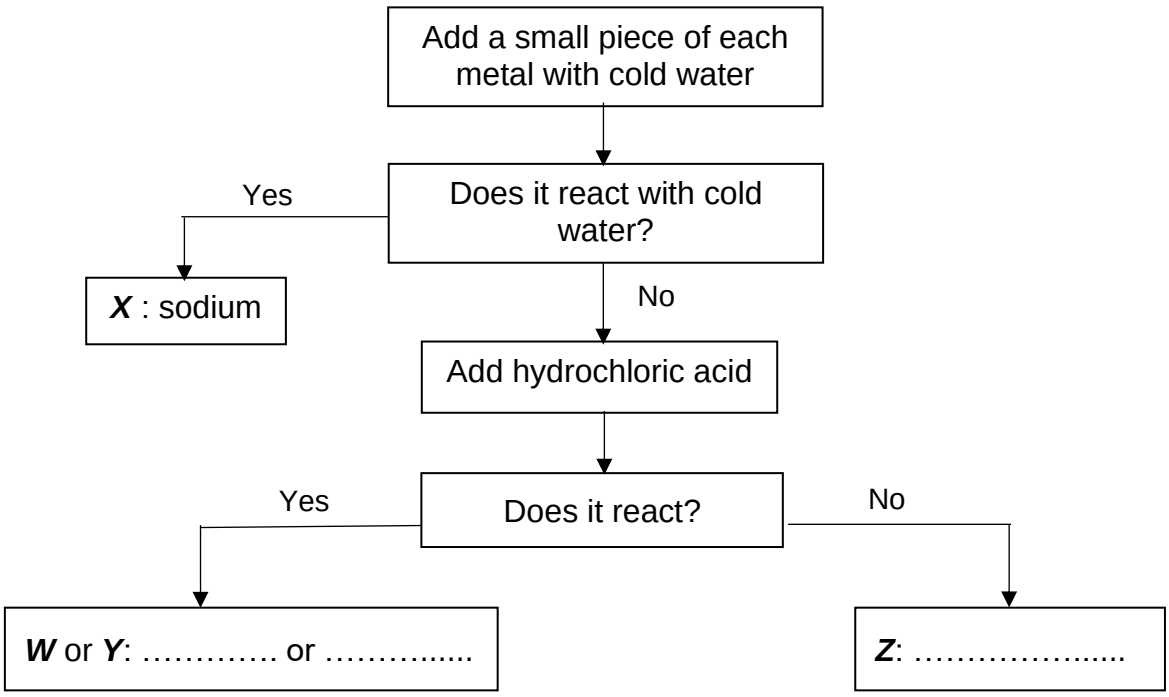
Difference: ..……..……

……...

..…… [2]

(c) A chemist was given four metals labelled ***W***, ***X***, ***Y*** and ***Z***. He had to identify which one was copper, iron, sodium or zinc. To do so, he carried out a series of experiments.

The flow chart below summarises what the chemist did.



(i) Fill in the blanks for ***W***, ***Y*** and ***Z*** in the chart. [1]

(ii) Sodium reacts with cold water to produce a solution. A few drops of Universal Indicator were added to the solution. A colour change was observed.

State the colour change observed.

…….. [1]

Explain your observation of the colour change stated.

……..

……..…… [1]

(d) Zinc and copper reacts separately in oxygen to produce their respective oxides. Identify the type of oxide each metal produced. [1]

metal	**type of oxide**
zinc	
copper	

[Total: 8 marks]

6. Hydrocarbons can get into the air from the incomplete combustion of fuels such as petrol, kerosene or diesel. Unburnt hydrocarbons in the air is an air pollutant which causes health concerns. The concentration of hydrocarbons in the air in a city from 1984 to 1995 was measured and recorded. The concentration measured is in parts per billion (ppb).

From the data collected, a graph is plotted of concentration/ppb of hydrocarbons against year. The graph is shown in Figure 6.1 below.

