



YUHUA SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2022

SECONDARY FOUR EXPRESS

4E	CANDIDATE NAME			
	CLASS		INDEX NUMBER	

CHEMISTRY

6092/02

Paper 2

25 August 2022
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

Setter: Ms Cerenna Ng

READ THESE INSTRUCTIONS FIRST

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

Section A

Answer **all** questions in the spaces provided.

Section B

Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
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 **21**.
The use of an approved scientific calculator is expected, where appropriate.

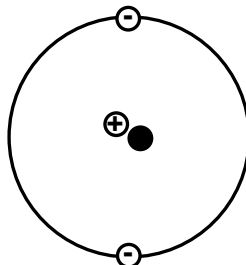
For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

2
Section A (50 marks)

Answer **all** the questions in the spaces provided.

- 1 Deuterium is an isotope of hydrogen.

The diagram shows the structure of an ion of deuterium.



- (a) Complete the following table to show the names and charges of the particles in this deuterium ion.

symbol	name	charge
●	neutron	
⊕		+1
⊖		-1

[1]

- (b) Using the symbol **D** to represent deuterium, give the chemical formula of

(i) the ion shown above; [1]

(ii) the compound formed between deuterium and sodium. [1]

- (c) Would you expect the oxide of deuterium to be a solid, a liquid or a gas at room temperature and pressure? Explain your reasoning.

.....

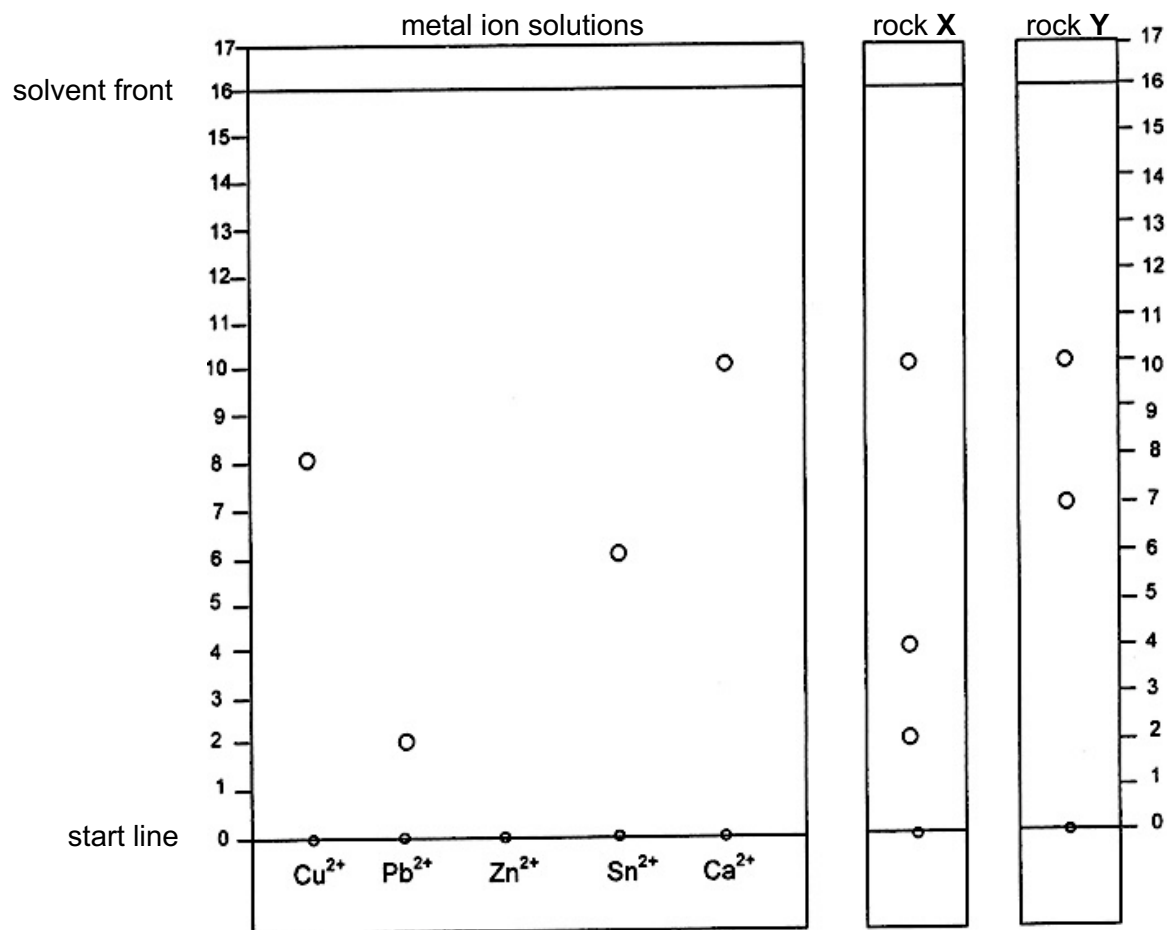
..... [2]

