සියළුම හිමිකම් ඇවිරිණි / All Rights Reserved]

බස්නාහිර පළාත් අධ්‍යාපන දෙපාර්තමේන්තුව
மேல் மாகாணக் கல்வித் திணைக்களம்
Department of Education - Western Province

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය **2025** නොවැම්බර් උපකාරක ප්‍රශ්න පත්‍රය
General Certificate of Education (Adv. Level) Exam, November 2025 Supportive Seminar Paper

රසායන විද්‍යාව I Chemistry I	**02**	**E**	**I**	**13** ශ්‍රේණිය **Grade 13**	*පැය දෙකයි* ***Two hour***

Universal gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$	Plank constant	$h = 6.626 \times 10^{-34}\ J\ s$
Avogadro constant	$N_A = 6.022 \times 10^{23}\ mol^{-1}$	speed of light	$c = 3 \times 10^{8}\ m\ s^{-1}$

Instructions: –

- This question paper has **09** pages.
- A periodic table is provided
- Answer all questions.
- **Use of calculators is not allowed**.
- Write your exam number in the given space on the answer sheet.
- Read the other instructions given at the back of the answer sheet carefully.
- For each question from 1 to 50, select the correct or most appropriate answer from the answers (1), (2), (3), (4), (5) and mark it with a cross (x) as per the instructions on the back of the answer sheet.

1. Which of the following sets of quantum numbers does not represent the set of quantum numbers (n, l, m_l, m_s) for an electron in a nitrogen atom?

   (1) 2, 1, 0, -1/2 (2) 1, 0, 0, +1/2 (3) 2, 0, 0, -1/2
   (4) 2, 2, 1, +1/2 (5) 2, 1, 0, +1/2

2. In which of the following answers are all the atoms in both molecules located in the same plane?
   (1) C_2H_2, NH_3 (2) C_2H_4, SF_4 (3) PCl_5, H_3O^+ (4) C_2H_2, XeF_4 (5) SCl_4, PCl_3

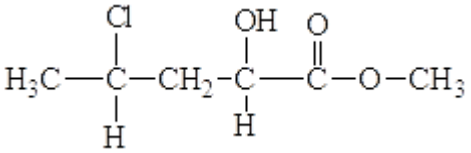
3. Arrange the following wavelengths, in ascending order of wavelength,
   Gamma rays (λ_1), Micro waves (λ_2), X rays (λ_3), Infrared waves (λ_4)

   (1) $\lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$ (2) $\lambda_4 < \lambda_2 < \lambda_3 < \lambda_1$ (3) $\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4$
   (4) $\lambda_1 < \lambda_3 < \lambda_4 < \lambda_2$ (5) $\lambda_3 < \lambda_2 < \lambda_1 < \lambda_4$

4. What is the volume of concentrated HCl acid of density 1.20 g cm^{-3} and purity 36% (w/w) required to make 250 cm^3 of 0.192 mol dm^{-3} HCl solution? (H = 1, Cl = 35.5)
   (1) 5.0 cm^3 (2) 4.0 cm^3 (3) 0.5 cm^3
   (4) 6.0 cm^3 (5) 3.6 cm^3

5. The IUPAC name of the given compound is

   (1) methyl 4–chloro–2–hydroxypentanoate
   (2) methyl–4– chloro–2–hydroxypentanoate
   (3) methyl–2–hydroxy–4–chloropentanoate
   (4) methyl 2–hydroxy–4–chloropentanoate
   (5) 4–chloro–2–hydroxy–1–methoxypentanoate

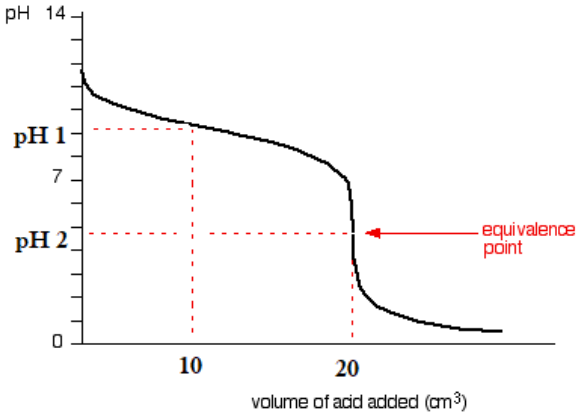


6. You are provided with two aqueous solutions of $Na_2S_2O_3$ and Na_2SO_3. Which of the following reagents **cannot** be used to distinguish the two solutions?
(1) $AgNO_3$ (aq) (2) $Pb(NO_3)_2$(aq) (3) HCl (aq) (4) H_2SO_4(aq) (5) Na_2CO_3(aq)

7. The pressure inside the rigid container containing 2.0 g of gas X is 1.0×10^5 Pa. When 3.0 g of gas Y is added to this container at the same temperature, the pressure increases to 1.5×10^5 Pa. If X and Y are ideal gases then the ratio of molar masses of X and Y is
(1) 1 : 1 (2) 1 : 2 (3) 1 : 3 (4) 1 : 4 (5) 1 : 5

8. Which of the following statements regarding enthalpy is correct?
(1) The standard enthalpy of the formation of all stable compounds in nature is negative
(2) The standard enthalpy of formation of all elements is zero
(3) All non-metallic elements have a negative standard electron-gaining enthalpy
(4) The standard enthalpy of combustion of graphite is the same as the standard enthalpy of formation of CO_2(g).
(5) The standard atomization enthalpy of O_2 gas is equal to the standard bond dissociation enthalpy of O_2 gas

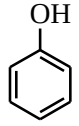
9. The pH curve given below corresponds to the titration of a 20 cm^3 volume of a weak monoacid base (B) of concentration 1 mol dm^{-3} with HCl solution of concentration 1 mol dm^{-3}.
At 25 ^{0}C, K_b of B = 1×10^{-5} mol dm^{-3}.
The values of pH_1 and pH_2 corresponding to the graph can be, respectively



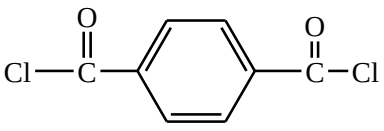
(1) 10 and 6.25 (2) 8.5 and 5.35
(3) 9 and 4.65 (4) 9 and 7.04 (5) 8 and 6.28

10. Which of the following statements is false about carbonyl compounds?
(1) $LiAlH_4$ as well as $NaBH_4$ can be used for the reduction of carbonyl compounds
(2) The characteristic type of reaction of carbonyl compounds is nucleophilic addition reactions
(3) All carbonyl compounds undergo aldol condensation in the presence of dilute NaOH to form compounds with double the number of carbon atoms
(4) 2,4-DNP can be used to distinguish carbonyl compounds from other organic compounds.
(5) Ketones react with CH_3MgX and undergo hydrolysis to give tertiary alcohols

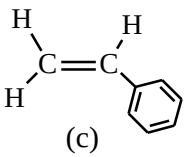
11. Consider the structures given below



(a)

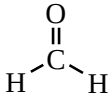


(b)

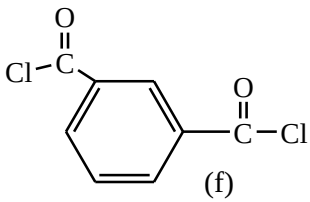


(c)

$H_2N(CH_2)_4NH_2$
(d)



(e)



(f)

Using which of the above pairs of structures, do you predict that a synthetic linear polymer can be formed?
(1) a and e (2) c and e (3) d and f (4) b and f (5) c and d

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12. A rigid container contains a mixture containing equal molar amounts of gases P and Q. When a little of a solid catalyst is added to it, the following equilibrium occurs

$$P(g) + Q(g) \rightleftharpoons 2R(g) + S(g)$$

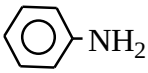
The total pressure of the system is 1 x 10^5 Pa and the mole fraction of S is 0.2 at this temperature the value of K_p for the above equilibrium is,

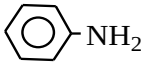
(1) 3.2 x 10^5 Pa (2) 7.2 x 10^5 Pa (3) 1.6 x 10^5 Pa
(4) 2.4 x 10^5 Pa (5) 4.2 x 10^5 Pa

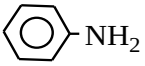
13. Which of the following aqueous solutions gives the same color as the color of an aqueous solution of $Cr(NO_3)_3$ in the presence of excess H_2O_2 in basic medium?

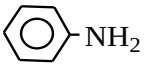
(1) $[Cu(NH_3)_4]^{2-}(aq)$ (2) $[CoCl_4]^{2-}(aq)$ (3) $[CuCl_4]^{2-}(aq)$
(4) $[CrCl_4]^{-}(aq)$ (5) $[Ni(NH_3)_6]^{2+}(aq)$

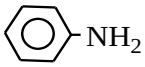
14. The correct order of increasing basicity of below compunds is,

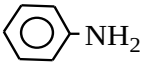
$(CH_3)_3N$, $(CH_3)_2NH$, CH_3NH_2 ,  , NH_3

(1) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N > NH_3 >$ 

(2) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3 >$ 

(3) $(CH_3)_2NH > (CH_3)_3N > CH_3NH_2 >$  $> NH_3$

(4) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3 >$ 

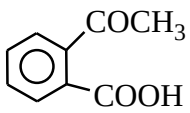
(5) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 >$  $> NH_3$

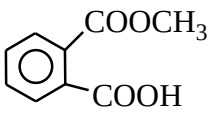
15. $$2A \rightarrow B + 2C$$

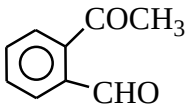
The rate-determining steps of a reaction are shown above. When the concentration of A is 0.16 mol dm^{-3}, the rate of reaction is R. When the rate of reaction is 9R, what is the concentration of A in mol dm^{-3}?

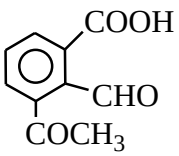
(1) 0.16 (2) 1.44 (3) 1.2 (4) 2.4 (5) 0.48

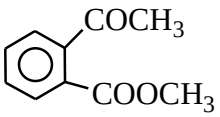
16. Organic compound X is insoluble in aqueous NaOH and forms an orange precipitate with Brady's reagent. X oxidizes an ammonical $AgNO_3$ solution giving Y and reacts with Brady's reagent to give an orange precipitate. Identify X?

(1) 

(2) 

(3) 

(4) 

(5) 

17. A student made an electrode chemical cell by connecting a Zn rod immersed in a 1 mol dm^{-3} $ZnSO_4$ solution and an Ag rod immersed in a 1 mol dm^{-3} $AgNO_3$ solution with a salt solution. The standard notation of this cell is,

$$E^{\Theta}_{Ag^{+}(aq)/Ag(s)} = +0.80\,V \quad E^{\Theta}_{Zn^{2+}(aq)/Zn(s)} = -0.76\,V$$

(1) $Zn(s)|Zn^{2+}(aq,1\ mol\ dm^{-3})\ ||\ |Ag(s)|Ag^{+}(aq)$

(2) $Ag(s)|Ag^{+}(aq,1\ mol\ dm^{-3})\ ||\ Zn(s)|Zn^{2+}(aq)$

(3) $Zn(s)|Zn^{2+}(aq,1\ mol\ dm^{-3})\ ||\ Ag^{+}(aq,\ 1\ mol\ dm^{-3})|Ag(s)$

(4) $Ag(s)|Ag^{+}(aq,1\ mol\ dm^{-3})\ ||\ Zn^{2+}(aq,1\ mol\ dm^{-3})|Zn(s)$

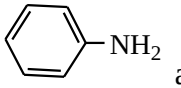
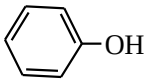
(5) $Zn(s)|Zn^{2+}(aq,1\ mol\ dm^{-3})\ |\ Ag^{+}(aq,\ 1\ mol\ dm^{-3})|Ag(s)$

18. The Kp value for the reaction $2X(g) \rightleftharpoons 3Y(g) + Z(g)$ at temperature T is five. If the reaction $\frac{1}{3}Z(g) + Y(g) \rightleftharpoons \frac{2}{3}X(g)$ takes place at the same temperature, its Kp value will be,

(1) $\left(\frac{1}{125}\right)^{\frac{3}{5}}$ (2) $\left(\frac{1}{5}\right)^{\frac{1}{3}}$ (3) $\left(\frac{1}{125}\right)^{\frac{1}{5}}$ (4) $\left(\frac{1}{5}\right)^{3}$ (5) $(125)^{\frac{1}{3}}$

19. Which of the following statements is **incorrect** regarding the ammonia?

(1) Ammonia gives a pink color with Nessler reagent.
(2) The oxidation state of nitrogen in ammonia is -3.
(3) Ammonia is used as one of the raw materials in the production of nitric acid.
(4) Ammonia is used to remove acidic components from crude oil.
(5) Ammonia is produced when Aluminium powder, $NaNO_3$, and aqueous sodium hydroxide mixture is heated.

20. Which of the following **cannot** be used to distinguish  and  ?

(1) HNO_2 solution. (2) Br_2 / water. (3) NaOH (aq).
(4) Wet litmus paper. (5) Neutral $FeCl_3$ solution.

21. $$P(g) + Q(g) \rightleftharpoons R(g) \quad \Delta H < 0$$

Which of the following statement/s is/are correct concerning the above equilibrium system when increasing temperature?

(A) The rate of forward reaction increases.
(B) The rate of backward reaction increases.
(C) The reaction rate remains unchanged.
(D) Forward and backward reaction rates increase by equal amounts

(1) B only (2) A only (3) D only
(4) B and D only (5) A and B only

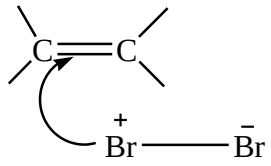
22. Compound B dissolves in water and forms an ideal solution. When B dissolves in water, its vapor pressure decreases from 1 x 10^4 Pa to 8 x 10^3 Pa. The concentration of B is 4 mol dm^{-3} and the density is 0.56 g cm^{-3}. The molar mass of B is,

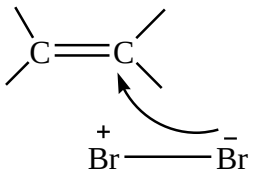
(1) 104 g mol^{-1} (2) 26 g mol^{-1} (3) 208 g mol^{-1}
(4) 68 g mol^{-1} (5) 52 g mol^{-1}

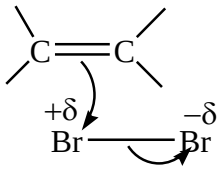
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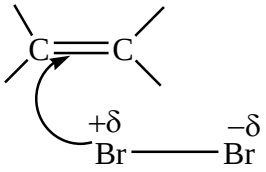
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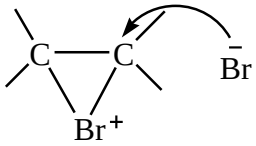
23. Which of the following best represents the first step in the mechanism of addition of Br_2 to an alkene?

(1) 

(2) 

(3) 

(4) 

(5) 

24. The reaction between NO and H_2 occurs in three basic steps as follows:

$$NO(g) + NO(g) \rightleftharpoons N_2O_2(g) \text{ (Fast)}$$

$$N_2O_2(g) + H_2(g) \rightarrow H_2O(l) + N_2O(g) \text{ (slow)}$$

$$N_2O(g) + H_2(g) \rightarrow N_2(g) + H_2O(l) \text{ (Fast)}$$

According to the above mechanism, the expression for the rate (R) for the reaction between NO and H_2 is

(1) $R = k\,[NO(g)]^2$ (2) $R = k\,[NO(g)]^2[H_2(g)]$ (3) $R = k\,[N_2O_2(g)][H_2(g)]$
(4) $R = k\,[NO(g)]$ (5) $R = k\,[N_2O(g)][H_2(g)]$

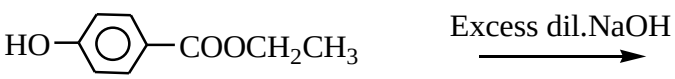
25. The table below shows the main observations obtained in each chemical identification and the formulas of the chemical compounds corresponding to those observations

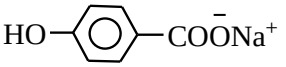
	Chemical identification	Formula and relevant observations
A	Adding a solution of $K_3[Fe(CN)_6]$ (aq) with Fe^{2+} (aq) to detect Fe^{2+} ions	$KFe[Fe(CN)_6]$ Deep blue precipitate
B	Adding a solution of $K_4[Fe(CN)_6]$ (aq) with Fe^{3+} (aq) to detect Fe^{3+} ions	$Fe_4[Fe(CN)_6]_3$ Persian blue precipitate
C	Adding a solution of NH_4SCN (aq) with Fe^{3+} (aq) to detect Fe^{3+} ions	$\left[Fe(SCN)\right]^{2+}$ (aq) Blood red solution
D	Adding a solution of $K_4[Fe(CN)_6]$ (aq) with Cu^{2+} (aq) to detect Cu^{2+} ions	$Cu_2[Fe(CN)_6]$ Chocolate brown precipitate
E	Add concentrated H_2SO_4 acid with a freshly prepared $FeSO_4$ solution to detect the NO_3^- or NO_2^- ions	$[Fe(H_2O)_5(NO)]SO_4$ Brown color complex

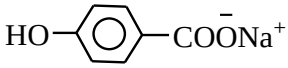
Which of the above scenarios is correct?

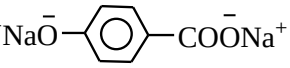
(1) A and B only (2) A,B and C only (3) B, C and D only
(4) C, D and E only (5) All the above cases are correct.

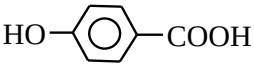
26. What are the main products of the following reaction?

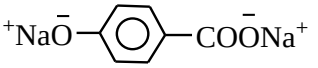


(1)  and $CH_3CH_2\bar{O}Na^+$

(2)  and CH_3CH_2OH

(3)  and $CH_3CH_2ONa^+$

(4)  and CH_3CH_2OH

(5)  and CH_3CH_2OH

27. In a Winkler's method experiment to determine the concentration of dissolved oxygen in a water sample, 200 cm^3 of the sample was titrated with a 0.025 mol dm^{-3} $Na_2S_2O_3$ solution. The titration required 10.0 cm^3 of $Na_2S_2O_3$ solution to reach the endpoint. Calculate the concentration of dissolved oxygen in the water sample in **ppm**

(1) 2 (2) 10 (3) 25 (4) 44 (5) 52

28. At 25^{o}C, the concentration of Cl^- ions in the solution prepared by mixing equal volumes of 0.20 mol dm^{-3} $AgNO_3$ and 0.10 mol dm^{-3} NaCl solutions is, (K_{sp} of AgCl = 1.8 x 10^{-8} mol^2 dm^{-6})

(1) 3.6 x 10^{-7} mol dm^{-3} (2) 1.34 x 10^{-5} mol dm^{-3} (3) 1.44 x 10^{-8} mol dm^{-3}
(4) 3.42 x 10^{-7} mol dm^{-3} (5) 1.25 x 10^{-8} mol dm^{-3}.

