SERANGOON SECONDARY SCHOOL
PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS

CANDIDATE NAME	( )	CLASS	
CENTRE NUMBER	S	INDEX NUMBER	

CHEMISTRY

Paper 1 Multiple Choice

6092/01
24 Aug 2022
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

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 separate Answer Sheet.

Read the instructions on the Answer Sheet 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.
A copy of the Periodic Table is printed on the last page.
The use of an approved scientific calculator is expected, where appropriate.

For examiner's use
40

This question paper consists of **19** printed pages, including this cover page.

1 25 cm^3 of aqueous sodium hydroxide is pipetted into a conical flask and titrated with dilute hydrochloric acid from a burette. How can the accuracy of the titration be improved?

I. Rinse the interior of the pipette with aqueous sodium hydroxide.
II. Rinse the interior of the pipette with aqueous hydrochloric acid.
III. Rinse the interior of the conical flask with aqueous sodium hydroxide.
IV. Rinse the interior of the burette with dilute hydrochloric acid.

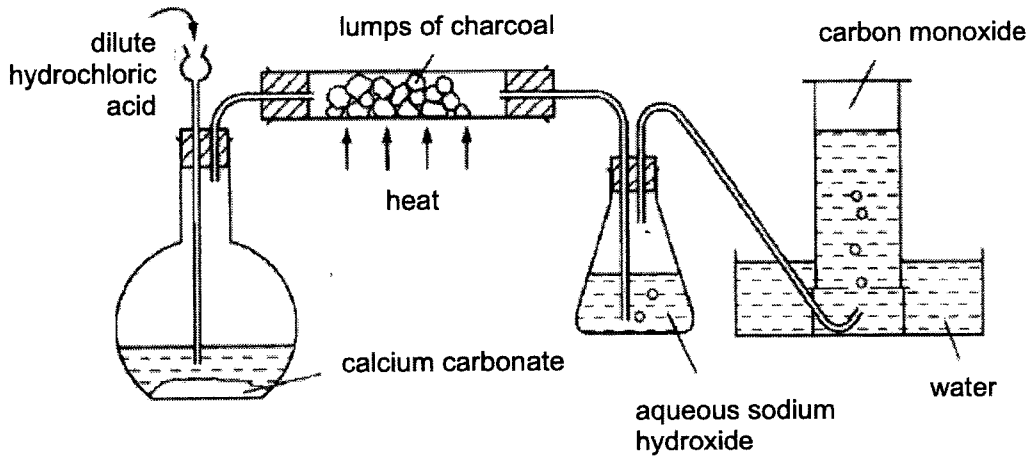
A I and III only

B I and IV only

C II and III only

D I, III and IV

2 The diagram below is a set-up used to obtain carbon monoxide.



What is the main purpose of the aqueous sodium hydroxide?

A Dry the carbon monoxide.

B Remove the carbon dioxide.

C Remove the excess acid.

D Remove the oxygen present.

3 Esters can be prepared by reactions of alcohols and carboxylic acids. The yield of these reactions is often low. One way of improving the yield is to remove the ester formed as the reaction proceeds and this can be done by carrying out fractional distillation.

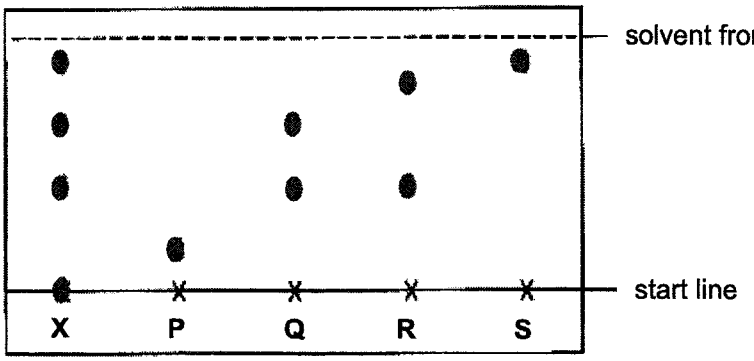
Which of the following mixtures will yield an ester as the distillate using this method?

A	ethanol (B.P: 78°C)	ethanoic acid (B.P: 118°C)	ethyl ethanoate (B.P: 77°C)
B	butanol (B.P: 117°C)	ethanoic acid (B.P: 118°C)	butyl ethanoate (B.P: 128°C)
C	ethanol (B.P: 78°C)	butanoic acid (B.P: 164°C)	ethyl butanoate (B.P: 121°C)
D	methanol (B.P: 65°C)	butanoic acid (B.P: 164°C)	methyl butanoate (B.P: 102°C)

B.P. : Boiling Point

4 Vitamins are essential nutrients needed in small amounts for various roles in the human body. They are either water-soluble or fat-soluble.

A sample of herbal tea, **X**, was analysed using chromatography with four water-soluble vitamins, P, Q, R and S, using water as the solvent. When the solvent front reached the position indicated, the chromatogram was placed under ultra-violet light. The following diagram shows the chromatogram obtained.



What can be deduced from the results?

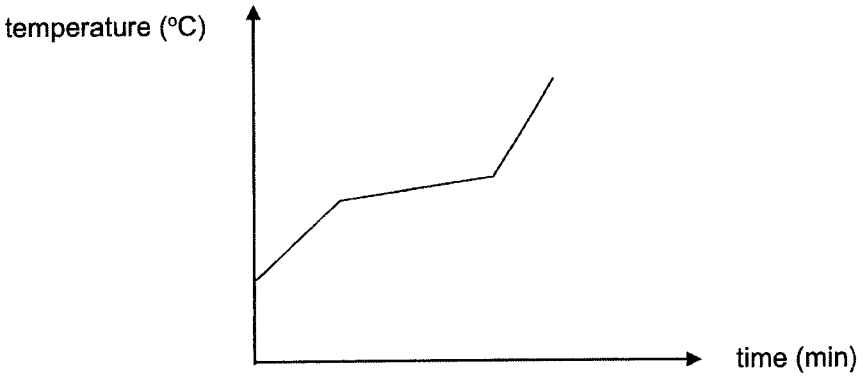
A All vitamins in **X** are soluble in water.

B One of the vitamins in **X** is not soluble in water.

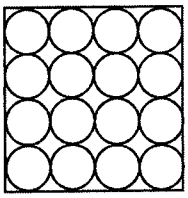
C Vitamin **X** consists of vitamin Q, R and S.

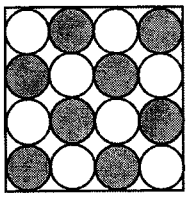
D Vitamin **X** contains three different components.

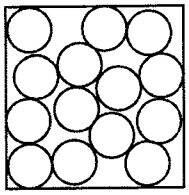
5 The diagram below shows the heating curve of substance X.

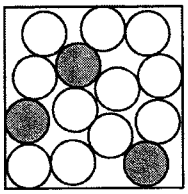


Which of the following represents the arrangement of the particles in substance X?

A 

B 

C 

D 

6 The chemical symbol of an element is shown below.

$$^{197}_{79}X$$

Which of the following describes how this element achieves a stable electronic configuration?

A gain electrons to form positive ion

B lose electrons to form negative ions

C lose electrons to form positive ions

D share electrons to form diatomic molecules

7 The proton number and electron number of some particles are shown below. The symbols used here do not represent the actual chemical symbol of the elements.

particle	P	Q	R	S
proton number	4	15	19	30
electron number	4	18	19	28

Which two particles are found in an ionic compound?

A P and R

B P and Q

C Q and S

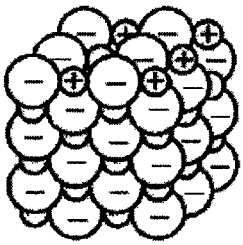
D R and S

8 The properties of an unknown substance are given below.

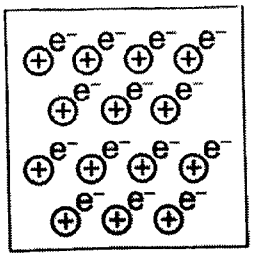
- low melting and boiling point
- low density
- good conductor of electricity in solid state

Which of the following is the substance?

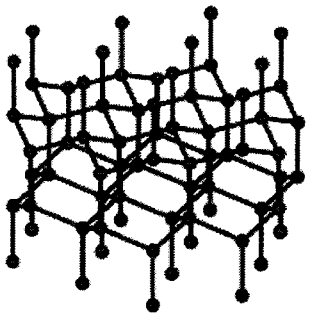
A



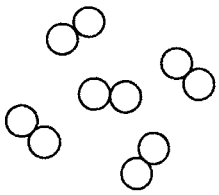
B



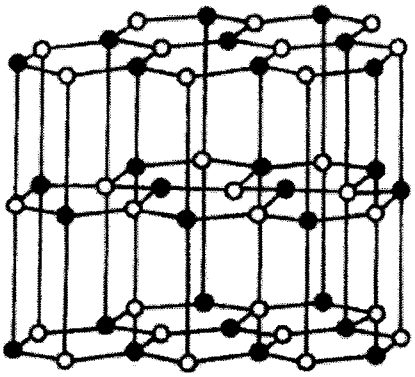
C



D



9 Which of the following best explains the reason why the substance with the structure shown below would be a good lubricant?