[Total: 5]

- 2 Two samples of rocks, **X** and **Y**, were tested to find out if they originated from the same region.

The rock samples were crushed and a suitable acid was added to dissolve impurities in the rock samples. The resulting solutions from the mixtures were chromatographed, together with five known metal ions.

The diagram shows the chromatograms after spraying with a locating agent.



- (a) State why a locating agent was used.

.....
[1]

- (b) Deduce if the two samples of rock were from the same region. Give a reason for your answer.

.....

[2]

4

- (c) Calculate the R_f value for Pb^{2+} ions.

[1]

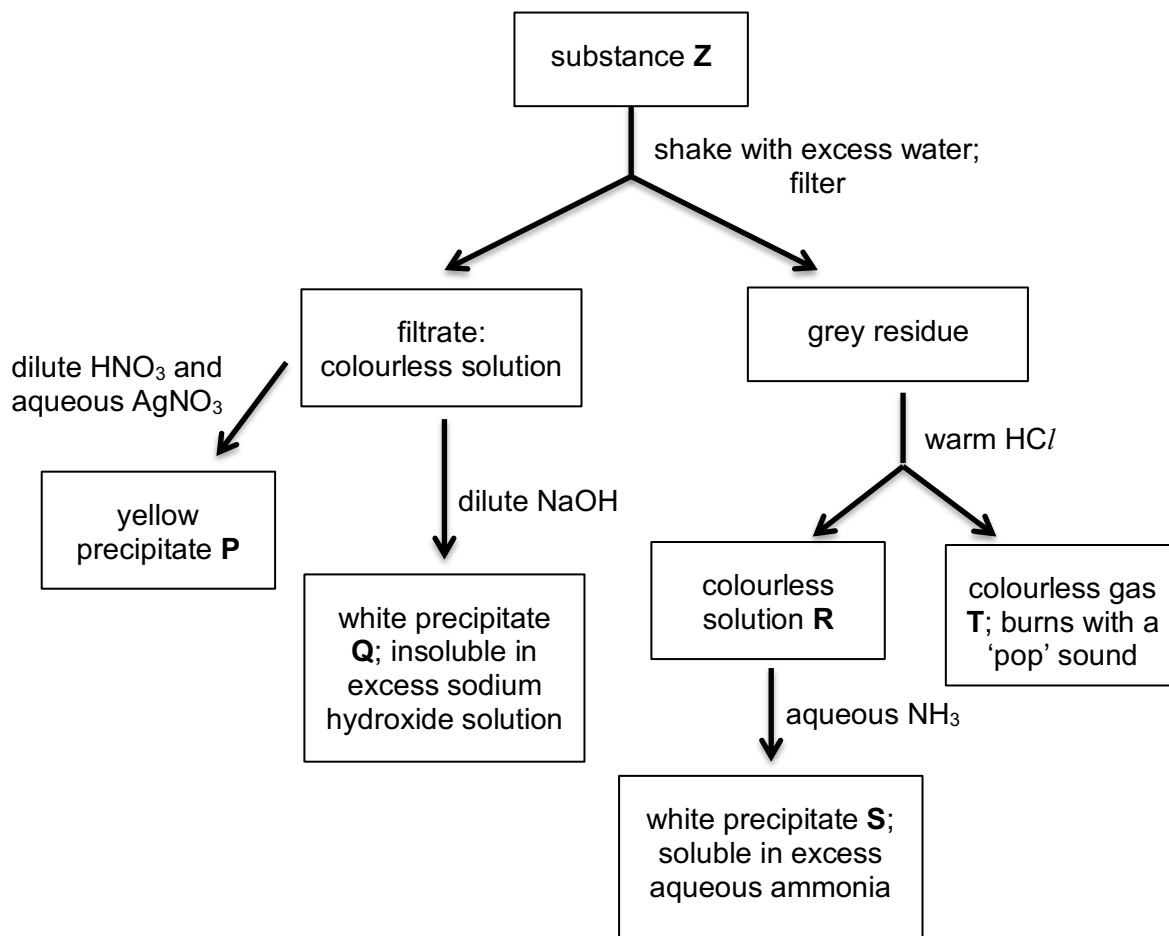
- (d) Draw on the diagram, the spot for Zn^{2+} ions given that the R_f value for these ions is 0.75.