29. Which of the following quantities is measured in NTU units?

(1) Conductivity of a water sample (2) Acidity of a water sample
(3) Turbidity of a water sample (4) Hardness of a water sample
(5) Eutrophication status of a water sample

30. Which of the following reactions is not a correct reaction in the Oswald method for the production of nitric acid?

(1) $4NH_3(g)+5O_2(g)\xrightarrow{\Delta}4NO(g)+6H_2O(l)$ (2) $2NO(g)+2O(g)\rightarrow 2NO_2(g)$
(3) $2NO(g)+O_2(g)\rightarrow 2NO_2(g)$ (4) $4NO_2(g)+2H_2O(g)+O_2(g)\rightarrow 4HNO_3(aq)$
(5) $3NO_2(g)+H_2O(l)\rightarrow 2HNO_3(aq)+NO(g)$

- For each questions **31** to **40**, one or more responses out of the four responses (a), (b), (c) and (d) given is/are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark

(1) if only (a) and (b) are correct
(2) if only (b) and (c) are correct
(3) if only (b) and (c) are correct
(4) if only (b) and (c) are correct
(5) if **any other** number or combination responses is correct

Summary of the above instructions

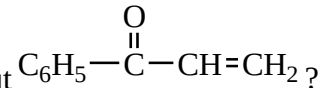
(1)	(2)	(3)	(4)	(5)
only (a) and (b) are correct	only (b) and (c) are correct	only (c) and (d) are correct	only (d) and (a) are correct	**Any other** number or combination of responses is correct.

31. Which of the following compound /compounds has the same electron pair geometry?

(a) O_3 (b) SO_2 (c) CO (d) PH_3

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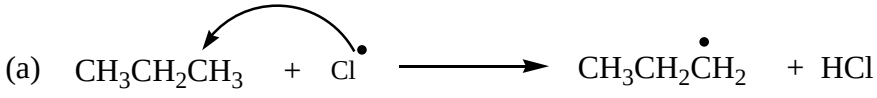
32. A rigid container at constant temperature contains equal masses of O_2 and H_2 gases. These behave as ideal gases. Which of the following statement/s is/are correct for this ideal gas system,
(a) Partial pressure of O_2 = Partial pressure of H_2
(b) The density ratio of O_2 and H_2 is 1:1.
(c) (Number of moles of O_2) x 16 = number of moles of H_2
(d) (Density of O_2) x 16 = density of H_2

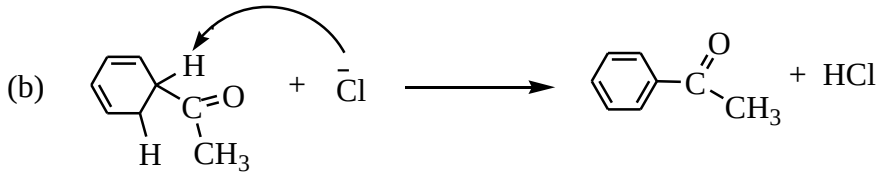
33. Which of the following statement(s) is/are true about  ?
(a) It reacts with HCN (b) It reacts with HBr
(c) It has geometric isomers (d) It reacts with dilute NaOH and undergo condensation

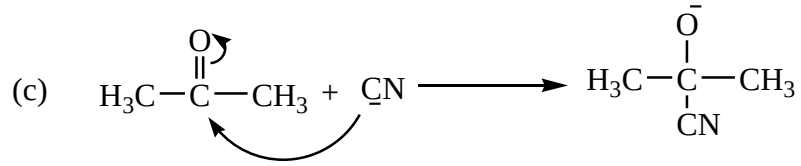
34. Which of the following is/are correct with regard to an equilibrium reaction at standard state? K is reaction constant and Q is reaction quotient
(a) $\Delta H^{o} = 0$ (b) $Q < K$ (c) $\Delta G^{o} = 0$ (d) $Q = K$

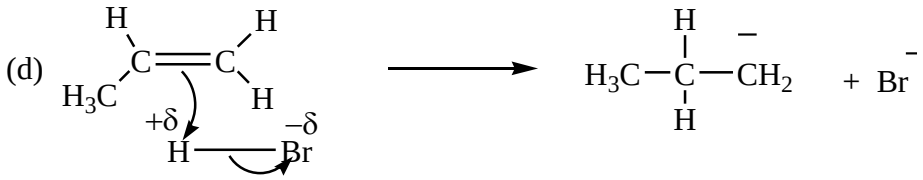
35. Which of the following compound/compounds not used for the salt bridge are,
(a) NH_4OH (b) AgCl (c) NH_4NO_3 (d) KNO_3

36. Which of the following is/are a step/s in an organic reaction mechanism? ,

(a) 

(b) 

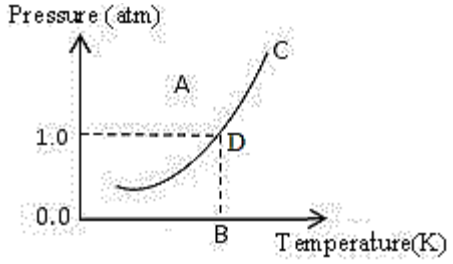
(c) 

(d) 

37. A water-soluble compound A is thoroughly mixed with a volume of water V_{aq} and a volume of water-immiscible organic layer V_O at a temperature of T K and allowed to equilibrate. Which of the following is correct in this regard?

(a) The amount of A extracted into the organic solvent does not depend on the volume of Vaq.
(b) The amount of A extracted into the organic solvent depends on the volume of V_O.
(c) The fraction extracted in to organic layer is given by $\dfrac{V_O}{V_O + \left(\dfrac{V_{aq}}{K_D}\right)}$
(d) The experiment is temperature-independent.

38. Which of the following statement/s is/are correct concerning this graph between water pressure and temperature?



(a) Zone A contains water vapor.
(b) No liquid water is at a temperature higher than B.
(c) The temperature corresponding to C is the standard boiling point of water.
(d) The CD curve shows liquid-vapor equilibrium.

39. Which of the following statement/s is/are correct regarding the following equation,

$$3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$$

(a) Kp = Kc
(b) No change in equilibrium point on increasing pressure by decreasing volume.
(c) The backward reaction becomes faster when the concentration of Fe_3O_4 increases.
(d) The reaction moves backward on decreasing H_2 concentration.

40. Choose the **incorrect** statement/statements from the statements below

(a) The waste gas released from the blast furnace during iron extraction mainly contains CO_2.
(b) Seawater is directly used as a raw material in the extraction of magnesium metal by the Dow method.
(c) In the production of NaOH using membrane cell, the following reaction takes place near the anode.

$$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e$$

(d) In iron extraction, CO_2 is more stable compared to CO in the upper part of the blast furnace that is in the lower temperature part.

- In question Nos; **41** to **50**, two statements are given in respect of each question. From the table given below, select the response, out of the responses (1), (2), (3), (4) and (5) that **best** fits the two statements and mark appropriately on your answer sheet.

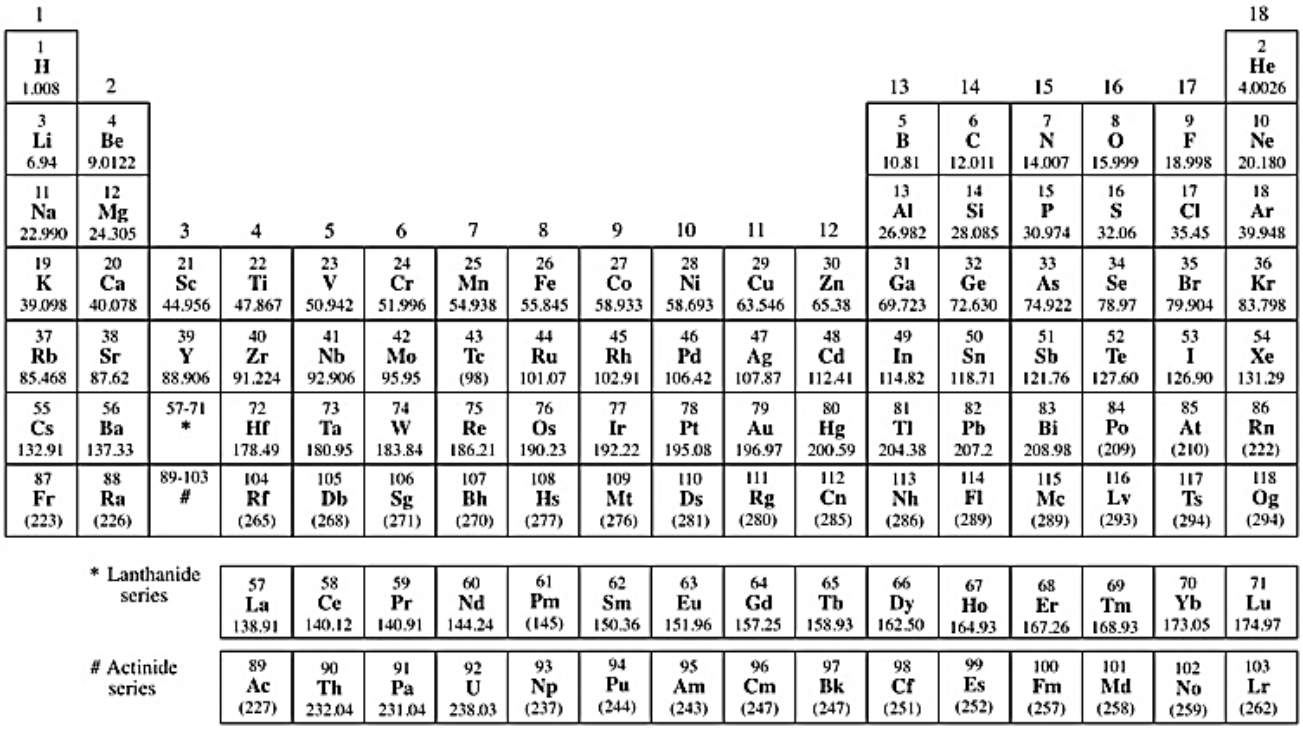
Response	First statement	Second statement
(1)	True	True and correctly explains the first statement
(2)	True	True and does **not** explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
(41)	The covalent character of KI is higher than that of KBr.	The polarizability of I^- is higher than that of Br^-.
(42)	In any condition Van der Waals equation cannot be applied to ideal gases.	Van der Waals equation can be used only for real gases.
(43)	Phenol is an aromatic compound, but ethanol is not.	The stability of the phenate ion is greater than the stability of the ethoxide ion.
(44)	Exothermic reactions are spontaneous at low temperatures.	An enthalpy is a state function.

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(45)	In a first-order reaction, the time taken to halve the concentration of the reactants is always the same.	The half-life of a first-order reaction is independent of the initial concentration of the reactants.
(46)	In an aqueous solution of a strong acid the dilution factor when changing the pH from 2 to 3 is equal to the dilution factor when changing the pH from 2 to 3 for an aqueous solution of a weak acid.	In a solution the concentration of $H^+(aq)$ must be diluted ten times to change the pH by one unit.
(47)	Ilmenite ($FeO.TiO_2$) is used as a key raw material in the chloride process for the production of titanium dioxide.	In the first step of the production process, $TiCl_4(l)$ is obtained as a main product.
(48)	Ethyne is more reactive towards electrophilic addition reactions than ethene	The electron density of ethyne is greater than that of ethene
(49)	HNO_3 act as both reducing agent as well as an oxidising agent.	N is in its highest oxidation state in HNO_3
(50)	Oxygen gas absorbs UV rays to give atomic oxygen as follows. $O_2(g) \xrightarrow{uv} O(g) + O(g)$	Oxygen is a greenhouse gas



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Department of Education - Western Province

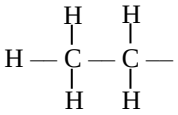
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General Certificate of Education (Adv. Level) Exam, November 2025 Supportive Seminar Paper

රසායන විද්‍යාව II Chemistry II	**02**	**E**	**II**	**13** ශ්‍රේණිය **Grade 13**	*පැය තුනයි* ***Three hours***

Index number : – .....

Extra reading time
10 minutes

- Periodic table is provided.
- **Use of calculators is not allowed**.
- Universal gas constant $R = 8.314\ JK^{-1}\ mol^{-1}$
- Avagadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$
- **In answering the paper, you may represent alkyl groups in a condensed manner.**

Example : –  group can be represented as CH_3CH_2 –

❑ PART A – Structured Essay (pages 02 – 09)

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

❑ PART B and PART C - Essay (pages 10 – 18)

- *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

Do not write anything in this column

Part A - Structure and essay

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

01. (a) Write on the dotted lines, whether the following statements are **true** or **false**.

(i) Among all the elements in the periodic table, F has the most negative electron-gaining energy .....

(ii) Li salts give crimson-red for the flame test .....

(iii) The decomposition of $(NH_4)_2CO_3$ produces a white powder .....

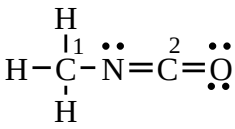
(iv) HCOONa(aq) is act as a buffer solution .....

(v) $Cl_2BrO_2^+$ ion is tetrahedral in shape .....

(vi) As the nuclear charge of isoelectronic ions increases, the ionic radius decreases .....

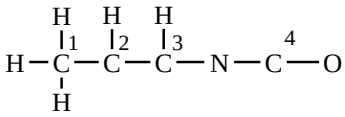
(24 marks)

(b) (i) State the shape around the atoms marked C^1, N, and C^2 in the structure shown below and their valence in the table.



Atom	Shape around the atom	Valence
C^1		
N		
C^2		

(ii) Draw the most acceptable Lewis dot–dash structure for molecule C_4H_5NO. Its template is shown below.



(iii) Draw two more Lewis dot-cross (resonance) structures that can be drawn for the stable Lewis structure drawn in (ii) above.

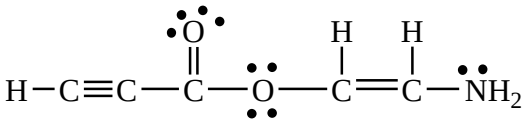
Identify whether the structures you drew are **unstable** or **stable** and indicate that under each structure.

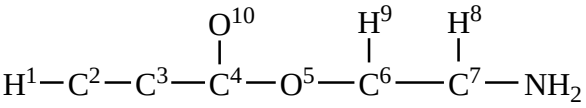
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(iv) Complete the given table based on the following Lewis dot-cross structure and its labeled skeleton.





		C^2	C^4	O^5	N
I	Number of VSEPR pairs around the atom				
II	Electron pair geometry around the atom				
III	shape around the atom				
IV	Hybridization of the atom				
V	The oxidation number of the atom				

- Parts (v) to (viii), based on the Lewis dotted line structure given in part (iv) above. Atom labeling is the same as in part (iv).

(v) Identify the atomic/bond orbitals involved in the formation of σ bonds between the following two atoms.

I	$H^1 - C^2$	H^1	.....	C^2	.....
II	$C^2 - C^3$	C^2	.....	C^3	.....
III	$C^3 - C^4$	C^3	.....	C^4	.....
IV	$C^4 - O^5$	C^4	.....	O^5	.....
V	$O^5 - C^6$	O^5	.....	C^6	.....
VI	C^7 - N	C^7	.....	N	.....

(vi) Identify the atomic/bond orbitals involved in the formation of π bonds between the following two atoms.

I	$C^2 - C^3$	C^2	.....	C^3	.....
		C^2	.....	C^3	.....
II	$C^4 - O^{10}$	C^4	.....	O^{10}	.....
III	$C^6 - C^7$	C^6	.....	C^7	.....

(vii) State the approximate bond angles around the C^2, C^4, O^5 and N atoms.

C^2 ..... , C^4..... , O^5 ..... , N.....

(viii) Arrange the O^5, C^2 C^6 and N atoms in order of increasing electronegativity.

..... < ..... <..... <.....

(54 marks)

Do not write anything in this column

(c) The Rydberg equation gives the wavelength of light emitted when electrons move between energy levels in an atom. The Rydberg equation for hydrogen is shown below.

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

λ = Wave length of the photon n_1 = Initial energy level
n_2 = Final energy level R_H = Rydberg constant
$R_H = 1.097 \times 10^7\ m^{-1}$

(i) Find the wavelength in nano meters of the photon emitted when an electron moves from the fourth energy level to the second energy level in a Hydrogen atom.

Clue -: $(1.097\times10^7 \times 0.1875)^{-1} = 4.86 \times 10^{-7}$

(ii) An electron in the Hydrogen atom falls from a certain energy level to another certain energy level by emitting a radiation with wavelength (λ) = 1.025×10^{-7} m. This transition falls into Lyman series, Find the initial energy level of the electron.

Clue -: $(1.025)^{-1} = 0.9756,\ \left(\frac{0.9756}{1.097}\right) = 0.889,\ (9)^{-1} = 0.111$

100

(22 marks)

02. (a) X, Y and Z are three elements belonging to p block which are non-gaseous at room temperature and, having atomic number **less than 20**, existing as allotropic forms in nature Only a common allotropic form (A) of element X conducts electricity. Only chlorides of elements Y and Z undergo hydrolysis, and chloride of Z hydrolyzes to give a cloudy solution and a gas (B) with a pungent smell that decolorizes the color of an acidified $K_2Cr_2O_7$ solution. Element Z undergoes disproportionation when reacted with dilute NaOH. Element Y reacts with dilute NaOH to give a colorless gas with a pyramidal shape and a sodium salt in which the ratio of H, Y and O atoms is 2:1:2 respectively.

(i) Identify the elements X, Y and Z

X – ……. Y – ……. Z – …….

(ii) Identify the allotropic form A and name another common allotropic form of element X

A – ……. Allotropic form – …….

(iii) Draw a sketch for the atomic arrangement of A and explain why A conducts electricity with the aid of its atomic structure.

……..……...

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(iv) Write the balanced chemical equations for the hydrolysis of chlorides of elements Y and Z.

