නව නිර්දේශය/ புதிய பாடத்திட்டம்/New Syllabus

NEW

කොළඹ දිස්ත්‍රික් පූර්ව වෛද්‍ය ශිෂ්‍ය සංගමය 2020
கொழும்பு மாவட்ட முன் மருத்துவச்சங்கம், 2020
Pre Medicine Association, Colombo District 2020

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය (ආදර්ශ), 2021
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை (மாதிரி), 2021
General Certificate of Education (Adv. Level) Examination (Model), 2021

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

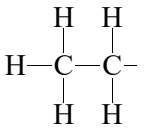
02 E II

පැය තුනයි
மூன்று மணித்தியாலம்
Three Hours

අමතර කියවීම් කාලය - මිනිත්තු 10 යි
மேலதிக வாசிப்பு நேரம் - 10 நிமிடங்கள்
Additional Reading Time - 10 minutes

Use **additional reading time** to go through the question paper, select the questions and decide on the questions that you give priority in answering.

- *A periodic Table is provided on page 17.*
- ***Use of calculators is not allowed.***
- *Universal gas constant, R = 8.314 J K^{-1} mol^{-1}*
- *Avogadro constant, N_A = 6.022 x 10^{23} mol^{-1}*
- **In answering this paper, you may represent alkyl groups in a condensed manner.**

Example:  group may be shown as CH_3CH_2-

Index No. : .....

PART A - Structured Essay (pages 02 - 09)

- *Answer **all** the questions on the question paper itself.*
- *Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and that extensive answers are not expected.*

PART B and PART C - Essay (pages 09 - 14)

- *Answer **four** questions selecting **two** questions from each part. Use the papers supplied for this purpose.*
- *At the end of the time allotted for this paper, tie the answers to the three Parts **A**, **B** and **C** together so that Part **A** is on top and hand them over to the Supervisor.*
- *You are permitted to remove **only** Parts **B** and **C** of the question paper from the Examination Hall.*

For Examiner's Use Only

Part	Question No.	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
C	8	
	9	
	10	
Total		

Total

In Numbers	
In Letters	

Code Numbers

Marking Examiner 1	
Marking Examiner 2	
Checked by :	
Supervised by :	

[see page two]

PART A – STRUCTURED ESSAY

*Answer **all four** questions on this paper itself.* (*Each question carries* **100** *marks.*)

Do not write in this column.

1.(a) State whether the following statements are **true** or **false.**

(i) The ionic radius of the following cations varies as $K^+ > Ca^{2+} > Ga^{3+}$ (……..……)

(ii) The Van der waals radius is one half the distance between two equivalent bonded atoms in their most stable arrangement. (……..……)

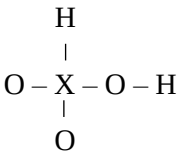
(iii) The energy for a gaseous atom to obtain an electron always becomes more positive when moving down a group. (……..……)

(iv) Inter-molecular hydrogen bonds can be seen in Para-Nitrophenol. (……..……)

(v) The energy difference between the line with the highest frequency in Balmer series and the line with longest wavelength in Lyman series, gives the energy of the line with the highest energy in the Paschen series. (……..……)

(02 Marks)

(b) The skeleton used to construct the Lewis structure of the anion $H_2XO_3^-$ is given below. **X** is an element belonging to the **P** block.



(i) If the arrangement with minimum charges on the atoms is stable, draw the **most** acceptable Lewis Structure for this ion.

(ii) To what group of the periodic table can the element **X** belong to? …...…….....

(iii) If **X** belongs to the 3rd period what element could **X** be? ….....……..

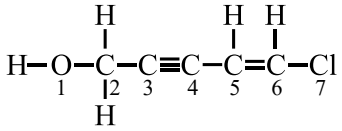
(iv) Draw **two** other resonance structures for above ion.

[see page three]

Do not write in this column.

(v) Based on the Lewis structure given below, state the following regarding the O and C atoms given in the table below.

I. VSEPR pairs around the atom
II. Electron pair geometry around the atom
III. Shape around the atom
IV. Hybridization of the atom



	O_1	C_2	C_3	C_5
VSEPR pairs around the atom				
Electron pair geometry around the atom				
Shape around the atom				
Hybridization of the atom				

(vi) Identify the atomic orbitals involved in the formation of the following π bonds in the Lewis structure given in part (v) above.