[1]

[Total: 5]

- 3 Substance **Z** is a mixture of a compound and an element. The compound is soluble in water but the element is not soluble in water.

The diagram shows the results of a series of qualitative analysis tests on substance **Z**.



- (a) Name the following substances.

- (i) yellow precipitate, **P** [1]
- (ii) white precipitate, **Q** [1]
- (iii) white precipitate, **S** [1]
- (iv) colourless gas, **T** [1]

- (b) Identify the cation present in the colourless solution **R**.

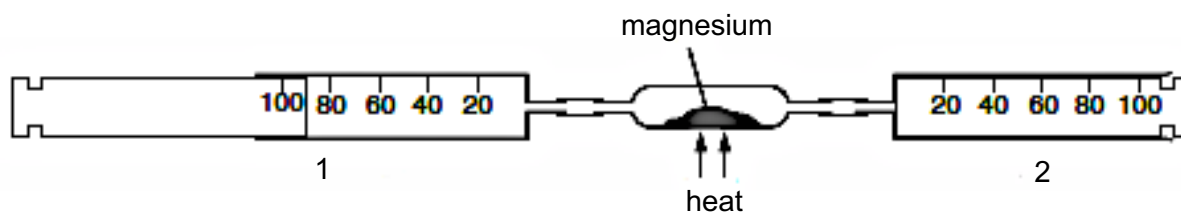
.....[1]

- (c) Construct a balanced chemical equation for the reaction of the grey residue from the filtration with warm hydrochloric acid.

.....[1]

[Total: 6]

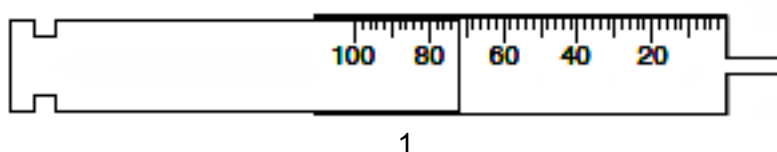
- 4 A student performed an experiment using the apparatus shown below.



Syringe 1 contains 90 cm^3 of air. The air is forced over heated magnesium into syringe 2. The air is then forced back over the heated magnesium into syringe 1.

The process is repeated several times until the volume of gas forced back into syringe 1 is constant. The apparatus is allowed to cool to room temperature.

The diagram below shows the volume of gas in syringe 1 at the end of the experiment.



- (a) Construct a balanced chemical equation, including state symbols, for the above reaction.

.....[1]

- (b) Name the major component of the gas remaining in syringe 1.

.....[1]

- (c) The magnesium used for the above reaction was in excess. Calculate the mass of magnesium that has reacted.

mass of magnesium = g [3]

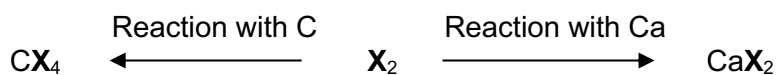
[Total: 5]

- 5 Element **X** exists as a diatomic molecule at room temperature and pressure.

An atom of element **X** has 7 electrons in its second electron shell, which is also its valence shell.

Element **X** undergoes reactions with carbon and calcium to form CX_4 and CaX_2 respectively. In both of the reactions, X_2 has been reduced.

A schematic diagram of the reactions is shown below.



- (a) Explain, in terms of oxidation states, why X_2 is reduced in both reactions.

.....
[1]

- (b) (i) Identify the type of bonding structure present in CX_4 and CaX_2 .

