Name | Reg. No | Class

MAYFLOWER SECONDARY SCHOOL

4EX

PURE CHEMISTRY

6092/01

Paper 1 [40 Marks]

PRELIMINARY EXAMINATION

September 2019

1 hour

Additional Materials
Approved Calculator
Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS TO CANDIDATES:

Do not start reading the questions until you are told to do so.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class, and index number on the OTAS provided.

INFORMATION FOR CANDIDATES:

There are forty questions on this paper. Answer **all** questions.

For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the **OTAS**.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

Page 18 is a blank page

A copy of the Periodic Table is printed on page 19

Setter: Chen Yanhui Timothy

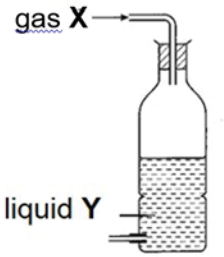
Vetter: Mdm Jarina Banu

Paper 1: Multiple Choice Questions (40 marks)

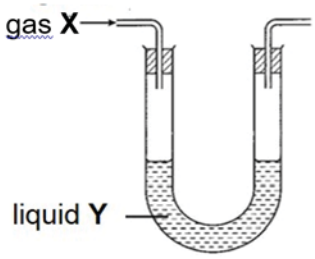
Answer **all** the questions in the OTAS provided.

1 Which of the following shows the most suitable set-up to purify gas **X** using liquid **Y**?

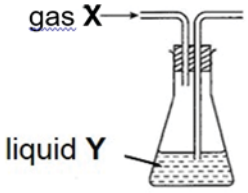
A



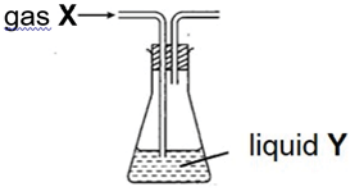
B



C

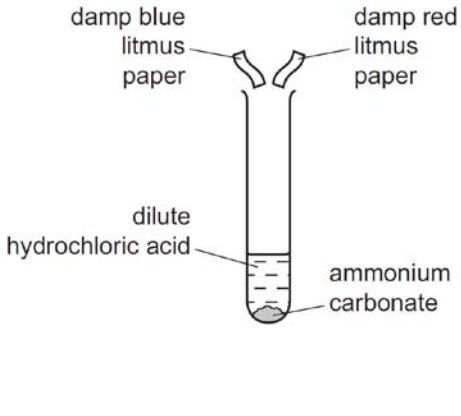


D

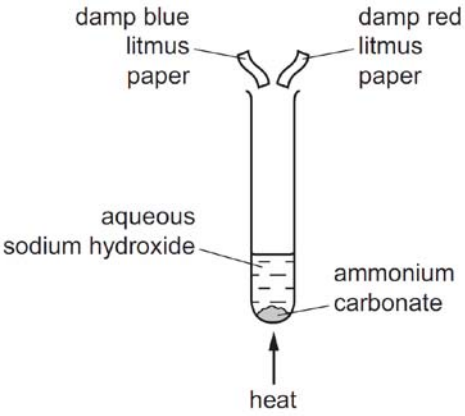


2 Two experiments were carried out.

In each experiment, the gas evolved was tested with damp blue litmus paper and damp red litmus paper.



experiment 1



experiment 2

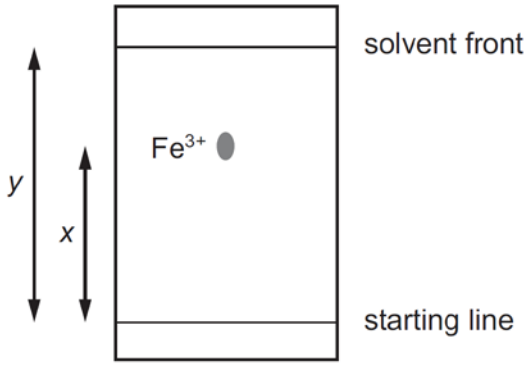
Which row correctly shows the colour of both the pieces of litmus paper at the end of each experiment?

	experiment 1	experiment 2
A	blue	blue
B	blue	red
C	red	blue
D	red	red

3 Which substance would diffuse most quickly?

A carbon dioxide at 0 °C
B carbon dioxide at 25 °C
C neon at 0 °C
D neon at 25 °C

4 A paper chromatography experiment is carried out to find an Rf value for $Fe^{3+}(aq)$. The result is shown.



To make the spot containing $Fe^{3+}(aq)$ more visible, the paper is sprayed with aqueous sodium hydroxide so that a precipitate of iron(III) hydroxide forms.

Under the conditions of the experiment, the R_f of $Fe^{3+}(aq)$ is given by **(a)** and the colour of the precipitate is **(b)**.

	(a)	**(b)**
A	x/y	red-brown
B	x/y	green
C	y/x	red-brown
D	y/x	green

5 Which statement about chlorine atoms and chloride ions is correct?

A They are both isotopes of chlorine.
B They have the same number of protons.
C They have the same physical properties.
D They undergo the same chemical reactions.

6 **X** represents the element of atomic number 8 and **Y** represents the element of atomic number 19.
The two elements react together to form a compound.

Which row is correct for the compound formed?

	formula	bonding
A	$\mathbf{X_2Y}$	covalent
B	$\mathbf{X_2Y}$	ionic
C	$\mathbf{Y_2X}$	covalent
D	$\mathbf{Y_2X}$	ionic

7 Some ionic compounds can have covalent character.

In general, the greater the positive charge of the cation, the more it causes the electron cloud of the anion to be distorted, causing covalent behavior.
In addition, if the size of the anion is larger, the electron cloud is more easily distorted compared to one that is smaller.

According to the information provided, which compound below exhibits the **greatest** covalent character?

A aluminum iodide
B calcium chloride
C lithium fluoride
D sodium oxide

8 Solid copper metal, aqueous copper(II) sulfate, solid graphite and molten magnesium chloride will all conduct electricity.

Which pair will conduct electricity because they both contain mobile electrons?

A aqueous copper(II) sulfate and molten magnesium chloride
B aqueous copper(II) sulfate and solid copper metal
C molten magnesium chloride and solid graphite
D solid copper metal and solid graphite

9 Which ionic equation best represents the reaction between aqueous potassium hydroxide with dilute nitric acid?

A $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
B $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(aq)$
C $K^+(aq) + HNO_3(aq) \rightarrow KNO_3(aq) + H^+(aq)$
D $KOH(aq) + H^+(aq) \rightarrow K^+(aq) + H_2O(l)$

10 The characteristics of a gas, **G**, are given.

- **G** reduces copper(II) oxide to a pink-brown solid.
- 1.4 g of **G** has a volume of 1.2 dm^3 at room temperature and pressure.

What is **G**?

A carbon monoxide
B hydrogen gas
C nitrogen gas
D nitrogen monoxide

11 In an experiment, 1 cm^3 of a gaseous hydrocarbon, **Z**, requires 5 cm^3 of oxygen for complete combustion to give 3 cm^3 of carbon dioxide. All gas volumes are measured at room temperature and pressure.

Which formula represents **Z**?

A C_2H_2 **B** C_2H_4 **C** C_3H_6 **D** C_3H_8

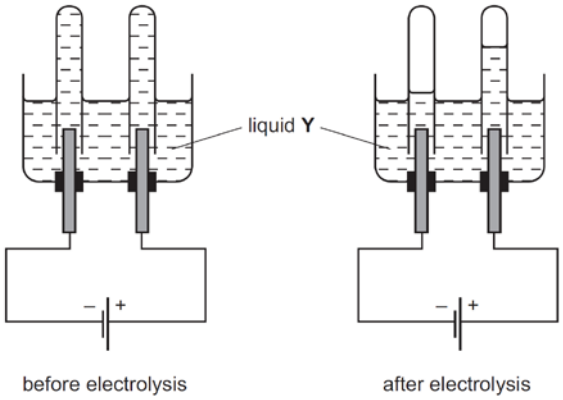
12 Analysis of a sample of a substance has the following composition by mass.

- percentage by mass of carbon is 41.9%
- percentage by mass of hydrogen is 3.1%
- percentage by mass of chlorine is 55%

What is its molecular formula?

A $C_3H_6Cl_4$
B $C_4H_9Cl_4$
C $C_8H_4Cl_9$
D $C_9H_8Cl_4$

13 The diagrams show an electrolysis experiment using inert electrodes.



What could liquid **Y** be?