Y- With less amount of water ……

Y- With excess amount of water ……

Z- ……

(v) Write the balanced chemical equations for the reaction between B gas and acidified $K_2Cr_2O_7$ solution

……

(vi) Write the balanced chemical equations for the reaction between dil.NaOH solution and element Y and Z

Y- ……

Z- ……

(50 marks)

(b) The experiments and their observations on salt **A** are shown in the table below

	Experiment	Observation
I	$BaCl_2$ (aq) was added to the aqueous solution containing salt **A**	Obtained the white precipitate **B**, which is insoluble in HNO_3
II	NaOH (aq) was added to the aqueous solution containing **A**	A white precipitate, **C**, was formed which turned blackish brown precipitate **D** when kept in air
III	H_2S (g) was added to the alkalized aqueous solution containing **A**.	Obtained a pinkish **E** precipitate, which is soluble in dilute HNO_3.

(i) Identify the compounds A, B, C, D, and E.

A – …… B – …… C – ……

D – …… E – ……

(ii) Salt A is used for a common test for quantitative analysis under alkaline conditions. What is the relevant test and the purpose of performing the test?

Test – ……

Purpose – ……

(iii) Write balanced chemical equations for each reaction **I** to **III** above

I ……

II Obtaining a white precipitate ……

Turned blackish brown when kept in air ……

III Obtaining a pinkish precipitate ……

Do not write anything in this column

(iv) Give the chemical formulae of five oxides of metal **A** and write the nature of each of the oxides as basic, weakly basic, amphoteric, weakly acidic and acidic

oxide	nature of oxide

oxides	nature of oxide

100

(50 marks)

03. (a) Dissolve 5 g of a solid sample containing NaOH and Na_2CO_3 in pure hot water to make a 100 cm^3 solution. 25.00 cm^3 of that solution was titrated with 1.0 $moldm^{-3}$ HCl solution with phenolphthalein as an indicator and the burette reading was observed as 20.00 cm^3 . Another volume of 25.00 cm^3 of the above solution was titrated with 1.0 $moldm^{-3}$ HCl solution using methyl orange as an indicator and obtained burette reading was 25.00 cm^3 .

(i) Write the balanced chemical equations for the reaction that take place in the first titration.

(ii) Write all the balanced equations for the reactions taking place in the second titration

(iii) What is the difference between the two burette readings in two titrations?

(iv) What can you calculate from the volume of HCl in question (iii) above

(v) Calculate the mass percentages of NaOH and Na_2CO_3 present in the mixture

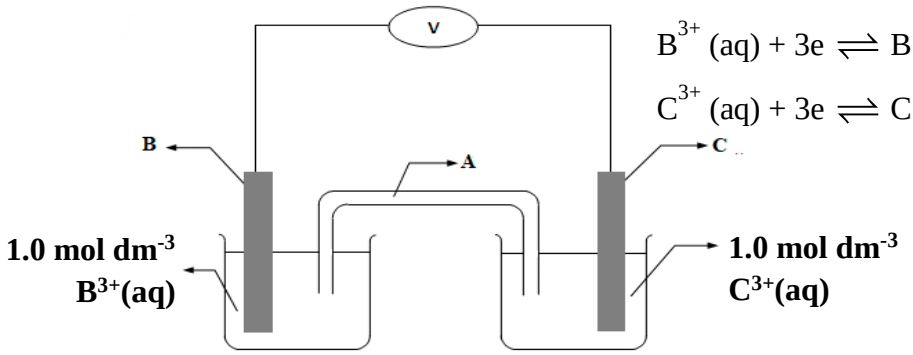
(vi) Sketch graph for the change in pH of the solution with the volume of HCl in the titration

(50 marks)

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(b) Following diagram shows a galvanic cell kept at 25 ^{o}C and 1 atm pressure consist of half cells B and C. The relevant reduction potential values are given. Answer the questions given below.



B^{3+} (aq) + 3e $\rightleftharpoons$ B (s) E^{o} = – 0.20 V

C^{3+} (aq) + 3e $\rightleftharpoons$ C (s) E^{o} = – 0.40 V

(i) Identify the component A and state two primary functions of A .

A -

Primary functions of A

(ii) Among the following chemicals, identify the most suitable chemical to be used for A. Mention reasons for rejection of each other chemicals. Comment on the conductivity of cation and anion your chosen chemical. (Note that the chloride salts of B and C are used to construct half-cells B and C).

List of chemicals –: $AgNO_3$ (aq) / CH_3COOH(aq) / KNO_3 (aq) / $NaNO_3$(aq)

Salt	Suitable / not suitable	reason
$AgNO_3$ (aq)		
CH_3COOH(aq)		
KNO_3 (aq)		
$NaNO_3$(aq)		

(iii) Identify the cathode and the anode of the above cell.

Anode –

Cathode –

(iv) Determine the direction of the current flow in the cell if the both ends are connected from a conducting wire.

(v) Calculate the electromotive force of the cell.

(vi) The relationship between Gibbs free energy and standard cell potential (E^{0}_{cell}) is given by the following equation.

$\Delta G^{0} = - nFE^{0}_{cell}$

n = number of moles of electrons participating

F = Faraday constant (96500 C)

Calculate ΔG^{0} for the cell using the above relationship

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(vii) Complete the following table by using the terms **positive, negative spontaneous** and **non – spontaneous**

	Sign of E^0_{cell}	Spontaneity of the reaction
Galvanic cell		
Electrolytic cell		

(50 marks)

100

04. (a) A, B, and C are structural isomers with the formula $C_5H_{11}Br$. All three isomers show optical isomerism. A, B, C give D, E, F respectively as main products when reacted with alcoholic KOH. Only D shows diastereomerism. E and F give the same compound G when reacted with HBr. Compound G is a structural isomer of A, B, and C. Compound G is optically inactive. B and C give H and I respectively when reacted with dil.NaOH. H and I reacts with PCC to give J and K. only K decolorizes the colour of $H^+/KMnO_4$ solution to give compound L.

(i) Identify the structures of A, B, C, D, E, F, G, H, I, J, K and L and draw them in the corresponding boxes given below.

A B C

D E F

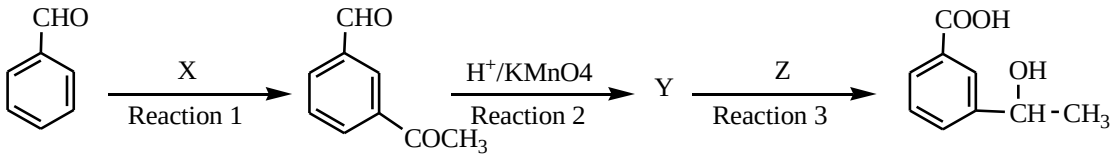
G H I

J K L

(ii) What is the colour change you observed on the reaction of K with $H^+/KMnO_4$

…… **(50 marks)**

(b) Write the structure of Y and the reaction conditions of X and Z in the appropriate boxes with respect to the following conversion.



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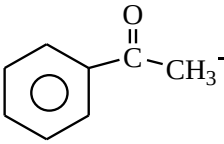
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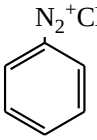
X Y Z

(12 marks)

(c) Draw the products given in each reaction below in the corresponding box.

1. $H_3C-\overset{\overset{O}{\|}}{C}-Cl$ $\xrightarrow{C_2H_5NH_2}$ [ ]

2.  $\xrightarrow{2,4\text{-DNP}}$ [ ]

3.  $\xrightarrow[NaOH]{C_6H_5OH}$ [ ]

(15 marks)

(c) State whether the following reaction takes place. If so then give the product. If the reaction does not happens then give the reasons.

$H_3C-\overset{\overset{O}{\|}}{C}-NH_2$ $\xrightarrow{C_2H_5Cl}$

(08 marks)

(d) Write the product obtained in the following reaction and write its mechanism.

$CH_3CH=CH_2 \xrightarrow{HBr}$

(20 marks)

100

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மேல் மாகாணக் கல்வித் திணைக்களம்
Department of Education - Western Province

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය **2025** නොවැම්බර් උපකාරක ප්‍රශ්න පත්‍රය
General Certificate of Education (Adv. Level) Exam, November 2025 Supportive Seminar Paper

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Chemistry II

02 **E** **II**

13 ශ්‍රේණිය
Grade 13

Universal gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$	Plank constant	$h = 6.626 \times 10^{-34}\ J\ s$
Avogadro constant	$N_A = 6.022 \times 10^{23}\ mol^{-1}$	speed of light	$c = 3 \times 10^{8}\ m\ s^{-1}$

PART B – ESSAY

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

5) (a) (i) Write the appropriate chemical reactions for the following enthalpy changes.

a) Enthalpy of formation of water at 80 ^{0}C - 300 kJ mol^{-1}

b) Enthalpy of combustion of $CH_4(g)$ at 80 ^{0}C - 800 kJ mol^{-1}

c) Standard enthalpy of vaporization of water + 42 kJ mol^{-1}

d) Standard enthalpy of formation of $CO_2(g)$ - 400 kJ mol^{-1}

(ii) $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$ $\Delta H_{rxn} = +125$ kJ mol^{-1} is given.

In the presence of sunlight and the presence of catalyst X, the following reaction takes place.

$$CH_4(g) + CO_2(g) \xrightarrow[uv]{X} 2CO(g) + 2\ H_2(g) \text{ -------①}$$

Based on the data provided in part (i) above and the given data, find the enthalpy change of reaction ① algebraic method (addition of equations) or by any other suitable method

(40 marks)

(b) I_2 is more soluble in $CHCl_3$ than in water. The distribution coefficient of I_2 between $CHCl_3$ and water at 175 ^{0}C is 90. 500 cm^3 of an aqueous solution containing 0.30 g of I_2 is extracted with 50 cm^3 of $CHCl_3$. (I – 127)

i) Write down the mathematical expression for the distribution co – efficient of I_2 between $CHCl_3$ and water at 175 ^{0}C.

ii) What is the amount of I_2 remaining in the water as a fraction from the initial amount, after the first extraction

iii) Calculate after how many times of extraction 99% of the I_2 in water is converted to $CHCl_3$ in the above extraction.

(50 marks)

(c) i. Write down a mathematical expression for the solubility product of $Ag_2CrO_4(s)$ at 25^0C.

ii. If the molar solubility of $Ag_2CrO_4(s)$ at 25^0C is 1×10^{-4} mol dm^{-3} then calculate the solubility product of $Ag_2CrO_4(s)$ at 25^0C.

iii. The following was carried out in a volume of 250 cm^3 of a saturated aqueous solution prepared by dissolving solid $Ag_2CrO_4(s)$ Note whether the free $Ag^+(aq)$ ion concentration in the medium decreases, increases or remains the same in each of those cases and calculate the new $Ag^+(aq)$ ion concentration if there is a change.

I. 250 cm^3 of NaCl(aq) solution of concentration 2 mol dm^{-3} was added
(The solubility product of AgCl(s) at 25 ^0C is $1x10^{-10}$ mol^2 dm^{-6})

II. 250 cm^3 of $AgNO_3(aq)$ solution of concentration 2 mol dm^{-3} was added

III. 250 cm^3 of $Na_2CrO_4(aq)$ solution of concentration 2 mol dm^{-3} was added.

iv. If Ag_2CrO_4 (s) precipitates in (III) above, calculate the amount of Ag_2CrO_4 (s) moles precipitated.

(60 marks)

6) (a) 25.00 cm^3 of a solution Q containing a monobasic weak acid HA and strong acid HNO_3 at 25^0C is titrated with a KOH solution of concentration 0.1 mol dm^{-3}. The pH of the medium was measured at several times and the pH values and the volume of base added are shown in the table below.

Volume of KOH(aq) / cm^3	pH
0	1.40
5	1.78
10	3.00
20	4.70
25	5.00
30	4.30
40	8.83

The first equivalence point of the titration was obtained when 10 cm^3 of KOH solution was added and the second equivalence point was recorded when the volume of KOH solution added was 40 cm^3. Calculate the following based on the above data.

(i) Calculate the concentrations of HNO_3 and HA acids in the initial Q solution.

(ii) The dissociation constant (Ka) of weak acid at 25 ^0C

(iii) Confirm by suitable calculation that the initial pH of solution Q is 1.4

(iv) Verify by suitable calculation that the pH of solution Q is 3.0 at the first equilibrium point.

(v) Verify by suitable calculation that the pH of solution Q is 8.8 at the second equilibrium point.

$\sqrt{(3/65)\times10^{-9}} = 6.79\times10^{-6}, \log\left(6.79\times10^{-6}\right) = 5.17$

(vi) State whether the above solution Q behaves as a buffer when the volume of KOH solution added is 25 cm^3.

(70 marks)

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(b) A reaction mechanism is shown below. k_1 , k_2 and k_3 are rate constants.

$$NO(g) + O_2(g) \underset{k_2}{\overset{k_1}{\rightleftharpoons}} NO_3(g) \quad \text{(fast)}$$

$$NO_3(g) + NO(g) \xrightarrow{k_3} 2NO_2(g) \quad \text{(slow)}$$

i) Obtain the overall reaction for the above mechanism.

ii) Write the rate equation for the reaction you obtained in (i) considering the above reaction mechanism. Name the symbols you obtained.

iii) State whether NO_3 in the above reaction is a catalyst or an intermediate give reasons

iv) Find the respective order of each reactant in the reaction using the fastest reaction and find the overall order of the reaction.

v) Draw the appropriate energy profile for the above reaction mechanism using reaction coordinate for X axis and energy for Y axis.

(40 marks)

(c) Below is the equation for the decomposition of compound A at temperatures above 400 ^{0}C. The reaction is first order with respect to A

$$A(g) \rightarrow 2B(g) + O_2(g)$$

The initial concentration of A(g) is 2 mol dm^{-3} and becomes half of that concentration in 5 minutes.

i. Show that the number of half-lives (n) required for the concentration of A(g) in the above reaction to decrease to α% of the initial concentration is $2^n = \frac{100}{\alpha}$.

ii. What is the time taken for the concentration of A(g) in the above reaction to decrease to 83.75% of the initial concentration?

Clue – : $\left(\frac{100}{85}\right) = 1.19$, $\log(1.19) = 0.0776$, $\left(\frac{0.0776}{0.3010}\right) = 0.258$

(40 marks)

7) (a) Consider an electrochemical cell made up using a standard aluminium electrode with standard oxygen electrode at 400 K. When there is a current flow across the electrodes,

$E^{\theta}_{O_2(g)/OH^-(aq)}$ = 0.40 V $\qquad$ $E^{\theta}_{Al^{3+}(aq)/Al(s)}$ = – 1.66 V

(1F = 96500 C mol^{-1}, Al = 27 g mol^{-1},O_2 = 16 g mol^{-1}, H = 1 g mol^{-1})

(i) Write down the anode and the cathode standard half–reactions

(ii) Write the overall cell reaction

(iii) Calculate the standard cell potential E^{θ}_{cell} of the cell at 400 K

(iv) (I) At 400 K if 2.5 moles of electrons passing through the cell in 400 s then how many moles of oxygen are consumed?

(II) Calculate the reduced mass of the anode

(III) Calculate the current passing through the cell

(v) Briefly explain how the e.m.f of the cell changes in each of the following situations.

I. Increasing the partial pressure of O_2

II. Increasing the temperature

(75 marks)

(b) A, B, and C are three 3d transition elements. Their sulphates are ASO_4, BSO_4, and CSO_4. Aqueous solutions of these form D, E, and F colored complex ions, respectively. When concentrated ammonia and concentrated HCl were added in excess separately to the aqueous solutions D, E, and F, the following observations were obtained.

Solution	Conc. NH_3(aq)	Conc. HCl(aq)
D	Yellow brown solution (P)	Blue colored solution (Q)
E	Dark blue solution (R)	Yellow colored solution (S)
F	Dark blue solution (T)	Yellow colored solution (U)

Aqueous solutions of E and F were taken separately, dilute HCl was added and H_2S was bubbled into those solutions. Only E gave a black precipitate.

(i) Identify the elements A, B and C.

(ii) Write the electronic configuration of the cations in A, B, and C sulphates

(iii) Write the chemical formulas of the complex ions in solutions D, E, and F

(iv) Write the chemical formulas of the complex ions related to the colors of P, Q, R, S, T, and U solutions.

(v) Write the IUPAC names of P, Q, R, and S complex ions.

(vi) (I) Write a chemical test and observation that is not mentioned here.to chemically identify the cation of C in a mixture of aqueous solutions of BSO_4 and CSO_4.

(II) Write a chemical test and observations to verify sulphate ions in the mixture.

(vii) There is a difference in the addition of conc. HCl to solutions E and F. Explain it. Use the chemical formulas of the chemical compounds obtained when conc.HCl is added to explain your answer.

(75 marks)

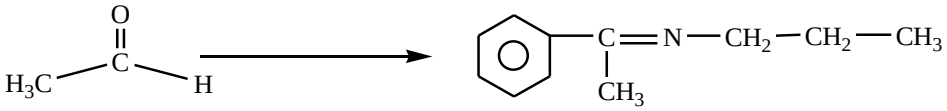
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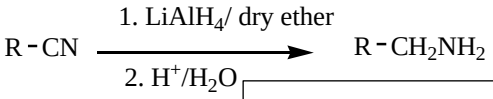
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PART C – ESSAY

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

08. **(a)** (i) Using only the chemicals given in the list, Show how would you carry out the following conversion.





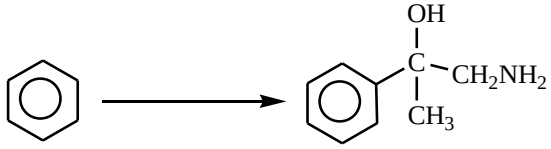
Hint :- Consider that

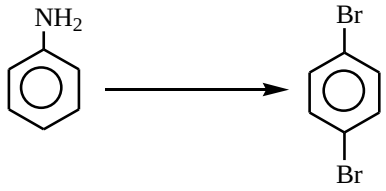
List of chemicals

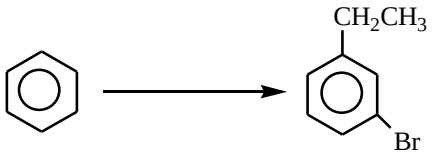
C_6H_6, $H^+/ KMnO_4$, Anhydrous $AlCl_3$, $LiAlH_4$, H^+/H_2O, dry ether. PCl_3 Alcoholic. Aqueous KCN

(55 marks)

(b) Show how the following conversion would be carried out in **not more than three** steps.

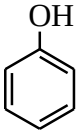
1. 

2. 

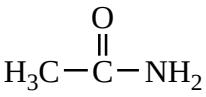
3. 

(45 marks)

(c) Explain the following expressions.