CX_4 :[1]

CaX_2 :[1]

- (ii) Draw a 'dot-and-cross' diagram to show the arrangement of valence electrons in CaX_2 .



[2]

- (c) Deduce which product, CX_4 or CaX_2 , has a higher melting and boiling point. Explain your answer in terms of structure and bonding.

.....

[2]

[Total: 7]

- 6 When iron is heated with steam in a sealed container, an equilibrium mixture is obtained.



The forward reaction is endothermic.

- (a) Define the term *endothermic*.

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

- (b) State and explain what happens to the rate of the forward reaction when the temperature is increased and pressure remains constant.

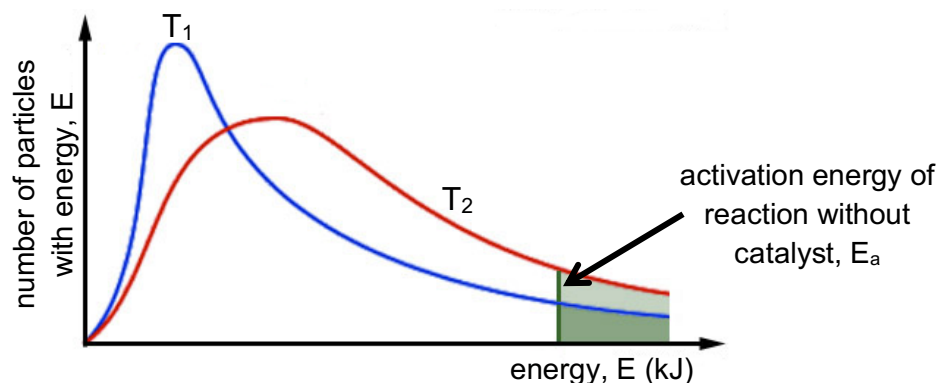
.....
.....
.....
.....[2]

- (c) When the pressure of a reversible reaction is increased, the direction of reaction that produces a lower number of moles of gas is favoured.

State and explain if there is any effect on the equilibrium when the pressure of the reaction mixture is increased and temperature remains constant.

.....
.....
.....
.....[2]

- (d) The Maxwell Boltzmann distribution curves, as shown below, are used to show the proportion of particles that have a particular amount of energy at temperatures T_1 and T_2 . The total area underneath each curve shows the total number of particles.



- (i) Deduce which temperature, T_1 or T_2 , is higher.

.....[1]

- (ii) On the distribution curve above, draw a vertical line to indicate the activation energy when a catalyst is added and label it as E_a' . [1]

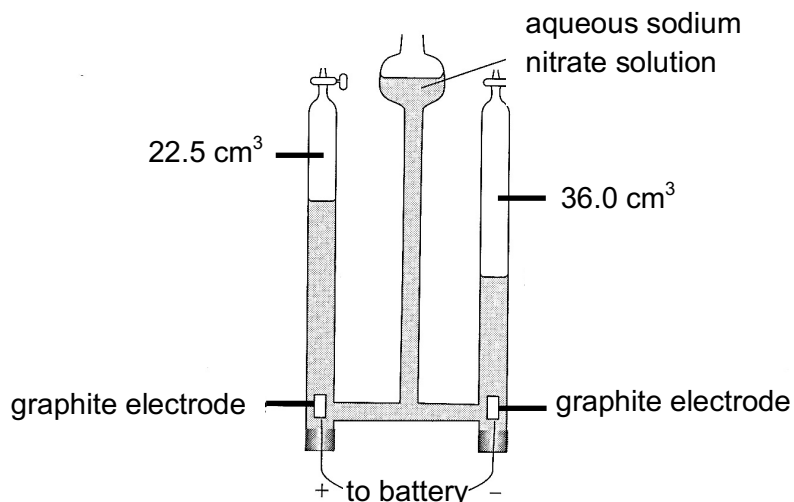
- (e) Calculate the mass of Fe_3O_4 formed when 5.6 g of iron completely reacts with excess steam. Assume that the forward reaction is complete.

mass of Fe_3O_4 = g [3]

[Total: 10]

- 7 A scientist carried out the electrolysis of aqueous sodium nitrate solution. Initially, the burettes above the electrodes were completely filled with solution.

The diagram shows the volume of gases collected above the two electrodes after a period of time.