A aqueous copper(II) sulfate
B concentrated aqueous sodium chloride
C dilute sulfuric acid
D ethanol

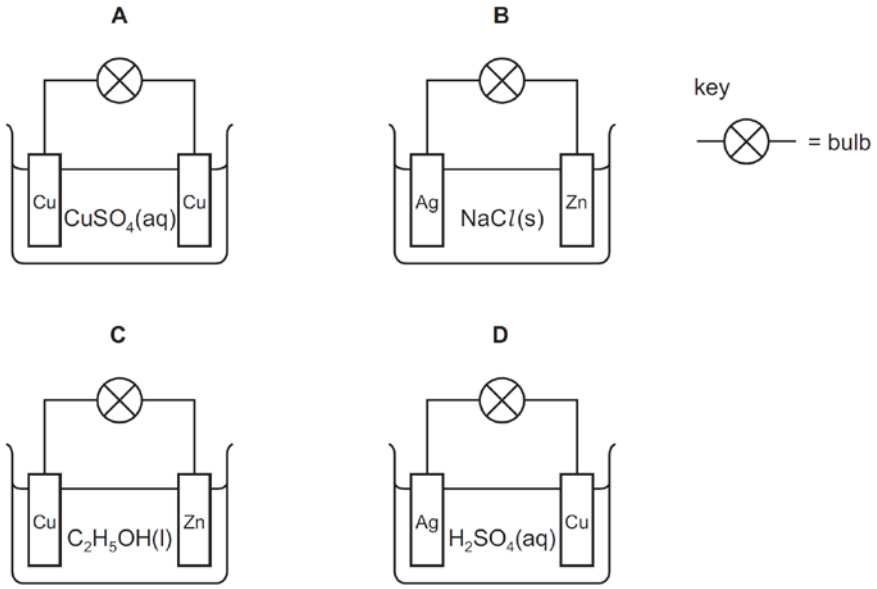
14 During the electroplating of a metal spoon using silver,

1. the anode is the silver metal.
2. the spoon is made the cathode.
3. the electrolyte used is aqueous silver nitrate.
4. the concentration of the electrolyte decreases during electroplating.

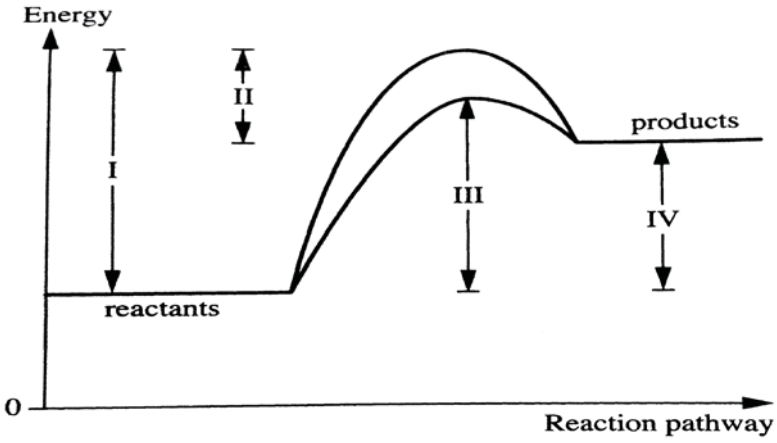
Which of the above statements are true?

A 1, 2 and 3 only
B 1 and 3 only
C 1, 3 and 4 only
D 2 and 3 only

15 In which circuit does the bulb light?



16 Below is an energy profile diagram for a chemical reaction showing the energy changes **I**, **II**, **III** and **IV**.



Which of the following energy changes indicates the activation energy for the catalyzed reaction?

A I **B** II **C** III **D** IV

17 Compound **Y** reacts with oxygen and this reaction has a positive enthalpy change of reaction.

What information can be deduced about **Y** and its reaction with oxygen?

A Compound **Y** can be used as a fuel.
B In the reaction the energy absorbed to break bonds is greater than the energy released when bonds are made.
C In the reaction the products are at a lower energy level than the reactants.
D The reaction could be combustion.

18 A student wrote two conclusions about calcium carbonate.

conclusion 1: The reaction with dilute hydrochloric acid is faster with powdered calcium carbonate than with large pieces of calcium carbonate.

conclusion 2: Grinding large pieces of calcium carbonate to form powder increases the particle size.

Which statement is correct?

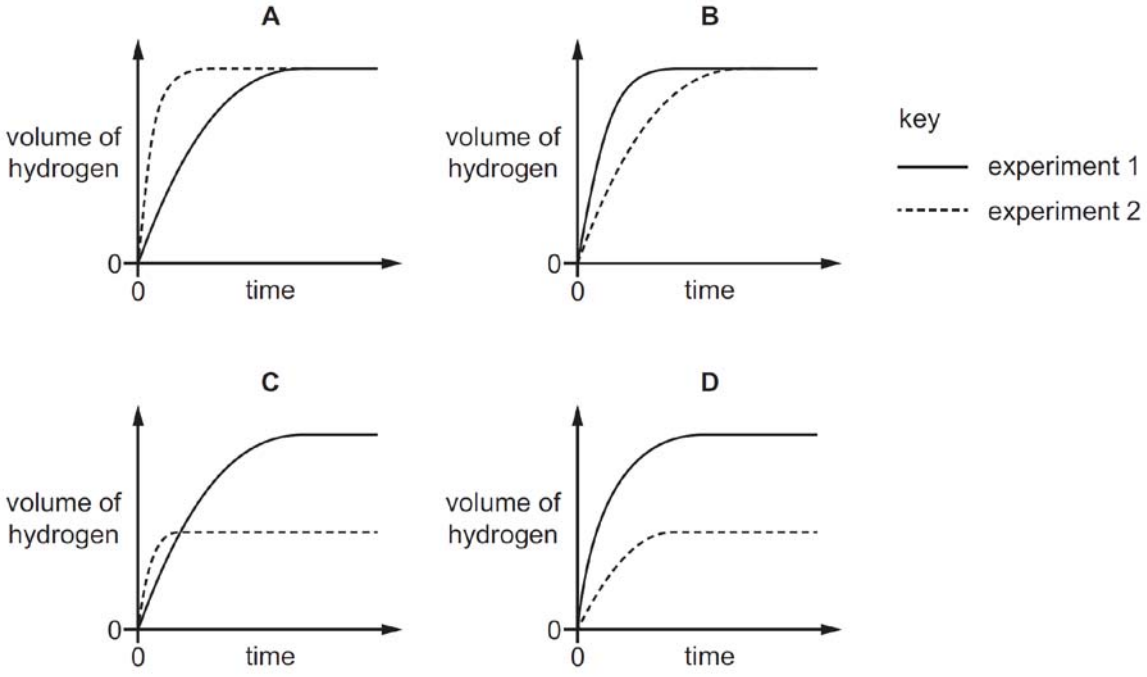
A Both conclusions are correct and conclusion 2 explains conclusion 1.
B Both conclusions are correct but conclusion 2 does not explain conclusion 1.
C Conclusion 1 is correct but conclusion 2 is not correct.
D Conclusion 2 is correct but conclusion 1 is not correct.

19 Magnesium reacts with dilute sulfuric acid.
Two experiments were carried out.

experiment 1: 24.0 g of magnesium was reacted with 100 cm^3 of 1.0 mol/dm^3 sulfuric acid.
experiment 2: 24.0 g of magnesium was reacted with 100 cm^3 of 2.0 mol/dm^3 sulfuric acid.

In each experiment the volume of hydrogen was measured at various times. The results were plotted on a graph.

Which graph is correct?



20 Which reaction does **not** involve oxidation or reduction?

A $2H_2 + O_2 \rightarrow 2H_2O$
B $Fe^{2+} \rightarrow Fe^{3+} + e^-$
C $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$
D $CuO + H_2 \rightarrow Cu + H_2O$

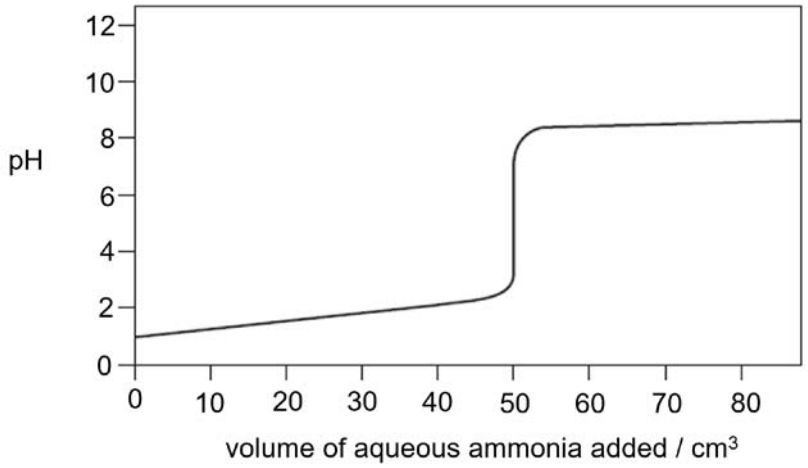
21 The reaction between iron(II) ions and manganate(VII) ions is represented by the following equation.

$$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$$

Which one of the following statements is correct?

