Geylang Methodist School (Secondary)
Preliminary Examination 2022

Candidate Name			
Class		Index Number	

CHEMISTRY **6092/02**

Paper 2 **Sec 4 Express**

Additional materials : Nil **1 hour 45 minutes**

22 Aug 2022

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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

Section B
Answer **all three** questions, the last question is in the form either/or.
Write your answers in the spaces provided.

At the end of the examination, hand in Section A and Section B together.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 24.

For Examiner's Use	
Section A	/50
B9	/10
B10	/ 10
B11	/10
Total	80

Section A

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

A1 The following ionic equations represent some common reactions.

A $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

B $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

C $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$

D $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

E $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

F $2I^-(aq) + Br_2(aq) \rightarrow I_2(aq) + 2Br^-(aq)$

Use the letters **A**, **B**, **C**, **D**, **E** or **F** to answer the following questions.
You may use the letters once, more than once or not at all.

(a) Which equation shows a reaction that forms a white precipitate?

…….. [1]

(b) Which equation shows only reduction?

…… [1]

(c) Which equation shows the neutralisation of a dilute acid by an aqueous alkali?

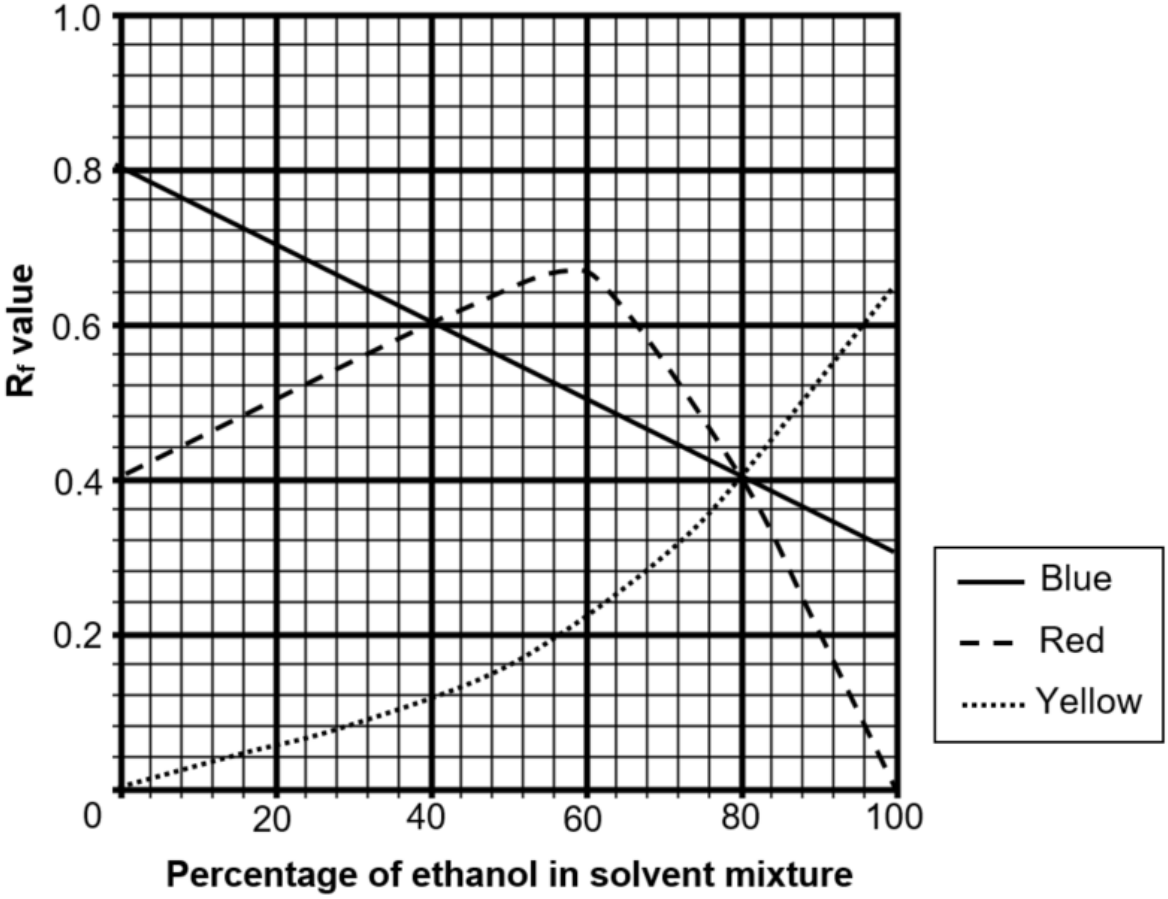
…… [1]