- (a) Write a half-equation to show the production of the gas which is collected above the cathode.

.....[1]

- (b) The gas collected above the anode was found to be a mixture of oxygen, carbon dioxide and carbon monoxide.

(i) Explain why these gases are found at the anode.

.....

[2]

- (ii) Write a balanced chemical equation, with state symbols, for any **one** of the gases formed at the anode.

.....[1]

- (c) If the scientist had used an aqueous potassium sulfate solution instead of an aqueous sodium nitrate solution, will there be any difference in the products formed? Explain your reasoning.

.....

[2]

[Total: 6]

- 8 Alkanes are a homologous series of hydrocarbons. Butane and decane are 4-carbon and 10-carbon members of alkanes respectively.

(a) Butane is used as a fuel.

Construct a balanced chemical equation, including state symbols, for the complete combustion of butane.

.....[1]

(b) Butane reacts with chlorine in the presence of ultraviolet radiation. Construct a balanced chemical equation for this reaction. State symbols are not required.

.....[1]

(c) Decane is heated strongly in the presence of a catalyst.

Two products are formed, an alkane **X** and an alkene **Y**.

(i) Name this type of reaction.

.....[1]

(ii) Alkane **X** contains 84.2 % carbon by mass. It has a molecular mass of 114 g/mol.

Determine the molecular formula for **X**.

molecular formula for **X** = [2]

(iii) State the molecular formula for **Y**.

.....[1]

[Total: 6]

Section B (30 marks)

Answer all **three** questions in the spaces provided.

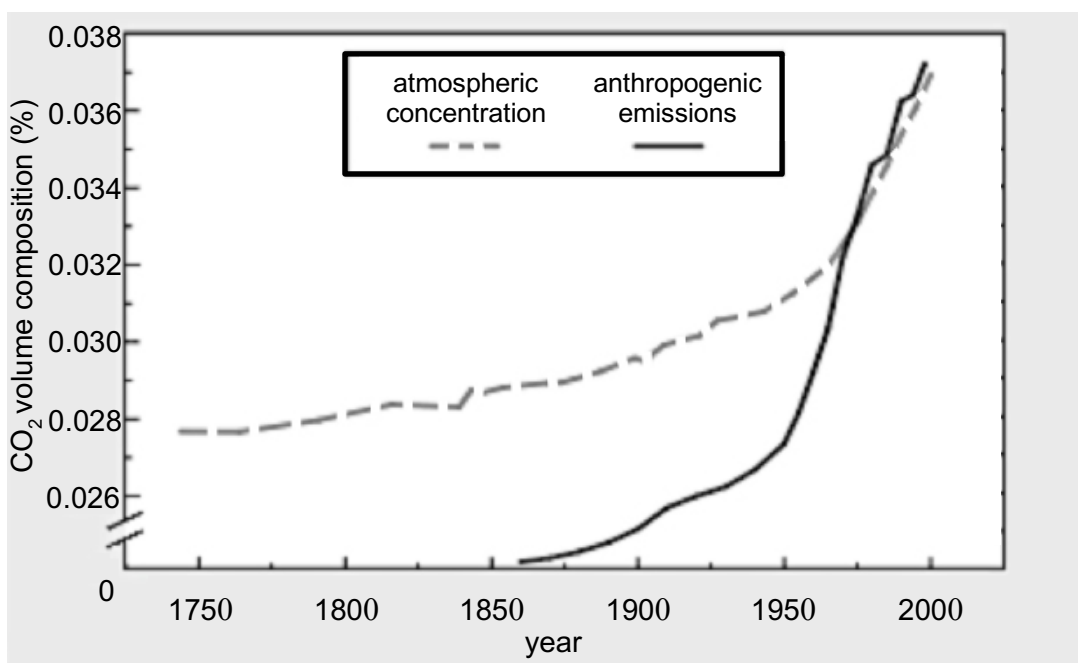
The last question is in the form of **either/or** and only one of the alternatives should be attempted.

9 The Atmosphere and Environment

- (a) Since the industrial revolution 150 years ago, the levels of carbon dioxide have increased drastically.

Fig. 9.1 shows the trends in atmospheric concentrations of carbon dioxide and anthropogenic emissions of carbon dioxide.