(i) 

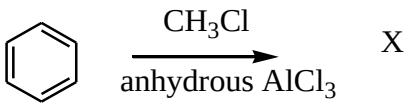
is more acidic as compared to C_2H_5OH

(ii) 

is less basic as compared to $CH_3CH_2NH_2$.

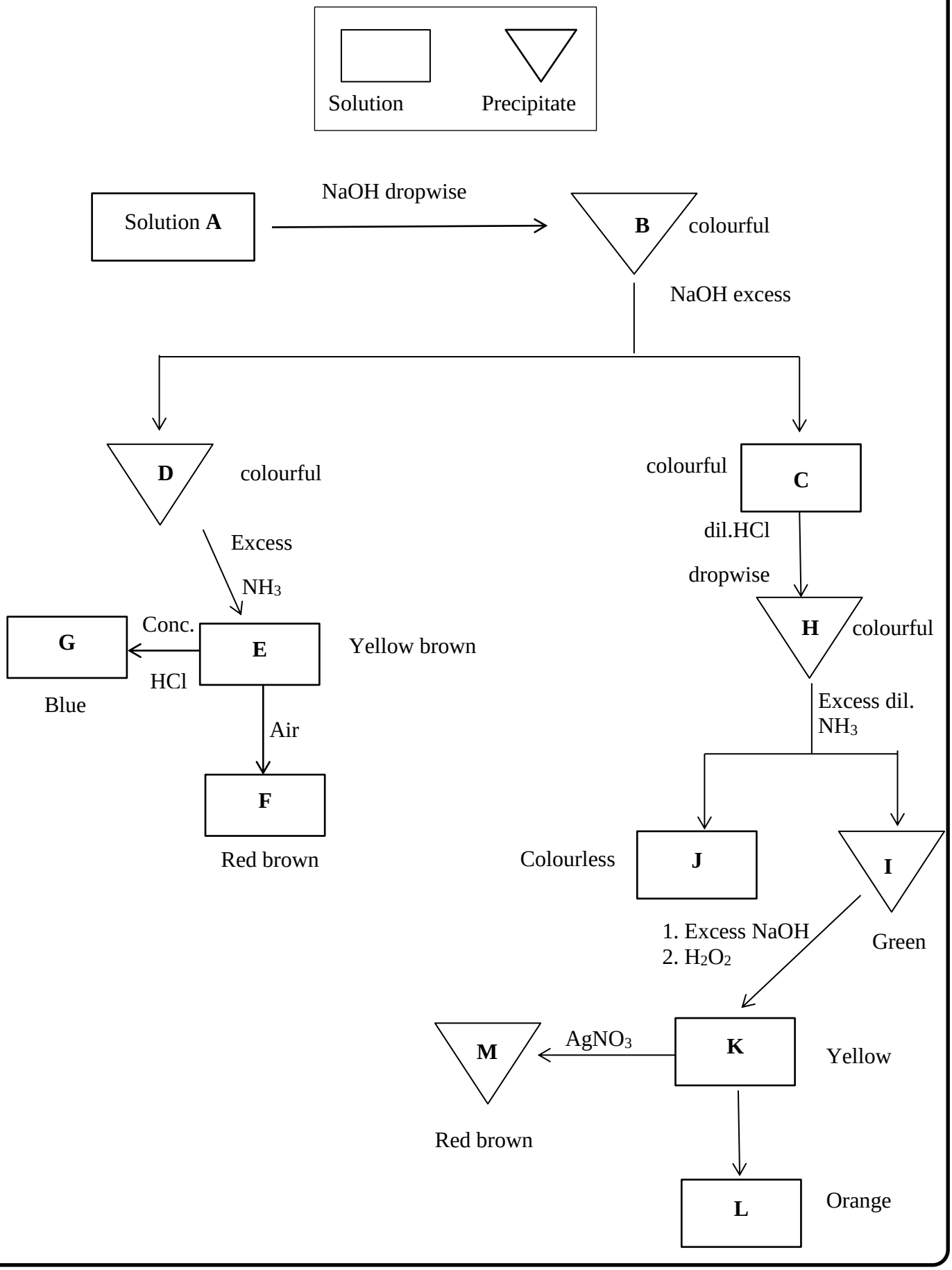
(20 marks)

(d) Write the structure of X of the following reaction and state the mechanism for the given reaction



(30 marks)

09.(a) Colored solution A contains three cations. Answer the following questions related to the series of reactions given below. (The symbols in the box represent solutions and precipitates.).



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(i) Identify the three cations present in solution A.

(ii) Write the chemical formulas of the compounds in colored precipitate B.

(iii) Identify the species responsible for the colour of solution C and state its colour.

(iv) Write the chemical formulas of the substances shown D to M.

(v) Write the balanced chemical equation for the reaction involved in converting I to K.

(vi) Give a suitable reagent to convert K to L

(75 marks)

(b) A sample of hematite ore (Fe_2O_3) containing some amount of the inert material Fe_3O_4 was analyzed using the following procedure to determine its purity.

A 10.00 g sample of ore was treated in an acidic medium with 50 cm^3 of excess aqueous KI to convert all of its iron to Fe^{2+}. The solution was then diluted to 100 cm^3. When 25.00 cm^3 of the diluted solution was titrated with 1.00 mol dm^{-3} $Na_2S_2O_3$, a volume of 24.00 cm^3 was required to reach the endpoint. Another portion of 25.00 cm^3 of the diluted solution was shaken well with CCl_4 to remove iodine completely and then titrated with 1.00 mol dm^{-3} $KMnO_4$ solution. The end point was reached with addition of 5.20 cm^3 of $KMnO_4$ solution.

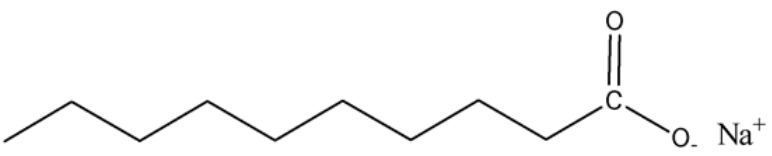
A sample contains $(NH_4)_2SO_4$ and PCl_5 and is contaminated with an inert substance X. Solution P was prepared by dissolving 3 g of the solid mixture in 250 cm^3 of distilled water. Then, 100 cm^3 of the P solution was added with 0.2 mol dm^{-3} $Ba(OH)_2$ solution and mixed thoroughly until no more gas was evolved. Then, the evolved gas was passed through 50 cm^3 of 0.4 mol dm^{-3} HCl solution and the HCl solution was titrated with the above $Ba(OH)_2$ solution to determine the amount of unreacted HCl. Then, the volume of $Ba(OH)_2$ consumed was 30 cm^3. The dry mass of the precipitate obtained by adding $Ba(OH)_2$ to the above P solution is 2.134 g.. (Ba = 137, H = 1, N = 14, O = 16, Na= 23, P = 31, S =32, Cl = 35.5)

(i) Identify the species that hydrolyzes when the sample is dissolved in water and give the balanced equation for its hydrolysis.

(ii) Find the mass percentages of $(NH_4)_2SO_4$ and PCl_5 in the sample separately.

(75 marks)

10. (a) Given below is the chemical structure of the main product of one of the main chemical industries you have studied. Answer the following questions based on the particular industry



i. Name two raw materials used in that chemical industry.

ii. What is the main difference between hot process and cold process used in that chemical industry?

iii. Name the 4 main steps that take place in this chemical industry.

iv. Mention the names of 4 saturated fatty acids and an unsaturated fatty acid mainly contained in coconut oil

v. State why the raw materials used in this manufacturing process are first passed over a type of clay called activated fuller's earth.

vi. There are two manufacturing processes namely continuous process and batch process and which process is traditionally used in the above industry?

vii. Write down the main reaction that occurs in step 1 of the above industry.

viii. In step 2, a concentrated brine solution is added to increase the efficiency of the product. Explain the process that takes place there in terms of physio-chemical principles.

ix. In addition to the raw materials used for this process, one more raw material is used to produce a product that is presented as an alternative solution to the modern energy crisis. Identify the raw materials used and the product produced. Mention a natural form and a synthetic form of obtaining that raw materials.

(i) Name the compound that acts as a catalyst in this manufacturing process and is used as a key ingredient in the industry you mentioned in part (ix) above.

(50 marks)

(b) Below is a table showing the Global Warming Potentials (GWP) of several greenhouse gases and their lifetimes in the atmosphere.

Gas	Global Warming Potential GWP	lifetime in the atmosphere (Yrs)
CO_2	1	300 – 1000
CH_4	22	7 – 12
N_2O	310	14 – 128
CHF_3 (HFC 23)	11700	222
CH_2F_2 (HFC 32)	675	5.2
CH_2FCF_3 (HFC 134a)	1300	13.8
CCl_2F_2 (CFC 12)	10600	140
$CHClF_2$ (HCFC 22)	1700	12.1

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1. What is a greenhouse gas?
2. Statement I – "O_3 is not a greenhouse gas as it is an Homo – atomic molecule"
   Statement II –"SO_2 is a gas of non-zero dipole moment. As such, it is a greenhouse gas".
   Do you agree with the above 2 statements or not? Give reasons.
3. CFC gases are a direct contributor to the depletion of the ozone layer. Explain with suitable reactions how ozone layer is damaged by CFC gases.
4. HCFC gases were first proposed as a remedy for this ozone layer depletion. So what is the main structural difference between HCFC gases and CFC gases?
5. State the reason why HCFC gases, which were proposed as a remedy for ozone layer depletion, failed.
6. Based on the data in the table provided above, which of the gases HFC 23 and HFC 134a is most favorable for ozone depletion? Give reasons
7. Although HFC gases are the ideal remedy for ozone depletion, what are the side effects of these gases on environment?

(50 marks)

(c) Using only the following compounds, identify the polymer corresponding to the given characteristic and state the corresponding structure and monomer in the table below. Copy the table in your answer sheet.

Compounds -:

CH_2CH_2, C_6H_5OH, $H_2NCH_2CH_2CH_2CH_2NH_2$, CH_2O, $CH_2=C(CH_3)CH=CH_2$, $HO\text{-}(C_6H_4)\text{-}OH$, $HOOCCH_2CH_2CH_2CH_2COOH$

Property	Structure of the monomer	Structure of the polymer
A synthetic, linear condensation polymer.		
A thermoplastic additional polymer.		
A thermosetting condensational polymer.		
An additional polymer with elastic properties.		
A synthetic, linear condensational polymer used in container and packaging applications.		

(50 marks)

***

1												13	14	15	16	17	18
1 **H** 1.008	2																2 **He** 4.0026
3 **Li** 6.94	4 **Be** 9.0122											5 **B** 10.81	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305	3	4	5	6	7	8	9	10	11	12	13 **Al** 26.982	14 **Si** 28.085	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.723	32 **Ge** 72.630	33 **As** 74.922	34 **Se** 78.97	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.95	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71 *	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89-103 #	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (280)	112 **Cn** (285)	113 **Nh** (286)	114 **Fl** (289)	115 **Mc** (289)	116 **Lv** (293)	117 **Ts** (294)	118 **Og** (294)

* Lanthanide series	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
# Actinide series	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

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Department of Education - Western Province

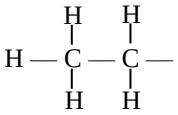
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General Certificate of Education (Adv. Level) Exam, November 2025 Supportive Seminar Paper

රසායන විද්‍යාව II Chemistry II	**02**	**E**	**II**	**13** ශ්‍රේණිය **Grade 13**	*පැය තුනයි* ***Three hours***

Index number : – .....

Extra reading time
10 minutes

- Periodic table is provided.
- **Use of calculators is not allowed**.
- Universal gas constant $R = 8.314\ JK^{-1}\ mol^{-1}$
- Avagadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$
- **In answering the paper, you may represent alkyl groups in a condensed manner.**

Example : –  group can be represented as CH_3CH_2 –

❑ PART A – Structured Essay (pages 02 – 09)

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

❑ PART B and PART C - Essay (pages 10 – 18)

- *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

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Part A - Structure and essay

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

01. (a) Write on the dotted lines, whether the following statements are **true** or **false**.

(i) Among all the elements in the periodic table, F has the most negative electron-gaining energy **False**

(ii) Li salts give crimson-red for the flame test **True**

(iii) The decomposition of $(NH_4)_2CO_3$ produces a white powder **False**

(iv) HCOONa(aq) is act as a buffer solution **False**

(v) $Cl_2BrO_2^+$ ion is tetrahedral in shape **True**

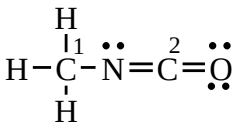
(vi) As the nuclear charge of isoelectronic ions increases, the ionic radius decreases **True**

*** If (T or F) or (√ or X) written instead of True or false in word deduct 1 mark each**

(4x6=24 marks)

24

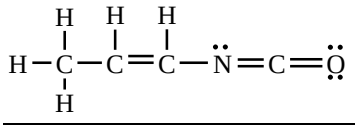
(b) (i) State the shape around the atoms marked C^1, N, and C^2 in the structure shown below and their valence in the table.



Atom	Shape around the atom	Valence
C^1	**Tetrahedral**	**4**
N	**Bent / V shape/ Angular**	**3**
C^2	**Linear**	**4**

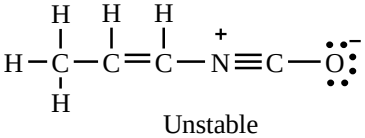
If + or – written for valance no marks **(1x6 = 6 marks)**

(ii) Draw the most acceptable Lewis dot–dash structure for molecule C_4H_5NO. Its template is shown below.

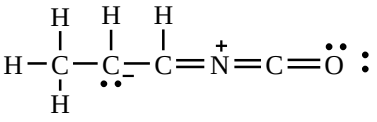


(iii) Draw two more Lewis dot-cross (resonance) structures that can be drawn for the stable Lewis structure drawn in (ii) above.

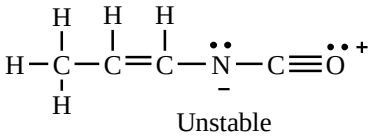
Identify whether the structures you drew are **unstable** or **stable** and indicate that under each structure.



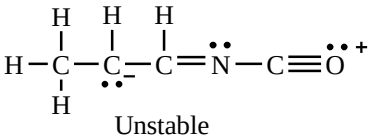
Unstable



Unstable



Unstable



Unstable

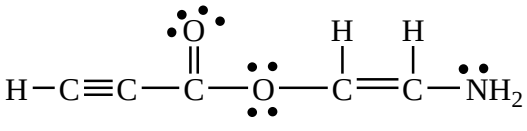
Any 2 structures (2+1) x 2 = 6

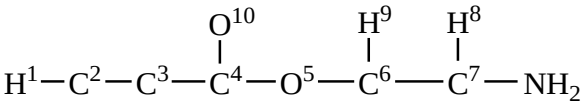
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(iv) Complete the given table based on the following Lewis dot-cross structure and its labeled skeleton.





		C^2	C^4	O^5	N
I	Number of VSEPR pairs around the atom	**2**	**3**	**4**	**4**
II	Electron pair geometry around the atom	**Linear**	**Trigonal planner**	**Tetrahedral**	**Tetrahedral**
III	shape around the atom	**Linear**	**Trigonal planner**	**Bent / V shape/ Angular**	**Pyramidal**
IV	Hybridization of the atom	**sp**	**sp^2**	**sp^3**	**sp^3**
V	The oxidation number of the atom	**-1**	**+3**	**-2**	**-3**

(1x20 = 20 marks)

- Parts (v) to (viii), based on the Lewis dotted line structure given in part (iv) above. Atom labeling is the same as in part (iv).

(v) Identify the atomic/bond orbitals involved in the formation of σ bonds between the following two atoms.

I	$H^1 - C^2$	H^1	**1s * no marks for s only**	C^2	sp
II	$C^2 - C^3$	C^2	sp	C^3	sp
III	$C^3 - C^4$	C^3	sp	C^4	sp^2
IV	$C^4 - O^5$	C^4	sp^2	O^5	sp^3 **no marks for 2p**
V	$O^5 - C^6$	O^5	sp^3	C^6	sp^2
VI	C^7 - N	C^7	sp^2	N	sp^3

*** No marks for sp_2 or sp_3 deduct maximum 5 marks from total for wrong representation of the symbol** **(1x12 = 12 marks)**

(vi) Identify the atomic/bond orbitals involved in the formation of π bonds between the following two atoms.

I	$C^2 - C^3$	C^2	2p	C^3	2p
		C^2	2p	C^3	2p
II	$C^4 - O^{10}$	C^4	2p	O^{10}	2p
III	$C^6 - C^7$	C^6	2p	C^7	2p

(1x8 = 8 marks)

(vii) State the approximate bond angles around the C^2, C^4, O^5 and N atoms.

C^2 **180^0** , C^4 **$120^0 \pm 1$** , O^5 **$104^0 \pm 1$**, N **$107^0 \pm 1$** **(1x4 = 4 marks)**

(viii) Arrange the O^5, C^2 C^6 and N atoms in order of increasing electronegativity.

$C^6 < C^2 < N < O^5$

(4 marks)

64

Do not write anything in this column

(c) The Rydberg equation gives the wavelength of light emitted when electrons move between energy levels in an atom. The Rydberg equation for hydrogen is shown below.

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

λ = Wave length of the photon n_1 = Initial energy level
n_2 = Final energy level R_H = Rydberg constant
$R_H = 1.097 \times 10^7\ m^{-1}$

(i) Find the wavelength in nano meters of the photon emitted when an electron moves from the fourth energy level to the second energy level in a Hydrogen atom.

Clue -: $(1.097\times10^7 \times 0.1875)^{-1} = 4.86 \times 10^{-7}$

$$\frac{1}{\lambda} = 1.097\times10^7\left[\frac{1}{2^2} - \frac{1}{4^2}\right] \quad (4\ marks)$$

$$\lambda = \left(1.097\times10^7 \times 0.1875\right)^{-1} = 486\ nm \quad (2\ marks)$$

(ii) An electron in the Hydrogen atom falls from a certain energy level to another certain energy level by emitting a radiation with wavelength (λ) = 1.025×10^{-7} m. This transition falls into Lyman series, Find the initial energy level of the electron.

