Candidate Name: _____ **Index No:** ____ **Class:** _____

ZHENGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
SECONDARY FOUR EXPRESS
CHEMISTRY

Paper 2 **6092 / 02**

25 August 2022

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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READ THESE INSTRUCTIONS FIRST

Write your index number, class 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 staples, 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 page 23.

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

For Examiner's Use	
Total	

Name of Setter: Ms Natalie Tan Li Er

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Choose from the following list of substances to answer the questions below.

nitrogen	sodium oxide	carbon dioxide	silicon dioxide
iron(II) chloride	silver chloride	zinc oxide	diamond

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

(a) Which element has a giant covalent structure?

……...[1]

(b) Which substance will react with potassium hydroxide to form precipitate which will change colour on standing?

……...[1]

(c) Which compound exists as discrete molecules?

……...[1]

(d) Which substance will dissolve to form an acidic solution?

……...[1]

(e) Which substance can be added in excess to hydrochloric acid to form a soluble salt?

……...[1]

[Total: 5]

A2 Silver dichromate, $Ag_2Cr_2O_7$, is a red insoluble salt.

Silver dichromate can be made by reacting silver nitrate solution with ammonium dichromate solution as shown by the equation below.

$$2AgNO_3 + (NH_4)_2Cr_2O_7 \rightarrow 2NH_4NO_3 + Ag_2Cr_2O_7$$

(a) Describe how you can obtain pure and dry solid silver dichromate after mixing silver nitrate solution and ammonium dichromate solution.

……

……

……..[2]

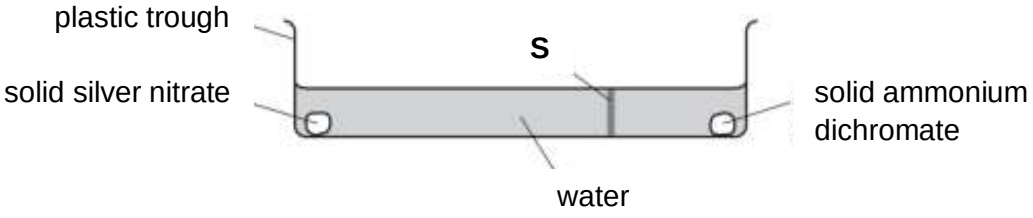
(b) **(i)** Deduce the oxidation state of chromium in $Ag_2Cr_2O_7$.

……..[1]

(ii) Write the ionic equation with state symbols for the formation of silver dichromate in this reaction.

……[2]

(c) The apparatus shown below is set up.



After five minutes, a red solid appeared at the position marked **S** on the diagram.

(i) Explain why a red solid appeared at the position marked **S**.

……..…

……..…

……..[2]

(ii) The experiment is then repeated at a higher temperature.

What effect, if any, would this have on the time taken for the red solid to appear?

Explain your answer.

……..…

……..[1]

[Total: 8]

A3 Fig. 3.1 shows an article from a textbook about elderberries.

Elderberries are widely used in wine making. Extract of elderberries is a useful pH indicator and it can be separated by chromatography.

As an indicator, the colour of the extract changes to pink at a pH of 2 – 3 and to blue at a pH of 11 – 12.

elderberries

Fig. 3.1

(a) The chromatogram in Fig. 3.2 was obtained when water was added to a drop of elderberries extract at the centre of a filter paper.

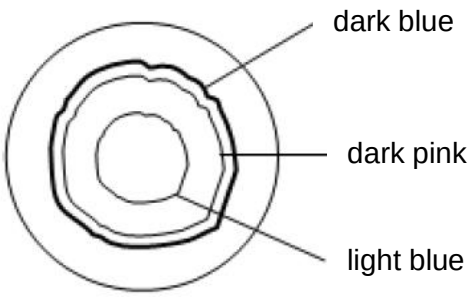


Fig. 3.2

(i) Predict the colour of the elderberries extract at pH 7.