I. $C_3 – C_4$ C_3 ..... C_4 .....
II. $C_5 – C_6$ C_5 ..... C_6 .....

(vii) Identify the atomic/hybrid orbitals involved in the formation of the following σ bonds in the Lewis structure given in part (V) above.

I. $H – O_1$ H ..... O_1 .....
II. $O_1 – C_2$ O_1 ..... C_2 .....
III. $C_2 – C_3$ C_2 ..... C_3 .....
IV. $C_3 – C_4$ C_3 ..... C_4 .....
V. $C_6 – Cl_7$ C_6 ..... Cl_7 .....

(viii) What is the approximate value of the bond angle around atom C_5 in the Lewis structure given in part (v) above?

.....

(05 Marks)

[see page four]

Do not write in this column.

(c) (i) The dipole moment of LiH is 1.964×10^{-29} Cm. If the bond length of LiH is 1.596×10^{-10} m, Find percentage ionic character of LiH.
(Charge of an electron = 1.602×10^{-19} C)

(ii) Arrange the following in the **increasing** order of the property indicated in parentheses.

I. Na, K, Mg, Mn (metallic bond strength)

…… < …… < …… < ……

II. NH_2OH, NO, NO_2^-, NO_3^- (N-O bond length)

……..…. < ….....…… < …...…… < …...……

III. F, O, N, Ne (Second ionization energy)

…… < …… < …… < ……

IV. $NaNO_3$, KNO_3, $Mg(NO_3)_2$, NH_4NO_3 (Decomposition Temperature)

….....…… < ….....…… < ….....…… < ….....……

(03 Marks)

100

2.(a) **X**, **Y** and **Z** are 3 consecutive elements with atomic numbers less than 20. One of them exists as a gas at room temperature. Out of their oxides with the highest oxidation numbers, the oxides of **Y** and **Z** react with water giving strong acids while the oxide of the **X** gives a weak acid.

(i) Identify **X**,**Y** and **Z**.

X: …… **Y**: …… **Z**: ……

(ii) Write down the reactions of their oxides with the highest oxidation number with water.

……..

……..

……..

(iii) Write the reaction of $\mathbf{Z_2}$ with cold diluted $NaOH_{(aq)}$.

……..

(iv) Which of the products in part (iii) above show bleaching properties?

……..

[see page five]

Do not write in this column.

(v) Show how the product behaves as a bleaching agent by means of chemical reactions.

……..

……..

(vi) Give reactions to show how **Y** behaves in each of the following cases.

I. Oxidizing agent : ……

II. Reducing agent : ……

(vii) Give the balanced chemical equation for the reaction of **Z** with water.

……..

(viii) Draw a rough diagram to show the variation of the boiling points of the hydrides in the group to which **Z** belongs.

(06 Marks)

(b) **X** and **Y** are two water soluble salts. The following tests are carried out to identify **X** and **Y**.

Test	Observation
(1) Added dilute HCl to **X**.	A gas (**P**) with a pungent smell was evolved and a yellow turbidity was obtained
(2) **X** and **Y** were mixed together.	Precipitate **A** and Solution **B** were obtained.
(3) Only when **A** was heated	A black precipitate (**D**) and a colourless gas (**Q**) was obtained. (**Q** is a strong acid)
(4) Solution **B** is heated is the presence of Al in a basic medium.	A gas **R** with a pungent smell, which turns red litmus blue was released.
(5) Added dilute H_2SO_4 to **B**.	No observation was noted.
(6) **X** is subjected to the flame test	Shows a yellowish colour.

(i) Identify **X** and **Y**.

X: ……. **Y**: ……

(ii) Identify precipitate **A** and **D** and gases **P**, **Q** and **R**.

A: …….. **P**: …….. **R**: ……..

D: …….. **Q**: ……..

(iii) Write the reactions taking place in (3) and (4) above.

……..

……..

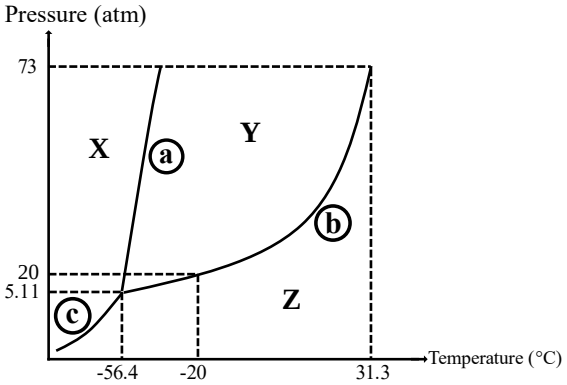
(04 Marks)

100

[see page six]

Do not write in this column.