Clue -: $(1.025)^{-1} = 0.9756,\ \left(\frac{0.9756}{1.097}\right) = 0.889,\ (9)^{-1} = 0.111$

$$\frac{1}{1.025\times10^{-7}} = 1.097\times10^7\left[\frac{1}{1} - \frac{1}{n^2}\right] \quad (4\ marks)$$

$$0.889 = \left(1 - \frac{1}{n^2}\right) \Rightarrow \frac{1}{n^2} = 0.111$$

$$n^2 = 9 \therefore n = 3 \quad (2\ marks)$$

12
100
100

02. (a) X, Y and Z are three elements belonging to p block which are non-gaseous at room temperature and, having atomic number **less than 20**, existing as allotropic forms in nature Only a common allotropic form (A) of element X conducts electricity. Only chlorides of elements Y and Z undergo hydrolysis, and chloride of Z hydrolyzes to give a cloudy solution and a gas (B) with a pungent smell that decolorizes the color of an acidified $K_2Cr_2O_7$ solution. Element Z undergoes disproportionation when reacted with dilute NaOH. Element Y reacts with dilute NaOH to give a colorless gas with a pyramidal shape and a sodium salt in which the ratio of H, Y and O atoms is 2:1:2 respectively.

(i) Identify the elements X, Y and Z

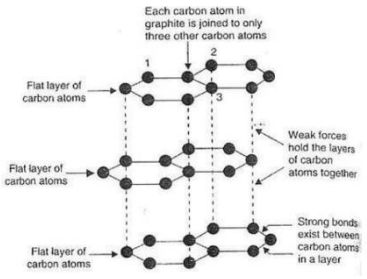
X – **C** Y – **P** Z – **S** **(5x3 = 15 marks)**

(ii) Identify the allotropic form A and name another common allotropic form of element X

A – **graphite** Allotropic form – **diamond / buck minster fullerene**
(3x2 = 6 marks)

(iii) Draw a sketch for the atomic arrangement of A and explain why A conducts electricity with the aid of its atomic structure.

Each carbon atom in **graphite is sp² hybridized**. Three of its four valence electrons form σ (sigma) bonds with neighboring carbon atoms in the same plane.
The fourth electron remains in a p orbital, which overlaps with neighboring p orbitals above and below the plane to form a delocalized π-electron cloud.
These delocalized electrons are free to move across the layers.
Therefore, graphite conducts electricity parallel to the layers due to the mobility of delocalized π-electrons.



(2 marks for diagram 2 marks for reason = 4 marks)

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(iv) Write the balanced chemical equations for the hydrolysis of chlorides of elements Y and Z.

Y- With less amount of water **$PCl_5 + H_2O \rightarrow POCl_3 + 2\ HCl$** **(3 marks)**

Y- With excess amount of water **$PCl_5 + 4\ H_2O \rightarrow H_3PO_4 + 5\ HCl$** **(3 marks)**

Z- **$SCl_2 + 2\ H_2O \rightarrow S + SO_2 + 4HCl$** **(3 marks)**

(v) Write the balanced chemical equations for the reaction between B gas and acidified $K_2Cr_2O_7$ solution

$H_2SO_4 + 3\ SO_2 + K_2Cr_2O_7 \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + H_2O$ **(5 marks)**

(vi) Write the balanced chemical equations for the reaction between dil.NaOH solution and element Y and Z

Y- **$3\ H_2O + 3\ NaOH + 4P \rightarrow 3\ NaH_2PO_2 + PH_3$** **(3 marks)**
{ $P \rightarrow PH_3$, $P \rightarrow H_2PO_2^-$ disproportionation}

Z- **$6\ NaOH + 3S \rightarrow 2\ Na_2S + Na_2S_2O_3 + 3\ H_2O$** **(3 marks)**

45

(b) The experiments and their observations on salt **A** are shown in the table below

	Experiment	Observation
I	$BaCl_2$ (aq) was added to the aqueous solution containing salt **A**	Obtained the white precipitate **B**, which is insoluble in HNO_3
II	NaOH (aq) was added to the aqueous solution containing **A**	A white precipitate, **C**, was formed which turned blackish brown precipitate **D** when kept in air
III	H_2S (g) was added to the alkalized aqueous solution containing **A**.	Obtained a pinkish **E** precipitate, which is soluble in dilute HNO_3.

(i) Identify the compounds A, B, C, D, and E.

A – **$MnSO_4$** B – **$BaSO_4$** C – **$Mn(OH)_2$**
D – **MnO_2** E – **MnS** **(4x5=20 marks)**

(ii) Salt A is used for a common test for quantitative analysis under alkaline conditions. What is the relevant test and the purpose of performing the test?

Test – **Winkler test** **(3 marks)**

Purpose – **detect dissolved Oxygen in a water sample** **(2 marks)**

(iii) Write balanced chemical equations for each reaction **I** to **III** above

I **$MnSO_4 + BaCl_2 \rightarrow MnCl_2 + BaSO_4 \downarrow$** **(5 marks)**

II Obtaining a white precipitate **$MnSO_4 + 2\ NaOH \rightarrow Na_2SO_4 + Mn(OH)_2$** **(5 marks)**

Turned blackish brown when kept in air **$2\ Mn(OH)_2 + O_2 \rightarrow 2\ MnO_2 + 2\ H_2O$** **(5 marks)**

III Obtaining a pinkish precipitate **$MnSO_4 + H_2S \rightarrow MnS + H_2SO_4$** **(5 marks)**

(iv) Give the chemical formulae of five oxides of metal **A** and write the nature of each of the oxides as basic, weakly basic, amphoteric, weakly acidic and acidic

oxide	nature of oxide
MnO	**Basic**
Mn_2O_3	**weakly basic**
MnO_2	**amphoteric**

oxides	nature of oxide
MnO_3	**weakly acidic**
Mn_2O_7	**acidic**

(1x10= 10 marks)

55

100
100

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03. (a) Dissolve 5 g of a solid sample containing NaOH and Na_2CO_3 in pure hot water to make a 100 cm^3 solution. 25.00 cm^3 of that solution was titrated with 1.0 $moldm^{-3}$ HCl solution with phenolphthalein as an indicator and the burette reading was observed as 20.00 cm^3 . Another volume of 25.00 cm^3 of the above solution was titrated with 1.0 $moldm^{-3}$ HCl solution using methyl orange as an indicator and obtained burette reading was 25.00 cm^3 .

(i) Write the balanced chemical equations for the reaction that take place in the first titration.

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
$Na_2CO_3(aq) + HCl(aq) \rightarrow NaHCO_3(aq) + H_2O(l)$ **(4x2=8 marks)**

(ii) Write all the balanced equations for the reactions taking place in the second titration

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
$Na_2CO_3(aq) + HCl(aq) \rightarrow NaHCO_3(aq) + H_2O(l)$
$NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$ **(4x3=12 marks)**

(iii) What is the difference between the two burette readings in two titrations?

5 cm^3 **(5 marks)**

(iv) What can you calculate from the volume of HCl in question (iii) above

The $NaHCO_3(aq)$ amount **(5 marks)**

(v) Calculate the mass percentages of NaOH and Na_2CO_3 present in the mixture

Let x be the moles of NaOH and y be the moles of Na_2CO_3

$for\,25cm^3$

$$x + y = \frac{1}{1000} \times 20$$

$$x + 2y = \frac{1}{1000} \times 20$$

$$\therefore y = \frac{5}{1000}, x = \frac{15}{1000} (5 marks)$$

$for\,100cm^3$

$$y = \frac{20}{1000}, x = \frac{60}{1000}$$

$mass\%of\ NaOH$

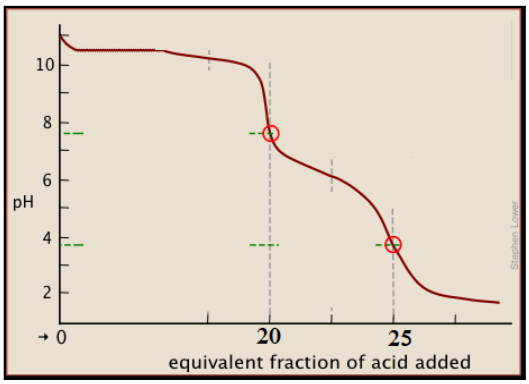
$$\frac{60}{1000} \times 40 \times \frac{100}{5} = 48\% (5\,marks)$$

$mass\%of\ Na_2CO_3$

$$\frac{20}{1000} \times 84 \times \frac{100}{5} = 34.4\%$$

$(5\,marks)$

(vi) Sketch graph for the change in pH of the solution with the volume of HCl in the titration



First eq point between pH 8-10 = 1 mark
2nd eq point less t han pH 7 = 1 mark
Correct two axis = 1x2 = 2 marks
Shape of the curve = 1 mark

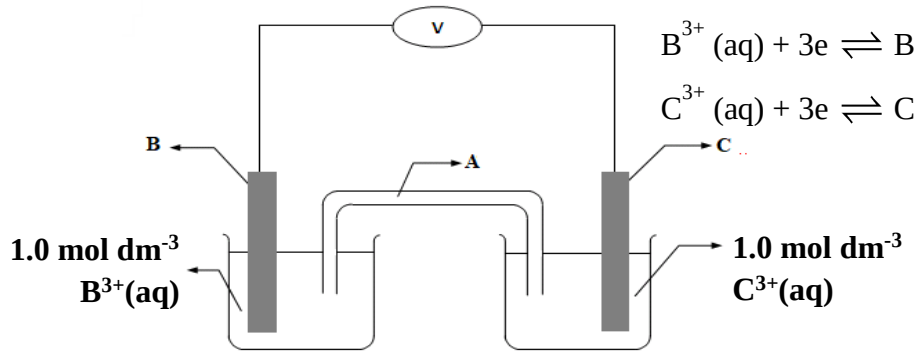
(5 marks)

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(b) Following diagram shows a galvanic cell kept at 25 ^{o}C and 1 atm pressure consist of half cells B and C. The relevant reduction potential values are given. Answer the questions given below.



B^{3+} (aq) + 3e $\rightleftharpoons$ B (s) E^{o} = – 0.20 V

C^{3+} (aq) + 3e $\rightleftharpoons$ C (s) E^{o} = – 0.40 V

(i) Identify the component A and state two primary functions of A .

A – **Salt bridge** **(3 marks)**

Primary functions of A

- ✳ **Maintains electrical neutrality**
- ✳ **Prevents polarization of the cell**
- ✳ **Completes the circuit**
- ✳ **Minimize the liquid junction potential** **(any two 2x2 = 4 marks)**

(ii) Among the following chemicals, identify the most suitable chemical to be used for A. Mention reasons for rejection of each other chemicals. Comment on the conductivity of cation and anion your chosen chemical. (Note that the chloride salts of B and C are used to construct half-cells B and C).

List of chemicals –: $AgNO_3$ (aq) / CH_3COOH(aq) / KNO_3 (aq) / $NaNO_3$(aq)

Salt	Suitable / not suitable	reason
$AgNO_3$ (aq)	**Not Suitable**	**AgCl will precipitate**
CH_3COOH(aq)	**Not Suitable**	**Weak electrolyte so increases the liquid junction potential**
KNO_3 (aq)	**Suitable**	**ok**
$NaNO_3$(aq)	**Not Suitable**	**Mobility of cataion and anion are considerably different**

*** If student has taken $NaNO_3$ also suitable without knowing the mobility of ions then consider it as correct** **(2x4 = 8 marks)**

(iii) Identify the cathode and the anode of the above cell.

Anode – **C(s)**

Cathode – **B(s)** **(4x2 = 8 marks)**

(iv) Determine the direction of the current flow in the cell if the both ends are connected from a conducting wire.

From C to B **(2 marks)**

(v) Calculate the electromotive force of the cell.

$$E^{\theta}_{Cell} = E^{\theta}_{Cathode} - E^{\theta}_{anode} \qquad (5\,Marks)$$

$$E^{\theta}_{Cell} = (-0.2V) - (-0.4V) = +0.2V \qquad (5\,Marks)$$

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(vi) The relationship between Gibbs free energy and standard cell potential (E^0_{cell}) is given by the following equation.

$\Delta G^0 = - nFE^0_{cell}$

n = number of moles of electrons participating
F = Faraday constant (96500 C)

Calculate ΔG^0 for the cell using the above relationship

$\Delta G^0 = - nFE^0_{cell}$

$\Delta G^0 = -3 mol \times 96500\ C\ mol^{-1} 0.2V$ $(3+1=4 Marks)$

$= -57.9\ kJ\ mol^{-1} (3 Marks)$

(vii) Complete the following table by using the terms **positive, negative spontaneous** and **non – spontaneous**

	Sign of E^0_{cell}	Spontaneity of the reaction
Galvanic cell	**Positive**	**Spontaneous**
Electrolytic cell	**Negative**	**Non – Spontaneous**

*** no marks if the student uses symbols + or -** **(1x4 = 4 marks)**

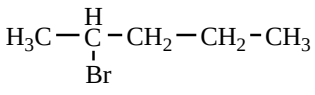
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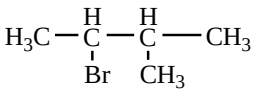
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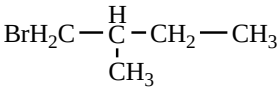
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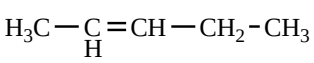
04. (a) A, B, and C are structural isomers with the formula $C_5H_{11}Br$. All three isomers show optical isomerism. A, B, C give D, E, F respectively as main products when reacted with alcoholic KOH. Only D shows diastereomerism. E and F give the same compound G when reacted with HBr. Compound G is a structural isomer of A, B, and C. Compound G is optically inactive. B and C give H and I respectively when reacted with dil.NaOH. H and I reacts with PCC to give J and K. only K decolorizes the colour of $H^+/KMnO_4$ solution to give compound L.

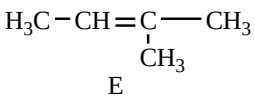
(i) Identify the structures of A, B, C, D, E, F, G, H, I, J, K and L and draw them in the corresponding boxes given below.

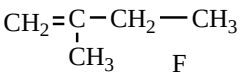

A

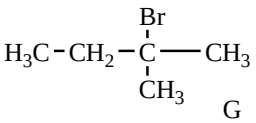

B

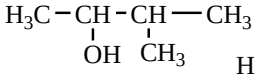

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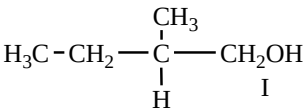

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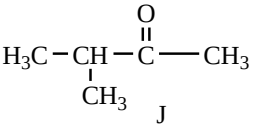

E

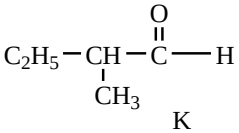

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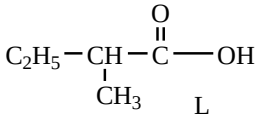

G


H


I


J


K


L

(4x12=48 Marks)

50

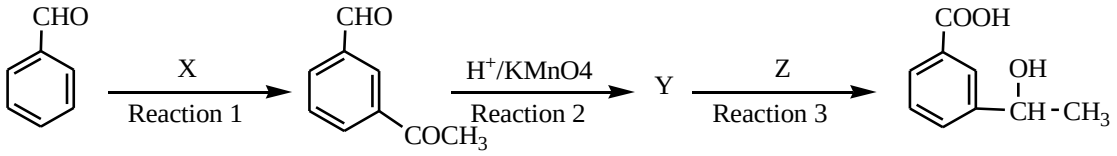
(ii) What is the colour change you observed on the reaction of K with $H^+/KMnO_4$

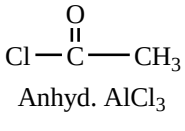
Purple → Colour **(2 marks)**

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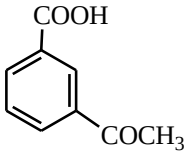
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(b) Write the structure of Y and the reaction conditions of X and Z in the appropriate boxes with respect to the following conversion.





X



Y

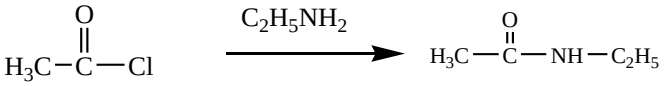
NaBH4
CH3OH

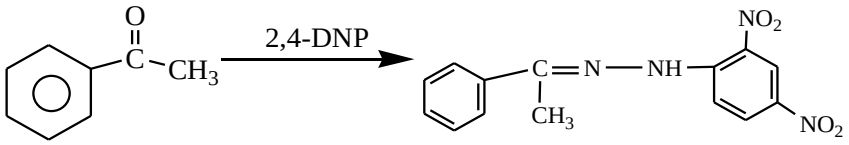
Z

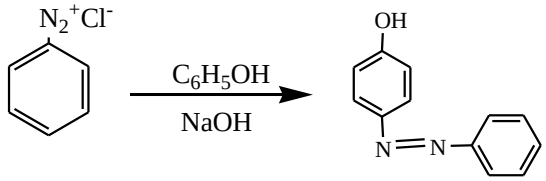
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(4x3=12 marks)

(c) Draw the products given in each reaction below in the corresponding box.

1. 

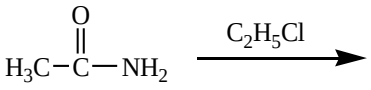
2. 

3. 

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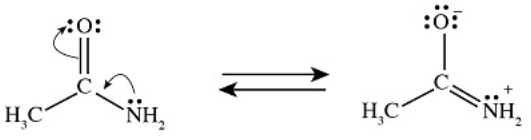
(5x3=15 marks)

(c) State whether the following reaction takes place. If so then give the product. If the reaction does not happens then give the reasons.



No **(2 marks)**

The <u>lone pair on nitrogen in ethanamide is involved in resonance with the carbonyl group,</u> <u>making it unavailable for reaction with ethyl chloride.</u> Hence, ethanamide does not react with ethyl chloride. **(2x2 = 4 marks)**



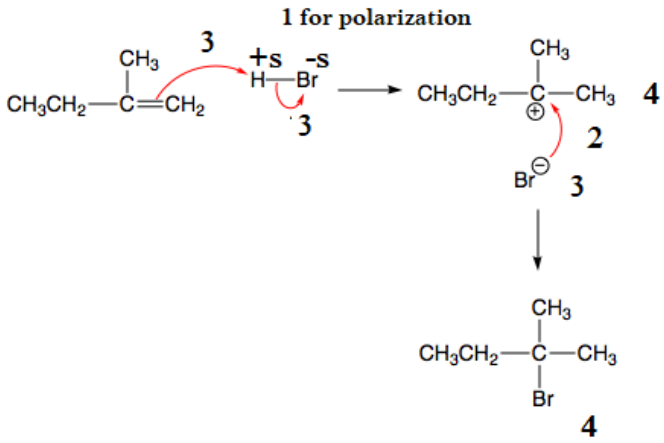
(**(2 marks)**

8

(d) Write the product obtained in the following reaction and write its mechanism.