Anthropogenic emissions are emissions due to human activities.



source: Oak Ridge National Laboratory, carbon dioxide information analysis centre

Fig. 9.1

- (i) State one possible human activity that could explain the sudden increase in atmospheric concentration of carbon dioxide after 1850.

.....
[1]

- (ii) State one environmental effect caused by increasing carbon dioxide concentration.

.....
[1]

- (iii) Based on the information in Fig. 9.1, predict the volume composition (in percentage) of the atmospheric concentration of carbon dioxide in air in the year 2025.

.....[1]

- (b) The percentage composition of carbon dioxide in the atmosphere is naturally regulated through the carbon cycle.

The table shows the major carbon dioxide inputs and outputs in the global carbon cycle, measured in billion tons of carbon dioxide per year.

areas	source of carbon dioxide input	source of carbon dioxide output
industries and motor vehicles	-	burning fossil fuels (6 billion tons)
plants	photosynthesis (120 billion tons)	plant respiration (60 billion tons)
ocean	ocean uptake (92 billion tons)	ocean loss (90 billion tons)
volcanoes	-	volcanic eruptions (0.1 billion tons)
biological remains	-	decay of plants and animal remains (60 billion tons)

- (i) "Carbon sinks" are areas that take in more carbon dioxide than they release into the atmosphere. State one example of "carbon sinks".

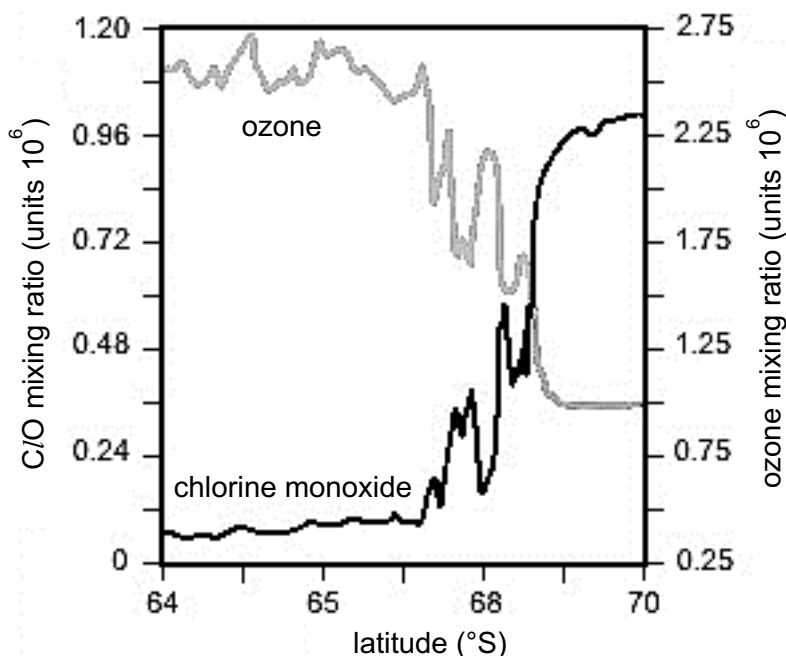
.....
[1]

- (ii) Describe how ocean uptake regulates the amount of carbon dioxide in the atmosphere.

.....
[1]

- (c) In 1987, the Antarctic Airborne Ozone Expedition flew a research aircraft equipped with measuring instruments through the Antarctic ozone hole. They measured the composition of ozone and chlorine monoxide present in the atmosphere at different latitudes in the area, as shown in Fig. 9.2.

Latitude is an angle which ranges from 0° at the Equator to 90° (North or South) at the poles. This research was widely accepted by scientists as proof that the presence of chlorofluorocarbons (CFCs) in the atmosphere is the main cause of ozone depletion.



*mixing ratio of a gas is defined as the number of moles of the gas per one mole of air

Fig. 9.2

- (i) CFCs are known to react with ozone to form chlorine monoxide. From the information provided, deduce how scientists concluded that the presence of CFCs in the atmosphere result in ozone depletion.

.....