A strong covalent bonds between the layers of atoms

B weak forces of attraction between the layers of atoms

C weak covalent bonds between the layers of atoms

D weak electrostatic forces of attraction between the layers of atoms

10 Which statement about groups in the Periodic Table is correct?

A All groups contain both metals and non-metals.

B Atoms of the elements in the same group have the same number of total electrons.

C Atomic radius decreases down the group.

D Ionisation energy decreases down the group.

11 $X_2 + 2KY \rightarrow 2KX + Y_2$

Based on the equation shown above, _____.

A the reaction is a redox reaction

B the reaction is a metal displacement reaction

C X is less reactive than Y

D X_2 is the reducing agent

12 The setup below was used to collect the gas produced when an excess magnesium was added to 50 cm^3 of 1 mol/dm^3 of hydrochloric acid.
The time taken for the reaction to be completed was also recorded.
The table below shows the results obtained.

volume of gas (cm^3)	600
time taken for reaction to complete (s)	60

Which of the following would likely be the results obtained when same concentration of propanoic acid is used instead?

	volume of gas (cm^3)	time taken for reaction to complete (s)
A	300	30
B	300	60
C	600	60
D	600	180

13 In an experiment, 5 cm^3 of 1.0 mol/dm^3 of sodium hydroxide is gradually added to 10 cm^3 of 1.0 mol/dm^3 of hydrochloric acid, containing methyl orange indicator.

Which change occurs in the mixture?

A A white precipitate is formed.

B Methyl orange changes in colour.

C The concentration of OH^- increases.

D The concentration of H^+ decreases by half.

14 X, Y and Z elements are found in Period 3 of the Periodic Table.
X forms an acidic oxide when burnt in oxygen.
Y forms a basic oxide when burnt in oxygen.
Z forms an amphoteric oxide when burnt in oxygen.

What is the order of the three elements across the Periodic Table?

A X, Y, Z

B X, Z, Y

C Y, X, Z

D Y, Z, X

15 Which of the following reactions is **unlikely** to take place?

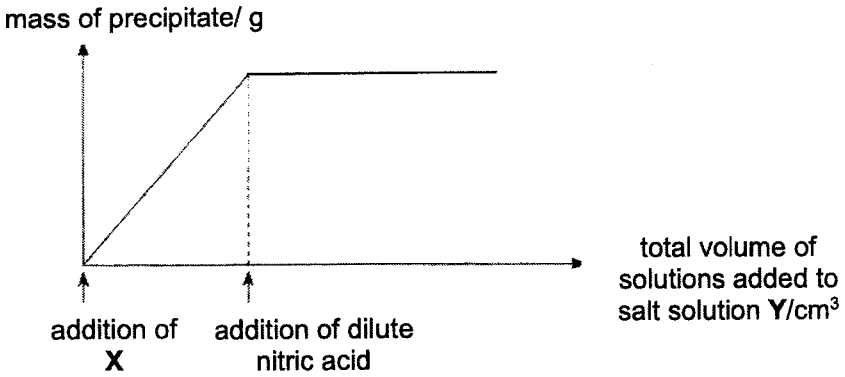
A Pb^{2+} (aq) + 2Cl^- (aq) → $PbCl_2$ (s)

B Fe^{2+} (aq) + Mg (s) → Mg^{2+} (aq) + Fe (s)

C $2H^+$ (aq) + Cu (s) → H_2 (g) + Cu^{2+} (aq)

D $2H^+$ (aq) + CO_3^{2-}(aq) → CO_2 (g) + H_2O (*l*)

16 In a chemistry experiment, solution **X** is gradually added to a salt solution **Y**, followed by the addition of a dilute nitric acid solution. The graph shows how the mass of precipitate formed changes with the addition of the different solutions.



Which of the following would produce the graph as shown above?

	solution **X**	ions present in salt solution **Y**
A	aqueous silver nitrate	chloride ion and carbonate ion
B	aqueous silver nitrate	nitrate ion and sulfate ion
C	aqueous barium nitrate	sulfate ion and carbonate ion
D	aqueous barium nitrate	sulfate ion and nitrate ion

17 The table shows the observations made when an aqueous solution X was tested.

reagent added	observation
acidified silver nitrate	solution remained colourless.
aqueous sodium hydroxide	pungent gas turns moist red litmus paper blue.

Which of the following could X possibly be?

A ammonium nitrate **B** ammonium chloride

C zinc nitrate **D** zinc chloride

18 A gas was produced during a reaction. The descriptions below show some of the properties of the gas produced.

- turns moist blue litmus paper red
- pungent smell
- no visible change with limewater

What is the identity of the gas produced?

A ammonia **B** carbon dioxide

C nitrogen monoxide **D** sulfur dioxide

19 Which element contains the greatest number of atoms in 1 g?

A aluminium **B** carbon

C iodine **D** nitrogen

20 An impure sample of 1 g of silver oxide reacts with excess of nitric acid to form silver nitrate and water. The reaction produces, 0.86 g of silver nitrate.

$$Ag_2O + 2HNO_3 \rightarrow AgNO_3 + H_2O$$

What is the percentage purity of the sample?

A 31.3 % **B** 58.7 %

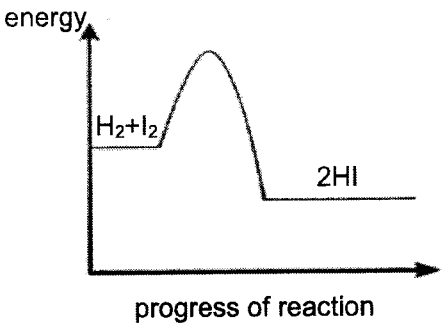
C 85.5 % **D** 86.0 %

21 Hydrogen and iodine react according to the equation shown below.

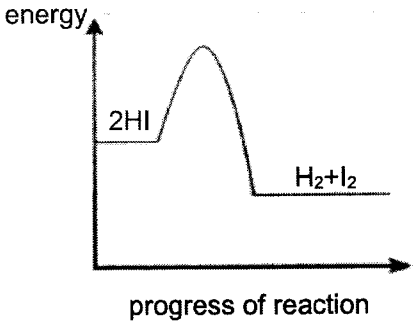
$$H_2 + I_2 \rightleftharpoons 2HI \quad \Delta H = +52.96 \text{ kJ}$$

Which of the following energy profile diagrams shows the backward reaction?

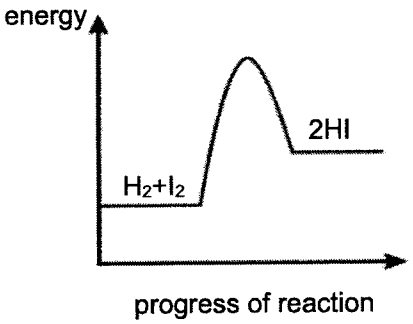
A



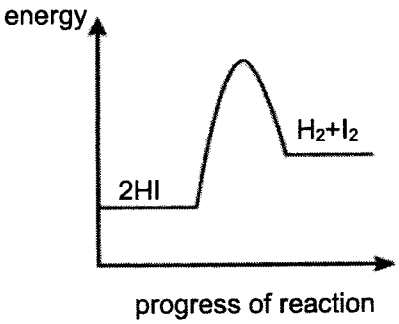
B



C



D



22 The scheme shows four stages I to IV in the conversion of solid candlewax, $C_{30}H_{62}$, into carbon dioxide and water.

$$C_{30}H_{62}(s) \xrightarrow{I} C_{30}H_{62}(l) \xrightarrow{II} C_{30}H_{62}(g) \xrightarrow{III} \begin{matrix} 30CO_2(g) \\ + \\ 31H_2O(g) \end{matrix} \xrightarrow{IV} \begin{matrix} 30CO_2(g) \\ + \\ 31H_2O(l) \end{matrix}$$

Which stage(s) is/are exothermic?