3.



(i) Identify curves **a**, **b** and **c** of the above graph.

a: .....

b: .....

c: .....

(ii) Identity phases **X**, **Y** and **Z**.

X: .....

Y: .....

Z: .....

(iii) Define the critical pressure of a gas, and state the corresponding value for CO_2.

.....

.....

(iv) "Liquid CO_2 can be obtained by maintaining temperatures below 0°C under standard pressure" Explain whether this statement is true or false by referring to the above graph.

.....

.....

.....

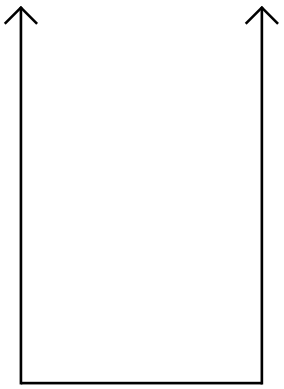
.....

(v) $AB_{2(l)}$ is a non-polar liquid. Draw the temperature - composition diagram of an ideal solution of $AB_{2(l)}$ and $CO_{2(l)}$ placed in a closed container, under a pressure of 20 atm. The melting point of $AB_{2(l)}$ at 20 atm is -5°C

[see page seven]

Do not write in this column.

(vi) Draw the vapour pressure - composition diagram for $CO_{2(l)}$ and $AB_{2(l)}$ at -20°C. Consider the vapour pressure of AB_2 at -20°C to be 16 atm.



(vii) Find P_{CO_2} of a solution, placed in a closed container, where the molar ratio of CO_2 and AB_2 in the liquid phase is 2 : 3, and mark this value on the graph drawn in part (vi) above.

.....

.....

.....

.....

(viii) Find the composition of the solution at the point where curves of P_{CO_2} and P_{AB_2} intersect in the graph drawn in (vi) above.

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.....

.....

(10 Marks)

100

[see page eight]

Do not write in this column.

4.(a) **A**, **B**, **C**, **D** and **E** are organic compounds with the same molecular formula C_5H_8O. All five react with Tollen's reagent to give a silver mirror. Only **A** and **B** do not show geometric isomerism, but **A** exhibits optical isomerism. When HBr is added to **B** in a polar medium and is then treated with Hg/Zn and conc. HCl, **F** is obtained. **F** exhibits optical isomerism. When **C** and **E** are reacted with Br_2/CCl_4 and the products thus obtained are reacted with alcoholic KOH, **G** and **H**, which are positional isomers of each other, are obtained. **H** underwent self-condensation in diluted NaOH.

(i) Draw the structures of **A**, **B**, **C**, **D**, **E**, **F**, **G** and **H** in the boxes given below.

A **B** **C**

D **E** **F**

G **H**

(ii) Draw the structures of the product obtained when **A** is reacted with Para methyl aniline.

(iii) Name **A** according to IUPAC Nomenclature.

.....

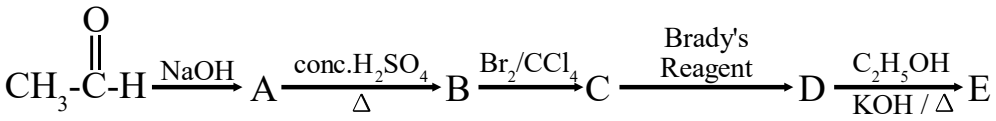
(iv) Draw the isomers of **A**.

(4.5 Marks)

[see page nine]

Do not write in this column.

(b) (i) Draw the structures to fill the spaces in the reaction scheme given below.



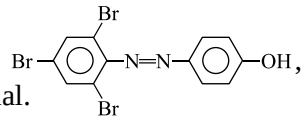
A

B

C

D

E

(ii) Show how you would synthesize 

, in **not more than 5** steps, using aniline as the only organic material.

(iii) Write the mechanism for the substitution of water to CH_3COCl.