(d) Which equation shows a displacement reaction?

…… [1]

[Total: 4]

A2 A sample of black ink contains a mixture of red, blue and yellow dyes. Usually, the solvent used to separate the dyes in black ink is a mixture of ethanol and water. The coloured dyes have different R_f values in solvents with different compositions of ethanol as shown in the graph below.



(a) Using evidence from the graph, predict the colours of the separated spots observed when the solvent used consists of 40% ethanol in the mixture.

……. [1]

(b) State the R_f value of blue dye on the chromatogram when the solvent is a mixture of 32 cm^3 of ethanol and 168 cm^3 of water.

……. [1]

(c) Using evidence from the graph, explain why a pure solvent such as water is **not** suitable for the separation of the black ink using paper chromatography.

……..

……..

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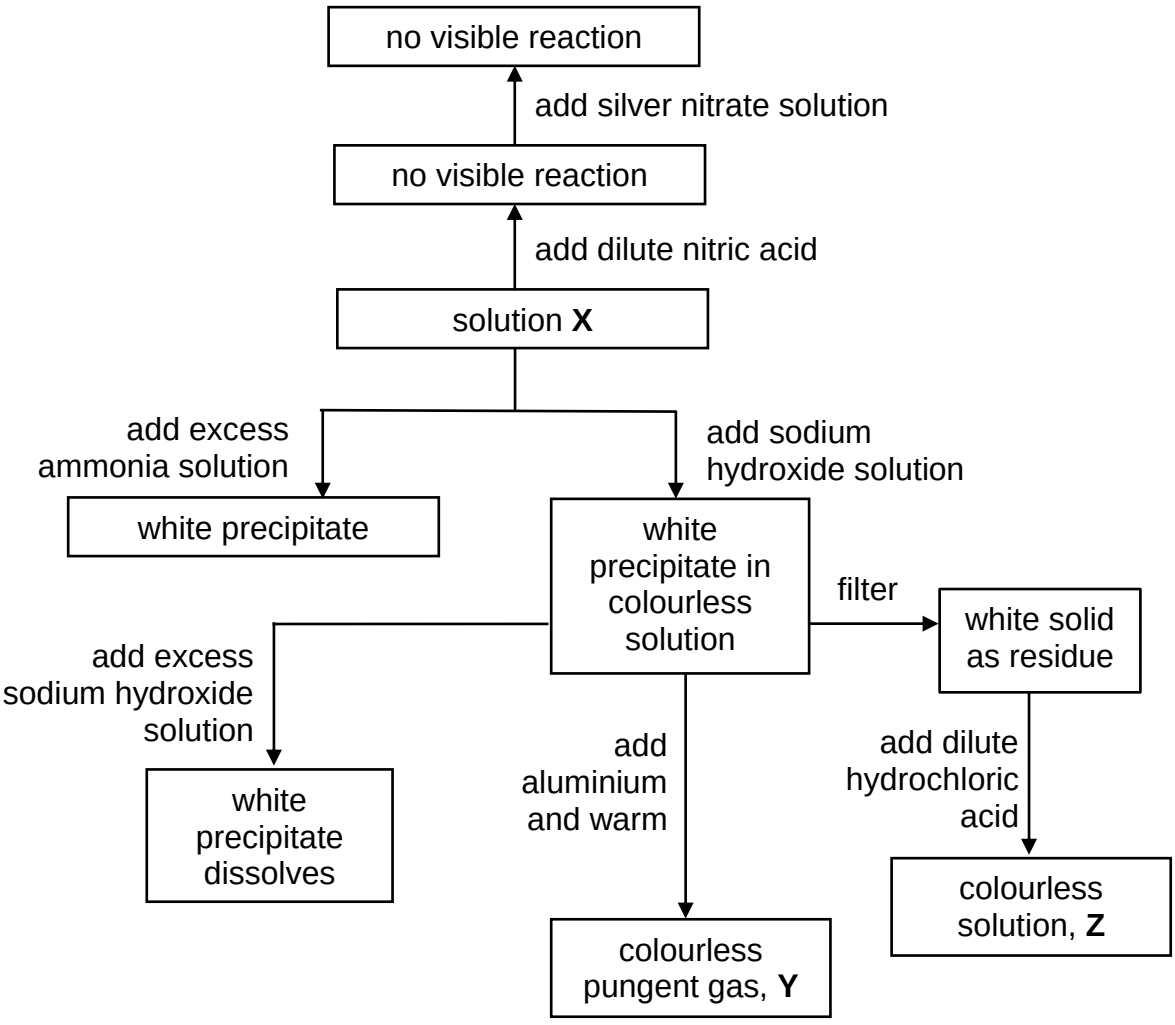
……..