A Fe^{2+} gained electrons to form Fe^{3+}.
B Fe^{2+} is a reducing agent.
C The oxidation state of hydrogen had decreased.
D The oxidation state of manganese has increased.

22 The graph below shows the pH changes when 0.1 mol/dm^3 of aqueous ammonia solution is added to 50.0 cm^3 of 0.1 mol/dm^3 of hydrochloric acid.



Which of the following indicators is **not** suitable for use in determining the endpoint for the neutralisation reaction above?

	indicator	pH range of indicator
A	bromothymol blue	6.0 – 7.6
B	bromothymol red	5.2 – 6.8
C	methyl orange	3.1 – 4.4
D	phenolphthalein	8.3 – 10.0

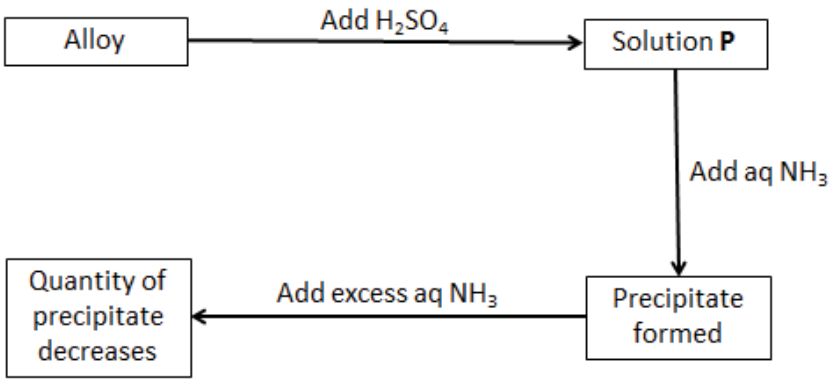
23 Which of the following statements about oxides is correct?

A A basic oxide is an oxide of a non-metal.
B Acidic oxides contain ionic bonds.
C Amphoteric oxides contain a metal.
D Basic oxides are always gases.

24 Which of the following reactants when mixed produces a salt that can be obtained as a residue after filtration?

A aqueous copper(II) sulfate and aqueous sodium nitrate
B aqueous sodium hydroxide and dilute nitric acid
C dilute sulfuric acid and aqueous barium nitrate
D zinc metal and dilute hydrochloric acid

25 A sample of an alloy containing two metals was subjected to the following tests.
What are the two metals present in the alloy?



A copper and zinc
B iron and copper
C iron and lead
D iron and zinc

26 Element **X** has the following properties.

- forms **X**F_3 when heated with fluorine
- forms **X**SO_4 when reacted with dilute sulfuric acid

To which part of the Periodic Table does Q belong?

A Group II
B Group III
C Group IV
D Transition metals

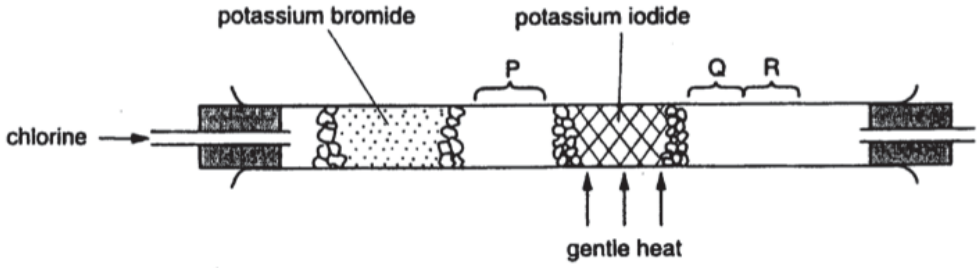
27 Caesium, Cs, is an element in the same group of the Periodic Table as lithium, sodium and potassium. Some statements of caesium metal is given below.

- It reacts explosively with cold water.
- It forms a soluble carbonate salt.
- It forms a carbonate with a formula of $CsCO_3$.
- It can be extracted via electrolysis of concentrated aqueous Cs*Cl*.

How many statements about caesium are likely to be **wrong**?

A 1 **B** 2 **C** 3 **D** 4

28 Using the apparatus shown, chlorine is passed through the tube. After a short time, coloured substances are seen at **P**, **Q** and **R**.



What would be observed at P, Q and R?

	P	Q	R
A	green gas	violet vapour	black solid
B	green gas	red-brown vapour	violet vapour
C	red-brown vapour	violet vapour	black solid
D	violet vapour	red-brown vapour	red-brown vapour

29 The following table refers to four metals and some of their compounds.

Metal	Action of dilute sulfuric acid on metal	Effect of carbon on heated oxide	Action of metal on a solution of the sulfate of H
E	hydrogen evolved	reduced	no reaction
F	no reaction	reduced	no reaction
G	hydrogen evolved	no action	metal H formed
H	hydrogen evolved	no action	no reaction

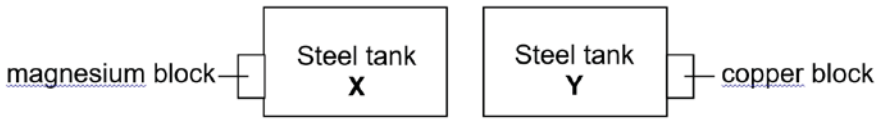
Which of the following lists the metals in order of **decreasing** reactivity?

A	F	E	H	G
B	G	H	E	F
C	G	H	F	E
D	H	G	E	F

30 Which statement about the extraction of iron in the blast furnace is correct?

A Carbon reacts with carbon dioxide to produce carbon monoxide
B Iron(III) oxide reacts with carbon dioxide to produce molten iron.
C Limestone is added to remove basic impurities.
D Molten iron floats on molten slag at the bottom of the furnace.

31 A block of magnesium and a block of copper were attached to underground steel tanks, **X** and **Y** as shown below.



Which pair of equation would represent the reactions that would occur at tanks **X** and **Y**?

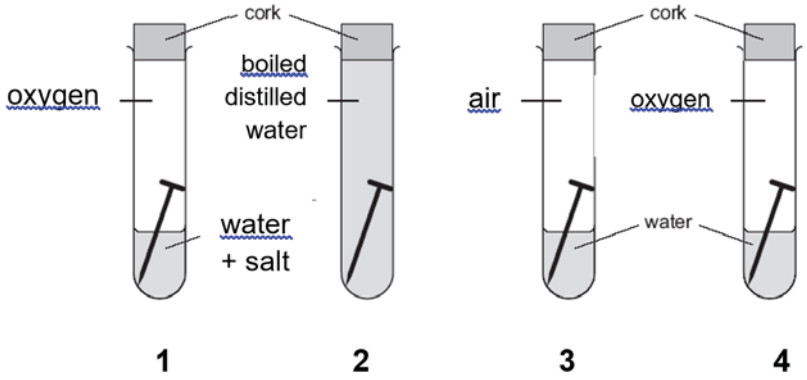
	Steel tank **X**	Steel tank **Y**
A	$Fe \rightarrow Fe^{2+} + 2e$	$Cu \rightarrow Cu^{2+} + 2e$
B	$Fe \rightarrow Fe^{2+} + 2e$	$Fe \rightarrow Fe^{2+} + 2e$
C	$Mg \rightarrow Mg^{2+} + 2e$	$Cu \rightarrow Cu^{2+} + 2e$
D	$Mg \rightarrow Mg^{2+} + 2e$	$Fe \rightarrow Fe^{2+} + 2e$

32 A recycling company is to decide on which metals to recycle.

Based on the information provided in the table below, for which metal is the company **least** likely to recycle?