[3]

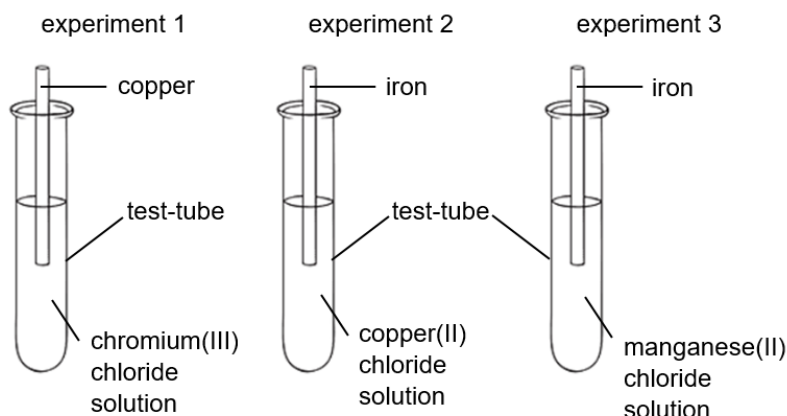
- (ii) Explain why the depletion of the ozone layer is harmful to human health.

.....

[2]

[Total: 10]

- 10 A student investigated the reactivity of four metals, copper, chromium, iron and manganese. He carried out two different sets of experiments. The diagram shows the first set of experimental set-up.



The table shows the results obtained in the first set of experiments.

	experiment 1	experiment 2	experiment 3
changes to metal strip	reddish-brown metal remains unchanged		grey metal remains unchanged
changes to solution	green solution remains unchanged		colourless solution remains unchanged

- (a) (i) Complete the above table to show the observations made in experiment 2. [2]

(ii) Explain your answer for (a)(i).

.....
[1]

- (b) In the second set of experiments, the student made use of dilute hydrochloric acid and samples of the metals.

He found out that chromium is the second most reactive metal.

(i) State **two** observations made when chromium reacts with dilute hydrochloric acid.

.....

[2]

- (ii) The student measures the volume of gas produced for a fixed duration of reaction. Explain how the data shows that chromium is the second most reactive metal and suggest a reason why the loss in mass for a fixed duration of reaction is not recommended.

.....
.....
.....
.....[2]

- (iii) Assuming all the experimental conditions remain the same, describe how will the measurements collected in (b)(ii) change if dilute ethanoic acid is used instead of dilute hydrochloric acid. Explain your answer.

.....
.....
.....
.....[2]

- (c) Give one reason why recycling of metal is important.

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

[Total: 10]

EITHER

- 11 (a) **X** and **Y** are organic compounds. Both are soluble in water, forming colourless solutions.

X has a molecular formula of $\text{C}_5\text{H}_{12}\text{O}$ and forms a neutral solution in water.

Y has a molecular formula of $\text{C}_3\text{H}_6\text{O}_2$ and forms an acidic solution in water.

- (i) Suggest the chemical names of **X** and **Y**.

.....

.....[2]

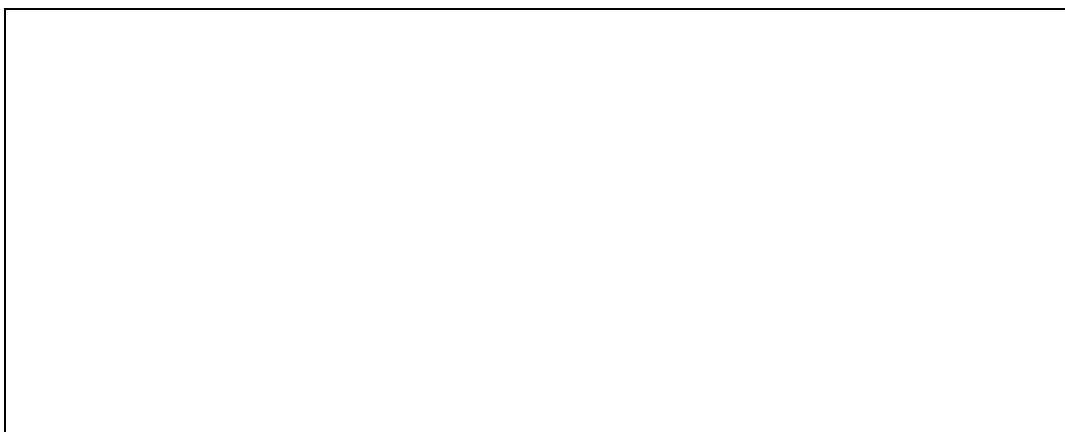
- (ii) Describe a chemical test to distinguish between **X** and **Y**.