A III only

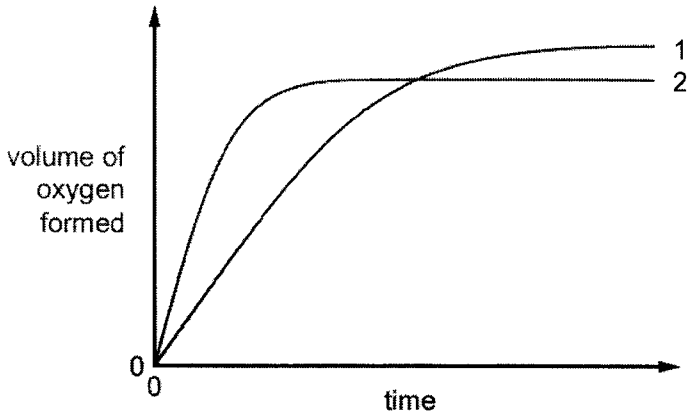
B III and IV only

C I, II and III only

D I, II and IV only

23 In the graph, curve 1 was obtained by observing the decomposition of 100 cm^3 of 1.0 mol/dm^3 hydrogen peroxide solution, catalysed by manganese(IV) oxide.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$



Which alteration to the original experimental conditions would produce curve 2?

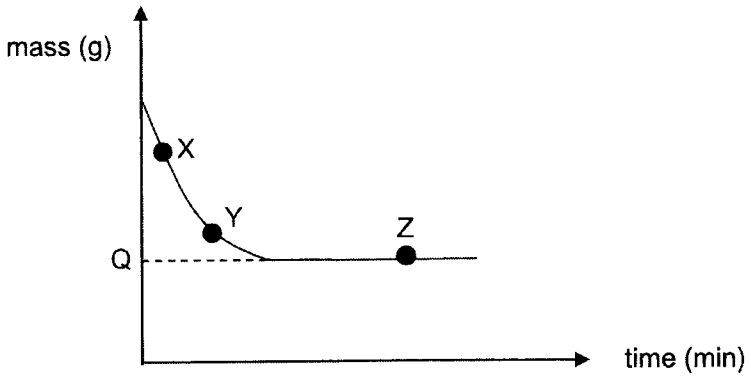
A increase the pressure

B lower the temperature

C using 100 cm^3 of 1.2 mol/dm^3 hydrogen peroxide solution

D using 50 cm^3 of 1.2 mol/dm^3 hydrogen peroxide solution

24 The graph shows the mass of hydrogen gas evolved, plotted against time, when excess hydrochloric acid reacts with 2 g of magnesium ribbon.



Which statement is correct?

A The reaction is faster at point X than at point Y.

B The reaction first reaches completion at point Z.

C The mass of hydrogen gas evolved will be higher if magnesium powder is used instead.

D Mass of hydrogen gas evolved is Q g.

25 The statements below describe the reactions of metals P, Q and R.

- Metal P does not react with cold water but reacts quickly with an acid.
- Metal Q reacts slowly with an acid but has no reaction with steam.
- Metal R reacts fast with cold water.

Which of the following statements is correct?

A Metal P can only be extracted by electrolysis from its ore.

B Metal Q exists naturally uncombined.

C Metal R cannot be reduced by coke.

D Metals P and Q are positioned below hydrogen in the metal reactivity series.

26 Which of the following equations show the protection of iron from rusting?

A $3Ca^{2+} + 2Fe \rightarrow 2Fe^{3+} + 3Ca$

B $Zn^{2+} + Fe \rightarrow Fe^{2+} + Zn$

C $Mg + Fe^{2+} \rightarrow Fe + Mg^{2+}$

D $Sn + Fe^{2+} \rightarrow Fe + Sn^{2+}$

27 Which of the following is true about steel?

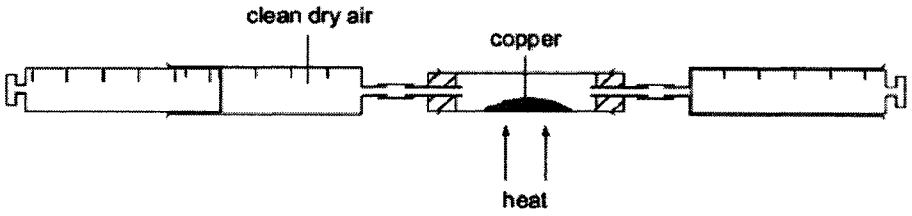
A It is resistant to corrosion.

B It is softer than pure metal.

C It is a poor conductor of electricity.

D It reacts with acid to form hydrogen gas.

28 A 150 cm^3 sample of clean, dry air is passed over hot excess copper at room temperature and pressure until there is no further change in volume. The pink copper metal turns black at the end of the reaction.



What is the minimum mass of copper metal that is needed for this reaction?

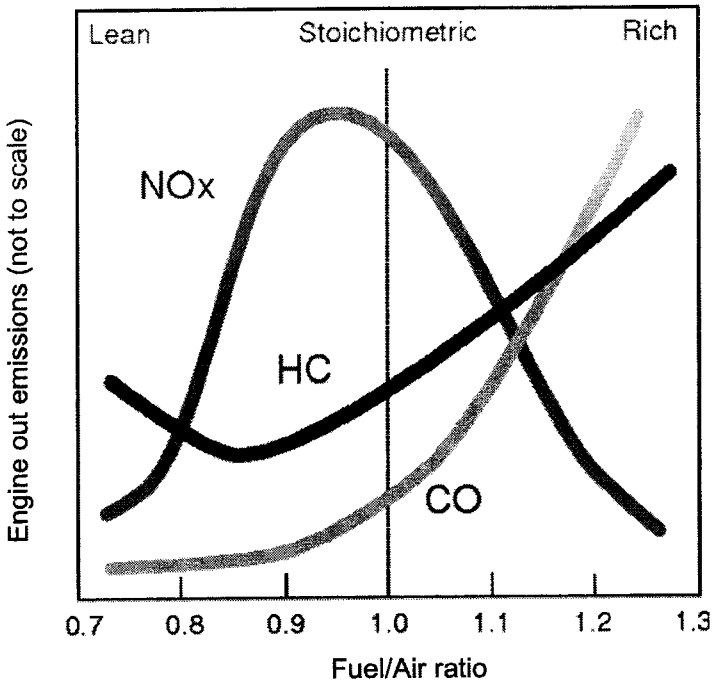
A 0.084 g

B 0.168 g

C 0.316 g

D 0.632 g

29 The diagram below shows the changes to the emission of different gases from a car engine at different fuel/air ratio.



Why is there an increase in the emission of CO when the fuel/air ratio increases from 0.8 to 1.0?

A There is a decrease in the volume of air in the engine, leading to internal combustion.

B There is an increase in the volume of air in the engine, leading to internal combustion.

C There is a decrease in the volume of air in the engine, leading to incomplete combustion.

D There is an increase in the volume of air in the engine, leading to incomplete combustion.

30 Which two processes in the carbon cycle help to regulate the carbon level in the atmosphere?

A combustion and respiration

B decomposition and respiration

C deforestation and photosynthesis

D photosynthesis and combustion

31 Why is iron metal added to Haber Process?

A To lower the pressure needed for the reaction.

B To lower the temperature needed for the reaction.

C To lower the activation energy level of the process.

D To react with hydrogen and nitrogen to form ammonia.

32 Given the following reaction

$$2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$$

Which statement about the reaction above is true?

A MnO_4^- is acting as the reducing agent.

B SO_3^{2-} is oxidised to form SO_4^{2-} .

C H^+ is oxidised.

D SO_3^{2-} is neither oxidised nor reduced.

33 During electroplating process, an object is coated with silver metal. The mass of the was measured before and after the process.

mass of object before process (g)	4.78
mass of object after process (g)	6.15

The difference in the mass recorded is due to _____.

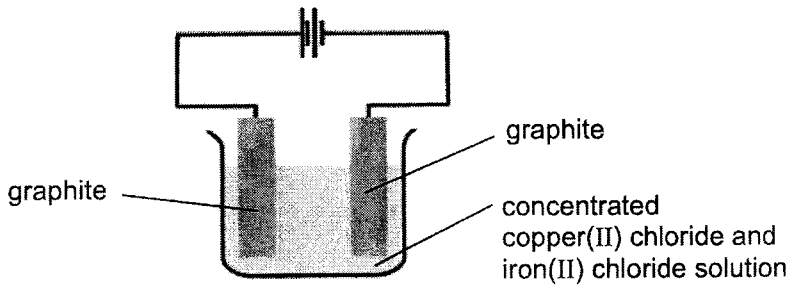
A a gas being produced at the object

B a salt being produced on the object

C oxidation of silver metal

D reduction of silver ions

34



Which of the following statements correctly describes the observations made in the setup a few hours later?

A Green fumes observed at the cathode.

B The electrolyte would be blue in colour.

C The electrolyte would be green in colour.

D The anode will increase in size.

35 In the electrolysis of an aqueous solution of cerium nitrate, 70 g of cerium, Ce, (A_r = 140) is deposited at the cathode by 2 moles of electrons. What is the charge on the cerium ion?