	Abundance of raw metal/metal ore on Earth	Ease of extracting metal from the Earth	Cost of preparing the used metal for recycling
A	High	Low	Moderate
B	Low	High	High
C	Low	High	Low
D	Moderate	High	High

33 An experiment was set up as shown below to investigate the rate of rusting under different conditions.

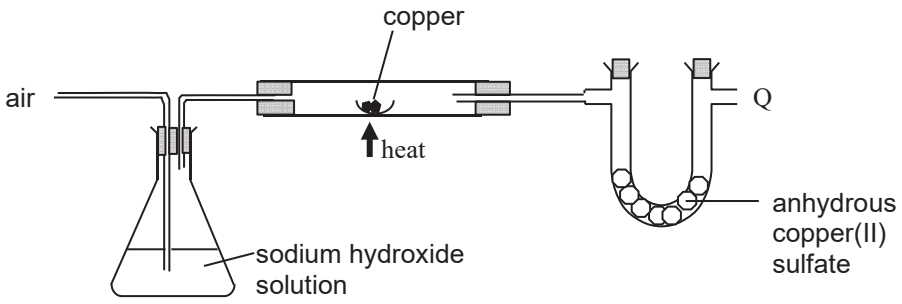


Predict the order of the test-tubes in which rust would first appear.

A 1, 3, 4, 2
B 1, 4, 3, 2
C 2, 3, 4, 1
D 3, 4, 1, 2

34 In the experiment below, an air sample is bubbled into excess sodium hydroxide solution, then passed over excess copper and finally into some anhydrous copper(II) sulfate.

What is the constituent of the gas that came out from **Q**?

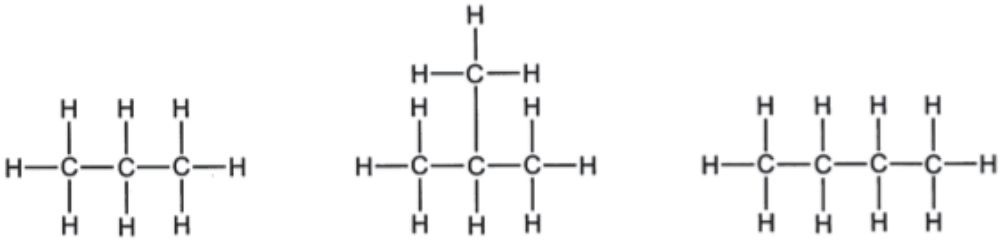


A nitrogen, noble gases
B nitrogen, noble gases and carbon dioxide
C nitrogen, noble gases and oxygen
D water vapour and noble gases

35 Which row correctly compares carbon dioxide and methane?

	both contain carbon	both are described as a greenhouse gas	both increases the pH of water when they dissolve in it
A	✓	×	✓
B	✓	✓	×
C	×	✓	✓
D	×	✓	×

36 The diagrams show the structures of three hydrocarbons.



Which statement is correct for **all** three compounds?

A They are isomers of each other.
B They have the same general formula.
C They have the same physical properties.
D They react with aqueous chlorine.

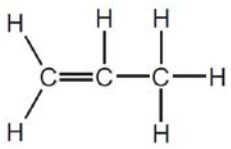
[Turn over

37 **Z** is a compound that:

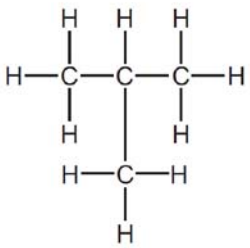
- can be formed, as the only other product, when the alkane C_8H_{18} is cracked to produce butane
- decolourises bromine water

What is the formula of **Z**?

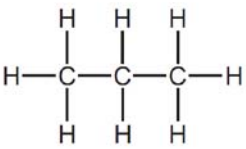
A



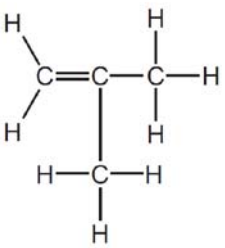
B



C



D

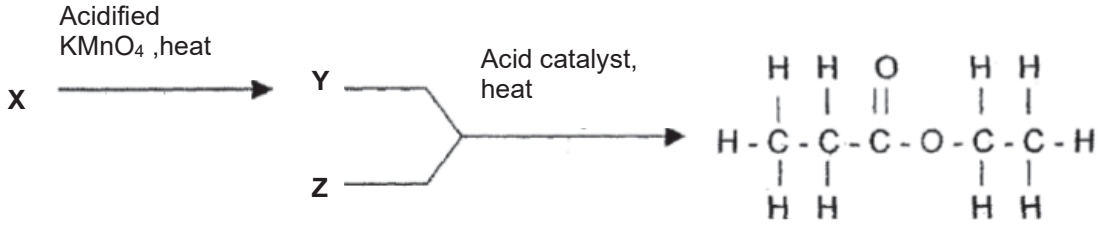


38 Under certain conditions, 1 mole of ethane reacts with 2 moles of chlorine in a substitution reaction.

What is the formula of the organic product in this reaction?

A C_2H_5Cl
B $C_2H_4Cl_2$
C $C_2H_2Cl_4$
D CH_2Cl_2

39 The following reaction scheme shows the reactions of three substances, **X**, **Y** and **Z**.

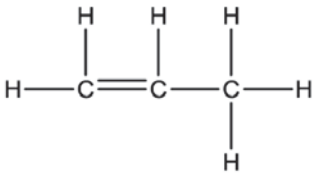


What are the molecular formulae of substances, **X**, **Y** and **Z**?

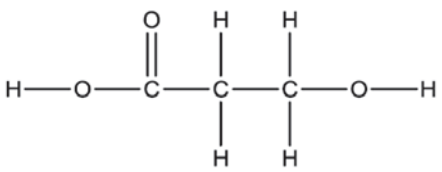
	X	Y	Z
A	C_3H_8O	$C_3H_6O_2$	C_2H_6O
B	C_2H_6O	$C_3H_6O_2$	C_2H_6O
C	C_3H_6	C_3H_8O	$C_2H_5O_2$
D	C_3H_8O	$C_4H_8O_2$	C_2H_6O

40 Which compounds would undergo polymerisation on their own?

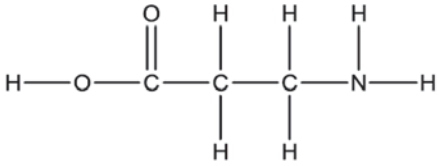
1



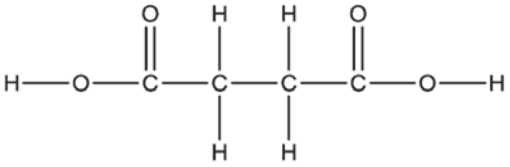
2



3



4



A 1 and 2 only
B 1, 2 and 3 only
C 1, 2, 3 and 4
D 2 and 3 only

- - - - - End of Paper 1 - - - -

BLANK PAGE

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							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											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 rubicium 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 –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lantharum 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.).

Name | **Reg. No** | **Class**

4EX

PURE CHEMISTRY

6092/02

Paper 2
[80 Marks]

PRELIMINARY EXAMINATION
September 2019
1 hour 45 minutes

Additional Materials:
Approved calculator

INSTRUCTIONS TO CANDIDATES:

Do not open this booklet until you are told to do so.

Write your name, index number and class in the spaces at the top of this page and on any separate answer paper used.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the space provided.

Paper 2: Section B
Answer **three** questions in the space provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

FOR EXAMINER'S USE	
Section	**Marks**
Paper 1 MCQ	/ 40
Paper 2: A	/ 50
Paper 2: B	
B 8	/ 10
B 9	/ 10
B10 Either / Or	/ 10
Total	**/ 120**

INFORMATION FOR CANDIDATES:

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 **22**.

This question paper consists of **22** printed pages

Setter: Chen Yanhui Timothy

Vetter: Mdm Jarina Banu

Section A (50 marks)

Answer all the questions in this section in the spaces provided.

A1 **(a)** Choose from the list of gases to answer the questions.

ammonia
carbon monoxide
chlorine
butane
hydrogen
nitrogen
oxygen
propane
sulfur dioxide

Each gas can be used once, more than once or not at all.
Which gas:

(i) burns in air to give only water

.....[1]

(ii) is acidic

.....[1]

(iii) has a molecule containing only 11 atoms

.....[1]

(iv) Is the most abundant gas in dry air

.....[1]

(v) is released when calcium hydroxide is added to soil that contains the fertilizer ammonium nitrate?

.....[1]

(b) 2 gases in the list reacts to form ammonia gas in the Haber Process.

(i) Write a balanced chemical equation for this reaction to form ammonia

.....[2]

(ii) List the three optimal conditions for the formation of ammonia in Haber Process.

.....

……...[1]

[Total: 8]

A2 Sodium and calcium hydrides react with water to form the hydroxide and hydrogen.

$$NaH + H_2O \rightarrow NaOH + H_2$$

$$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$$

(a) **(i)** Deduce the general ionic equation for these reactions.

……[1]

(ii) Hence, explain why this reaction is considered a redox reaction, in terms of oxidation state.