……[1]

(ii) An alternative set-up for the above experiment was shown in Fig. 3.3 below.

dye	R_f value	distance travelled (cm)
light blue	0.2	
dark pink	0.4	1.00
dark blue	0.5	

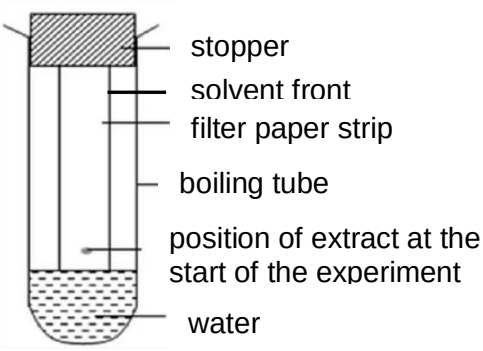


Fig. 3.3

Given that the distance travelled by the dark pink dye is 1.00 cm, complete the table above by stating the distance travelled by the light blue and dark blue dyes. [1]

(b) Fig. 3.4 shows how pH values changed during a titration when an acid was added from a burette into an alkali. A few drops of elderberries extract were added at the start of titration to monitor the pH of the solution.

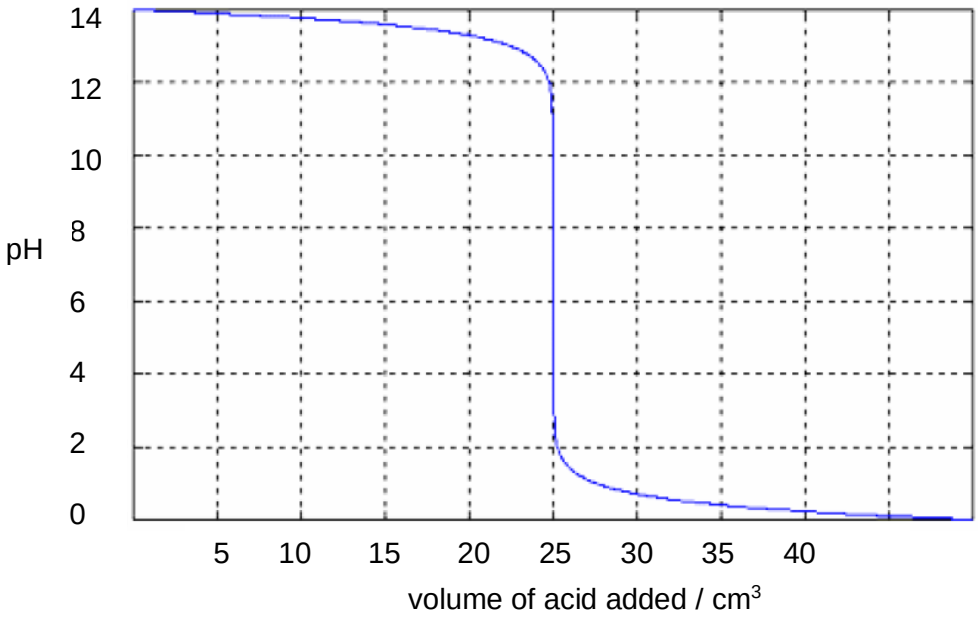


Fig. 3.4

(i) State and explain what could be one possible chemical formula of the alkali used.

……

……[2]

(ii) State the colour of the elderberries extract when the volume of acid added was

20 cm^3 ……

30 cm^3 …… [2]

[Total: 6]

A4 This question is about compounds containing chlorine.

The equation shows the reaction of aqueous methanol with dilute hydrochloric acid.

$$CH_3OH\ (aq) + HCl\ (aq) \rightarrow CH_3Cl\ (g) + H_2O\ (l)$$

The progress of this reaction can be followed by taking small samples of the reaction mixture every hour and determining the concentration of dilute hydrochloric acid.

(a) **(i)** Draw a 'dot and cross' diagram to show the bonding in a molecule of methanol. Draw only the outer shell electrons.

[2]

(ii) Explain, using ideas about structure and bonding, why methanol exists in liquid state at room temperature and pressure.