…… [2]

[Total: 4]

A3 An unknown colourless solution, **X**, was spotted in the laboratory.

Several tests were carried out as shown in the flow chart below:



(a) **(i)** Identify gas **Y**.

……... [1]

(ii) Describe a test to confirm the identity of Y.

……

……

…… [1]

(b) Identify solution **Z**.

……... [1]

(c) Prior to the addition of silver nitrate solution, dilute nitric acid was added to unknown solution **X**.

(i) Explain the purpose of adding dilute nitric acid.

……

…….. [1]

(ii) What can be deduced from the “no visible reaction” as the observation, prior to adding the silver nitrate?

……..

…… [1]

[Total: 5]

A4 The reaction between hydrazine and hydrogen peroxide is commonly used in rocket technology due to the rapid production of gases. The equation below shows the reaction between hydrazine and hydrogen peroxide.

$$N_2H_4\,(l) + 2H_2O_2\,(aq) \rightarrow N_2\,(g) + 4H_2O\,(g) \qquad \Delta H = -777\ kJ$$

(a) **(i)** Draw the dot and cross diagram of hydrazine, showing only the valence electrons.

[2]

(ii) Predict and explain in terms of bonding and structure the electrical conductivity of aqueous hydrogen peroxide.

……

……

……

…… [2]

(b) **(i)** Explain, in terms of bond breaking and bond forming, why the reaction of hydrazine and hydrogen peroxide is exothermic.

……

……

……

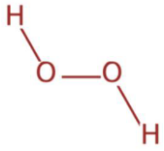
…… [2]

(ii) Table 4.1 shows the bond energies of various covalent bonds.

Table 4.1

bond	bond energy (kJ/mol)	bond	bond energy (kJ/mol)
N–H	391	H - H	436
N - N	160	O - H	463
N = N	418	O - O	***y***
N ≡ N	941	O = O	496

Using the information provided in Table 4.1 and the structural formula of H_2O_2 as shown here, calculate the bond energy of O–O, ***y***.

Structural formula of H_2O_2 

[2]

(c) In the reaction, 100 kg of hydrazine was used to react with 200 kg of hydrogen peroxide. Calculate the followings:

(i) the number of mole in 100 kg of hydrazine;

[1]

(ii) the number of mole in 200 kg of hydrogen peroxide;

[1]

(iii) Identify the limiting reactant.