……

……

……

……

……

……[3]

(b) Sodium is a soft metal with little catalytic activity.
Nickel is a hard metal which is often used as a catalyst.

(i) Describe two other differences in the physical properties of sodium and nickel.

1……

……

2……

……[2]

(ii) State one industrial use of nickel as a catalyst.

……[1]

[Turn over

(iii) Explain why an alloy of nickel and copper is less malleable than copper alone.

……

……

……

……[2]

[Total: 9]

A3 James is given four samples of metals. He labelled them **W**, **X**, **Y** and **Z** and carried out two experiments. His findings were as follows:

Experiment 1: Oxide of **W** would only react with **Z**.

Experiment 2: Oxide of **X** reacts with all metals but **not Y**.

(a) Arrange the four metals **W**, **X**, **Y** and **Z** in order of descending reactivity.

……[1]

(b) James noted that **X** is a silvery metal and has a melting point of 1528 °C.

He added a sample of **X** to a solution of dilute hydrochloric acid. This reaction produces a colourless gas and a coloured solution.

(i) Name the colourless gas.

……[1]

(ii) When aqueous sodium hydroxide was added into the solution, a dirty-green precipitate was formed.

Determine the identity of **X**.

……[1]

(iii) Hence, predict the identity of metal **Y**.

……[1]

[Total: 4]

A4 Alcohols can react with copper(II) oxide to form compounds called aldehydes.

Table 4.1 shows the aldehyde formed from the respective alcohol.

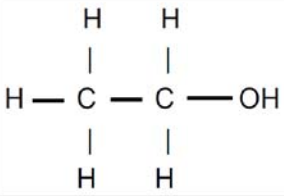
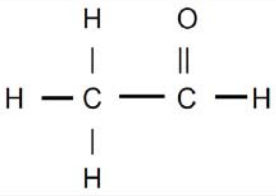
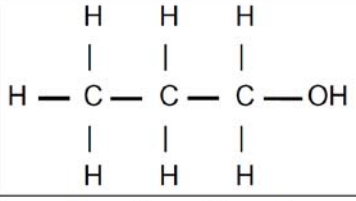
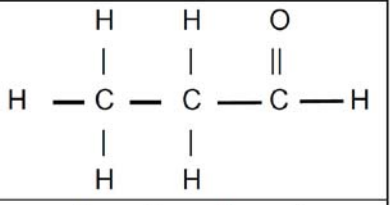
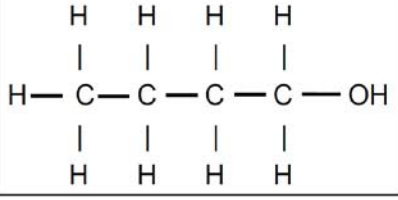
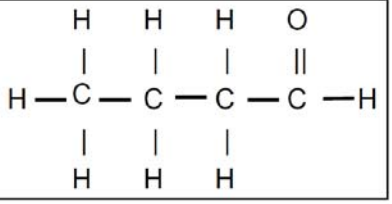
Alcohol	Structural formula of alcohol	Aldehyde	Structural formula of aldehyde
Ethanol		Ethanal	
Propanol		Propanal	
Butanol		Butanal	

Table 4.1

(a) Aldehydes are an example of a homologous series.

(i) Explain how the information in Table 4.1 show this.

……

……[1]

(ii) Predict three differences in physical property between ethanal and propanal.

……

……

……

……[2]

(b) A by-product from the reaction to form ethanal is water.

(i) Write a balanced chemical equation for the formation of ethanal.

……[1]

[Turn over

(ii) A sample of the alcohol with a mass of 15 g was used to make ethanal.

Determine the percentage purity of the ethanol if 11 g of ethanal was formed from the reaction.

[3]

(c) A student describes aldehydes as isomers of alcohol.

Explain, with a relevant example, whether this is a correct statement.

.....

.....

.....

.....

.....[2]

[Total: 9]

A5 Carbon suboxide (O=C=C=C=O), C_3O_2 is a colourless compound discovered in 1873.

(a) Predict the physical state of carbon suboxide at room conditions. Explain your answer in terms of bonding and structure.

.....

.....

.....

.....[2]

(b) Draw a 'dot and cross' diagram to show the bonding in carbon suboxide, showing only outermost electrons.

[2]

(c) Theoretically this compound can be polymerized to produce polymers that are rigid, which has great potential for molecular nanotechnology.

(i) Name the type of polymerisation.

……[1]

(ii) Draw the structure of the polymer showing only 2 repeating units.

[2]

[Total: 7]

A6 Magnesium and calcium occur naturally in the mineral dolomite, $MgCO_3.CaCO_3$, a mixture of insoluble carbonates.

Useful products like magnesium sulfate and calcium sulfate can be obtained indirectly by adding dilute hydrochloric acid and some other chemicals into dolomite.

Calcium sulfate is used in the production of cement board and magnesium sulfate is used as fireproofing fabrics.

A simplified reaction scheme of the process is shown in Fig. 6.1.

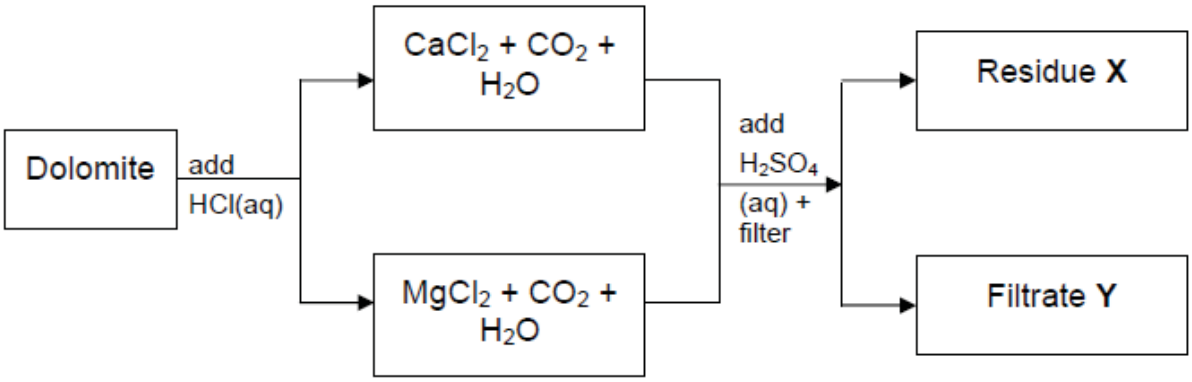


Fig. 6.1

(a) Identify residue **X** and filtrate **Y**.

residue X: .....

filtrate Y: .....[2]

(b) Explain why dolomite is added in excess to aqueous hydrochloric acid.

.....

.....[1]

(c) Describe the steps to obtain hydrated crystals from filtrate **Y**.

.....

.....

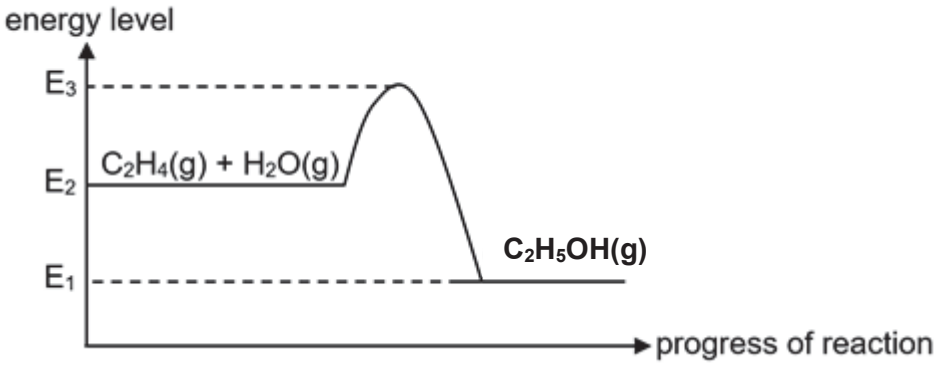
.....[2]

[Total: 5]

A7 The reaction between ethene and steam is reversible as shown by the equation.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The energy profile diagram depicts the changes in energy levels as the forward reaction proceeds. [Grab your reader's attention with a great quote from the document or use this space to emphasize a key point. To place this text box anywhere on the page, just drag it.]



(a) What does each of the energy changes represent?

(i) E_2 – E_1 : ……

(ii) $E_3 - E_1$: ……

(iii) $E_3 - E_2$: ……[3]

(b) The table shows some bond energies, measured in kilojoules per mole.

bond	bond energy in kJ / mol
H - H	436
C - O	358
O - H	463

bond	bond energy in kJ / mol
C - C	348
C = C	612
C - H	412

(i) Using the information given, calculate the enthalpy heat change of the forward reaction.