.....

.....

.....[2]

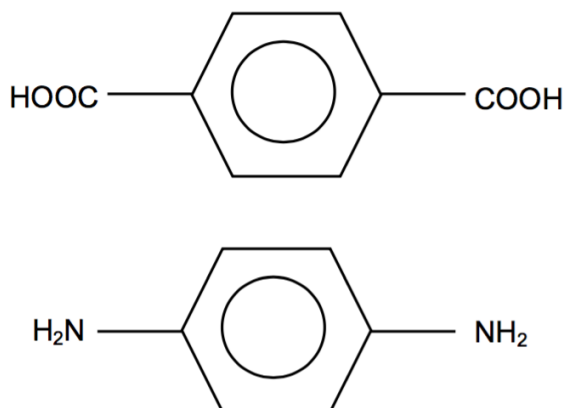
- (iii) Draw the full structural formula of the product formed between **X** and **Y**.



[1]

- (b) Kevlar is a synthetic polymer that is lightweight, has high tensile strength and is resistant to heat. It is used in many applications such as bulletproof vests and bicycle tyres.

The diagram shows the structures of the two monomers that make Kevlar.



- (i) Identify the type of polymerisation present in Kevlar. Explain your answer.

.....

[2]

- (ii) Draw the structural formula of Kevlar.



[2]

- (iii) Suggest one disadvantage of the widespread use of Kevlar in bulletproof vests and bicycle tyres.

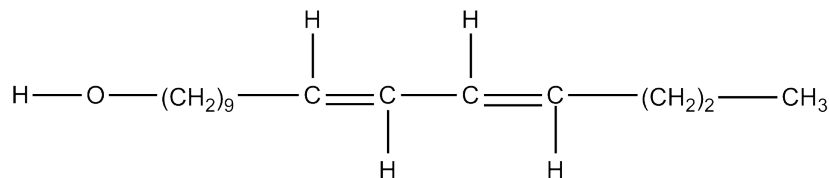
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[1]

[Total: 10]

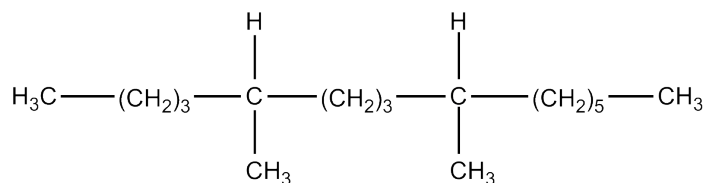
OR

- 11 Pheromones are organic compounds emitted by insects and other animals to send messages to individuals of the same species.

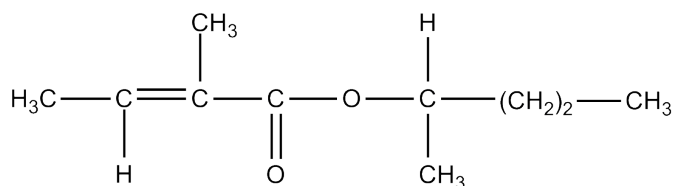
Researchers have identified and isolated pheromones from beetles, silkworm moths and leaf miner moths. The diagram shows their structures.



pheromone released by silkworm moths



pheromone released by leaf miner moths



pheromone released by beetles

- (a) Identify the functional group(s) found in pheromones released by silkworm moths.

.....
[2]

- (b) State two types of reactions that the pheromone released by silkworm moths can possibly undergo.

.....
[2]

- (c) From the structure provided, suggest and explain how one physical property of the pheromone released by leaf miner moths would differ from that of butane.

.....

[2]

- (d) Describe a chemical test to distinguish between the pheromones of silkworm moths and leaf miner moths.

.....
.....
.....[2]

- (e) Draw the full structural formulae of two possible compounds that can be reacted with each other to synthesize the pheromones released by beetles.

compound 1

compound 2

--	--

[2]

[Total: 10]**END OF PAPER**

The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	0
		Key proton (atomic) number atomic symbol name relative atomic mass															
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24	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										
19 K potassium 39	20 Ca calcium 40	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	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	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 —	112 Cn copernicium —	114 Fl flerovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganesson —	119 Uue unbinilium —	120 Uuh ununilium —									

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
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 -

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).