A 1+ **B** 2+

C 4+ **D** 6+

36 The table below shows the uses of two fractions obtained from fractional distillation of crude oil.

fraction	uses
X	fuel for lorries and trucks
Y	feedstock for petrol chemical industry

What is fraction X and Y based on the uses given?

	fraction X	fraction Y
A	diesel	lubricating oil
B	diesel	naphtha
C	petrol	lubricating oil
D	petrol	naphtha

37 One of the compounds found in bitumen has a molecular formula of $C_{20}H_{42}$. It undergoes cracking to form smaller molecules as shown in the equation below.

$$C_{20}H_{42} \rightarrow C_{12}H_{26} + 2 \_\_\_\_\_$$

What is the chemical formula of the other compound formed?

A C_4H_8

B C_4H_{10}

C C_8H_{16}

D C_8H_{18}

38 400 cm^3 of 5 mol/dm^3 of aqueous bromine was found to react with 1 mole of an unsaturated hydrocarbon.

What is the number of bromine atoms that would be found in the product formed?

A 2 **B** 3

C 4 **D** 6

39 Below shows a list of reactions.

I combustion of ethanol
II fermentation of glucose
III oxidation of ethanol by air in the presence of bacteria
IV reaction of sodium carbonate with ethanoic acid

In which reaction is carbon dioxide a product?

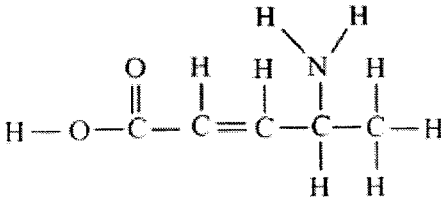
A I and II only

B I and IV only

C I, II and III only

D I, II and IV only

40 Which of the following reactions will **not** take place with the molecule shown below?



A bromination

B condensation polymerisation

C oxidation

D reaction with magnesium

END-OF-PAPER

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											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 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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.)

SERANGOON SECONDARY SCHOOL
PRELIMINARY EXAMINATION
SECONDARY 4 EXPRESS

CANDIDATE NAME	( )	CLASS	
CENTER NUMBER	S	INDEX NUMBER	

CHEMISTRY

Paper 2

6092/02
26 Aug 2022
1 hour 45 minutes

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name 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 staplers, paper clips, 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.

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 the last page.

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

For examiner's use	
Section A	/50
Section B	/30
9	
10	
11	
Total	/80

This question paper consists of **21** printed pages, including this cover page.

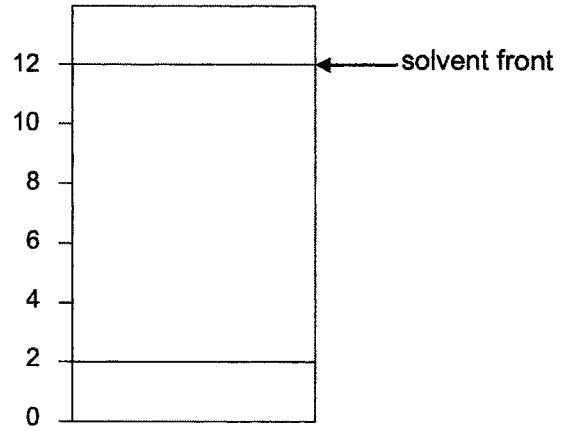
Section A [50 marks]
Answer **all** questions.

A1 The table below gives some information of an unknown substance **Y**.

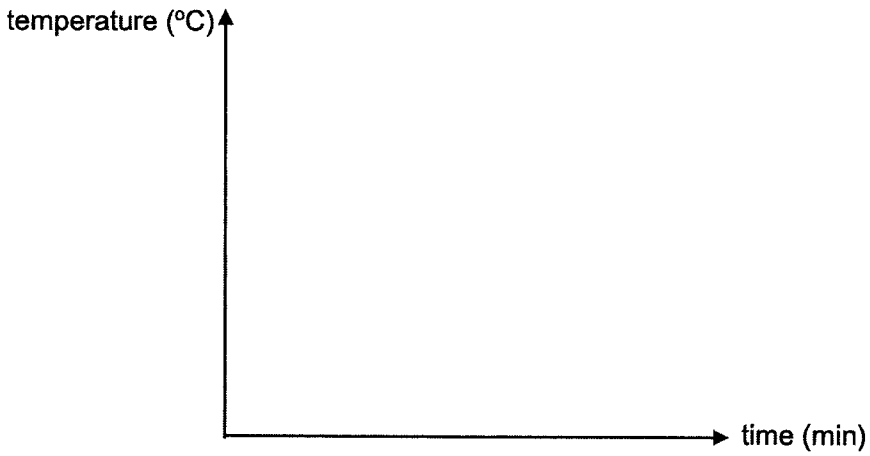
property of substance Y	
colour	black
melting point	1326 °C
boiling point	2000 °C
solubility in water	insoluble
chromatogram	R_f = 0.7

(a) Based on the information given above,

(i) Draw in the chromatogram the spot for **Y** that would be obtained below. [2]
Show your workings clearly on how the answer is derived.



(ii) Sketch in the axes below, the **freezing curve** of substance **Y**. [1]



(b)(i) Based on the information given, substance **Y** can be classified as either an element or a compound. Explain why this is so. [1]

.....

.....

.....

(ii) Describe and explain what can be done to determine whether substance **Y** is an element or a compound. [2]

.....

.....

.....

.....

.....

A2 Electronegativity is a measure of an atom's ability to attract shared electrons to itself.

The bond dissociation energy is the energy required to break a bond and form two atomic or molecular fragments, each with one electron of the original shared pair.

The table below shows the electronegativity and bond dissociation energy of halogens.

halogen	electronegativity	bond dissociation energy kJ/mol
fluorine	4	156
chlorine	3	243
bromine	2.8	193
iodine	2.5	151

(a)(i) Excluding fluorine, describe the relationship between electronegativity and bond dissociation energy of halogens. [1]

.....

.....

.....

(ii) Suggest a plausible reason for the relationship observed in **(a)(i)**. [3]

.....

.....

.....

.....

.....

.....

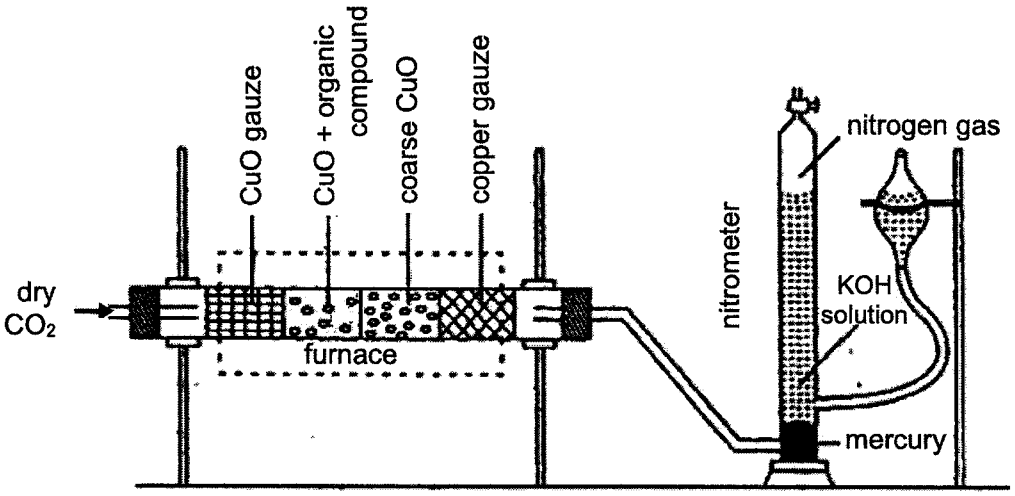
(b) Suggest a plausible reason for fluorine for **not** following the relationship describe in **(a)(i)**. [1]

.....

.....

.....

A3 Dumas method is a quantitative method used to determine nitrogen content in a given organic compound. The diagram below shows the setup used to determine nitrogen content in the Dumas method.



In the Dumas method, the organic compound containing nitrogen would be heated with excess copper(II) oxide in an atmosphere of carbon dioxide. During the reaction, nitrogen gas, carbon dioxide gas and water would be obtained.

Oxides of nitrogen is a by-product that would be also formed during the reaction. It would be converted to nitrogen when they are passed over heated copper gauze. Copper(II) oxide would also be formed during the reaction.

(a)(i) Write the chemical equation between nitrogen dioxide and copper gauze. [1]

.....

(ii) State and explain, in terms of oxidation state, whether nitrogen dioxide is oxidised or reduced by the copper gauze. [2]

.....

.....

.....

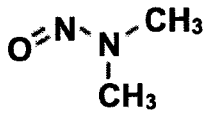
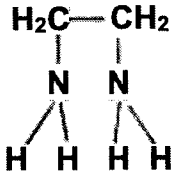
(b) Suggest a possible reason for the potassium hydroxide in the setup. [1]

.....