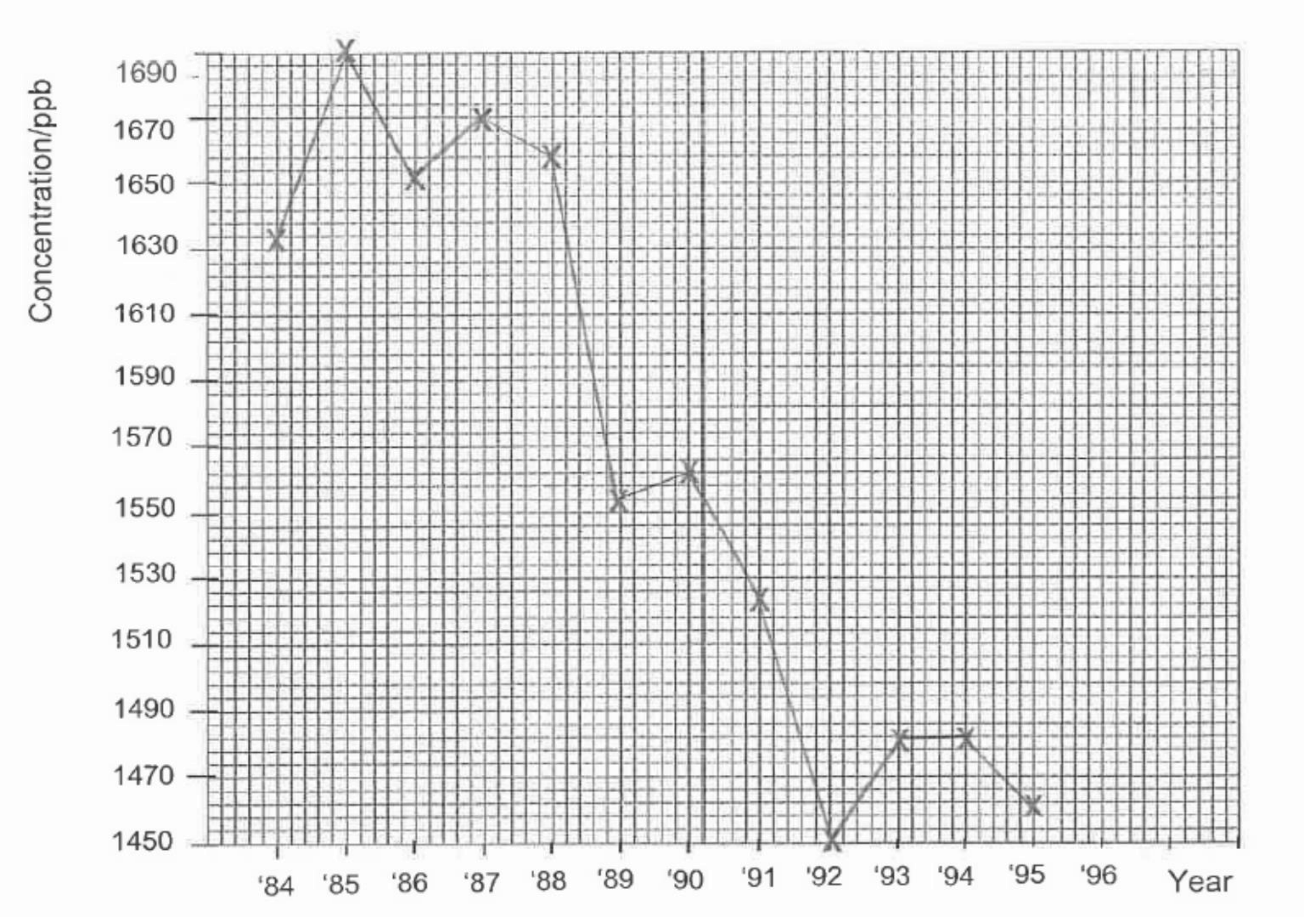


Fig. 6.1

(a) Cars are now manufactured with catalytic converters to remove hydrocarbons from exhaust gases.

Based on your graph in Fig. 6.1, deduce the year in which it became compulsory for cars to be fitted with catalytic converters. Explain your answer.

……

……

…… [2]

(b) Unburnt hydrocarbons contain mainly octane, C_8H_{18}. The following reaction occurs when unburnt hydrocarbons pass through a catalytic converter.

$$2C_8H_{18}(g) + \boldsymbol{x}O_2(g) \longrightarrow \boldsymbol{y}CO_2(g) + 18H_2O(g)$$

(i) What are the values of ***x*** and ***y***?

x …… ***y*** …… …… [1]

(ii) Draw a 'dot' and 'cross' diagram of a molecule of carbon dioxide, showing only outer shell electrons. [2]

(c) (**i**) Poly(propene) is an example of a non-biodegradable plastic which leads to a build-up of plastic waste in landfills, and contributes to land pollution.