…… [1]

(iv) Hence, calculate the energy released when 100 kg of hydrazine is reacted with 200 kg of hydrogen peroxide.

[1]

[Total: 12]

A5 Calcium nitrate reacts with sulfur under acidic condition to form sulfur dioxide, nitrogen monoxide and water. The ionic equation for the reaction is shown below.

$$4NO_3^- + 3S + 4H^+ \longrightarrow 3SO_2 + 4NO + 2H_2O$$

(a) Identify the oxidising agent and reducing agent in the reaction.

oxidising agent: ……

reducing agent: ……... [2]

(b) Explain why the reaction is considered a redox reaction by referring to changes in oxidation states.

……..…….....

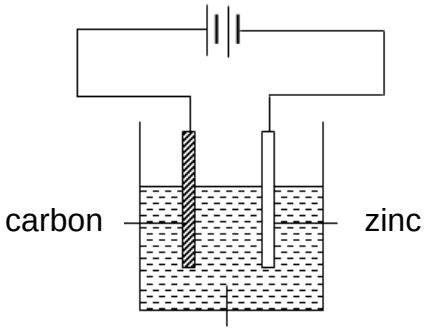
……..…….....

……..

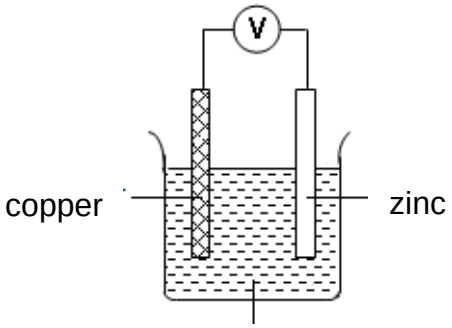
……..……..... [2]

[Total: 4]

A6 The diagram below shows an electrolytic cell **A** and a simple cell **B**.



Electrolytic cell A



Simple cell B

(a) Write an ionic half-equation for the reaction which takes place at the cathode in cell **A**.

…… [1]

(b) Write an ionic equation for the **overall** reaction which takes place in cell **B.**

…….. [1]

(c) Describe one observation that would only be seen in cell **B** but not in cell A.

…….. [1]

(d) To prevent iron from rusting, it can be electroplated with zinc.

Explain how does electroplating iron with zinc prevent rusting.

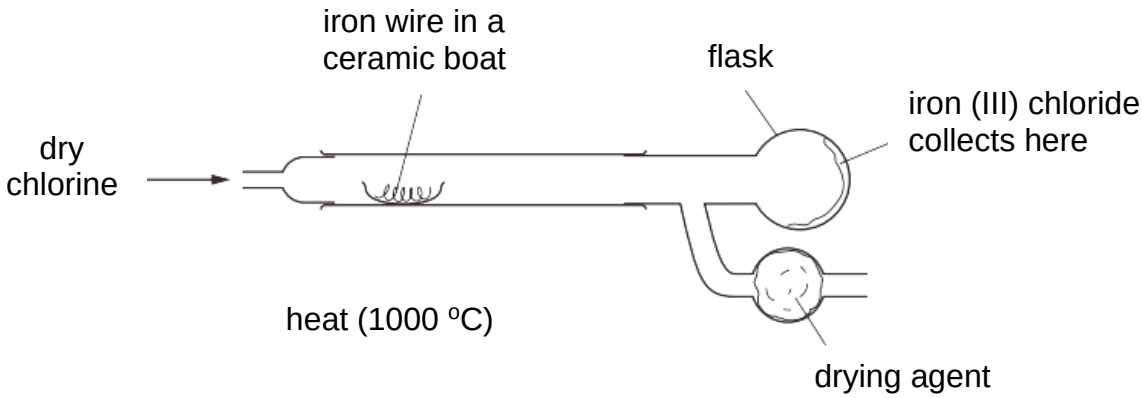
……

……

…… [2]

[Total: 5]

A7 Iron is heated with chlorine to form iron (III) chloride, $FeCl_3$.