.....

(c) From the analysis of an unknown organic compound, it was found that the percentage of nitrogen is 37.8%.

The table below shows a list of possible organic compound and their structural formula.

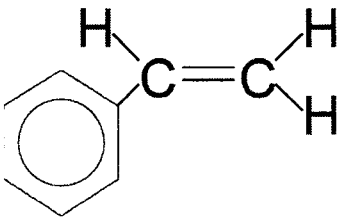
name of organic compound	structural formula
acetonitrile	$N\equiv C-CH_3$
N, N-dimethylnitrous amide	
ethylenediamine	

Determine the identity of the unknown organic compound. Explain how you derive your answer. You may show your workings to aid in your explanation. [2]

.....

.....

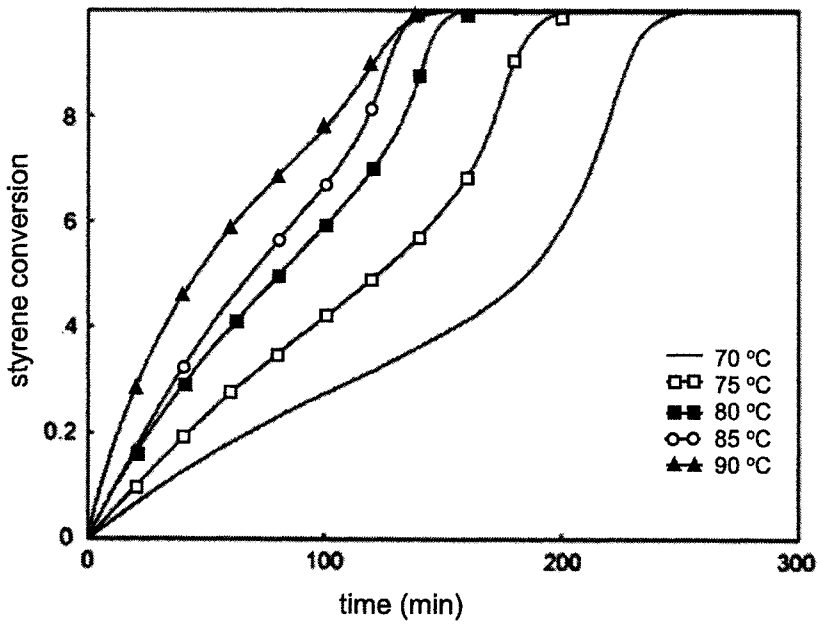
A4 The diagram below shows the structural formula of styrene. It can undergo polymerisations in the presence of a catalyst.



(a) Draw the structural formula of the polymer formed by styrene and give the name of the polymer formed. [2]

name of polymer: .....

(b) Experiments were carried out to determine the optimum temperature to carry out the polymerisation of styrene. The diagram below shows the results obtained.



Based on the results obtained, at which temperature should the polymerisation of styrene be carried out? Explain your answer in terms of collision theory. [3]

.....

.....

.....

.....

.....

(c) What would happen to the rate of polymerisation of styrene if the catalyst is not used? Explain. [1]

.....

.....

.....

A5 A student measured the temperature change when 5.0 g of potassium chloride was dissolved in excess water. The table below shows the results obtained.

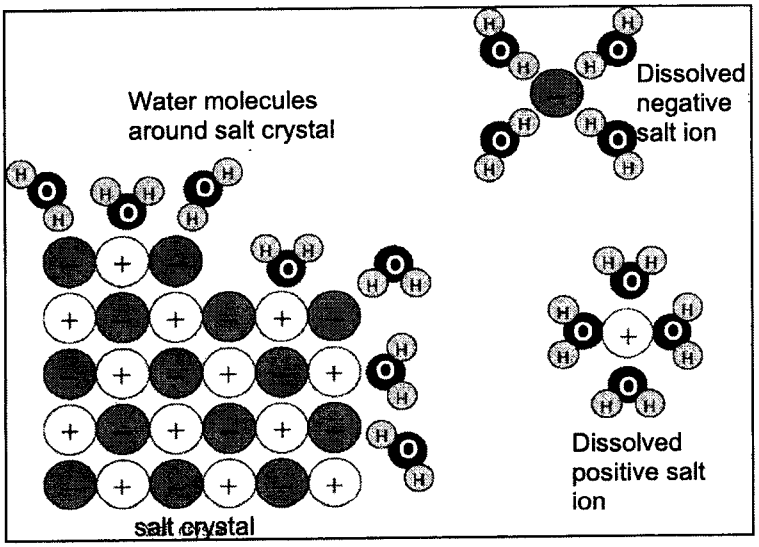
temperature / °C	24.5
highest /lowest recorded temperature / °C	22.0
calculated energy change / J	1160

https://socratic.org/questions/5709d5887c014947fcb6e231

(a) State and explain if the change is exothermic or endothermic. [1]

.....

(b) The process of dissolving involves both bond-forming and bond-breaking. The process and description are given below.



When water dissolves a substance, the water molecules attract and "bond" to the particles (molecules or ions) of the substance causing the particles to separate from each other. The "bond" that a water molecule makes is not a covalent or ionic bond. It is a strong force of attraction.

Using information given and your knowledge of bond-breaking and bond-forming, explain why the calculated energy change for dissolving potassium chloride is positive. [2]

.....

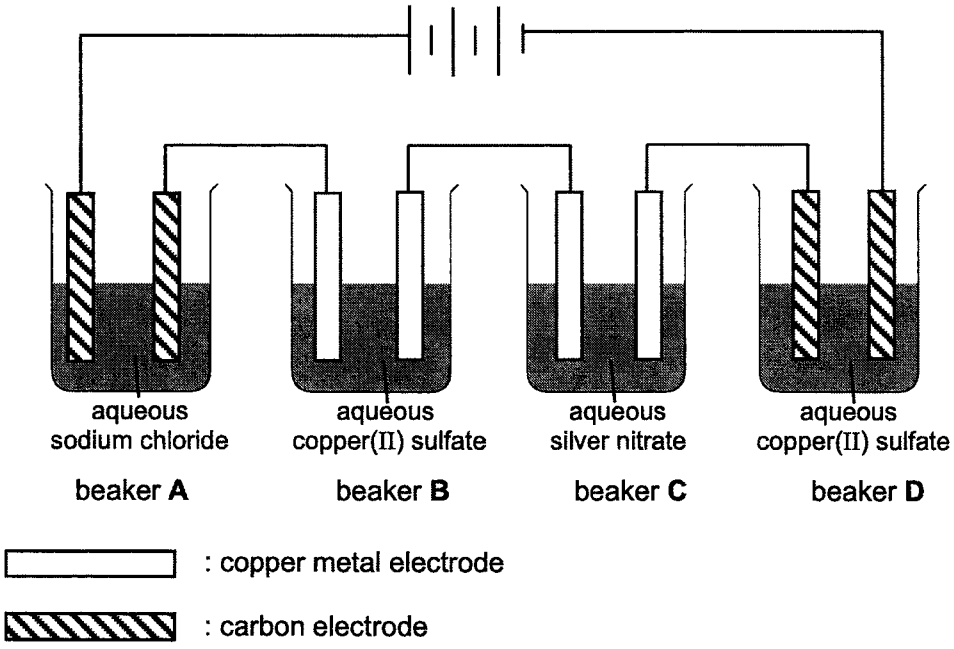
.....

.....

.....

(c) Use the student's results to calculate the enthalpy change when one mole of potassium chloride dissolves in excess water. [3]
Give your answer in kJ/mol, to three significant figures.

A6 The diagram below shows an electrolysis setup.



(a) In the table below, fill in the missing observations of the anode, cathode and electrolyte. [3]

beaker	anode	cathode	electrolyte
A			no visible change
B	decrease in size	increase in size	no visible change
C	decrease in size		
D		increase in size	

(b) After the setup has been running for some time, explain for the observation made on the electrolyte found in

(i) beaker **A,** [1]

.....

.....

.....

.....

(ii) beaker **B** and [1]

.....

.....

.....

(iii) beaker **C**? [2]

.....

.....

.....

.....

(c) Write the half equations, for the reactions at the anode and cathode in beaker **D**. [2]

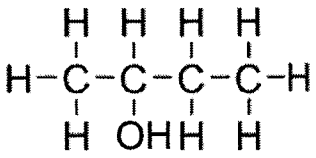
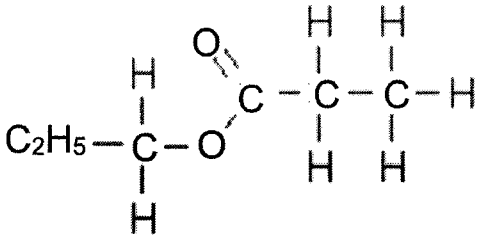
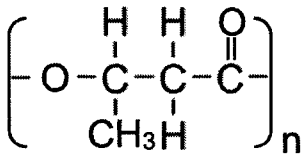
.....