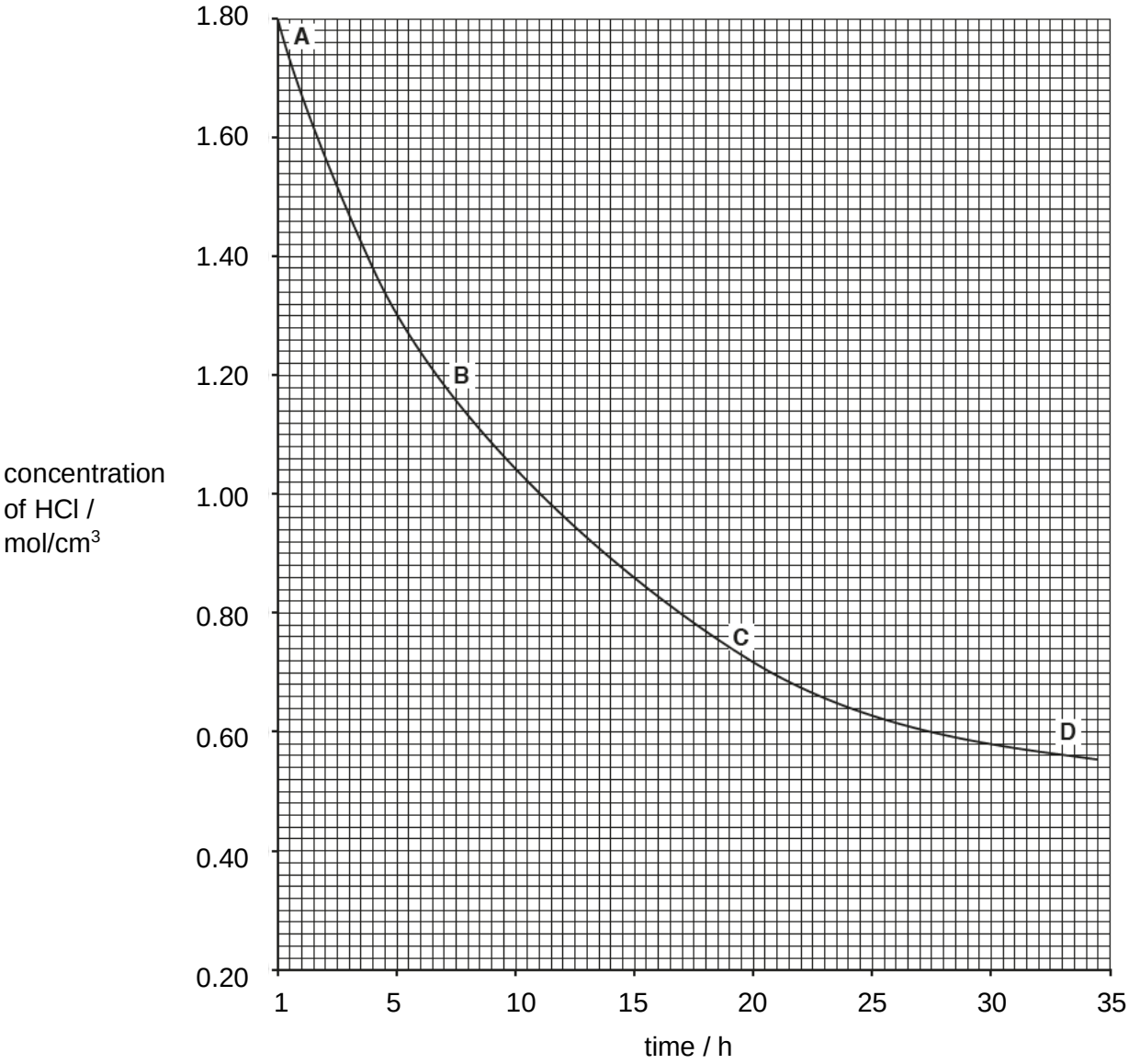
……

……

……

……[2]

(b) The graph shows how the concentration of hydrochloric acid changes as the reaction proceeds.



(i) Sketch the graph on the axes above when the temperature is decreased.

Label your graph "**Y**". [1]

(ii) Using data from the graph, describe how speed varies with time from **A** to **D**.

……

……

……

……

……

……[3]

(iii) Describe and explain, using ideas about collisions between particles, how the rate of a reaction changes when the temperature is decreased.

All other conditions stay the same.

……

……

……[2]

[Total: 10]

A5 A 1.50 g sample of solid lead(II) nitrate is added to 125 cm^3 of 0.100 mol/dm^3 sodium iodide solution.

(a) Write the chemical equation for the reaction.