However, plastics can now be recycled using a chemical method.
Give an example of a chemical method.
Briefly describe the method named.

……

……...

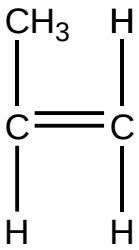
……...

……....

……...

…… [2]

(ii) Poly(propene) is an addition polymer formed from the propene monomer. The structure of propene is shown below.



Draw the structural formula of two repeating units of poly(propene). Show all bonds in your answer.

[1]

[Total: 8 marks]

---End of Paper 4---

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2024 4NA Science Chemistry Prelim

Suggested Answers

Paper 3: MCQ [20 marks]

1	2	3	4	5	6	7	8	9	10
B	C	C	A	D	A	D	C	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	D	A	B	C	B	D	C	C	A

Paper 4: Section A: Structured Questions [22marks]

1. (a) reacts with both acid and alkali to form salt and water. **Al_2O_3** [1]

   (b) contains a total of eight atoms. **K_3PO_4** [1]

   (c) reacts with aqueous sodium hydroxide to produce a gas which turns moist red litmus paper blue. **NH_4Cl** [1]

   [Total: 3 marks]

2. (a) 25.0 cm^3 of dilute hydrochloric acid **pipette**
   30.0 cm^3 of potassium hydroxide **measuring cylinder / burette**
   temperature of the solutions **thermometer** [2]

   [3 correct – 2m; 2 correct – 1m; 1 or 0 correct – 0m]

   (b)

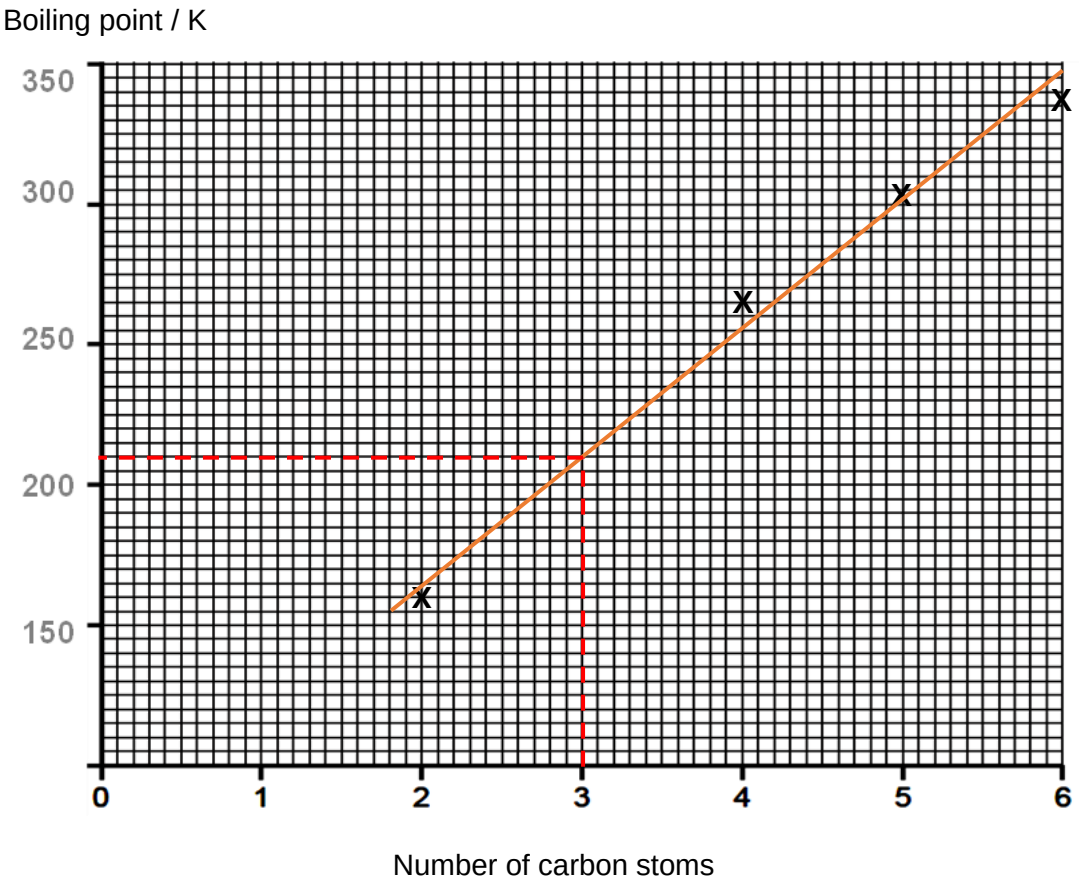
initial temperature / ^oC	19.0
final temperature / ^oC	**28.0**
temperature change / ^oC (final temperature – initial temperature)	**+9.0**