.....

.....

.....

A7 The diagram below shows three different organic compounds, **P**, **Q** and **R**.

compound	
P	
Q	
R	

(a)(i) State whether each statement below is true or false. [2]

statement	True / False
Compound **P** can be made by fermentation.	
Compound **Q** can be made by reacting compound **P** with an organic acid.	
Water is also produced during the formation of compound **Q** and **R**.	

(ii) State and explain one condition used when carrying out fermentation. [1]

.....

.....

.....

.....

(b)(i) What is the name of compound **Q**? [1]

.....

(ii) State a possible use for compound **Q**. [1]

.....

(c) Draw the reactant(s) that is/are used to form compound **R**. [1]

A8 A composite material is a mixture of two different substances. Reinforcing fibres are often used in a plastic to give the plastic extra strength. The table below gives some information about four different fibres that are used to make composite plastics.

fibre	density (kg/m^3)	force needed to break the fibre (N/m^2)
carbon	174	3.1
glass	257	3.7
kevlar	145	3.6
polyester	138	1

(a) Kevlar and carbon fibre composites are used in the building of spacecraft. Suggest reasons why,

(i) polyester fibre composites and [1]

.....

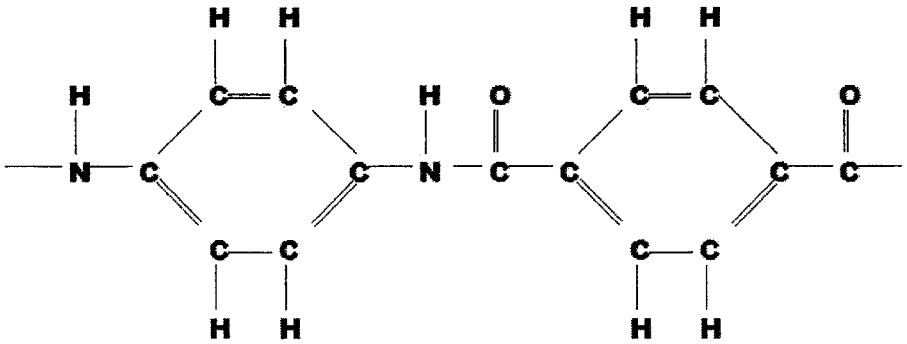
.....

(ii) glass fibre composites, are not suitable for this purpose. [1]

.....

.....

(b) Kevlar has a structure shown below.



Describe two differences between kevlar and polyester. [2]

.....

.....

.....

.....

.....

.....

(c) Glass is mainly made up of silicon dioxide. Describe another property of glass and explain in terms of bonding and structure for the property described. [2]

.....

.....

.....

.....

.....

.....

Section B [30 marks]

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

B9 Hard water is water that has high mineral content. These minerals may enter the water sources when rain, containing dissolved carbon dioxide, reacts with calcium carbonate and carry calcium ions away with it. Hardness refers to the total concentration of alkaline earth (Group II) ions in water. Due to the much higher concentrations of Ca^{2+} and Mg^{2+} than other alkaline earth ions, hardness can be equated to the concentration of Ca^{2+} and Mg^{2+}. Hardness is commonly expressed as the equivalent number of miligrams of calcium carbonate per dm^3. Thus, if concentration of Ca^{2+} and Mg^{2+} = 1 mmol/dm^3, we would say that hardness is 100 mg calcium carbonate per dm^3 of water as 100 mg of calcium carbonate is equivalent to 1 mmol of calcium carbonate. Water whose hardness is less than 60 mg calcium per dm^3 of water is considered to be "soft". If the hardness is above 270 mg/dm^3, the water is considered to be "hard".

To measure the total hardness, a sample of water is treated with ascorbic acid to reduce Fe^{3+} to Fe^{2+}. Titration with EDTA, a chemical substance, at pH 10 in ammonia solution, would then give the total concentration of Ca^{2+} and Mg^{2+}. The concentration of Ca^{2+} can be determined separately if the titration is carried out at pH 13 without ammonia.

Insoluble carbonates are converted to soluble bicarbonates by excess carbon dioxide:

$$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$$

Heating converts bicarbonate to carbonate by driving off carbon dioxide and causes calcium carbonate to precipitate.

Hard water reacts with soap ($C_{17}H_{35}CO_2Na$) to form insoluble curds:

$$Ca^{2+} + 2C_{17}H_{35}CO_2^- \rightarrow Ca(C_{17}H_{35}CO_2)_2$$

Enough soap is needed before the soap will lather and be useful for cleaning.

Hard water may be treated by using washing soda (Na_2CO_3) method where sodium carbonate is added into the hard water that contains chlorides and sulfates of calcium and magnesium.

(a) Explain why rain containing dissolved carbon dioxide can react with calcium carbonate. [2]

.....

.....

.....

(b) Suggest a chemical that can be added to carry out the titration at pH 13. [1]

.....

(c)(i) It is mentioned above that "enough soap is needed before the soap will lather and be useful for cleaning". Explain why this is so [1]

.....

.....

.....

(ii) A 500 cm^3 sample of water has a hardness reading of 275 mg/dm^3. Determine the minimum mass of soap that must be added into the sample of water before the soap will lather and be useful for cleaning. [3]

(d) Explain, with appropriate equation, how the addition of sodium carbonate will help to reduce the hardness of water. [3]
Describe how the treated water can be obtained after the treatment.

.....

.....

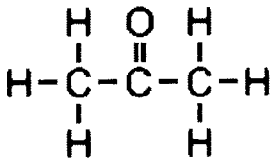
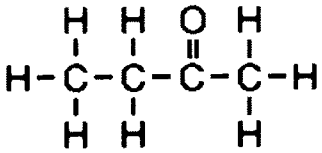
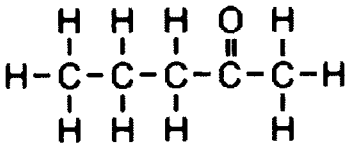
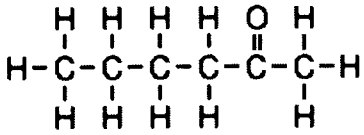
.....

.....

.....

.....

B10 In the table below shows a list of members found in the ketones homologous series.

name	molecular formula	structural formula	boiling point (°C)
propanone	C_3H_6O		56.2
butanone	C_4H_8O		79.6
pentanone	$C_5H_{10}O$		102
hexanone	$C_6H_{12}O$		

(a) Draw the structural formula and write the name of the next member after hexanone. [2]

Name: .....

(b) What is the general formula of the ketones homologous series? [1]

.....

(c) Draw an isomer of butanone. [1]

(d) Suggest the boiling point of hexanone. [3]
Explain your answer in terms of bonding and structure.

.....

.....

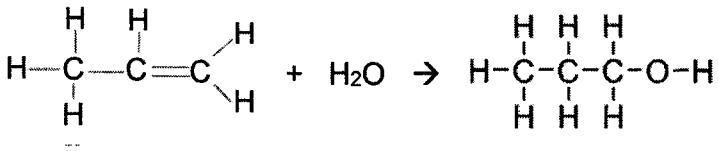
.....

.....

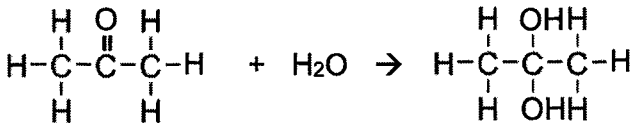
.....

(e) Ketones and alkenes both undergo addition reactions as shown by the structural equations shown below.

Alkene: Propene reaction with water



Ketone: Propanone reaction with water



(i) Describe **two** differences between the two addition reactions shown above. [2]

.....

.....

.....

.....

(ii) State and explain what would be observed when a few drops of Universal indicator are added into propanone. [1]

.....

.....

.....

Either

B11 Some metal carbonates, when heated, decompose to produce carbon dioxide.

Fig. 11.1 shows the results from an investigation on the rate of decomposition of four metal carbonates.