[2]

(ii) Explain, in terms of bond making and breaking, if the forward reaction results in any temperature change.

……

……

……

……[3]

[Total: 8]

- - - - End of Section A - - - -

Section B (30 marks)

Answer all **three** questions in this section in the spaces provided. The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 The polycarbonates are polymers which have organic functional groups linked together by carbonate groups.

There are many polycarbonates which vary in properties depending on their molecular mass and structure. As the molecular mass increases, the polymer becomes more rigid. Further, the properties are changed by blending it with other polymers, for example, with ABS and polyesters such as PET.

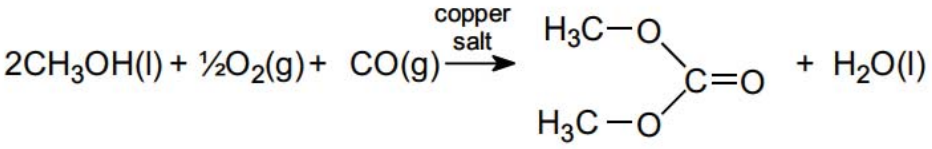
Polycarbonates used in engineering are strong, tough materials, and some grades are optically transparent. Application include the making of cell phone frames, data storage and aircraft components.

Disposal of objects containing polycarbonate in landfills is an issue as it forms BPA and carbon dioxide at higher temperatures. BPA is non-biodegradable and can leach into water bodies from the landfills. In addition, it leaches more over time as it ages in landfills.

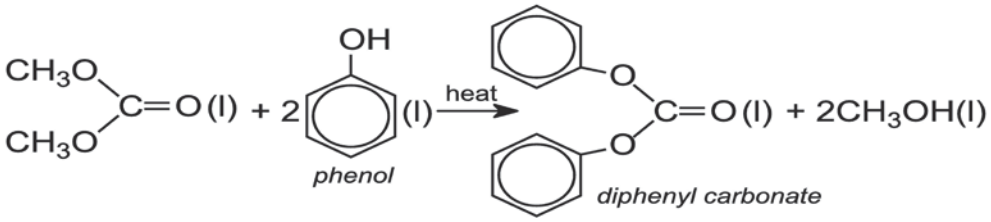
The polycarbonate can be manufactured by condensation polymerization between **bisphenol A** and **diphenyl carbonate**.

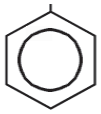
The production of diphenyl carbonate is a two-step process as shown below

1. Reaction of **methanol**, oxygen and carbon monoxide, in the presence of a copper salt such as copper(II) chloride, to form dimethyl carbonate. The copper salt is not used up and can be recycled for further reactions.

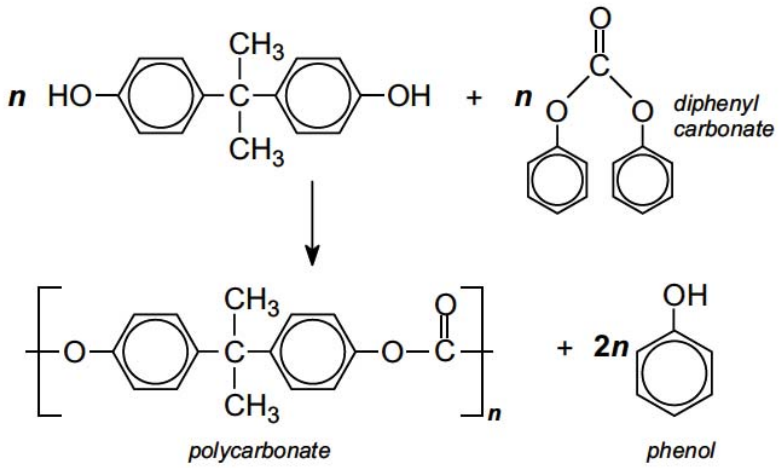


2. Dimethyl carbonate reacts with phenol to form diphenyl carbonate.



where  represents C_6H_x

Finally, Bisphenol A and the diphenyl carbonate are heated together to form a molten mass of polymer:



The phenol and excess reactants are removed by distillation under reduced pressure.

(a) Draw the structural formula of the linkage that is present in polycarbonates.

[1]

(b) Based on the information given, predict the adverse effects on the environment due to the disposal of polycarbonates.

……

……

……

…….. [3]

(c) **(i)** State the role of copper(II) chloride in the first reaction. Explain how you reach this conclusion.

……..

……..

……..... [2]

(ii) If the relative mass of phenol is 94, predict the value of x in $\mathbf{C_6H_x}$.

[1]

(iii) The relative mass of the polycarbonate ranges from 18 000 to 32 000.

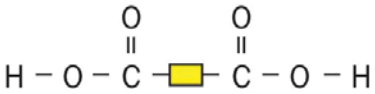
Find the minimum value of n for the polycarbonate and, hence, determine the minimum mass of phenol required for the formation of polycarbonates.

[3]

(d) Bisphenol A can also react with a dicarboxylic acid to form a polyester.

Draw the structural formula of the polyester formed.

The dicarboxylic acid can be represented by:



[2]

[Total: 12]

B9 Diagram 9.1 shows the electrolysis of dilute magnesium chloride.

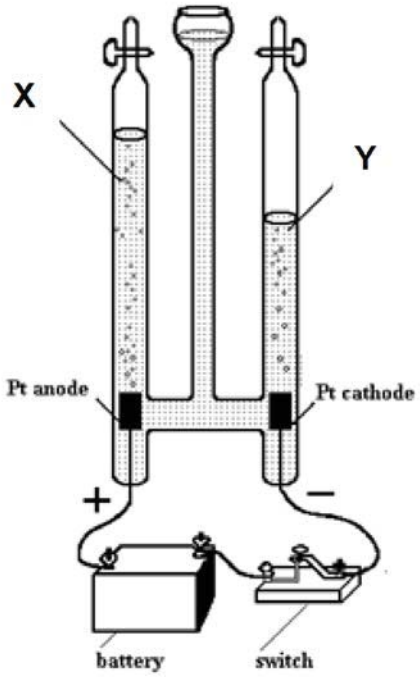


Diagram 9.1

(a) Write the balanced ionic equations, with state symbols, for the reactions at **X** and **Y**.

……

……...[2]

(b) **(i)** Explain why the theoretical ratio of the volumes of gases collected at X and Y should be 1:2.

……

……

……...[2]

(ii) Knowing that the gas collected at **X** is much more soluble in water than that in **Y**, Explain how would the actual volume ratio compare to the one in theoretical?

……

……

……...[2]

(c) A few drops of universal indicator is added to **Y**.

Determine and explain the observation at **Y**.

……..……..

……..……..

……[2]

[Total: 8]

Either

B10 Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.

Tiny particles of solids are produced when the fuel does not burn completely. This increases the level of particulates (PM10) in the atmosphere. These particles are small enough to pass through the throat and nose and enter the lungs.

One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels. Some of the relative amounts of these exhaust emissions are shown in Fig.10.1.

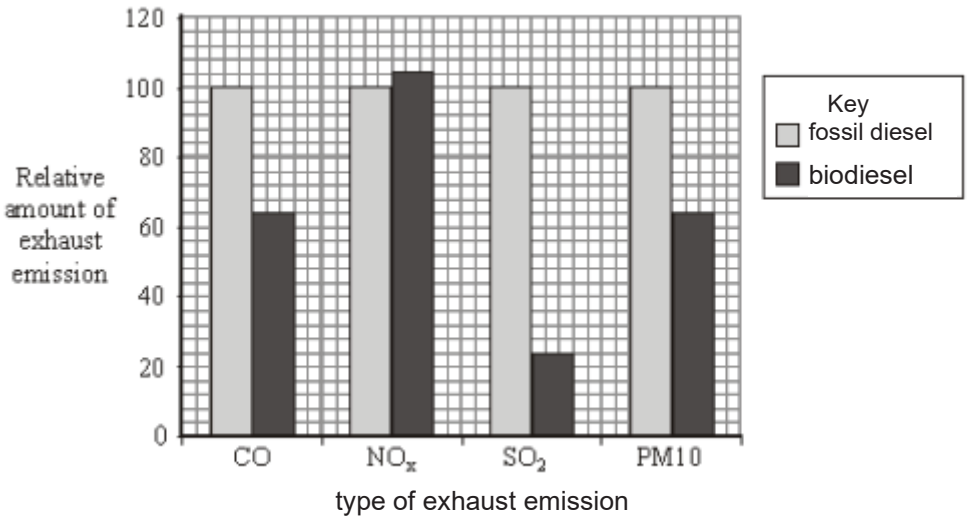


Fig. 10.1

(a) (i) Using the data given, compare the exhaust emission between fossil diesel and biodiesel.