(5.5 Marks) 100

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නව නිර්දේශය/ புதிய பாடத்திட்டம்/New Syllabus

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය (ආදර්ශ), 2021
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை (மாதிரி), 2021
General Certificate of Education (Adv. Level) Examination (Model), 2021

රසායන විද්‍යාව II
இரசாயனவியல் II
Chemistry II

02 E II

- Universal gas constant $R = 8.314\ J K^{-1}\ mol^{-1}$
- Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

PART B – ESSAY

*Answer **two** questions only.* (*Each question carries* **150 *marks.***)

5. (a) The compound **'N'** present in a certain type of flower is used for the production of various medicinal products. Since the chemical qualities of **'N'** are destroyed at temperatures exceeding 40°C, Steam distillation and other methods employing heat cannot be used for its extraction. Hence scientists conducted experiments to extract **'N'** using CO_2 liquified under pressure. For this, floral parts of the above flower type are taken, ground and mixed with water to prepare an aqueous solution of **'N'**. Then $100cm^3$ of this solution is mixed with $100cm^3$ of liquified CO_2, stirred and kept aside for a while. It was observed that the water and $CO_{2(l)}$ were separated into phases. Here, they found out that 75% of the compound **'N'** travelled from solution to the liquefied $CO_{2(l)}$. Finally, when the $CO_{2(l)}$ phase was separated and the exerted pressure was removed, in order to expel the CO_2 gas, 1.5g of pure **'N'** was left.

(Consider the molar mass of **'N'** to be $64\ g\ mol^{-1}$ and that the whole experiment was conducted at 25 °C).

(i) State **two** conditions under which the distribution coefficient can be applied.

(ii) Calculate the concentration of **'N'** in the initial aqueous solution.

(iii) Calculate K_D of **'N'** between CO_2 and water.

(iv) If the above process is repeated twice for a $50cm^3$ **'N'** solution, having half the concentration as that of the above aqueous solution, using $25cm^3$ of CO_2 for each procedure, calculate the number of moles of **'N'** remaining in the solution.

(b) (i) I. Define the standard lattice dissociation enthalpy of NaCl.

II. Some standard enthalpy changes are given below. Write down balanced chemical equations for each instance.

- Standard enthalpy of sublimation of $Na_{(s)}$ $+ 107\ kJ\ mol^{-1}$
- Standard first ionizing enthalpy of $Na_{(g)}$ $+ 496\ kJ\ mol^{-1}$
- Standard enthalpy of atomization of $Cl_{2(g)}$ $+ 244\ kJ\ mol^{-1}$
- Standard 1st electron gain enthalpy of $Cl_{(g)}$ $- 349\ kJ\ mol^{-1}$
- Standard enthalpy of formation of $NaCl_{(s)}$ $- 411\ kJ\ mol^{-1}$
- Standard enthalpy of hydration of $Na^+_{(g)}$ $- 405\ kJ\ mol^{-1}$
- Standard enthalpy of hydration of $Cl^-_{(g)}$ $- 364\ kJ\ mol^{-1}$

[see page eleven]

(ii) Calculate the lattice dissociation enthalpy of $NaCl_{(s)}$ using a Born - Haber cycle.

(iii) Out of $NaCl_{(s)}$ and $MgCl_{2(s)}$, which has the higher lattice dissociation enthalpy? Give reasons.

(iv) Using the above data calculate the standard enthalpy of dissolution of $NaCl_{(s)}$.

(v) I. Consider the reaction, $C_{(s)}+O_{2(g)} \rightarrow CO_{2(g)}$

If its enthalpy change (ΔH) = - 393.5 kJ mol^{-1} and its Gibbs free energy (ΔG) = - 394.4 kJ mol^{-1}, calculate its entropy change in J mol^{-1} K^{-1} at 25 °C.

II. Although the reaction should take place spontaneously according to part (vi), this doesn't practically happen. State possible reasons for this.

6. (a) Explain why solubility product is not applicable to water soluble ionic compounds.

(b) A certain mass of $Ca(OH)_2$ is mixed separately with two 100cm^3 portions of distilled water at 25 °C and 50 °C. 25 cm^3 portions from each solution are titrated separately with 2.75×10^{-2} mol dm^{-3} HCl using phenolphthalein as the indicator. The readings obtained are as follow.

For the 25 °C solution - 10 cm^3
For the 50 °C solution - 6.54 cm^3

(i) Find the OH^- concentration of the solutions, in each case.

(ii) What are the values obtained for K_{sp} of $Ca(OH)_2$ at 25 °C and 50 °C?

(iii) What unique change does the K_{sp} of $Ca(OH)_2$ show upon increase of temperature in comparison to most other ionic compounds?

(iv) What can be the reason for the change mention in part (iii) above?