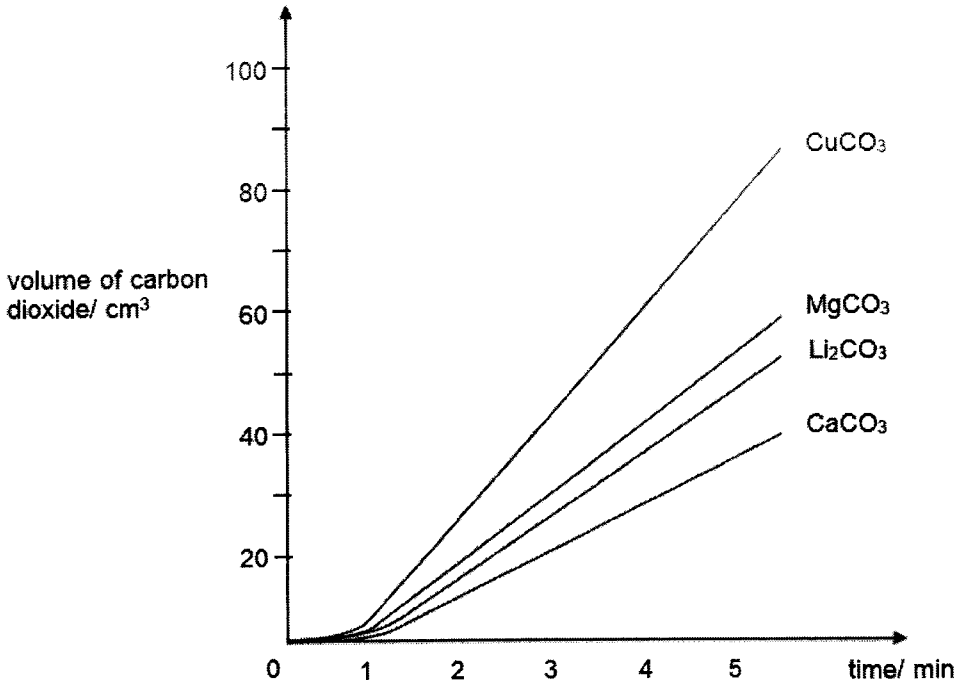


Fig. 11.1

In each experiment, 1.00 g of metal carbonate was heated to the same temperature using flame of the same intensity. The volume of carbon dioxide produced was measured at every minute interval.

(a) Suggest why very little carbon dioxide was collected at the start of each experiment. [1]

.....

.....

.....

(b) Using the information in **Fig. 11.1**, explain why the decomposition of metal carbonates were **not** completed at the end of the investigation. [1]

.....

.....

.....

(c)(i) Ignoring the volume of carbon dioxide recorded at time one minute, determine the speed of the decomposition lithium carbonate. [1]

(ii) Hence, determine the time it would take for 1 g of lithium carbonate to be completely decomposed. [3]

(d)(i) Using **only** the information in **Fig. 11.1**, state and explain which metal carbonate decomposed at the fastest rate. [2]

.....

.....

.....

.....

(ii) Describe and explain how the volume of carbon dioxide will change with time if potassium carbonate was used for the experiment. [2]

.....

.....

.....

.....

Or

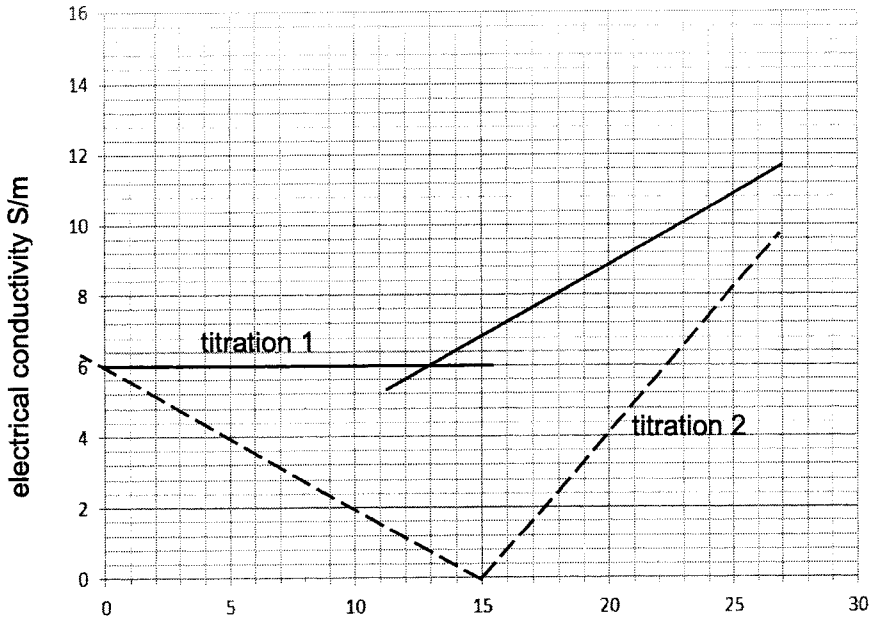
B11 Two titrations were carried with two different sets of solutions.
Titration 1 involved 20.0 cm^3 of sodium hydroxide and iron(II) nitrate solution.

$$2NaOH + Fe(NO_3)_2 \rightarrow Fe(OH)_2 + 2NaNO_3$$

Titration 2 involved 20.0 cm^3 barium hydroxide and sulfuric acid.

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$$

To determine the end-point of a titration, the electrical conductivity of the solution was monitored. With the data collected, graphs were plotted and shown below.



titration 1: volume of aqueous iron(II) nitrate / cm^3
titration 2: volume of sulfuric acid/ cm^3

(a)(i) One difference between the graphs obtained from titration 1 and titration 2 is that the electrical conductivity decreases to 0 S/m for titration 2 but not for titration 1. Explain why this is so. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) State another difference in the graphs obtained for titration 1 and titration 2. [1]

.....

.....

.....

(iii) Suggest a reason for the difference in **(a)(ii)**. [2]

.....

.....

.....

.....

(b) Determine the concentration of sodium hydroxide used in titration 1 given that the concentration of iron(II) nitrate used was 0.563 mol/dm^3. [3]

END OF PAPER

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											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 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 –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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.).

2022 Preliminary Examination 4E Chemistry Answer Scheme

Paper 1

1	2	3	4	5	6	7	8	9	10
B	B	A	B	D	C	C	B	B	D

11	12	13	14	15	16	17	18	19	20
A	D	D	D	C	D	A	D	B	B

21	22	23	24	25	26	27	28	29	30
B	B	D	A	C	C	D	B	C	D

31	32	33	34	35	36	37	38	39	40
C	B	D	C	C	B	A	C	D	C

Paper 2

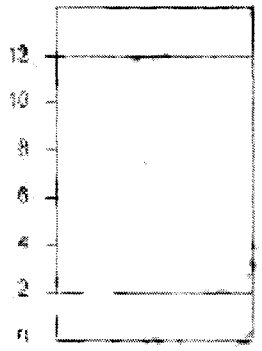
Section A

A1

ai (2)

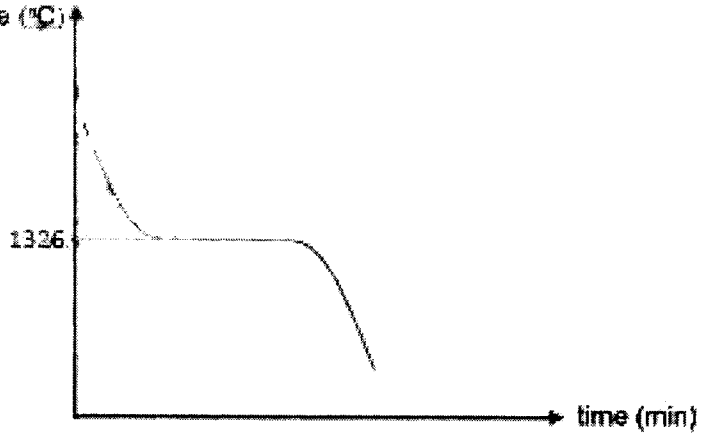
Distance travelled = 0.7 / 10

Distance travelled=7 [1]



Position of spot at 7. [1]

ii (1)



bi (1)

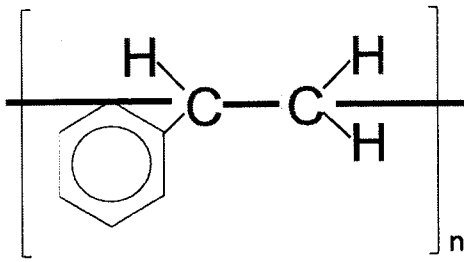
Based on the information provided, they only informed us that substance Y is a pure substance. A pure substance can be an element or a compound.

ii (1 + 1)

Heat substance Y.

If only one product is formed, substance Y is an element and if more than one product is formed, substance Y is a compound.