   [final temperature & temperature change correct with (+) sign – 1m each] [2]
   [deduct 1m each for reading without 1 dec place and no (+) sign]

   (c) **$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$** [1]

   [Total: 5 marks]

3. (a)

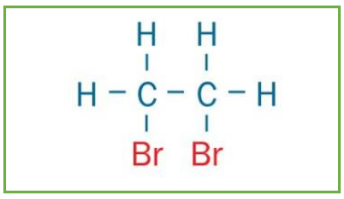


[1m for all points plotted correctly; 1m for best-fit line] [2]

(b) ~ 210 K (± 10K) (*based on student's graph*) [1]

(c) (i) The **reddish-brown colour** of aqueous bromine was **decolourised**/ the aqueous bromine turns **from reddish-brown to colourless**. [1]

(ii)



[1]

(d) **R** is C_9H_{20} [1]

[Total: 6 marks]

4. (a) above boiling point: **chlorine molecules are <u>far apart</u> and <u>moving rapidly in all directions/ moving randomly at great speeds</u>** [1]

below melting point: **chlorine molecules are <u>closely packed in an orderly manner and vibrate at their fixed positions</u>** [1]

(b)

particle	number of		
	protons	neutrons	electrons
a chlorine atom, $^{37}_{17}Cl$	17	***20***	***17***
a chloride ion, $^{35}_{17}Cl^-$	17	***18***	***18***

[all correct – 1m]

(c) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ [1]

(d) Number of moles of zinc reacted = $\frac{6.5}{65}$ = **<u>0.100 mol</u>** [1]

(e) Relative formula mass of M_r of $AlCl_3$ = 27.0 + 3(35.5)
= **133.5** [1]

Mass of $AlCl_3$ produced = number of moles x M_r
= 0.05 x 133.5 = 6.675
= **<u>6.68 g</u>** [1]

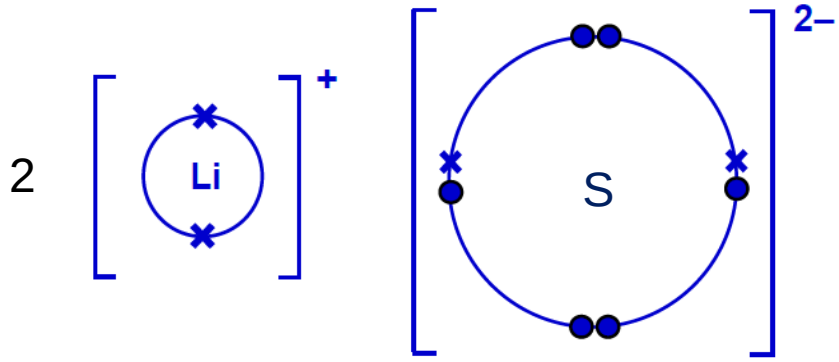
(f) The excess zinc granules can be removed by **filtering (or by filtration)** from the reaction mixture. [1]

[Total: 8 marks]

Section B [8 marks]

Answer **one** question from this section.

5. (a) (i)



[2]

[1m for correct electronic structure and '+' charge for $2Li^+$ drawn;
1m for correct electronic structure and '2–' charge for S^{2-} drawn.]