(a) Iron (III) chloride has the following properties:

melting point / °C	308
boiling point / °C	315

(i) Predict the state of iron (III) chloride formed at the flask.

…… [1]

(ii) Explain your reasoning.

……

…… [1]

(iii) Suggest why the iron (III) chloride is collected in the flask instead of in the ceramic boat.

……

…… [1]

(b) The following reaction occurs at even higher temperatures:

$$2\ FeCl_3 \longrightarrow 2\mathbf{X} + Cl_2$$

(i) State the type of reaction iron (III) chloride undergoes in this reaction.

…… [1]

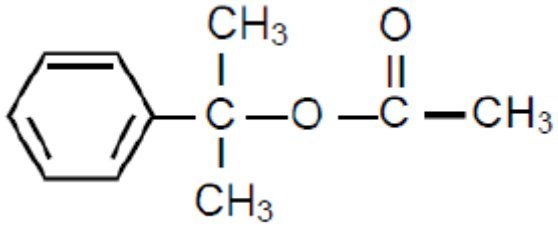
(ii) Give the chemical formula of substance **X**.

…… [1]

[Total: 5]

A8 Perfumes usually contain three groups of compounds called the top note, the middle note and the end note.

(a) Top note consists of small, light molecules that evaporate quickly.
An example of a top note compound is shown below:



(i) With reference to the structure of the compound, explain why it is likely to have a pleasant smell.

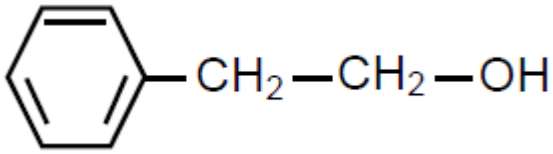
…….. [1]

(ii) Draw the structural formula of the alcohol and carboxylic acid used to make the top note compound.

[2]

(b) The middle note compounds vaporise less rapidly than the top note compounds. A typical compound of the middle note is 2-phenylethanol.

The structure of 2-phenylethanol is shown below:



(i) Describe a chemical test which would distinguish the top note compound from the middle note compound.

……

……

……

……

……

…… [2]

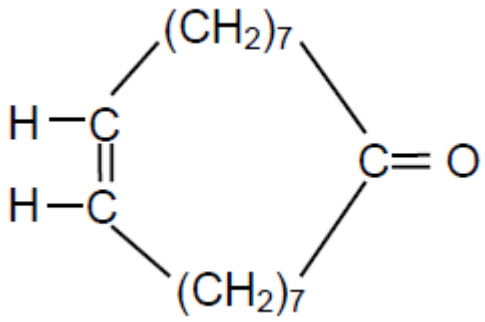
(ii) Name and draw the full structural formula of the molecule formed in the positive test in **(b)(i)**.

Name of molecule: ……

Structural formula:

[2]

(c) The end note compound of a perfume has a long-lasting odour which stays with the user. An example of an end note compound is shown below.



(i) Explain why the end note compound is described as unsaturated.

……

…… [1]

(ii) The end note compound undergoes hydrogenation reaction.

State the conditions that are essential for the hydrogenation reaction.

…… [1]

(iii) Iodine reacts with unsaturated compounds. The iodine value is a measure of how unsaturated a compound is. It is based on the mass, in grams, of iodine that reacts with 100 g of the compound.

If the relative molecular mass of the end note compound is 250, calculate the iodine value for the end note compound.

[2]

Total: 11]

End of Section A

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.

The total mark for this section is 30.

B9 Ionisation Energy of Group II metals

The ease of a metal atom losing an electron can be determined from ionisation energy. If the electron is more strongly held by the nucleus of the atom, a higher ionisation energy is needed.