$CH_3CH{=}CH_2 \xrightarrow{HBr}$

Do not write anything in this column



20

(20 marks)

***

100

100

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No. .....

Part B

Western Provincial Paper 2025

Date. .....

5(a) i) (a) $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ $-300\ kJ\ mol^{-1}$ —(1)

(b) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$ $-800\ kJ\ mol^{-1}$ —(2)

(c) $H_2O(l) \longrightarrow H_2O(g)$ $+42\ kJ\ mol^{-1}$ —(3)

(d) $C(s) + O_2(g) \longrightarrow CO_2(g)$ $-400\ kJ\ mol^{-1}$ —(4)

(4 × 5 = 20)

ii) $C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g)$ $+125\ kJ\ mol^{-1}$ —(5)

(1) × 2

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$ $-600\ kJ\ mol^{-1}$ —(1)'

(1)' + (3) × 2

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$ $(-600 + 84)\ kJ\ mol^{-1}$

$= -516\ kJ\ mol^{-1}$ —(A)

(2) + (3) × 2

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$ $(-800 + 84)\ kJ\ mol^{-1}$

$\equiv -716\ kJ\ mol^{-1}$ —(B)

(5) × (2)

$2C(s) + 2H_2O(g) \longrightarrow 2CO(g) + 2H_2(g)$ $+250\ kJ\ mol^{-1}$ —(C)

(4) × −2

$2CO_2(g) \longrightarrow 2C(s) + 2O_2(g)$ $+800\ kJ\ mol^{-1}$ —(4)'

(4)' + (C) $2CO_2(g) + 2H_2O(g) \longrightarrow 2CO(g) + 2H_2(g) + 2O_2(g)$

$+1050\ kJ\ mol^{-1}$ —(D)

(B) + (D)

$CH_4(g) + CO_2(g) \longrightarrow 2CO(g) + 2H_2(g)$ $(1050 - 716)\ kJ\ mol^{-1}$

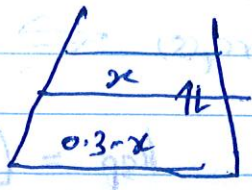
$-334\ kJ\ mol^{-1}$

(20 marks)

5a 40

No: _____ Date: __/__/____

5b i) $K_D = \frac{[I_2]_{CHCl_3}}{[I_2]_{H_2O}} = 90$ (5)



ii) Let x be the amount of I_2 remains in water and M be the molar mass of I_2.

$[I_2]_{H_2O} = \left(\frac{x}{M} \times \frac{1000}{500}\right)$ mol dm^{-3} — (1) (5)

$[I_2]_{CHCl_3} = \left(\frac{0.3-x}{M}\right) \times \frac{1000}{50}$ mol dm^{-3} — (2) (5)

$\frac{(2)}{(1)}$ $K_D = \frac{0.3-x}{x} \times \frac{500}{50}$

$90 = \left(\frac{0.3-x}{x}\right) 10$ (5)

$x = 0.03$ g. (5)

∴ So the fraction remains $= \frac{0.03}{0.30} \times 100\% = 10\%$ (5)

iii) after 1st extraction amount remains in water $= 0.3 \times \frac{10}{100}$ g

after 2nd extraction amount remains in water $\longrightarrow \left(0.3 \times \frac{10}{100}\right) \times \frac{10}{100} = 0.3 \times \left(\frac{10}{100}\right)^2$ g (4)

∴ after n^{th} extraction amount remains in water $= 0.3 \times \left(\frac{10}{100}\right)^n$ g $= 0.3 \times \left(\frac{1}{10}\right)^n$ g (4)

(4)

So 99% extracted means only 1% remains in water.

∴ So, $0.3 \times \frac{1}{100} = 0.003$ g

∴ $0.003\text{ g} = 0.3 \times \left(\frac{1}{10}\right)^n$ g

$\frac{1}{100} = \left(\frac{1}{10}\right)^n$

∴ $n = 2$. (4)

∴ after 2 extractions there will be 99% of (4)

5b 50

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Past Papers Wiki

No: _____ Date: __/__/____

5 c i) $Ag_2CrO_4(s) \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)}$ (4)

$K_{sp} = [Ag^+_{(aq)}]^2 [CrO_4^{2-}{}_{(aq)}]$ (4)

ii) Let x mol dm^{-3} be the solubility (2) of $Ag_2CrO_4(s)$

$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)}$

$\therefore$ / $x - \alpha$ 2α α (4) mol dm^{-3}

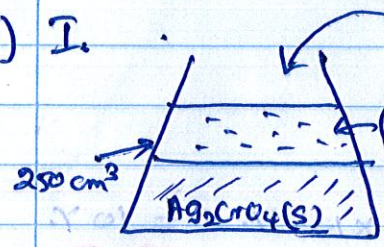
$K_{sp} = [Ag^+_{(aq)}]^2 [CrO_4^{2-}{}_{(aq)}]$

$= (2\alpha)^2 (\alpha)$ mol^3 dm^{-9} (4)

$= 4\alpha^3$ mol^3 dm^{-9}

$\therefore K_{sp} = 4 \times (1 \times 10^{-4})^3 = 4 \times 10^{-12}$ mol^3 dm^{-9} // (1+1)

iii) I.



K_{sp} of AgCl. 1×10^{-10} mol^2 dm^{-6}.

$[NaCl_{(aq)}] = [Cl^-_{(aq)}] = \frac{2}{100} \times \frac{250 \times 1000}{(250+250)} = 1$ mol dm^{-3}

$\therefore$ when Cl^- is added $Ag^+_{(aq)}$ will be precipitated as $AgCl(s)$ therefore the amount of $Ag^+_{(aq)}$ in the initial mixture will reduces (4)

the new $[Ag^+_{(aq)}]$ in the medium can be found by using K_{sp} of AgCl.

$K_{sp} = [Ag^+_{(aq)}][Cl^-_{(aq)}]$

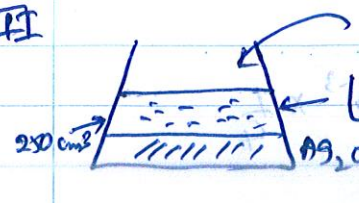
1×10^{-10} mol^2 dm^{-6} $= [Ag^+_{(aq)}]$ 1 mol dm^{-3} (4)

$\therefore [Ag^+_{(aq)}] = 1 \times 10^{-10}$ mol dm^{-3}

$\therefore [Ag^+_{(aq)}]_{new} = 2 \times 10^{-4}$ mol dm^{-3} $\xrightarrow[\text{upto}]{\text{reduces}}$ 1×10^{-10} mol dm^{-3} // (2)

Atlas

II



$[Ag^+_{aq}] = 2\times10^{-4}$ mol dm^{-3}

new $[AgNO_3] = \frac{2}{1000} \times 250 \times \frac{1000}{250+250}$

$= 1$ mol dm^{-3}.

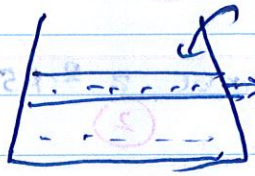
when $[Ag^+_{aq}]$ is added the $[Ag^+_{aq}]_{free}$ increases. Nothing is there to ppt with Ag^+_{aq} (5)

$\therefore AgNO_3(aq) \longrightarrow Ag^+_{(aq)} + NO_3^-{}_{(aq)}$

1 mol dm^{-3} 1 mol dm^{-3}

$\therefore [Ag^+_{aq}]_{free} = (1.0000 + 2\times10^{-4})$ ≈ 1 mol dm^{-3} // (5)

III.



Now $[Na_2CrO_4(aq)] = \frac{2}{1000} \times 250 \times \frac{1000}{250+250}$

$= 1$ mol dm^{-3}

$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{aq}$ (3)

$K_{sp} = [Ag^+_{aq}]^2 [CrO_4^{2-}{}_{aq}]$

4×10^{-12} mol^3 dm^{-9} $= [Ag^+_{aq}]^2_{new} \times 1$ mol dm^{-3} (3)

$\therefore 2\times10^{-6}$ mol dm^{-3} $= [Ag^+_{aq}]_{new}$ //

$\therefore [Ag^+_{aq}]$ reduces up to 2×10^{-6} mol dm^{-3} // (2)

(2)

ii) precipitated $[Ag^+_{aq}] = 2\alpha = (2\times10^{-4} - 2\times10^{-6})$ mol dm^{-3}

$= 198\times10^{-6}$ mol dm^{-3} (4)

$2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)} \rightleftharpoons Ag_2CrO_4(s)$

2α α

$\therefore$ for 1 l, amount of Ag_2CrO_4(s) precipitated $= \frac{198\times10^{-6}}{2}$ mol

(4)

$\therefore$ for 500 cm^3 solution $= \frac{198\times10^{-6}}{2} \times \frac{1}{2}$ mol

$\therefore$ Mass of Ag_2CrO_4(s) obtained $= 2.475\times10^{-5}$ mol //

(2)

mango

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Or

initially at 250 cm^3 $n_{Ag^+_{aq}} = 2 \times 10^{-4}\ mol\ dm^{-3} \times \frac{1}{4}$

$n_{Ag^+_{aq}} = 0.5 \times 10^{-4}\ mol$

after 500 cm^3 the $n_{Ag^+_{aq}}$ which must be there at the medium $= 2 \times 10^{-6}\ mol\ dm^{-3} \times \frac{1}{2}$ (2)

$= 1 \times 10^{-6}\ mol\ dm^{-3}$ (2)

∴ the precipitated $n_{Ag^+_{aq}} = (0.5 \times 10^{-4} - 1 \times 10^{-6})\ mol$

$= (50 - 1) \times 10^{-6}\ mol$ (2)

$= 49 \times 10^{-6}\ mol$ (2)

$n_{Ag^+} : n_{Ag_2CrO_4} = 1 : 2$

$n_{Ag_2CrO_4(s)}$ obtained $= \frac{49}{2} \times 10^{-6}\ mol = 2.45 \times 10^{-5}\ mol$ (2)

5C

60

5 - 1 150

6 (a) (i) for the first end point only HNg (strong acid) will be neutralized by KOH. (4)

$KOH_{(aq)} + HNg_{(aq)} \longrightarrow KNg_{(aq)} + H_2O_{(l)}$

$\therefore n_{KOH_{(aq)}} = \frac{0.1}{1000} \times 10$ mol

$\therefore n_{HNg} = \frac{0.1}{1000} \times 10 = 1 \times 10^{-3}$ mol (2)

$\therefore [HNg_{(aq)}] = \frac{1 \times 10^{-3}}{25} \times 1000 = 4 \times 10^{-2}$ mol dm^{-3} // (4)

When the second eq. point the HA $_{(aq)}$ is being neutralized by KOH

So. $KOH_{(aq)} + HA_{(aq)} \longrightarrow KA_{(aq)} + H_2O_{(l)}$ (4)

$\therefore n_{KOH_{(aq)}} = \frac{0.1}{1000} \times 30$ mol

$\therefore n_{HA_{(aq)}} = \frac{0.1}{1000} \times 30$ mol (2)

$\therefore [HA_{(aq)}] = \frac{0.1}{1000} \times 30 \times \frac{1000}{25} = 0.12$ mol dm^{-3} // (2) (2)

ii) When 25 cm^3 of KOH was added the half-eq. point of HA is reached. (4)

(reqired volume of KOH = 30 cm^3 so for the ½ eq. 15 cm^3 of KOH is needed. So after the 1st eq. point 10 + 15 = 25 cm^3 of KOH) (2)

at ½ eq. point the pH of the medium = pKa of the HA. (3)

$\therefore pH = pKa = 5$

$\therefore K_a = 1 \times 10^{-5}$ mol dm^{-3} // (3)

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iii) initial pH of Q.

$[HNO_3(aq)] = [H^+_{(aq)}] = 4 \times 10^{-2}$ mol dm^{-3} (04)

Assume that the contribution for the $[H^+_{(aq)}]$ of the medium by HA is negligable. (02)

$\therefore pH = -\log_{10}(4 \times 10^{-2})$ (02)

$= 2 - \lg 4 = 2 - 0.6 = 1.4$ // (02)

iv) at the 1st eq. point only HA remains in the medium which can contributes to the pH of the medium. (dissociation of water is negligible), now the $HA_{(aq)}$ has diluted from 25 cm^3 to 35 cm^3. (02)

$\therefore [HA_{(aq)}]_{new} = 0.12 \text{ mol dm}^{-3} \times \frac{25}{35} = 0.08571$ (02)

$= 8.571 \times 10^{-2}$ mol dm^{-3} (02)

$HA_{(aq)} \rightleftharpoons H^+_{(aq)} + A^-_{(aq)}$

at eq $0.12 - x$ x x mol dm^{-3} (02)

$K_a = \frac{[H^+_{(aq)}][A^-_{(aq)}]}{[HA_{(aq)}]}$ (04)

Since x is small (02)

$1 \times 10^{-5} \text{ mol dm}^{-3} = \frac{[H^+_{(aq)}]^2}{(8.571 \times 10^{-2})}$ $\quad 8.571 \times 10^{-2} - x \approx 8.571$.

$\therefore [H^+_{(aq)}] = \sqrt{8.571 \times 10^{-7}}$ mol dm^{-3}

$= \sqrt{8.571 \times 10^{-7} \times 35}$ mol dm^{-3} (02) cm^3

$\therefore pH = 3.5 - \frac{1}{2}\lg 8.571$ (02)

$= 3.5 - \frac{1}{2}(0.9330) = 3.5 - 0.4665$

$\therefore pH \approx 3.03$ // ≈ 3 // (02)

v) at the second eq. point all KOH and HA has reacted and only KA remains (02)

$KOH_{(aq)} + HA_{(aq)} \longrightarrow KA_{(aq)} + H_2O_{(l)}$

$A^-_{(aq)} + H_2O_{(l)} \overset{K_b}{\rightleftharpoons} HA_{(aq)} + OH^-_{(aq)}$

$x \qquad x$

$[A^-_{(aq)}] = \frac{0.1}{1000} \times 30 \times \frac{1000}{40+25}$ mol dm^{-3} (02)

No : _____ Date: __/__/____

dissociation of A^- will have the k_b since A^- is the conjugate base of HA

$\therefore k_b = \frac{[HA_{(aq)}][OH^-_{(aq)}]}{[A^-_{(aq)}]}$ (01) (02)

(02) $\frac{k_w}{k_a} = \frac{[OH^-_{(aq)}]^2}{[A^-_{(aq)}]}$ Since $k_w = k_a \times k_b$ (01)

$\frac{10^{-14}}{10^{-5}} = \frac{[OH^-_{(aq)}]^2}{[A^-_{(aq)}]}$

$\therefore [OH^-_{(aq)}] = \sqrt{10^{-9} \times 0.04615}$ mol dm^{-3} (02)

$\therefore$ pOH = 5.17

$\therefore$ pH = 14 − 5.17 = 8.83 // (at 25°C $k_w = 10^{-14}$ mol^2 dm^{-6})

At 25°C (04) (02)

vi) when 25 cm^3 of KOH is added half of the weak acid is converted to its salt, therefore the medium contains HA and KA both. therefore the solution behaves as a buffer. (03)

(02) 69/85

6(b) i) $NO_{(g)} + O_{2(g)} \underset{k_2}{\overset{k_1}{\rightleftharpoons}} NO_{3(g)}$ (Speed) — (1)

$NO_{3(g)} + NO_{(g)} \longrightarrow 2NO_{2(g)}$ (slow) — (2)

(1) + (2) $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$ (5) ← overall reaction

ii) according to the slowest step, (R.D.S),

Rate = $k_1 [NO_{3(g)}]^1 [NO_{(g)}]^1$ — (A) (05)

k = rate constant.

iii) $NO_{3(g)}$ is an intermediate (03)

Since it appears during the reaction and dissapears when the reaction is over. (02)

iv) K_c for the (1) step

$K_c = \frac{[NO_{3(g)}]}{[O_{2(g)}][NO_{(g)}]}$ (05) $\Rightarrow [NO_{3(g)}] = K_c \cdot [O_{2(g)}][NO_{(g)}]$

Atlas

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by (3) and (4),

$$\text{Rate} = k_1 k_2 [O_2(g)][NO(g)][NO(g)]$$ (05)

$$\text{Rate} = k' [NO(g)]^2 [O_2(g)]$$ (05)

overall order = 2 + 1 = 3 //

order w.r.t $[NO(g)] = 2$ (05)

order w.r.t $[O_2(g)] = 1$.

6b 40

(6c) (i) after 1st half life = $2 \times \frac{1}{2}$ (5)

remaining $[A(g)]$

after n^{th} half time = $2 \times \left(\frac{1}{2}\right)^n$

remaining $[A(g)]$ (5)

$\therefore$ remaining amount of $[A(g)] = 2 \times \frac{\alpha}{100}$

$\therefore 2 \times \frac{\alpha}{100} = 2\left(\frac{1}{2}\right)^n$

$\frac{\alpha}{100} = \frac{1}{2^n}$ (5)

$\therefore 2^n = \frac{100}{\alpha}$

(ii) $2^n = \frac{100}{83.75}$

$2^n = 1.19$ $\leftarrow$ $\therefore$ the time taken

$n \lg 2 = \lg(1.19)$ $= 0.258 \times 5 \text{ min} \times 60\ s$

$\therefore n = \frac{0.0776}{0.3010} = 0.258$ $= 77.4\ s$ (5)

(5)

6c 25

* Since this is a bit far from the A/L Scope only 10 marks were allocated for the part (ii). and the hint given in the paper should be corrected as $\left(\frac{100}{83.75} = 1.19\right)$

6 — 150

Atlas

No. ..... Date. .....

7(a) (i) Anodic reaction

$Al(s) \longrightarrow Al^{3+}(aq) + 3e^-$ — (1) (5)

cathodic reaction

$2H_2O(l) + 4e^- + O_2(g) \longrightarrow 4OH^-(aq)$ — (2) (5)

ii) (1)×4 + (2)×3

$4Al(s) + 6H_2O(l) + 3O_2(g) \longrightarrow 4Al(OH)_3(s)$ (08)

iii) $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{Anode}$ (2)

$= (+0.40V) - (-1.66V)$ (2)

$= +2.06\ V$. (3)

iv) I) for 12 mol of electron → 3 moles of O_2 need

∴ 2.5 " " " → $\frac{3}{12} \times 2.5$ moles of O_2

∴ required amount of $O_2(g)$ = 0.625 mol // (10)

II) for 12 moles of elect → 4 moles of Al dissolves

∴ 2.5 " " " → $\frac{4}{12} \times 2.5$ moles of Al

∴ mass of Al dissolves = $\frac{4}{12} \times 2.5 \times 27$ g mol^{-1}

∴ reduce mass of Anode = 22.5 g // (10)

III) $Q = It$ (02)

$I = \frac{96500\ C\ mol^{-1} \times 2.5\ mol}{400\ s.}$ (05)

$I = 603.125\ A$ // $\simeq 603\ A$ // (03)

iv) I) increasing the partial pressure of O_2 the equilibrium (or cell reaction) shifts forward direction According to the Lechatelier's Principle (05)

∴ the e.m.f of cell increases (05)

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II) the cell reaction is exothermic reaction (0.5)

∴ According to the Le chatelier's principle when temperature of the system increases, the system tried to reduces it's temperature by enhancing the endothermic reaction.