……

……

……

……...[2]

[Turn over

(ii) Exhaust emissions from fossil diesel cause more harm to human health than those from biodiesel. Explain why.

……

……

……

……...[2]

(b) Some scientists suggest that biodiesel is ***carbon neutral***. Explain why.

……

……

……

……[2]

(c) Refrigerants are substances used to cool refrigerators and freezers. Until recently, many of the compounds used as refrigerants were chlorofluorocarbons (CFCs).

One such reaction with $CFCl_3$ is shown below.

$$CFCl_3 \xrightarrow{\text{UV light}} CFCl_2 + Cl$$

The *Cl* atom reacts with ozone in a two-step reaction.

Step 1: $Cl + O_3 \rightarrow ClO + O_2$
Step 2: $ClO + O \rightarrow Cl + O_2$

(i) One molecule of $CFCl_3$ can destroy thousands of ozone molecules.
Explain why.

……

……

……...[2]

(ii) Fig. 10.2 below shows the mass and amount of carbon, fluorine and chlorine atoms in one mole of a certain compound of CFCs found in the aerosol can of hairspray.

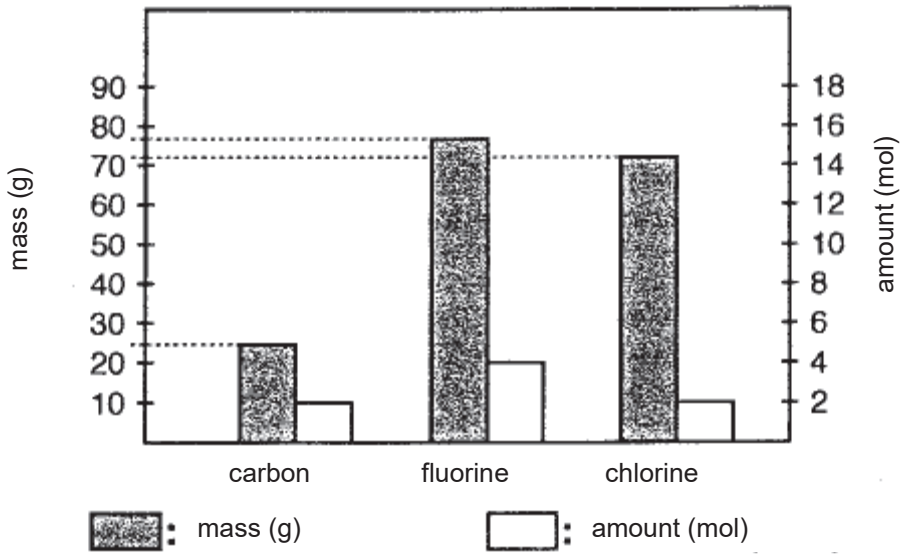


Fig. 10.2

Using the above information, determine the molecular formula of this CFCs compound.

[2]

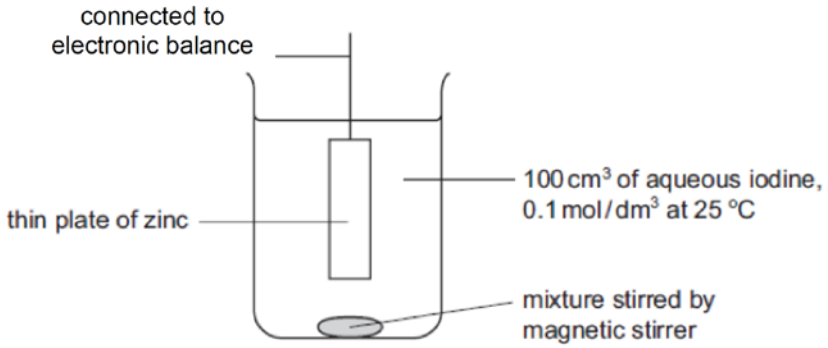
[Total: 10]

[Turn over

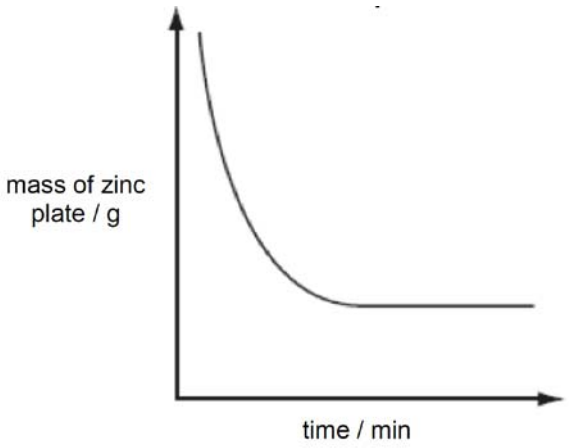
Or

B10 Zinc reacts with aqueous iodine to form zinc iodide. The following apparatus below was used to measure the rate of the reaction between zinc and aqueous iodine at 25 °C.

The mass of the zinc plate was measured every minute until the reaction was completed.



Graph 10.1 below shows the results obtained.



Graph 10.1

(a) Identify the reagent that was used in excess.

……[1]

(b) **(i)** The experiment was repeated with 100 cm^3 of 0.05 mol/dm^3 of aqueous iodine and keeping all other conditions the same. On the same axes as **Graph 10.1** above, sketch the curve that would be obtained and label it '**Y**'.

[1]

(ii) Explain the shape of the graph obtained in **(b)(i)**.

……

……

……

……...[2]

(c) Explain, in terms of collisions between reacting particles, the effect on the speed of reaction if the experiment was repeated at 30 °C with all other conditions kept constant.

……

……

……

……

……[3]

(d) Aqueous chlorine was bubbled into zinc iodide solution.

(i) Write the chemical equation for the reaction.

……...[1]

(ii) Explain, in terms of electron transfer, why this reaction is considered a redox reaction.

……

……

……...[2]

[Total: 10]

- - - - - End of Section B - - - -

- - - - - End of Paper - - - -

[Turn over

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							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											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 rubicium 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 racium –	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 –		114 Fl flerovium –		116 Lv livermorium –		

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 –

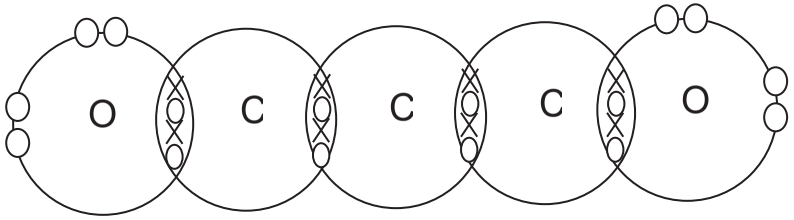
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

2019 Sec 4EX Prelims Pure Chem MS

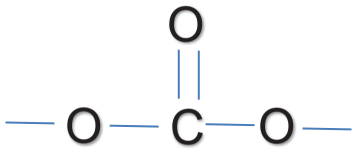
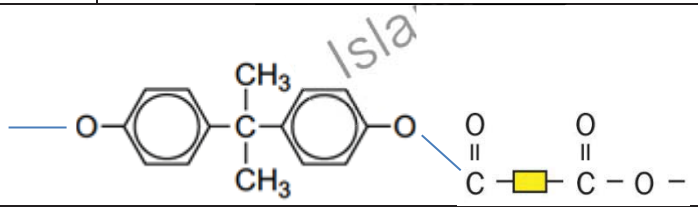
	MCQ							
1	D	**11**	D	**21**	B	**31**	D	
2	C	**12**	D	**22**	D	**32**	A	
3	D	**13**	C	**23**	C	**33**	B	
4	A	**14**	A	**24**	C	**34**	A	
5	B	**15**	D	**25**	D	**35**	B	
6	D	**16**	C	**26**	D	**36**	B	
7	A	**17**	B	**27**	B	**37**	D	
8	D	**18**	C	**28**	C	**38**	B	
9	A	**19**	A	**29**	B	**39**	A	
10	A	**20**	C	**30**	A	**40**	B	