First ionisation energy is the energy required to remove 1 mole of electrons from 1 mole of gaseous atoms to produce 1 mole of gaseous ions each with a charge of 1+. The reaction can be described by the equation below:

$$X\,(g) \rightarrow X^{+}\,(g) + e^{-}$$

The second ionisation energy is the energy required to remove 1 mole of electrons from 1 mole of gaseous cations with a charge of 1+ to produce 1 mole of gaseous ions each with a charge of 2+.

$$X^{+}(g) \rightarrow X^{2+}\,(g) + e^{-}$$

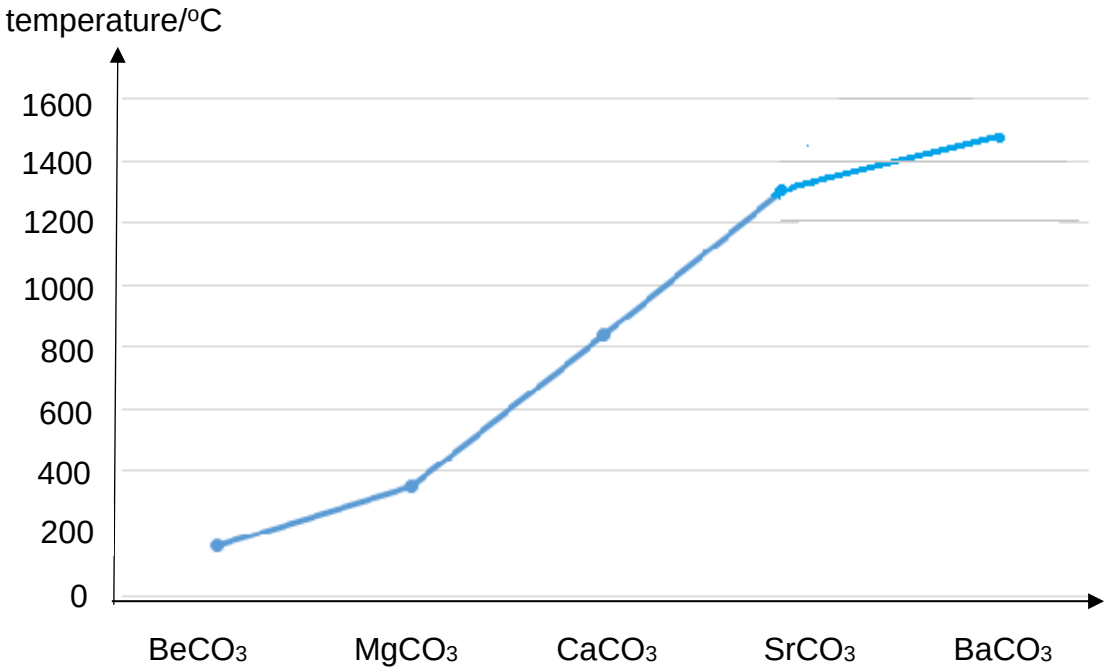
Table 1 shows a list of first and second ionisation energies of Group II metals. The metals are arranged according to their reactivity

Table 9.1

	metal	first ionisation energy / kJ/mol	second ionisation energy / kJ/mol
least reactive	beryllium	899	1757
↓	magnesium	738	1450
	calcium	589	1145
	strontium	549	1064
most reactive	barium	503	965

Thermal stability of carbonates of Group II metals

The graph below shows the temperature at which the carbonates of Group II metals decomposes.



In an experiment, 1 g of the metal carbonate is heated until no further change and the volume of carbon dioxide is measured.

The result of the experiment is given in Table 2.

metal carbonate	volume of carbon dioxide collected/ cm^3
$BeCO_3$	348
$MgCO_3$	286
$CaCO_3$	240
$SrCO_3$	0
$BaCO_3$	0

Table 2

(a) What is the relationship between the second ionisation energy and the position of the metals in Group II?

…….. [1]

(b) Calculate the number of moles of calcium atoms in 1 g of calcium. Hence, find the energy required for 1 g calcium atoms to form Ca^{2+} ions.