(c) (i) RH is a weakly acidic organic compound. Consider an aqueous 0.1 mol dm^{-3} RH solution. If its pOH is 7.7 and the K_w of water is 2×10^{-14} mol^2 dm^{-6} at 35 °C, find K_a of RH at that temperature.

(ii) When a solution of AgCl is added drop-wise to a 0.144 mol dm^{-3} 250 cm^3 RH solution, 5 drops of AgCl were required to just get a precipitate of AgR at the bottom. Find the concentration of the added AgCl solution.
(The K_{sp} of AgR at 35 °C is 2.4×10^{-12} mol^2 dm^{-6} while the volume of a water droplet is approximately 0.05 ml.)

(iii) 450 cm^3 of a 0.0001 mol dm^{-3} HCl solution is added to 50 cm^3 of the initial solution in part (ii). Find the concentration of H^+ ions in the new solution.

(iv) Find the new concentration of R^- ions in that solution.

(v) Find the mass of $AgNO_3$ required to just begin precipitation of AgR in the new solution.
(Ag-108)

7. (a) (i) Draw and label a silver-silver chloride electrode. Write the reaction that takes place in it.

(ii) I. Write down the cell notation for a cell made by joining a standard chlorine electrode and a standard Calomel electrode.

II. Find the e.m.f. of above cell.
$E^\circ_{(Cl_{2(g)}|Cl^-_{(aq)})} = +1.36$ V and $E^\circ_{(Hg_{(l)}|Hg_2Cl_{2(aq)})} = +0.27$ V

[see page twelve]

(iii) I. Write down the Faraday's laws on electrolysis.
II. Write down **three** differences between an electrolytic cell and an electrochemical cell.

(iv) A dilute solution of $CuSO_4$ is electrolyzed using inert electrodes..
I. Write down the anode reaction, cathode reaction and overall cell reaction in the above electrolysis.
II. Calculate the volumes of gas released near the anode and cathode, when a 2A current is continuously sent through the above solution for 5 hours. (The molar volume of a gas at 0 °C and 1 atm is 24.4 dm^3)

(b) Four Coordination compounds made by the hydration of $CoCl_2$, $CoBr_2$ and CoI_2 are contained in solutions **A**, **B**, **C** and **D**. These compounds have octahedral geometry. While their respective halide ions can be present as ligands in the complex, the rest of the ligands in the complex are water molecules. The compounds can be analyzed using the procedures given below.

(Cl-35.5, Ag-108, Br-80, I-127, Co - 59)

Analysis of A

Excess $AgNO_{3(aq)}$ was added to 20 cm^3 of a 0.5 mol dm^{-3} solution of **A**. A white precipitate was obtained. The dry mass of the precipitate was 1.435 g. The precipitate dissolved when concentrated NH_3 was added.

Analysis of B

Excess $AgNO_{3(aq)}$ was added to 20 cm^3 of a 0.5 mol dm^{-3} solution of **B**. A yellow precipitate was obtained. The dry mass of the precipitate was 4.7 g. The precipitate did not dissolve even when concentrated NH_3 was added.

Analysis of C

Excess $AgNO_{3(aq)}$ was added to 20 cm^3 of a 0.5 mol dm^{-3} solution of **C**. A light yellow precipitate was obtained. The dry mass of the precipitate was 1.88 g. While the precipitate did not dissolve in diluted NH_3, it dissolved when concentrated NH_3 was added.

Analysis of D

Excess $AgNO_{3(aq)}$ was added to 10 cm^3 of a 0.5 mol dm^{-3} solution of **D**. A white precipitate was obtained. The dry mass of the precipitate was 1.435 g. The precipitate dissolved in both diluted and concentrated NH_3.