(b) **Similarity**: Both elements are solids at room temperature. [1]

Difference: Lithium conducts electricity while sulfur does not conduct electricity. [1]

(c) (i) ***W*** or ***Y***: **iron or zinc** and ***Z***: **copper** [1m for both answers] [1]

(ii) Colour changes from **green to blue/purple/violet**. [1]

Sodium reacts with water to **produce an alkaline solution**. [1]

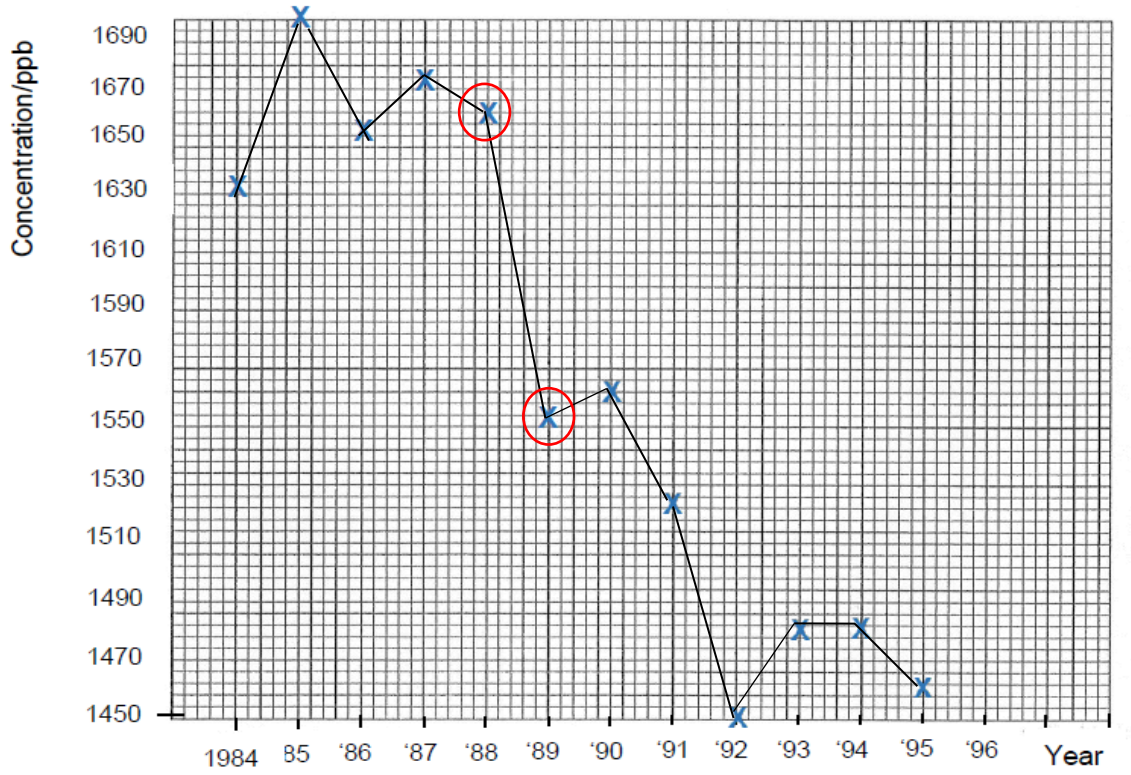
(d)

metal	type of oxide
zinc	***amphoteric***
copper	***basic***

[1m for both answers correct]

[Total: 8 marks]

7.

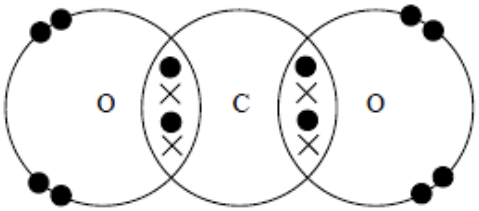


(a) Year **1988**. [1]

Based on the graph, there was **a highest/largest drop of concentration of hydrocarbons from 1988 to 1989**, as the catalytic converters converted the hydrocarbons to carbon dioxide and water vapour. [1]

(b) (i) ***x*** : **25** ***y*** : **16** [1]

(ii)



● : electron of O

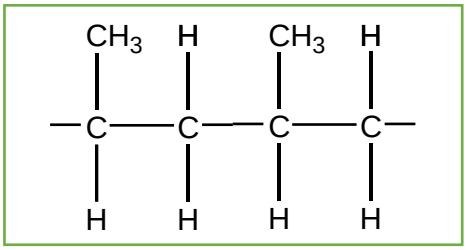
× : electron of C

[1m for correct shared paired of electrons; 1m for correct lone pairs of electrons for O] [2]

(c) (i) Plastic can be recycled using the **cracking process**. [1]

Plastic waste undergo cracking to **form smaller molecules of alkanes and alkenes**. This process **requires high temperature and presence of catalyst**. [1]

(ii)



[1]

[Total: 8marks]