……...[1]

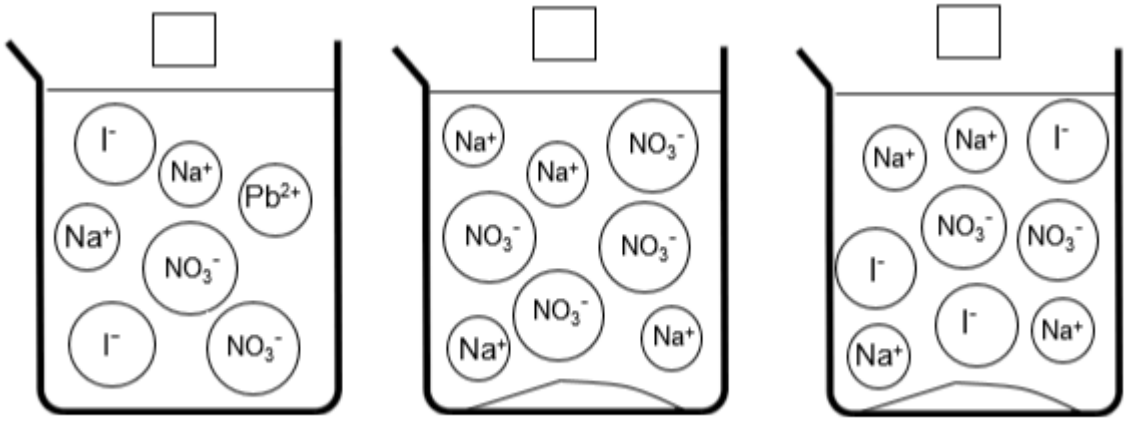
(b) Identify the limiting reactant in the reaction, showing your calculations clearly.

[2]

(c) Using your answer in **(b)**, calculate the concentration of the nitrate ions in the mixture after the reaction is complete.

[2]

(d) Place a √ in the box to indicate the diagram that best represents the mixture when the reaction is complete. The diagrams do not show the actual number and ratio of ions present. [1]



no precipitate | precipitate formed | precipitate formed

precipitate formed | precipitate formed

(e) Describe how a pure, dry sample of lead(II) nitrate crystals can be prepared from insoluble lead(II) oxide.

……

……

……

……...[3]

[Total: 9]

A6 Paracetamol, the active drug ingredient in Panadol, is commonly used to reduce fever and relief pain. Based on recommended dosages, an adult should not take more than 4 g of paracetamol daily.

(a) A sample of paracetamol was found to contain 63.6% of carbon, 5.9% of hydrogen, 9.3% of nitrogen and 21.2% of oxygen by mass.

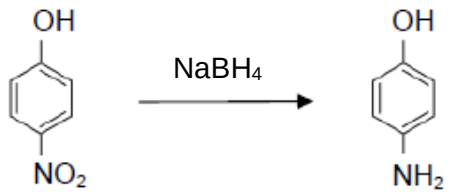
Show, by means of calculation, that the empirical formula of paracetamol is $C_8H_9NO_2$.

[2]

(b) Paracetamol can be synthesised in the laboratory via a three-step process.

Step 1: phenol $\xrightarrow[NaNO_3]{\text{dilute } H_2SO_4}$ 2-nitrophenol + 4-nitrophenol

Step 2:



4-nitrophenol ($C_6H_5NO_3$) 4-aminophenol (C_6H_7NO)

Step 3: $C_6H_7NO + C_4H_6O_3 \rightarrow C_8H_9NO_2 + C_2H_4O_2$

4-aminophenol paracetamol ethanoic acid

(i) Suggest why the yield of paracetamol in the laboratory is less than 50%.

……..

……....[1]

(ii) Explain why $NaBH_4$ acts as a reducing agent in step 2.

……..

……....[1]

(iii) One paracetamol tablet contains 500 mg of the active ingredient paracetamol.

Calculate the mass of 4-aminophenol required to synthesise 8 Panadol tablets.

[3]

(iv) How can the purity of the synthesised paracetamol be tested?

……..

……...[1]

(v) Explain, in terms of bonding, why paracetamol is a solid but ethanoic acid is a liquid at room temperature and pressure.

……..

……..

……..

…….[2]

(c) The correct dosage of paracetamol for children varies according to a child's weight. However, a child weighing 10 kg should only consume a maximum of 600 mg of paracetamol in a day.

Given that a bottle of Panadol syrup contains 120 mg of paracetamol per 5 m*l* of syrup, calculate the correct dose of Panadol syrup (in m*l*) that should be given every 6 hours for a 10 kg child.