[3]

(c) Explain why the volume of carbon dioxide collected decreases from beryllium carbonate to calcium carbonate.

……

……

…… .. [2]

(d) Give a reason why no carbon dioxide is obtained from heating of the carbonates of strontium and barium.

……

…… [1]

(e) 1 g of an unknown Group II metal carbonate produces 122 cm^3 of carbon dioxide when reacted with excess hydrochloric acid according to the equation below.

$$XCO_3 + 2HCl \rightarrow XCl_2 + H_2O + CO_2$$

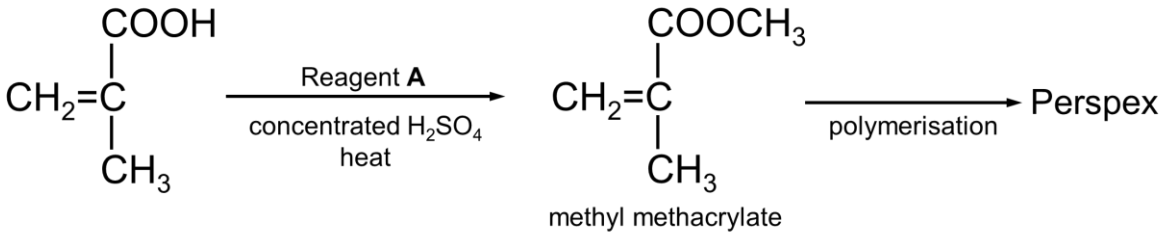
Show by calculation that this Group II metal is barium.

[3]

[Total: 10]

B10 Perspex, also known as acrylic, is a transparent thermoplastic that is made from the polymerisation of a monomer, methyl methacrylate.

The process below shows part of the production process of methyl methacrylate.



methyl methacrylate

(a) Name reagent **A**.

…… [1]

(b) State the type of polymerisation that methyl methacrylate undergoes and suggest the chemical name of Perspex.

……

…… [2]

(c) Draw two repeating units in the polymer Perspex.

[2]

(d) Aqueous bromine solution is added to Perspex.

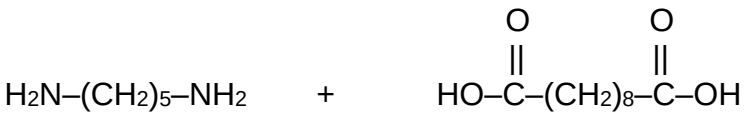
(i) State the observation.

…… [1]

(ii) State one conclusion, based on the observation in part **(d)(i)**, about Perspex.

…… [1]

(e) Another type of polymer, Nylon-5,10 is made by reacting these two monomers together.



Draw the structure of nylon-5,10.

[2]

(f) State one difference between the polymerisation process of Perspex and nylon-5,10.

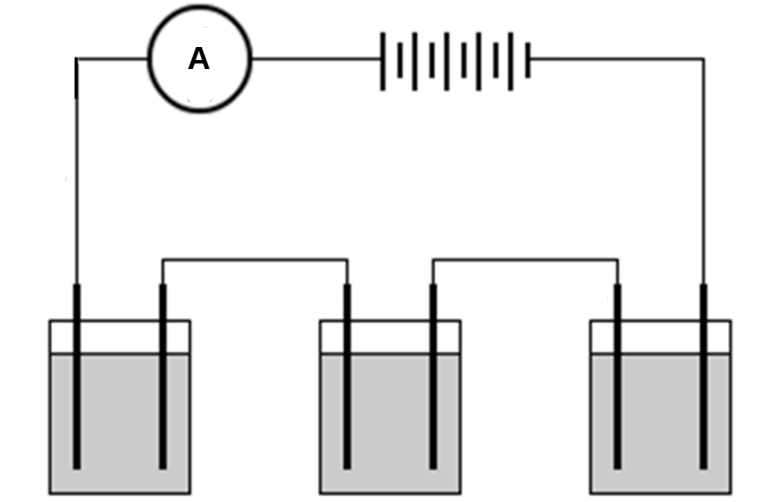
……

…… [1]