	Section A			Marks	Markers report
A1	**(a)**		hydrogen	[1]	
	(b)		sulfur dioxide	[1]	
	(c)		propane	[1]	
	(d)		nitrogen	[1]	
	(e)		ammonia	[1]	
	(f)	**(i)**	$N_2 + 3H_2 \leftrightharpoons 2NH_3$	[1]	
		(ii)	450 – 500 °C 200 – 250 atm Powdered iron as catalyst	[2 for 1m, 3 for 2m]	
A2	**(a)**	**(i)**	$H^+ + H_2O \rightarrow OH^- + H_2$	[1]	
		(ii)	Hydrogen has been reduced as the oxidation state of hydrogen decreases from +1 to 0 while Hydrogen ion has been reduced as the oxidation state of hydrogen increases from -1 to 0.	[0.5] [1] [0.5] [1]	
	(b)	**(i)**	Nickel has a much higher density compared to sodium Nickel has a much higher melting point compared to sodium	[1] [1]	
		(ii)	For the hydrogenation of vegetable oil to margarine.	[1]	
		(iii)	Since an alloy of nickel and copper consist of atoms of different	[1]	

			sizes, Therefore, this disrupts the regular arrangement of the pure metal, making it harder to slide when a force is applied As a result, this causes it to be less malleable.	[1]	
A3	**(a)**	Z, W, X, Y		[1]	
	(b)	**(i)** **(ii)** **(iii)**	hydrogen gas iron lead / copper / silver	[1] [1] [1]	
A4	**(a)**	**(i)** **(ii)**	It has a functional group of CHO / it has a general formula of $C_nH_{2n+1}CHO$. Propanal has a higher melting / boiling point than ethanal Propanal has a higher viscocity than ethanal Propanal has a lower flammability than ethanal	[1] [2 for 1m, 3 for 2m] [1] [1]	
	(b)	**(i)** **(ii)**	$C_2H_5OH + CuO \rightarrow CH_3CHO + Cu + H_2O$ Mole of ethanal = 11 / 44 = 0.25 mol Mole ratio of ethanol: ethanal = 1:1 =0.25:0.25 Mass of ethanol = 0.25 * 46 = 11.5g Therefore, % purity of ethanol = 11.5 / 15 = 76.7 %	 [1] [1] [1]	
	(c)	Comparing relevant example (e.g ethanol and ethanal) with the same number of carbon atoms, the number of hydrogen atoms are different. Therefore, they are not isomers as this will result in different molecular formula.		[1] [1]	
A5	**(a)**	It should be a gas at room temperature. This is because it exist as a simple molecular structure in which molecules are held by weak intermolecular forces.		[1] [1]	

	(b)			[1m for the correct number of sharing electrons, 1m for correct number of unshared valence electrons]	
	(c)	**(i)**	Addition polymerisation		
		(ii)		[1m for 2 repeat units, 1m for correct arrangement of a repeat unit]	
A6	**(a)**	Calcium sulfate Magnesium sulfate		[1] [1]	
	(b)	To make sure all the acid has been reacted.		[1]	
	(c)	Heat until a saturated solution is formed Cool the solution, crystallisation takes place Filter the crystals to remove left over solution / Dry crystals between filter paper		[1] [1]	
A7	**(a)**	**(i)**	$E_2 - E_1$: enthalpy change/ ΔH $E_3 - E_1$: activation energy for backward reaction $E_3 - E_2$: activation energy for forward reaction.	[1] [1] [1]	
	(b)	**(i)**	Bond breaking: (1 x 612)+(4 X 412) + (2 x 463) = +3186 kJ	[1]	

			Bond making: (5 x 412) + 463 + 348 + 358 = -3229 kJ Overall Enthalpy = +3186kJ -3229kJ = -43 kJ	[1]	
		(ii)	less energy is taken in during the breaking of bonds in ethane and steam molecules compared to energy given out during making of bonds in ethanol molecules Therefore, energy is released to the surroundings which raises temperature.	[1] [1] [1]	

	Section B			
B8	**(a)**		[1]	
	(b)	Disposal of polycarbonates results in the formation of BPA and carbon dioxide. Carbon dioxide is a greenhouse gas which will result in global warming. In addition, BPA is non-biodegradable and can leach into water bodies which could cause harm to marine life. It leaches more over time as it ages in the landfills	[1] [1] [1]	
	(c)	**(i)** It is acting as a **catalyst** for the reaction. It is not used up over time. **(ii)** 94 – 16 – 6(12) – 12 = 4 Therefore, x = 4. **(iii)** n for the polycarbonate = 18 000 / (4 * 76 + 4*12 + 3*16 + 6) = 44.33 ≈ 45 45 moles of diphenyl carbonate is required to form the poly carbonate. Therefore, 90 moles of phenol is required. Mass of phenol required = 90 * 94 = 8460 g.	[1] [1] [1] [1] [1] [1]	
	(d)		[1m for correct formula, 1m for n]	

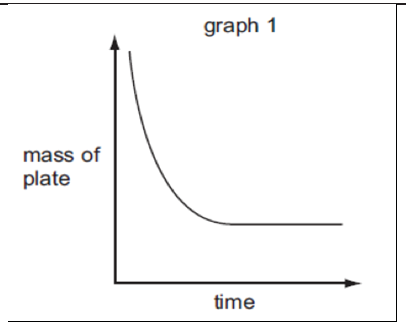
B9	**(a)**	X: $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$ Y: $2H^+(aq) + 2e^- \rightarrow H_2(g)$		[1] [1]	
	(b)	**(i)**	The overall equation of the electrolysis: $2H_2O \rightarrow 2H_2 + O_2$ Therefore, 1 mole of oxygen is formed at X for every moles of hydrogen formed at Y. / For every **4** moles of electrons, 1 mole of oxygen gas is formed at X while 2 moles of hydrogen are formed at Y.	[1] [1] [1] [1]	
		(ii)	Since oxygen is more soluble than hydrogen, less oxygen will be collected at X. Therefore, the ratio of hydrogen collected compared to oxygen will be greater than 2:1	[1] [1]	
	(c)	The universal indicator will turn purple at Y The is because there is a reduction in H^+ ions, resulting in a decrease in acidity / increase in alkalinity		[1] [1]	
B10	**(a)**	**(i)**	The amounts of CO, SO_2 and PM10 emissions are lower when using biodiesel than fossil diesel. [1] On the contrary, the amount of NOx exhaust emission is higher when burning biodiesel than fossil diesel. [1]	[1] [1]	
		(ii)	There is more amount of CO produced. CO is a pollutant which binds irreversibly with haemoglobin in red blood cell to form carboxyhaemoglobin, impairing its ability to transport oxygen causing breathing difficulties and death. There is more SO_2 produced. SO_2 irritate the eyes and lungs and causes breathing difficulties	[1] [1]	
	(b)	Burning of biodiesel releases CO_2 to the atmosphere. Biodiesel is formed from plants which absorb CO_2 in the atmosphere during photosynthesis.		[1]	

<table>
<tr><td></td><td></td><td colspan="2">Hence there is no net increase of CO_2 in the atmosphere.</td><td>[1]</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>One molecule of $CFCl_3$ produces a Cl atom under UV light which reacts with one molecule of O_3 to form one molecule of ClO
Another Cl atom is regenerated when one molecule of ClO reacts with an O atom.</td><td>[1]

[1]</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>From graph,
<table><tr><td></td><td>C</td><td>F</td><td>Cl</td></tr><tr><td>moles</td><td>2</td><td>4</td><td>2</td></tr><tr><td>simplest ratio</td><td>1</td><td>2</td><td>1</td></tr></table>The empirical formula is CF_2Cl.
From graph,
<table><tr><td></td><td>C</td><td>F</td><td>Cl</td></tr><tr><td>Mass of 1 mole of compound/g</td><td>24</td><td>76</td><td>71</td></tr></table>Mr of $CFCs$ = 171
n = 2
Molecular formula is $C_2F_4Cl_2$</td><td>[1]

[1]</td><td></td></tr>
<tr><td>Or

B10</td><td>(a)</td><td colspan="2">zinc</td><td>[1]</td><td></td></tr>
</table>

	(b)	**(i)**		[1]	
		(ii)	Gradient is less steep as the concentration of iodine is halved, resulting in a slower speed of reaction. Half the mass of zinc reacted since only half the number of mole of the limiting reagent, iodine is present.	[1] [1]	
	(c)		At 15 °C, the zinc atoms and iodine molecules have lower kinetic energy. Hence, less particles have energy greater or equal to the activation energy. The frequency of effective collisions between the zinc atoms and iodine molecules decreases. Hence, speed of reaction decreases.	[1] [1] [1]	
	(d)	**(i)**	$ZnI_2 + Cl_2 \rightarrow ZnCl_2 + I_2$	[1]	
		(ii)	I^- loses electrons to form I_2 while Cl_2 gains electrons to form Cl^- ions Therefore, I^- has being oxidised while Cl_2 is reduced	[1] [1]	