[2]

[Total: 12]

Section B

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

B7 The reaction between colourless peroxodisulfate (VI) ions and iodide ions is represented by the following ionic equation.

$$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

The same volume of aqueous $S_2O_8^{2-}$ and aqueous I^- are used for each experiment.
The Table 7.1 below shows the results of each experiment when different concentrations of each reactant are used.

Table 7.1

experiment	initial concentration/ mol/dm^3		initial rate of reaction/ mol/dm^{3}s
	$S_2O_8^{2-}$	I^-	
1	0.008	0.020	1.22×10^{-3}
2	0.016	0.020	2.44×10^{-3}
3	0.032	0.020	4.88×10^{-3}
4	0.008	0.040	2.44×10^{-3}
5	0.008	0.080	4.88×10^{-3}

Order of Reactions

The order of a reaction refers to the power dependence of the rate of reaction on the concentration of each reactant. It is a numerical value.

In a zero-order reaction, the concentration of the reactants has no effect on the initial rate of reaction.

In a first-order reaction, the initial reaction rate is directly proportional to the concentration of one of the reactants.

In a second-order reaction, the initial rate of reaction quadruples when the concentration of one of the reactants is doubled.

Increasing the rate of reaction

If a small amount of Fe^{2+} ions is added to the reaction mixture, they will react with the peroxodisulfate (VI) ions, forming Fe^{3+} ions, which will then react with the iodide ions in the following two stages:

Stage 1: $2Fe^{2+}(aq) + S_2O_8^{2-}(aq) \rightarrow 2Fe^{3+}(aq) + 2SO_4^{2-}(aq)$
Stage 2: $2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(aq)$

(a) Two students made comments about the reaction.

Student 1: The reaction is first order with respect to $S_2O_8^{2-}$.

Student 2: The reaction is second order with respect to I^-.

Which student is correct? Show by calculation using information from the table to support your answer.

……

……

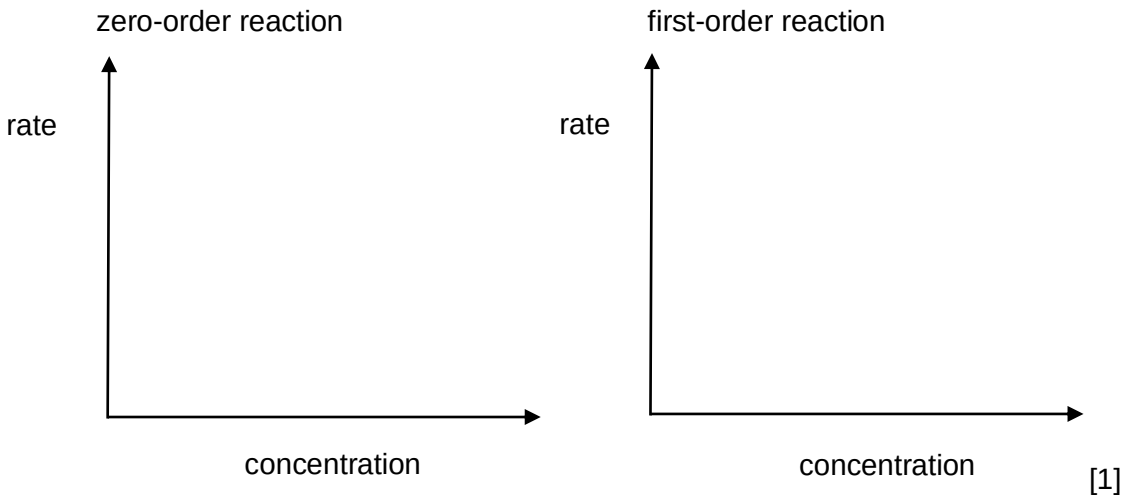
……

……

……

.....[3]

(b) Sketch the graphs of rate against concentration of reactant for a zero-order and a first-order reaction.



[1]

(c) Another two similar experiments were carried out and the result is shown in Table 7.2.