∴ the cell reaction moved backward (0.3)

∴ the emf of the cell reduces. (0.2)

7a 7.5

7(b) (i) A = Co B = Cu C = Ni

3×3 = (15)

ii) $A = Co^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7$

$B = Cu^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$

$C = Ni^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$ 3×3 = (9)

iii) D = $[Co(H_2O)_6]^{2+}$ E = $[Cu(H_2O)_6]^{2+}$ F = $[Ni(H_2O)_6]^{2+}$

3×3 = (9)

iv) P = $[Co(NH_3)_6]^{2+}$ R = $[Cu(NH_3)_4]^{2+}$ T = $[Ni(NH_3)_6]^{2+}$

Q = $[CoCl_4]^{2-}$ S = $[CuCl_4]^{2-}$ U = $[NiCl_4]^{2-}$

3×6 = (18)

v) P = hexaammine cobalt(II) ion Q = tetrachloridocobaltate(II) ion

R = tetraammine copper(II) ion S = tetrachloridocuprate(II) ion

2×4 = (8)

vi) I add DMG. → it gives a reddish pink precipitate (3)

II add $BaCl_2$ (aq) solution and obtain the white precipitate which doesn't dissolve upon the addition of dil. HCl (3)

vii) when addition of conc. HCl to E it first turns green and then on further addition it gives yellow colour (3)

$Cu^{2+}_{(aq)} \xrightarrow{\text{Conc. HCl}} [CuCl(H_2O)_5]^{+}_{(aq)} \xrightarrow{\text{Conc. HCl}} [CuCl_4]^{2-}_{(aq)}$

lightblue green. (2) yellow (2)

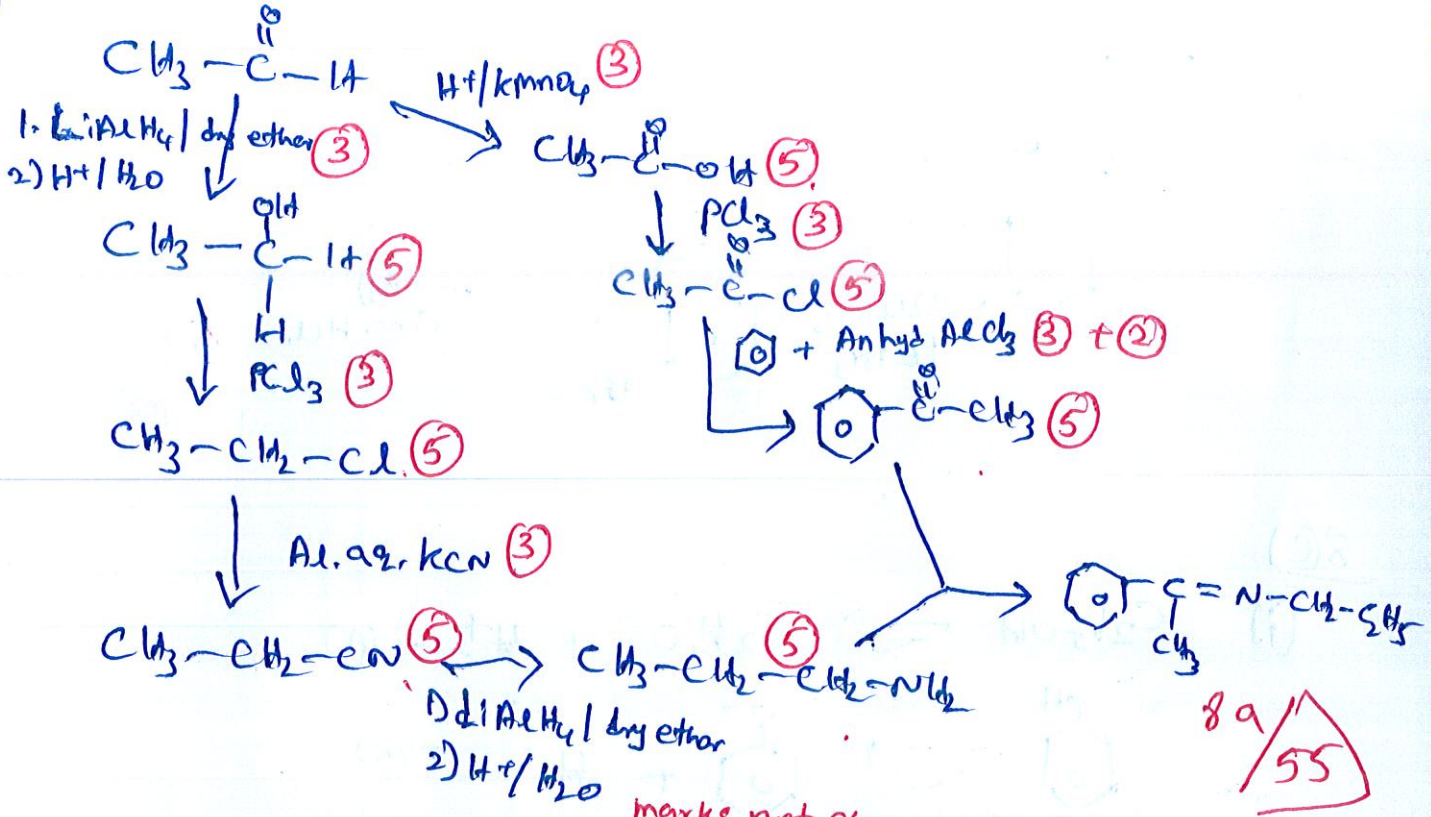
But Ni^{2+} gives directly yellow color. (3)

$Ni^{2+}_{(aq)} \xrightarrow{\text{Conc. HCl}} [NiCl_4]^{2-}_{(aq)}$ yellow

7b .75

7+ 150

8 (a)

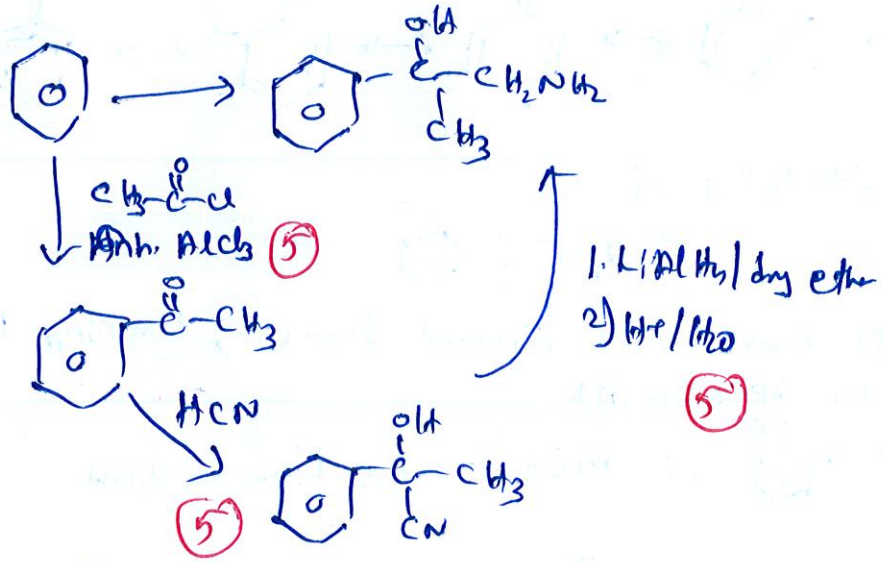


8 a 55

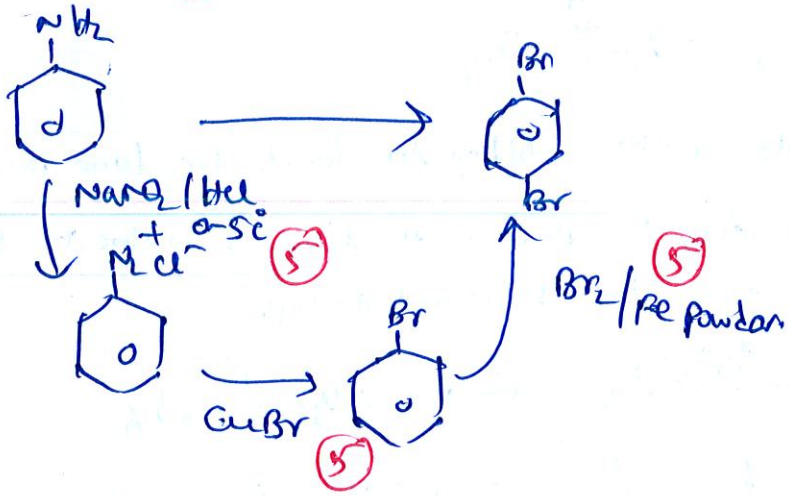
marks not given as this is given as hint.

8(b)

1.

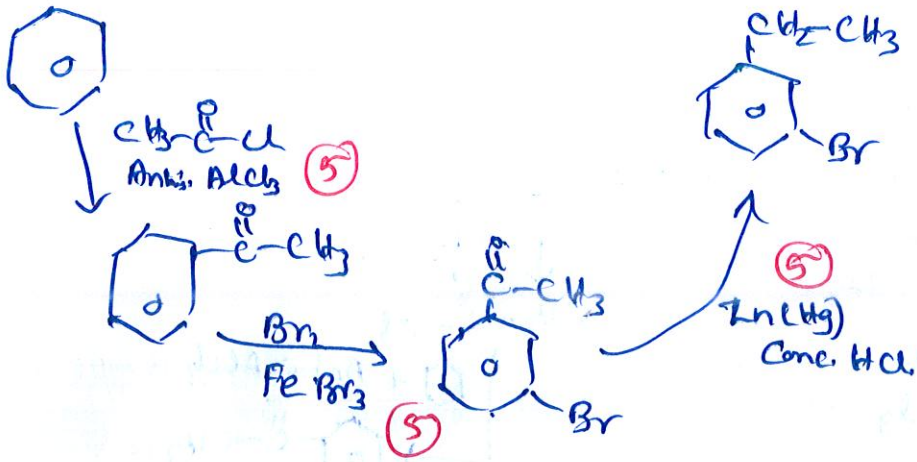


2.



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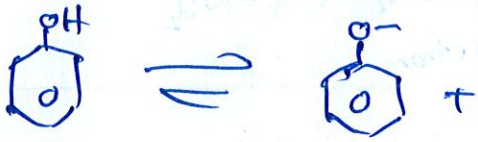


8b

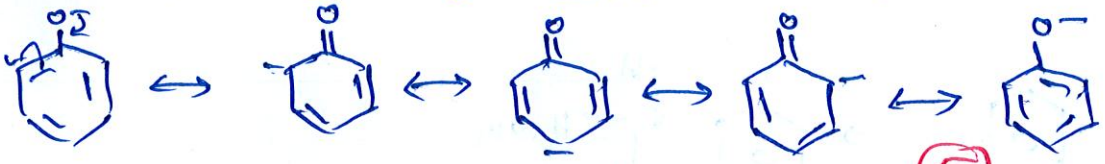
4.5

8(C)

(i) $C_2H_5OH \rightleftharpoons C_2H_5O^- + H^+$ — (A) 3



Phenate ion is more stable due to the following resonance structures



5

therefore Stability of,

$C_2H_5O^-$ < 

∴ the (B) moves more forward than (A), making Higher H^+ on reaction (B).

∴ the  is more acidic than C_2H_5OH. 4

(ii) $CH_3-CH_2-\ddot{N}H_2$, $CH_3-\overset{O}{\overset{\|}{C}}-\ddot{N}H_2$

Basicity depends on the ability to donate the lone pair on N atom but in amide the lone pair on N atom is delocalized over the π electron cloud of the carbonyl group. 03



03

this makes less feasible for the amide to donate the lone pair.

03

whereas in the amine due to the inductive effect of the R group the lone pair on N atom is easy to donate.

$CH_3-CH_2 \rightarrow \ddot{N}H_2$ (03)

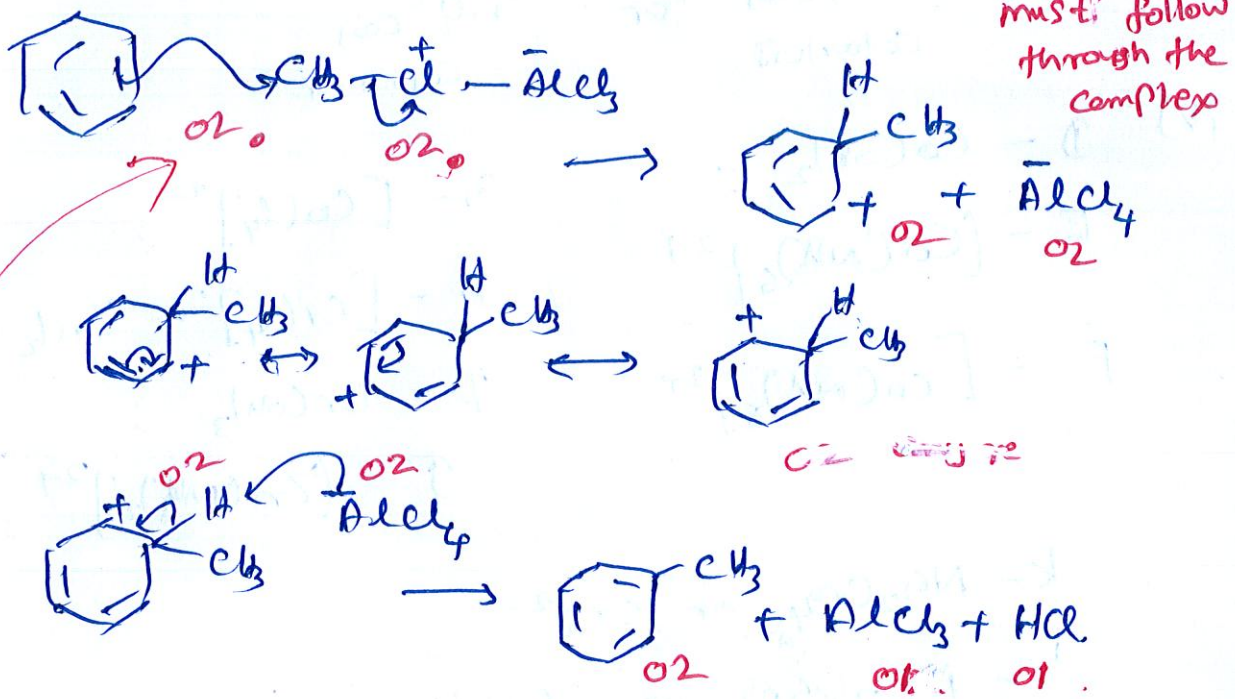
∴ the basisity of $CH_3CH_2-NH_2 > CH_3-\ddot{C}l-NH_2$ (03)

3C
30

8c

$CH_3-Cl: \xrightarrow{O2\bullet} AlCl_3 \longrightarrow CH_3-\overset{+}{Cl}-\bar{A}lCl_3$ O2•

* the reaction must follow through the complex



* If the Student use $^{+}CH_3$ deduct the 6 marks $(O2\bullet)\times 3$

8d
20

8 + 150

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9 (a)

(i) Co^{2+} (05) Cr^{3+} (05) Zn^{2+} (05)

ii) $Co(OH)_2$ (3) $Cr(OH)_3$ (3) $Zn(OH)_2$ (3)

iii) $[Cr(OH)_4]^-$ (aq) green or (3) $[Cr(OH)_6]^{3-}$ (aq) green

$[Zn(OH)_4]^{2-}$ (aq) (3) colourless or ZnO_2^{2-} (aq) colourless

iv) D - $Co(OH)_2$ 3

E - $[Co(NH_3)_6]^{2+}$ 3

F - $[Co(NH_3)_8]^{3+}$ 3

G - $[CoCl_4]^{2-}$ 3

H - $[CrCl_4]^-$ + $ZnCl_2$ 3

I - $Cr(OH)_3$ 3

J - $[Zn(NH_3)_2]^{2+}$ 3

K - Na_2CrO_4 or CrO_4^{2-} 3

L - $Na_2Cr_2O_7$ or $Cr_2O_7^{2-}$ 3

M - Ag_2CrO_4 3

$3 \times 10 = (30)$

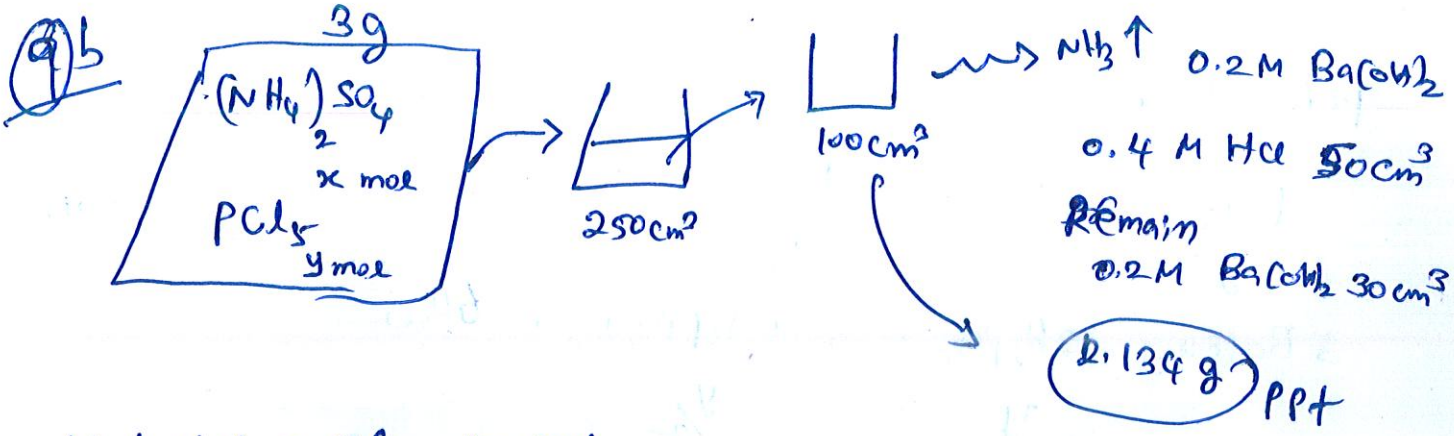
v) $2Cr(OH)_3 + 3H_2O_2 + 4NaOH \longrightarrow 2Na_2CrO_4 + 8H_2O$ (10)

vi) dil. HCl (5)

