WESTERN PROVINCE EDUCATION DEPARTMENT 02 E I

GENERAL CERTIFICATE OF EDUCATION ADVANCED LEVEL PREPARATION PROGRAM 2022

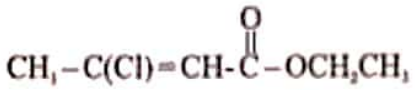
Subject - Chemistry | **Paper I** | **Time - 02 hours**

Universal Gas Constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$
Avogardro Constant	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Planck Constant	$h = 6.626 \times 10^{-34}\ J\ s$
Velocity of light	$c = 3 \times 10^{8}\ m\ s^{-1}$

1. "Planetary Model" on atomic structure was presented by
   1. Ernest Rurther ford 2. Robert Millikan 3. Niels Bohr
   4. J.J. Thomson 5. E. Goldstern

2. Ascending order of the number of unpaired electrons in the cations $Cr^{3+}, Fe^{2+}, Co^{2+}, Ni^{2+}$ in
   1. $Co^{2+}, Cr^{3+}, Fe^{3+}, Ni^{2+}$ 2. $Ni^{2+}, Co^{1+}, Fe^{2+}, Cr^{3+}$ 3. $Fe^{2+}, Cr^{3+}, Co^{2+}, Ni^{2+}$
   4. $Cr^{3+}, Fe^{2+}, Co^{2+}, Ni^{2+}$ 5. $Ni^{2+}, Cr^{3+}, Co^{2+}, Fe^{2+}$

3. IUPAC name of the compound given below is,



   1. methyl 3-chlorobut-2-enoate 3. ethyl 2-chlorobut-2-enoate
   2. ethyl-3-chlorobut-2-enoate 4. 2-chlorohex-2-en-4-one
   5. ethyl 3-chlorobut-2-enoate

4. Mass of NO_3^-, ion that would absorb one mole of electrons when No_3^- is converted to NO_2 in a given instant is,
   1. 6.2 g 2. 3.1 g 3. 31 g 4. 62 g 5. 48 g

5. Order of the elements with highest first second and third inoization energies, in the periodic table would be,
   1. Li,Be,He 2. Be ,He,Li 3. He,Na,Mg
   4. He,Li,Be 5. Ne,Li,Be

6. Compound A produces a yellow flame when subjected to the flame test part of this was dissolved in water and a dilute acid was added and a gas with pungent odour was liberated. The gas decolorizes H^+/MnO_4^- but does not form a precipitate. the gas decolorizes colorful flower petals compound A would be,

1. K_2SO_4 2. Na_2SO_4 3. Na_2SO_3
4. Na_2S 5. $Na_2S_2O_3$

7. Which of the following responses includes molecules/ ions with different repulsion pair geometry

1. PCl_5/SF_4 2. NH_4^+/CH_4 3. SF_6/ICl_4^-
4. NH_3/PH_3 5. XeF_4/SF_4

8. A volume of 15 cm^3 form a gaseous hydrocarbon was blasted and set on fire with 120 cm^3 $O_{2(g)}$. Then the volume was 90 cm^3. This gas volume was sent trough a solution of $KOH_{(aq)}$ and the volume decreased by 45 cm^3. If all the volumes were estimated under standard temperature and pressure, the molecular formulae would be,

1. C_2H_4 2. C_3H_6 3. C_3H_8 4. C_4H_6 5. C_4H_8

9. Calculate the conuntration of NaOH in mold m^{-3} when 400 ppm $NaOH_{(aq)}$ 50 cm^3 and 800 ppm NaOH 150 cm^3 were mixed (Na-23,O-16,H-1)

1. 0.035 2. 0.0175 3. 1.75 4. 3.5 5. 0.35

10. Which statement is false regarding HCOOH

1. $H^+/KMnO_4$ is reduced by it
2. Answer the Iolens reagents
3. It liberates Co_2 with Na_2CO_3
4. It forms CO when treated with H_2SO_4
5. It reduce feblings A and B

11. The order of variation in the electron negativity of natom in NO_2^+, NO, NO_2^-, NO_3^- N would be,

1. $NO > NO_2^+ > NO_2^- > NO_3^-$
2. $NO_2^+ > NO_2^- > NO_3^- > NO$
3. $NO_3^- > NO_2^- > NO_2^+ > NO$
4. $NO_2^- > NO_3^- > NO_2^- > NO$
5. $NO > NO_2^+ > NO_3^- > NO_2^-$