Table 7.2

experiment	concentration of $S_2O_8^{2-}$ / mol/dm^3	concentration of I^-/ mol/dm^3	initial rate of reaction/ mol/dm^{3}s
6	0.016	0.040	
7		0.080	9.76×10^{-3}

With reference to Table 7.2, complete the table by predicting the initial rate of reaction in experiment 6 and the concentration of $S_2O_8^{2-}$ in experiment 7. [2]

(d) Explain the role of Fe^{2+} ions in this chemical reaction.

……

……

...……[2]

(e) Suggest how you would remove Fe^{2+} ions from aqueous iodine after Stage 2.

……

……

...……[2]

[Total: 10]

B8 A student carries out a series of experiments. In each experiment, he electrolyses aqueous copper(II) sulfate solution using the apparatus shown in Fig. 8.1.

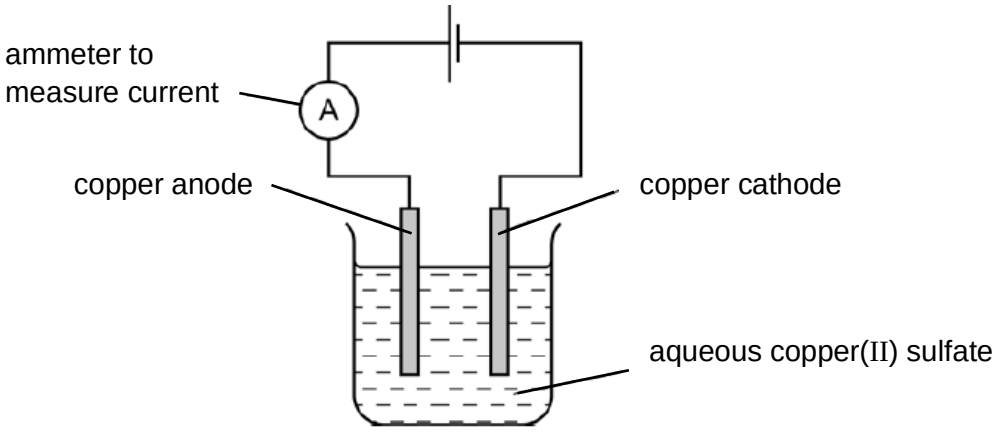


Fig. 8.1

He uses the same concentration of aqueous copper(II) sulfate each time, but changes the current he passes through the solution. He runs each electrolysis for 10 minutes. The student weighs the negative electrode before and after each experiment and works out the mass of copper deposited.

Table 8.1 shows the results of his experiments.

Table 8.1

experiment	time / mins	current / A	mass of copper deposited / g
1	10	1.0	0.21
2	10	2.0	0.40
3	10	3.0	0.58
4	10	4.0	0.81

(a) **(i)** Use data from the Table 8.1 to describe the relationship between the current and the mass of copper deposited.

……..……..[1]

(ii) Explain the trend observed in **(a)(i).**

……..……..[1]

(iii) Explain why the student ran the electrolysis for 10 minutes for all the experiments.

……..……..[1]

(b) The student carries out another experiment. He passes an electric current of 6.0A through a solution of copper(II) sulfate for 5 minutes.

Use the information above to predict the mass of copper that would be formed in the experiment. Explain how you derived at your answer by showing your calculation.

[2]

(c) At the end of the electrolysis, the student removes a sample of the electrolyte and puts it in a test tube. He then adds aqueous ammonia dropwise to the sample until there is no further change.

Describe and explain what the student observed.

……

……

……[2]

(d) The student carries out another electrolysis using aqueous silver nitrate and silver electrodes. His results are shown in Table 8.2.

Table 8.2

electrolyte	time / mins	current / Amps	mass of silver deposited / g
aqueous silver nitrate	10	4.0	2.7

(i) Write an ionic half equation with state symbols for the reaction that happens at the cathode.

...……..……..[1]

(ii) Carry out calculations to compare the difference in the number of moles of copper and the number of moles of silver that are formed when a current of 4.0 A is used for 10 minutes.