99

75

(a) b



added HCl $= \frac{0.4}{1000} \times 50$ mol

$= \frac{20}{1000}$ mol (02)

$Ba(OH)_2 + (NH_4)_2SO_4 \longrightarrow BaSO_4\downarrow + 2NH_3 + 2H_2O$ - (5)

x mol — 2x (02) Stichiometry

$NH_3 + HCl \longrightarrow NH_4Cl$ - (3)

2x — 2x (01) Stichiometry

$2HCl(aq) + Ba(OH)_2 \longrightarrow BaCl_2 + 2H_2O$ - (5)

2x — x (01) Stichiometry

$n_{Ba(OH)_2}$ for remaining HCl $= \frac{0.2}{1000} \times 30 = \frac{6}{1000}$ mol (02)

∴ remaining $n_{HCl} = 2 \times \frac{6}{1000} = \frac{12}{1000}$ mol (02)

∴ reacted $n_{HCl} = \frac{20}{1000} - \frac{12}{1000} = \frac{8}{1000}$ mol (02)

∴ released n_{NH_3} (2x) $= \frac{8}{1000}$ mol (02)

∴ $n_{(NH_4)_2SO_4}$ in 100 cm³ $= \frac{1}{2} \times \frac{8}{1000}$ mol

$= \frac{4}{1000}$ mol

$M_{(NH_4)_2SO_4} = 132\ g\ mol^{-1}$ (02)

∴ $(NH_4)_2SO_4$ in 250 cm³ $= \frac{4}{1000} \times \frac{250}{100} = \frac{10}{1000}$ mol // (02)

∴ $(NH_4)_2SO_4$ % $= \frac{10}{1000}\ mol \times 132\ g\ mol^{-1} \times \frac{100}{3} = 44\ \%$ // all (2)

35

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PCl_5 hydrolysis therefore :

$M_{BaSO_4} = 233\ g\ mol^{-1}$ (02)

$M_{Ba_3(PO_4)_2} = 601\ g\ mol^{-1}$ (02)

$$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl \quad (05)$$
$$y \qquad\qquad y$$

$$3Ba(OH)_2 + 2H_3PO_4 \longrightarrow Ba_3(PO_4)_2 + 6H_2O \quad (05)$$
$$y \qquad\qquad y/2$$

So the precipitate contains $BaSO_4$ and $Ba_3(PO_4)_2$. (02)

So in 100 cm^3 the amount of $BaSO_4$ = $n_{(NH_4)_2SO_4}$

$$= \frac{4}{1000}\ mol \quad (02)$$

$$\therefore m_{BaSO_4} = \frac{4}{1000}\ mol \times 233\ g\ mol^{-1} \quad (02)$$

$$= 0.932\ g \quad (02)$$

$\therefore$ in 100 cm^3 amount of $Ba_3(PO_4)_2$ = $2.134 - 0.932$ (02)

$$1.202\ g$$

$$\therefore n_{Ba_3(PO_4)_2\ (y/2)} = \frac{1.202\ g}{601\ g\ mol^{-1}} = \frac{2}{1000}\ mol \quad (02)$$

$$\therefore n_{PCl_5\ (y)} = 2 \times \frac{2}{1000}\ mol = \frac{4}{1000}\ mol \quad (02)$$

$\therefore$ in 250 cm^3 $n_{PCl_5} = \frac{4}{1000} \times \frac{250}{100} = \frac{10}{1000}\ mol$ (02)

$\therefore$ mass % of PCl_5 = $\frac{10}{1000} \times 208.5 \times \frac{1000}{3}$ % (02)

$M_{PCl_5} = 208.5\ g\ mol^{-1}$ (02)

$= 69.5\%$, all (2)

Since the total mass of the sample was printed as 3g instead of 5g the precentages will exceed 100%. so all consider for the last answer.

40

9 b = 75/75

9 - 150

10 a)

i. Name two raw materials used in that chemical industry.

Animal fat or plant oil (2)

NaOH or KOH (2)

ii. What is the main difference between hot process and cold process used in that chemical industry?

In the cold process, soap and glycerol are not separated. (2)

iii. Name the 4 main steps that take place in this chemical industry.

1. **Saponification**
2. **Removal of the by-product, glycerin**
3. **Purification**
4. **Finishing**

2×4 = (8)

iv. Mention the names of 4 saturated fatty acids and an unsaturated fatty acid mainly contained in coconut oil

saturated fatty acids – lauric acid, myristic acid, stearic acid and palmitic acid (2 each)

unsaturated fatty acids –oleic acid 2

2×5 = (10)

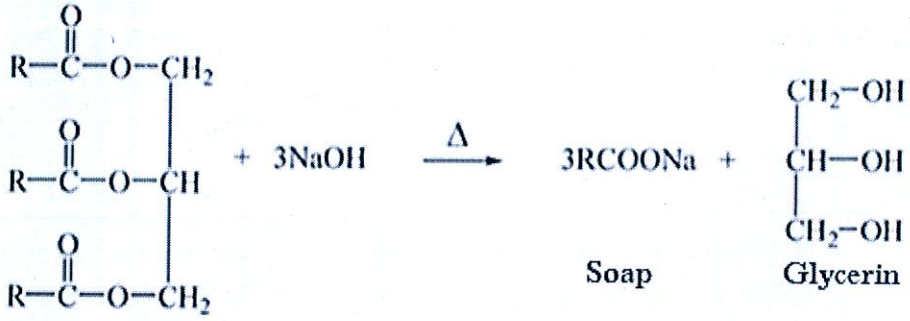
v. State why the raw materials used in this manufacturing process are first passed over a type of clay called activated fuller's earth.

To remove the pigments and impurities in oil (2)

vi. There are two manufacturing processes namely continuous process and batch process and which process is traditionally used in the above industry?

Batch process (2)

vii. Write down the main reaction that occurs in step 1 of the above industry.



(10)

viii. In step 2, a concentrated brine solution is added to increase the efficiency of the product.

Explain the process that takes place there in terms of physio-chemical principles.

(01)

To decrease the solubility of soap in the aqueous phase NaCl (brine) is added. As the Na⁺ ion concentration is high, the above equilibrium shifts to the left and the soap molecules separate from the aqueous phase. Glycerin dissolves in the salt solution. Density of the aqueous phase increases due to the addition of NaCl. After separating impure soap (crude) from the aqueous phase, the aqueous phase containing glycerin is pumped out

(02)

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$$\text{Water} + RCOO^-Na^+(s) \rightleftharpoons RCOO^-(aq) + Na^+(aq)$$

When increasing Na^+ ion concentration (01)

ix. In addition to the raw materials used for this process, one more raw material is used to produce a product that is presented as an alternative solution to the modern energy crisis. Identify the raw materials used and the product produced. Mention a natural form and a synthetic form of obtaining that raw materials.

Product acting as an alternative energy source — **Biodiesel** (02)

Natural source of triglycerides — **Vegetable oils (e.g., coconut oil, palm oil) or animal fats** (02)

Synthetic way to obtain triglycerides — **Laboratory/industrial esterification of glycerol with fatty acids** (02)

x. Name the compound that acts as a catalyst in this manufacturing process and is used as a key ingredient in the industry you mentioned in part (ix) above.

Sodium hydroxide (NaOH) *or* **Potassium hydroxide (KOH)** (02)

(09) 50

(50 marks)

(b) Below is a table showing the Global Warming Potentials (GWP) of several greenhouse gases and their lifetimes in the atmosphere.

Gas	Global Warming Potential GWP	lifetime in the atmosphere (Yrs)
CO_2	1	300 – 1000
CH_4	22	7 – 12
N_2O	310	14 – 128
CHF_3 (HFC 23)	11700	222
CH_2F_2 (HFC 32)	675	5.2
CH_2FCF_3 (HFC 134a)	1300	13.8
CCl_2F_2 (CFC 12)	10600	140
$CHClF_2$ (HCFC 22)	1700	12.1

1. What is a greenhouse gas?

   The gases which can absorb infrared radiations exist stably in the atmosphere for a long period of time are referred to as greenhouse gases. (05)

2. Statement I – "O_3 is not a greenhouse gas as it is an Homo – atomic molecule"

   Statement II –"SO_2 is a gas of non-zero dipole moment. As such, it is a greenhouse gas".

   Do you agree with the above 2 statements or not? Give reasons.

Statement I – "O_3 is not a greenhouse gas as it is an Homo – atomic molecule"

False

O_3 is having a non – zero dipole moment hence it absorbs IR radiation and therefore O_3 is a greenhouse gas

05

Statement II –"SO_2 is a gas of non-zero dipole moment. As such, it is a greenhouse gas"

False

The gases such as SO_2, NO_2, NO and CO are not reckoned as greenhouse gases. This is because their life span in the atmosphere is very short.

05

3. CFC gases are a direct contributor to the depletion of the ozone layer. Explain with suitable reactions how ozone layer is damaged by CFC gases.

The CFCs describe above are very stable compounds. They are not thermally decomposed and are resistant to bio-degradation. For this reason these compounds can stay long in the atmosphere. However, these compounds are very volatile. Hence, they can evaporate rapidly and reach the stratosphere which accommodates the ozone layer where they are exposed to high energy UV rays in upper atmosphere which do not found in lower atmosphere. Under the influence of these C-Cl bonds undergo fission producing .Cl free radicals. These free radicals react with ozone. They catalyze the breakdown reaction of ozone speeding it up and adding another process of breakdown to the natural breakdown of ozone. Because of this the ozone-breaking process outstrips the ozone making process and the ozone layer is subjected to degradation. This can be illustrated by the following equations.

02

$^{\cdot}Cl$ free radicals react with ozone

$$^{\cdot}Cl(g) + O_3(g) \longrightarrow O_2(g) + {}^{\cdot}OCl(g) \quad \text{---------- (1)}$$

$^{\cdot}OCl$ free radicals formed react with oxygen atoms formed by the natural breakdown of ozone and regenerates free radical.

$$O_3(g) \longrightarrow O_2(g) + {}^{\cdot}O(g) \quad \text{---------- (2)}$$

$$^{\cdot}OCl(g) + {}^{\cdot}O(g) \longrightarrow O_2(g) + {}^{\cdot}Cl(g) \quad \text{---------- (3)}$$

(1) + (2) + (3),

05

$$2O_3(g) \longrightarrow 3O_2(g)$$

This shows that after the decomposition of an O_3 molecule by a .Cl free radical the .Cl free radical is regenerated without being destroyed. That means, until getting destroyed by another reaction a .Cl free radical can decompose a large number of O_3 molecules. Hence .Cl free radicals have acted as a catalyst in the breakdown of O_3 molecules

03

4. HCFC gases were first proposed as a remedy for this ozone layer depletion. So what is the main structural difference between HCFC gases and CFC gases?

HCFC (Hydrochlorofluorocarbon) was the first alternative gas used for CFCs. This molecule is very much similar to CFC and the only difference was presence of a hydrogen atom in addition to chlorine and fluorine atoms.

05

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5. State the reason why HCFC gases, which were proposed as a remedy for ozone layer depletion, failed.

The C-H bond in these molecules are disassociated by solar rays in the lower atmosphere, which carry relatively lower energy. For this reason a considerable part of this compound is decomposed before it reaches the ozone layer. But due to high volatility this gas also can reach the stratosphere. If it reaches the ozone layer like this it has the potential to damage the of ozone layer by the cleavage of the C-Cl bond under the influence of high energy UV rays and formation of .Cl free radicals. 05

6. Based on the data in the table provided above, which of the gases HFC 23 and HFC 134a is most favorable for ozone depletion? Give reasons

HFC 23 is most favorable for ozone depletion since it has a higher GWP value 05

7. Although HFC gases are the ideal remedy for ozone depletion, what are the side effects of these gases on environment?

Although **HFCs** solve the ozone problem, they have **serious environmental side effects**:

Effect	Explanation
High Global Warming Potential (GWP)	HFCs absorb IR radiation strongly → major greenhouse gases.
Long atmospheric lifetime	They persist for decades, enhancing global warming.
Indirect climate impact	Contribute to rising global temperatures even without ozone depletion.

10

10 b

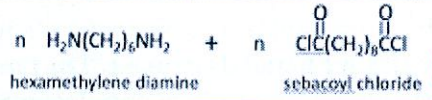
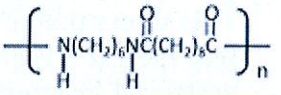
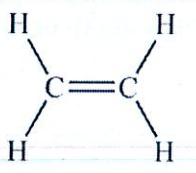
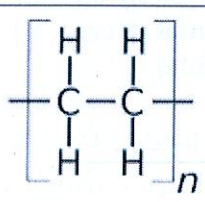
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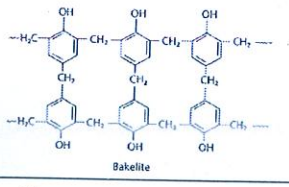
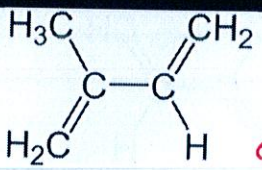
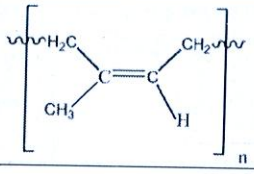
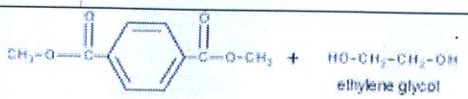
(50 marks)

(c) Using only the following compounds, identify the polymer corresponding to the given characteristic and state the corresponding structure and monomer in the table below. Copy the table in your answer sheet.

Compounds -:

CH_2CH_2, C_6H_5OH, $H_2NCH_2CH_2CH_2CH_2NH_2$, CH_2O, $CH_2=C(CH_3)CH=CH_2$, HO-(C_6H_4)-OH, $HOOCCH_2CH_2CH_2CH_2COOH$

Property	Structure of the monomer	Structure of the polymer
A synthetic, linear condensation polymer. Nylon	 10	 05
A thermoplastic additional polymer. Polythene	 05	 05

A thermosetting condensational polymer. Bakelite	[redacted]	Structure of Bakelite  Bakelite 05
An additional polymer with elastic properties. rubber	 05	 05
A synthetic, linear condensational polymer used in container and packaging applications. PET	 ethylene glycol 05	 terephthalate group ethylene group 05

(50 marks)

10C /50

***

10 - /100

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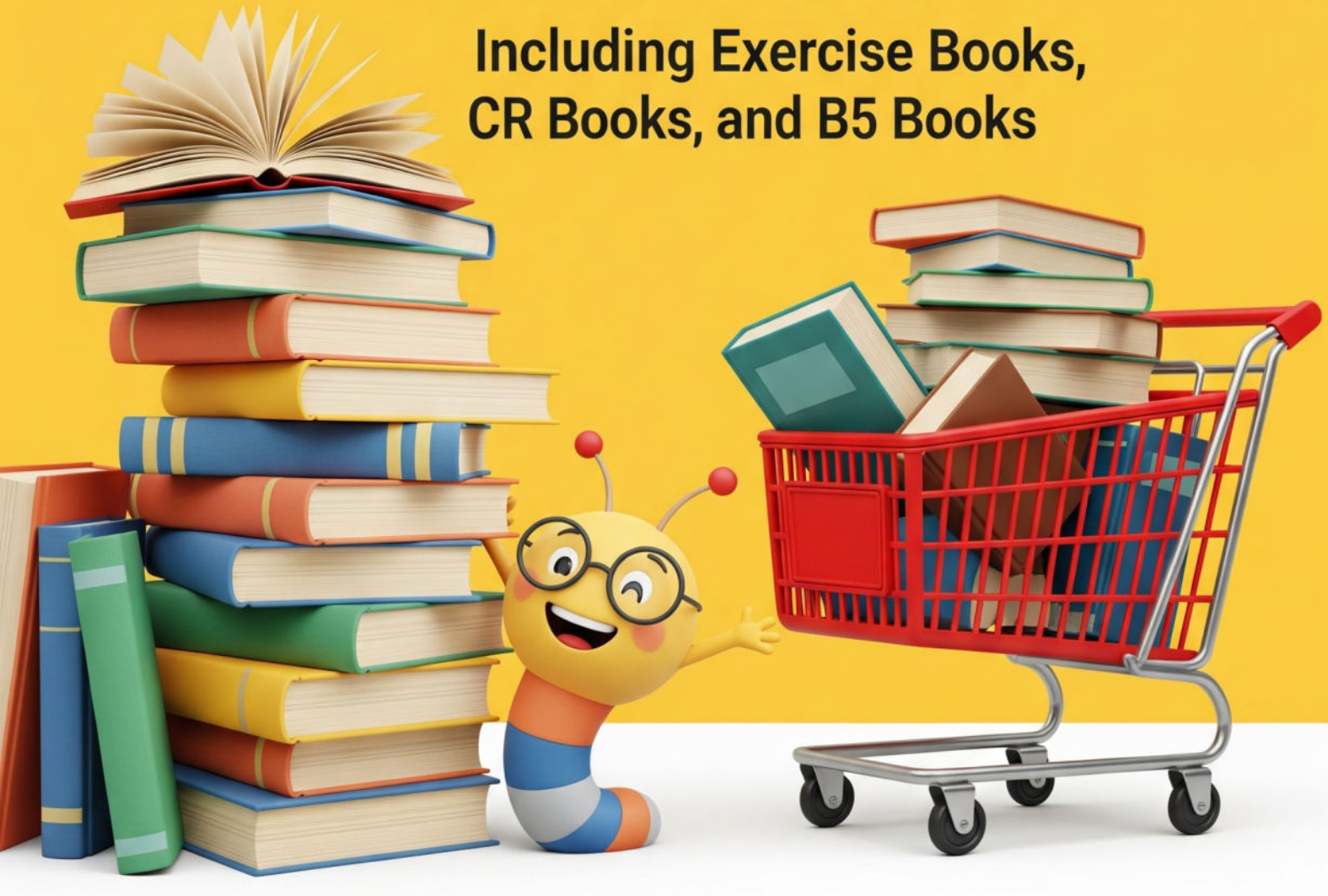
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