Or

	Carry out thermal decomposition If substance Y did not break down into simpler substance, it is an element but if it breaks down to simpler substances, it is a compound.	
A2		
ai	Down the group from chlorine to iodine, as the electronegativity decreases, the bond dissociation energy decreases.	1
ii	Down the group, the atomic radius increases and the attraction between the nucleus between the shared electrons decreases. Hence, the electronegativity decreases. Thus, the amount of energy required to break the bond would be lower.	1 1 1
b	Fluorine has a small atomic radius and this cause the electrons in the atoms to repel each other. Hence, the bond dissociation energy is lower than expected.	1
A3		
a	$4Cu + 2NO_2 \rightarrow 4CuO + N_2$	1
ii	Nitrogen dioxide is reduced. The oxidation state of nitrogen decreases from +4 to 0 in nitrogen gas.	1 1
b	To remove the carbon dioxide gas/ unreacted oxides of nitrogen so that the nitrogen gas collected is pure.	1
c	Acetonitrile: % of nitrogen =34.15% N, N-dimethylnitrous amide: % of nitrogen = 37.8% Ethylenediamine: % of nitrogen = 46.7% The identity of the unknown organic compound is N, N-dimethylnitrous amide. The percentage of nitrogen in N, N-dimethylnitrous amide is the same as the unknown organic compound.	1 1
A4		
a	 Name of polymer: poly(styrene)	1 1
b	It should be carried out at 90 °C. At a 90 °C, the styrene monomers have a higher kinetic energy. This leads to a higher frequency effective collision and hence the rate of polymerisation is higher.	1 1 1
c	In the absence of catalyst, the rate of polymerisation of styrene decreases. The activation energy of the reaction is higher and lesser number of reacting particles would have the minimum energy.	1
A5		
a	The change is endothermic as the temperature of the mixture decreases after KC*l* is added into the water.	1
b	Energy taken in to break the bond in the KC*l* is more than the energy given out when the water molecules form bonds with the ions.	1 1
c	5 g of KC*l* takes in 1160 J of energy 0.067114 mols of KC*l* takes in 1160 J of energy 1 mol of KC*l* takes in 1160/0.067114 = 17284 J/mol = 17.3 kJ/mol	1 1 1

A6

a

beaker	anode	cathode	electrolyte	
A	Bubbles are formed	Bubbles are formed	no visible change	1
B	decrease in size	increase in size	no visible change	
C	decrease in size	*increase in size*	*Solution turns blue*	1
D	Bubbles are formed	increase in size	*Blue solution turns colourless*	1

bi For beaker A, there is no visible change to the electrolyte as the H+ and OH- ions preferentially discharged at the electrodes to form hydrogen and oxygen gas respectively. Water is being removed from the electrolyte — 1

ii For beaker B, the electrolyte will remain unchanged as the rate of oxidation of the copper anode is the same as the reduction of copper(II) ions at the cathode — 1

iii The copper anode will be oxidised to form copper(II) ions. However, the silver ions will be preferentially discharged at the cathode. — 1
With the presence of copper(II) ions in the electrolyte, the solution will gradually turn blue. — 1

c Anode: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ — 1
Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$ — 1

A7

ai

statement	True / False
Compound P can be made by fermentation.	False
Compound Q can be made by reacting compound P with an organic acid.	False
Water is also produced during the formation of compound Q and R.	true

All correct – 2M
2 correct – 1 M
1 or 0 correct – 0 M — 2

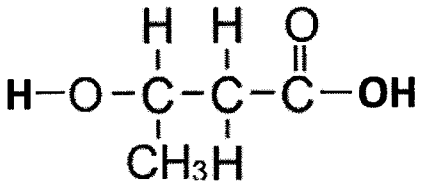
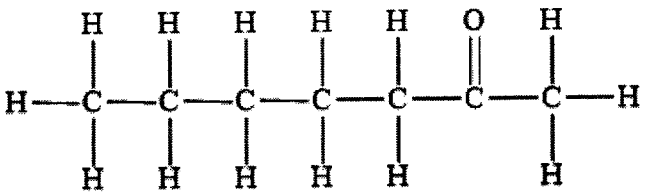
ii Temperature of about 37 °C — 1
Any temperature that is too high, the yeast will be denatured and too low, the yeast will be inactive.

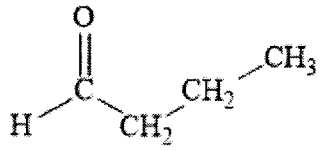
OR

Absence of oxygen
To prevent the oxidation of the alcohol produced.

bi Propyl propanoate — 1

ii As a solvent; for perfume; for food flavouring — 1

		1
A8		
ai	Polyester composites are too brittle/ break easily.	1
ii	Glass fibre has too high a density.	1
b	Kevlar has amide linkages but polyester has ester linkages. Kevlar is formed from reacting an amine with an organic acid while polyester is formed by reacting an alcohol with an organic acid.	1 1
c	Silicon dioxide has a high MP It has a giant molecular structure with strong covalent bonds between the silicon and oxygen atoms. Thus, a large amount of energy is needed to overcome these bonds. Or Silicon dioxide is a poor conductor of electricity. There are no free moving electrons or ions to Carry electrical charges from one end to the other.	1 1 1 1
Section B		
B9		
a	Carbon dioxide is an acidic oxide that can dissolve in rain to form a weak carbonic acid. The acidic solution can then react with calcium carbonate to form salt, water and carbon dioxide gas.	1 1
bi	Sodium hydroxide	1
ci	The soap needs to first react with the calcium ions found in hard water to form the insoluble curds before it can be used for cleaning purposes.	1
ii	Mass of $CaCO_3$ = 275 x 0.5 = 137.5 mg No. of moles of $CaCO_3$ = 137.5/100 = 1.375 mmoles (0.001375 mols) No. of moles of soap = 1.375 x 2 = 2.75 mmoles Mass of soap = 2.75 x (12 x 18 + 35 + 32 + 23) = 841.5 mg or 0.8415 g	1 1 1
d	Sodium carbonate will undergo precipitation with chlorides and sulfates of calcium and magnesium to form insoluble $CaCO_3$ or $MgCO_3$. The insoluble salts can be then removed by filtration. Equation	1 1 1
B10		
a		1

	Name: heptanone	1
b	$C_nH_{2n}O$	1
c		1
d	122 °C It has a larger molecular size than pentanone. Hence, it has a stronger attraction forces between its molecules. Thus, it needs more energy to overcome these forces leading to a higher temperature.	1 1 1
ei	When propene reacts with water, it forms propanol. However, when propanone reacts with water, it forms propanediol. The addition reaction between propene with water is the breaking of C=C while the addition reaction between propanone with water is the breaking of C=O.	1 1
ii	The Universal indicator would appear green. The propanone would not ionise in water to form any H^+ ions or OH^- ions. Thus, it will be neutral.	1
E11		
a	Energy was still being absorbed to overcome the activation energy Or most reactant particles have insufficient activation energy to undergo decomposition.	1
b	The volume of carbon dioxide gas collected did not remain constant.	1
ci	48/5 = 9.6 cm^3/min	1
ii	$Li_2CO_3 \rightarrow Li_2O + CO_2$ No. of moles of Li_2CO_3 = 1/ (14+12+16x3) = 0.013514 mols Vol of CO_2 = 0.013514 x 24 = 0.324336 = 324.336 cm^3 Time taken = 324.336 / 9.6 = 33.785 min	 1 1 1
di	Copper(II) carbonate decomposes at the fastest rate. It produces the highest volume of carbon dioxide gas at time 5 min or It has the steepest gradient.	1 1
ii	The volume of carbon dioxide gas will remain at 0 or close to 0 cm^3. The more reactive the metal, the more thermally stable its carbonate. Hence, potassium carbonate is not able to decompose readily to form carbon dioxide gas.	1 1
O11		
ai	When barium hydroxide reacts with sulfuric acid, barium sulfate salt and water are formed. Barium sulfate is insoluble in water. Hence, when all the barium hydroxide has reacted, solid barium sulfate and water are poor conductors of electricity, and the electrical conductivity decreases to 0 S/m.	1 1

	However, when sodium hydroxide reacts with iron(II) nitrate, sodium nitrate and iron(II) hydroxide are formed. Aqueous sodium nitrate contains free moving ions that can carry electrical charges from one end to the other and thus, the electrical conductivity did not decrease to 0 S/m.	1 1
ii	The electrical conductivity of titration 1 remains constant before it increases at 13 cm^3 of sulfuric acid while the electrical conductivity of titration 2 decrease before it increases at 15 cm^3 of iron(II) nitrate.	1
iii	The sodium nitrate solution formed replaces the hydroxide ions used up in the reaction with sodium hydroxide. Hence, there is no change in the concentration/ amount of free moving ions present in the solution. However, in titration 2, the hydrogen ions used to react with the hydroxide ions are not replaced due to the formation of insoluble barium sulfate and water. Hence the concentration of ions in the conical flask decreases overtime.	1 1
b	No. of moles of iron(II) nitrate = 0.563 x 13/1000 = 0.007319 mols No. of moles of NaOH = 0.007319 x 2 = 0.014638 mols Conc of NaOH = 0.014638 / 0.02 = 0.7319 moldm^3	1 1 1