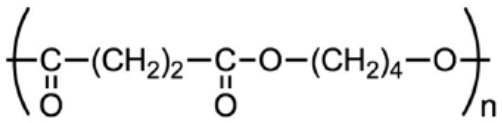
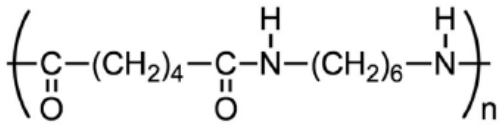
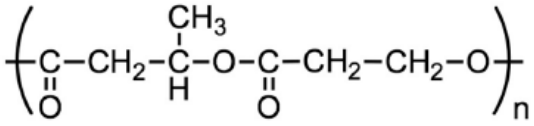
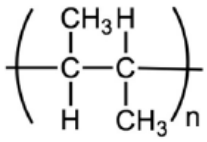
Suggest an explanation for the difference in the number of moles of each metal formed.

[2]

[Total: 10]

EITHER

B9 The diagram below shows the structures of some polymers.

A	
B	
C	
D	

(a) What is the name of the group that links the monomers together in both **A** and **C**?

……...[1]

(b) Name **D**.

...……..……..[1]

(c) Draw the structural formula of the monomers that react to form **C**.

[2]

(d) There are two types of polymerisation, addition and condensation.

Explain two differences between these types of polymerisation.

……

……

……

……...[2]

(e) A sample of **D** has a relative molecular mass of 71 400. How many carbon atoms are there in an average molecule of the polymer?

number of carbon atoms = …… [2]

(f) Some plastics, formed by polymerisation, are non-biodegradable.

Describe two pollution problems that is caused by non-biodegradable plastics.

……

……

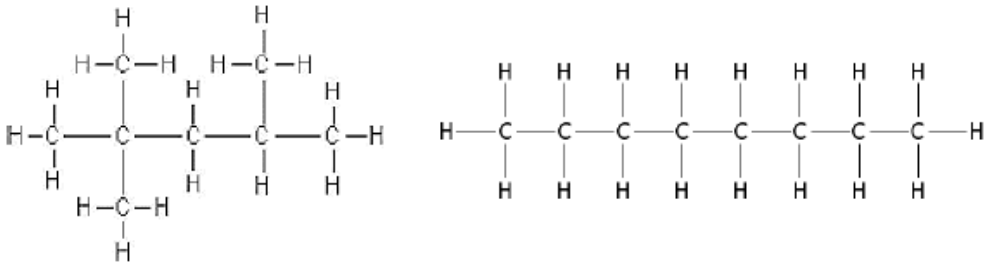
……...[2]

[Total: 10]

OR

B9 **(a)** 2,2,4-trimethylpentane, also known as isooctane, is an isomer of octane C_8H_{18}.

The structures of isooctane and octane are shown in Fig. 9.1.



Isooctane Octane

Fig. 9.1

The enthalpy changes of combustion and boiling points for isooctane and octane are given in Table 9.1.

Table 9.1

hydrocarbon	enthalpy change of combuistion/ kJ mol^{-1}	boiling point/ ^oC
Isooctane	-5460	99.3
Octane	-5460	126.1

(i) Write a balanced chemical equation for the complete combustion of isooctane.

……[1]

(ii) Suggest why the enthalpy change of combustion for isooctane and octane are the same.

……

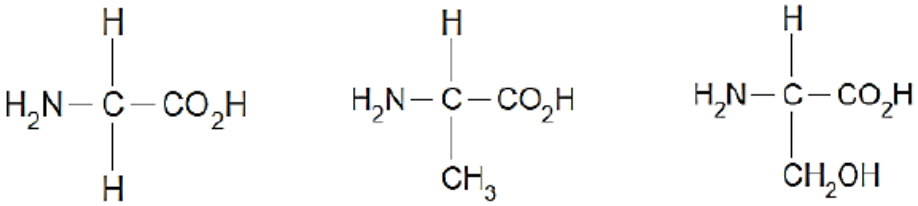
……

……[2]

(iii) Draw the structural formula of two other isomers of octane, C_8H_{18}.

[2]

(b) Spider silk is composed of polyamide chains mainly made from amino acids.
Fig. 9.2 shows the structural formula of the three main amino acid, glycine, alanine and serine, found in spider silk.



glycine alanine serine

Fig. 9.2

(i) Assuming spider silk is made from repetitive sequences of –glycine–alanine serine–, draw the structural formula of the repeat unit of the polyamide chain.

[2]

(ii) The *Mr* of each polyamide chain is about 600 000.
Assuming the polyamide chain is made from equal amounts of the above three amino acids, calculate the average number of amino acid monomers in each polyamide chain.

[3]

[Total: 10]

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 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 –		

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.).