[Total: 10]

EITHER

B11 (a) The diagram shows the electrolysis of three different solutions using inert electrodes.



cell A	**cell B**	**cell C**
dilute copper (II) sulfate solution	concentrated sodium chloride solution	silver nitrate solution

(i) Study the diagram above carefully and complete the table below about the electrolysis.

solution	name of products of electrolysis		ionic equation for reaction at each electrode
dilute copper(II) sulfate solution	at anode	oxygen	$4\ OH^-(aq) \rightarrow O_2(g) + 2\ H_2O(l) + 4e^-$
	at cathode		
concentrated sodium chloride solution	at anode		
	at cathode		
silver nitrate solution	at anode		
	at cathode	silver	$Ag^+(aq) + e^- \rightarrow Ag(s)$

[4]

(ii) A student took samples from cells **A**, **B** and **C** before the start of the experiment to perform tests on. He labelled them solutions **A**, **B**, **C** respectively.

However, he accidentally mixed up the labels.

Using named reagents, describe tests that the student can perform to differentiate the solutions **A**, **B** and **C** and state the expected observations. Include names of precipitates formed, if any.

……

……

……

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……

……

……

……

……

……

…… [3]

(b) The table below provides some information on sulfate salts of Group II elements.

name of salt	solubility (maximum grams dissolved in 100 cm^3 of water at room temperature and pressure)
magnesium sulfate	35.1
calcium sulfate	0.21
barium sulfate	2.45×10^{-4}
radium sulfate	2.10×10^{-8}

From the information given in the table above, suggest how you would prepare a pure, dry sample of radium sulfate. Name the starting reagents in your answer.

…..

…..

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…..

…..

…..

…..

….. [3]

[Total: 10]

OR

B11 Chlorofluorocarbons (CFCs) have been used in large quantities as solvents and aerosol propellants. CFCs are chemically inert and do not react with air or water.

When CFC molecules diffuse high up into the atmosphere they destroy the ozone layer in the atmosphere, which is about 30 kilometres from the Earth surface.

To prevent the damage of ozone, the use of CFCs is being greatly reduced and they are being replaced with other organic compounds that cause little or no harm to the ozone layer.

(a) One of the most widely used CFCs was CCl_2F_2, which can be made from methane in a series of reactions.

(i) By means of a 'dot and cross' diagram, show the arrangements of the valence electrons in a CCl_2F_2 molecule.

[2]

(ii) Name the type of reaction that is used to make CCl_2F_2 from methane.

…….. [1]

(iii) Explain the destruction of ozone layer by CFCs in the atmosphere.

……

……

……

…… [2]

(iv) Why is the ozone layer important to mankind?

……..

…… [1]

(b) A list of some CFCs in current use and their possible replacements is given in the following table.

	formula	code number	Potential for destroying the ozone layer (on a scale 0 - 1.0)
compounds in current use	CCl_2F_2	11	1.0
	CCl_2FCCl_2F	113	0.8
possible replacement compounds	CH_2ClF	22	0.05
	CF_3CH_2F	134a	0
	CF_3CCl_2H	123	0.02
	CH_3CCl_2F	141b	0.12
	CH_3CHF_2	152a	0

(i) Both compounds 134a and 152a do not harm the ozone layer. Suggest a reason for this.

……

…….. [1]

(ii) What feature do the formulae of compounds 22, 123 and 141b have in common that differs from the formulae of the compounds in 'current use'?

……

…… [1]

(iii) Compound 141b is made by adding hydrogen fluoride (HF) to an unsaturated organic compound.

In the space below, deduce the equation for this reaction, showing the **structural formulae** of the reactants and products.

[2]

[Total: 10]

End of Paper