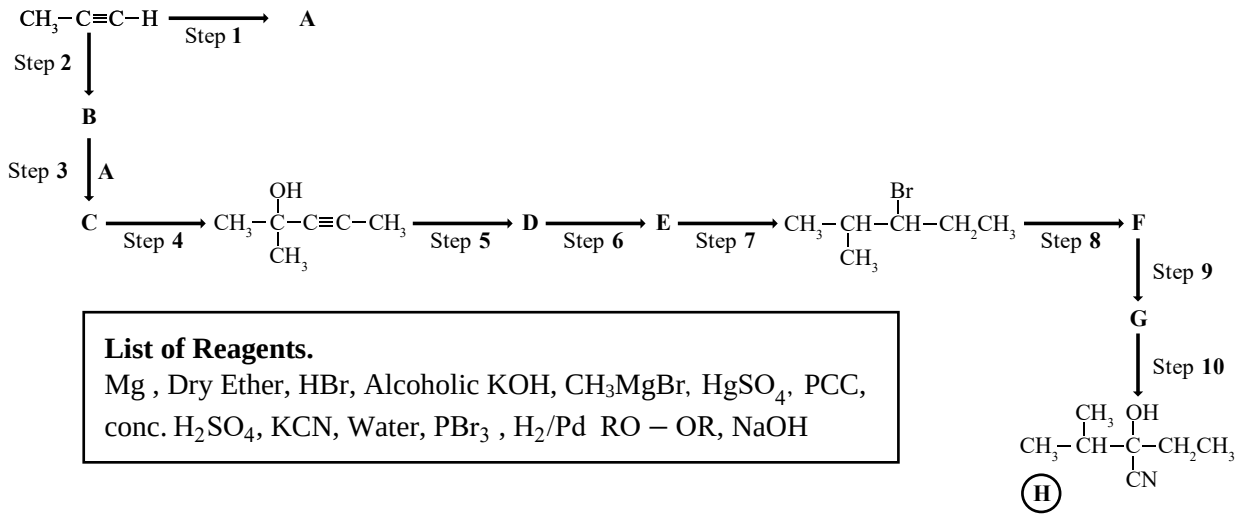
(i) Write down the electron configuration and oxidation number shown by Co in **A**, **B**, **C** and **D**.
(ii) Deduce the structures of the coordination complexes in the solutions **A**, **B**, **C** and **D**.
(iii) Name them according to IUPAC nomenclature.
(iv) Draw the structure of A.

[see page thirteen]

PART C – ESSAY

*Answer **two** questions only.* (*Each question carries* **150 *marks.***)

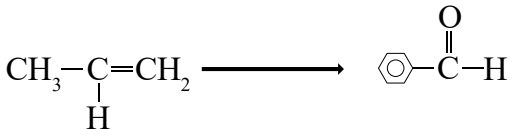
8. (a) The following reaction scheme is used to synthesize compound **H** beginning with $CH_3 - C \equiv CH$. Draw the structures **A, B, C, D, E, F** and **G** which are required to complete the reaction scheme. Name the reactants used from step **1 - 10**, using **only** the chemicals given in the list.



List of Reagents.
Mg , Dry Ether, HBr, Alcoholic KOH, CH_3MgBr, $HgSO_4$, PCC, conc. H_2SO_4, KCN, Water, PBr_3 , H_2/Pd RO − OR, NaOH

(b) (i) Compare the acidities of phenol and carboxylic acid.

(ii) Show how you would carry out the following conversion in **less than** 10 Steps, using ⬡ as the **only** external organic material.



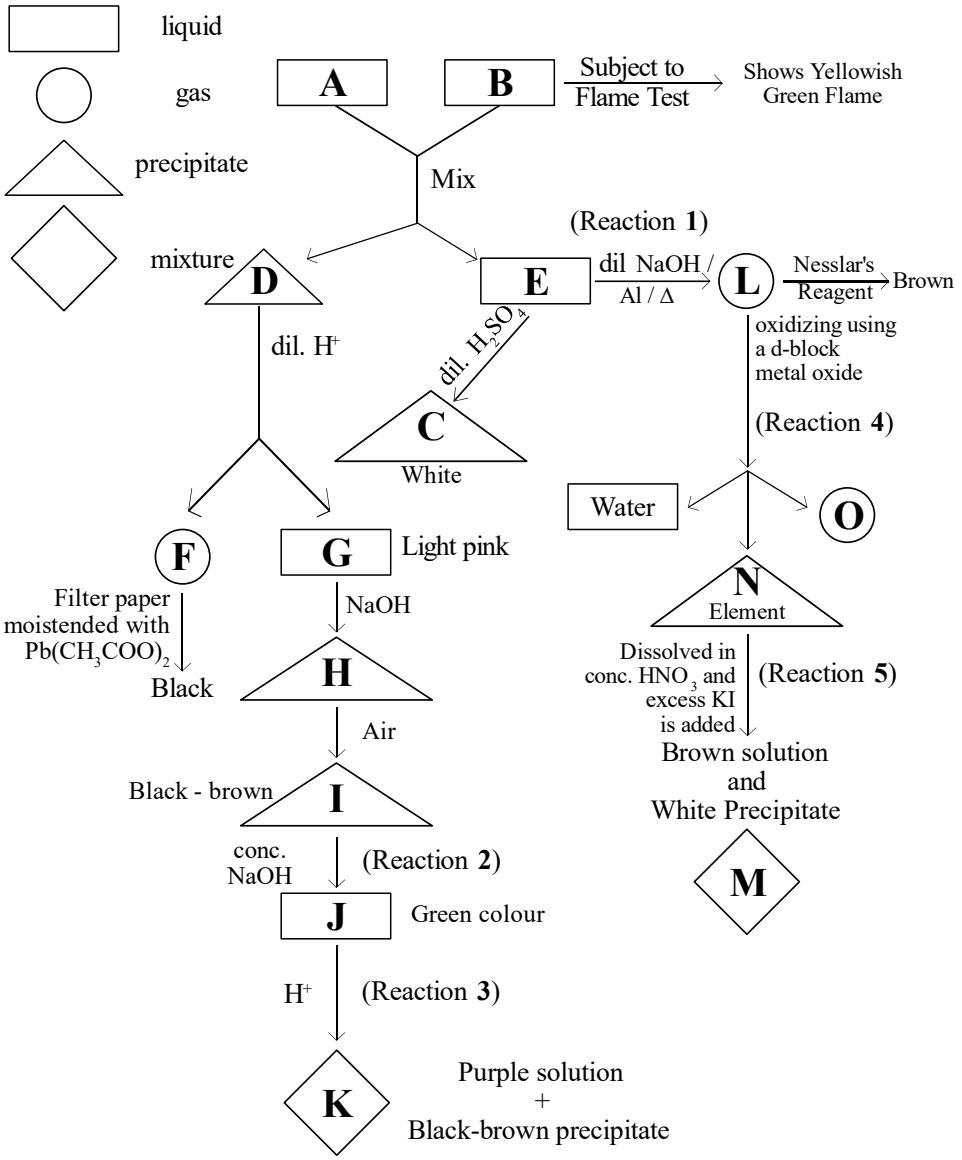
(c) $CH_3 - CH = CH - CH_3$ + cool concentrated $H_2SO_4 \rightarrow$ **Y**

(i) Draw the structure of **Y**.

(ii) Write down the mechanism for the above reaction.

[see page fourteen]

9.(a)



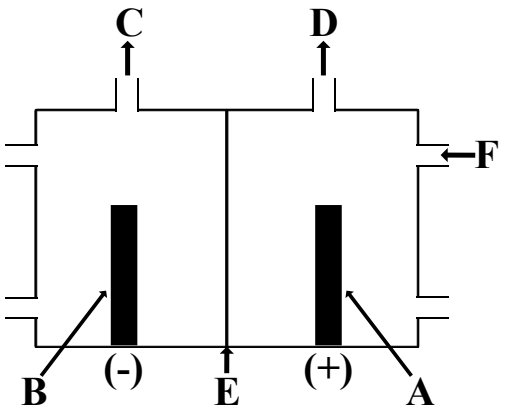
(i) Identify compounds **A** to **O**.
(ii) Write down reactions **1** to **5**.

(b) An aqueous solution contains $CuSO_4$, $NiSO_4$ and $Fe_2(SO_4)_3$. When excess $BaCl_2$ was added to 100 cm^3 of the initial solution, the mass of the precipitate **(X)** obtained was 9.32 g. When the filtrate was separated and KI was added, the mass of the precipitate thus obtained **(Y)** was 1.905 g. When the gas **(Z)** released during the addition of KI was titrated with a 1 mol dm^3 $Na_2S_2O_3$ Solution, the end point was 20 cm^3.
(Fe – 56, Cu – 63.5, Ni – 58.6, Ba – 137, S – 32, I – 127)

(i) Identify **X,Y** and **Z**.
(ii) Write the reaction(s) taking place upon the addition of KI.
(iii) Calculate the concentrations of Ni^{2+}, Fe^{2+}, Cu^{2+}, SO_4^{2-} in the mixture .
(iv) What is the indicator used for the above titration with $Na_2S_2O_3$.

[see page fifteen]

10. (a) The following question is based on the production of Caustic Soda using the membrane cell method and its uses.



(i) Name the electrodes **A** and **B** and the metals commonly used to make them.

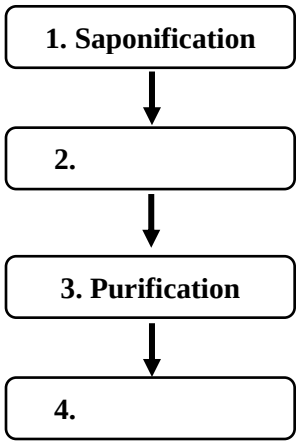
(ii) Write the reactions taking place at **A** and **B** and the gases released from **C** and **D**, when the cell operates.

(iii) Name **E**. What is the importance of **E** in the activity of cell?

(iv) Name the raw materials added into the cell through **F** and name three ionic impurities removed during their purification.

(v) State the two other methods used to produce NaOH in addition to the membrane cell method.

(vi) One of the principal uses of NaOH is the production of soap.



I. Name steps **2** and **4**.

II. Briefly explain the process that takes place in Step 4.

III. TFM is an important parameter in determining quality of soap. What is meant by the TFM value?

[see page sixteen]

(b) The wreckage caused by the **'Xpress Pearl'** ship in mid-2021 can be considered to have some of the most adverse effects on Sri Lanka's bio diversity in recent times.

(i) To assess the extent of the damage due to this incident, researchers obtain and analyze water samples. What are the units used to measure the following three water quality parameters?

I. Turbidity
II. Conductivity
III. Hardness

(ii) There were great quantities of chemical substances onboard the **'Xpress Pearl'** ship when it caught on fire. Some of them leaked into the ocean and the others were combusted and mixed with atmospheric air. Further, large amounts of plastic washed ashore on the western coast. Give **one** additive added to maintain each of the properties of plastic given below.

I. To provide vivid colours
II. To make plastic less rigid
III. Used as fillers in plastic

(iii) There is a possibility of occurrence of acid rain due to the mixing of chemicals into air by the burning of the above ship. Elucidate this statement providing examples where necessary.

(c) Consider the following polymers.
Polyethylene (PE), Nylon 6,6, Polyvinyl Chloride (PVC), Polystyrene (PS), Polyethylene Terypthalate (PET)

(i) According to the reaction taking place during production, polymers can be classified into two classes. Name them and classify the above polymers into these two classes.

(ii) According to the method of production there are **two** Main types of Polyethylene (PE). What are they?

(iii) Polymers can also be classified as thermoplastic and thermosetting polymers, based on their response to heat. Give an example each for a thermoplastic and a thermosetting polymer.

(iv) Bakelite is a polymer used in several industrial fields due to its electrical insulating properties. What are the **two** main compounds used in the production of this polymer?

***

1	1 **H**																2 **He**
2	3 **Li**	4 **Be**											5 **B**	6 **C**	7 **N**	8 **O**	9 **F**	10 **Ne**
3	11 **Na**	12 **Mg**											13 **Al**	14 **Si**	15 **P**	16 **S**	17 **Cl**	18 **Ar**
4	19 **K**	20 **Ca**	21 **Sc**	22 **Ti**	23 **V**	24 **Cr**	25 **Mn**	26 **Fe**	27 **Co**	28 **Ni**	29 **Cu**	30 **Zn**	31 **Ga**	32 **Ge**	33 **As**	34 **Se**	35 **Br**	36 **Kr**
5	37 **Rb**	38 **Sr**	39 **Y**	40 **Zr**	41 **Nb**	42 **Mo**	43 **Tc**	44 **Ru**	45 **Rh**	46 **Pd**	47 **Ag**	48 **Cd**	49 **In**	50 **Sn**	51 **Sb**	52 **Te**	53 **I**	54 **Xe**
6	55 **Cs**	56 **Ba**	**La-Lu**	72 **Hf**	73 **Ta**	74 **W**	75 **Re**	76 **Os**	77 **Ir**	78 **Pt**	79 **Au**	80 **Hg**	81 **Tl**	82 **Pb**	83 **Bi**	84 **Po**	85 **At**	86 **Rn**
7	87 **Fr**	88 **Ra**	**Ac-Lr**	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**	110 **Ds**	111 **Rg**	112 **Cn**	113 **Nh**	114 **Fl**	115 **Mc**	116 **Lv**	117 **Ts**	118 **Og**

57 **La**	58 **Ce**	59 **Pr**	60 **Nd**	61 **Pm**	62 **Sm**	63 **Eu**	64 **Gd**	65 **Tb**	66 **Dy**	67 **Ho**	68 **Er**	69 **Tm**	70 **Yb**	71 **Lu**
89 **Ac**	90 **Th**	91 **Pa**	92 **U**	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**