12. Which of the following solutions will give the highest value for change in pH at 25°C, when 1 cm^3 of 0.1 mol dm^{-3} Hcl is add
    1. 24 cm^3 of 1 $moldm^{-3}$ HCl
    2. 24 cm^3 of 1$moldm^{-3}$ NaOH
    3. 24 cm^3 of 1 $moldm^{-3}$ CH_3COOH and 1 $moldm^{-3}$ CH_3COONa
    4. 24 cm^3 of 1 $moldm^{-3}$ NaCl
    5. 24 cm^3 of 1 $moldm^{-3}$ NH_3 and 1 $moldm^{-3}$ $NH_4Cl_{(aq)}$

13. Product formed when excess CH_3MgBr is added hydrolyzed to CH_3COCl?
    1. CH_3COCH_3
    2. CH_3CO_2H
    3. $(CH_3)_3C\text{-}OH$
    4. $(CH_3)_3C\text{-}OMgBr$
    5. $CH_3CH(OH)CH_3$

14. Which of the following statements is false regarding benzene?
    1. C atoms in benzene are SP^2 Hybridized
    2. Characteristic reactions of benzene are electrophillic substitution reactions
    3. Benzene is converted to cyclohexane when treated with raney Ni and H_2 at 150 °C
    4. Bromo benzene is formed when $Br_{2(l)}$ is added to benzene
    5. Benzene is a defficient, understand compound

15. In the reaction given below, in which C is Formed by A and B, [A] is 1 $moldm^{-3}$ and [B] $1x10^{-4}$ $moldm^{-3}$ when [B] Increased four times, the rate law for the reaction would be,
    1. Rate $= k[A]^4$
    2. Rate $= k[A]^2[B]$
    3. Rate $= k[A][B]$
    4. Rate $= k[B]$
    5. Rate $= k[A]$

16. A slightly acidic solution of water was electrolyzed using 9.65 A Current for 200 s . The reaction at the anode would be, (1F = 96500 C) 1 mol of gas at S.T.P. 22.4 dm^3
    1. 112 cm^3 of O_2 liberated
    2. 56 cm^3 of H_2 liberated
    3. 0.0025 mol of $S_2O_8^{2-}$ formed.
    4. 112 cm^3 of H_2 liberated.
    5. 56 cm^3 of O_2 liberated

17. Which of the following is not a characteristic of a catalyst ?
    1. Initial amount remains Chemically unchanged
    2. Provides a new route for the reaction
    3. Does not alter the equilibrium constant
    4. Reduces the ethology change of a reaction
    5. Functions actively even when present in minutes quantities

18. Ksp value of $Mg(OH)_2$ is 32×10^{-12} $mol^3 dm^{-9}$ pH of a saturated solution of $Mg(OH)_2$ at 25°C would be,

1. 3.30 2. 10.61 3. 7 4. 4.62 5. 12.2

19. The two liquids, A and B with saturated vapour pressure in pure solvents 200mmHg and 300mmtth respectively, were mixed as 2mol of A and 3 mol of B, in a closed container what is the pressure in the vapour phase?

1. 200 mm Hg 2. 260 mm Hg 3. 340 mm Hg 4. 240 mm Hg
5. 360 mm Hg

20. The accurate order of water solubility of the given compounds is,

1. $CH_3OH > CH_3CH_2OH > CH_3CH_2CHO > CH_3CH_2CI > CH_3CH_2CH_3$
2. $CH_3CH_2OH > CH_3OH > CH_3CH_2CHO > CH_3CH_2CI > CH_3CH_2CH_3$
3. $CH_3CH_2CHO > CH_3OH > CH_3CH_2OH > CH_3CH_2CI > CH_3CH_2CH_3$
4. $CH_3CH_2CI > CH_3CH_2CH_3 > CH_3CH_2OH > CH_3OH > CH_3CH_2CHO$
5. $CH_3CH_2CH_3 > CH_3CH_2OH > CH_3OH > CH_3CH_2CI > CH_3CH_2CHO$

21. Select the correct statement

1. In the haber process of NH_3 Production , 450°C as temperature and a pressure of 205 atm are applied
2. During contact method of H_2SO_4 production low pressures (1atm) and a temperature about 450°C are applied
3. During Solvay process, CO_2 is sen t first in to brine solution and NH_3 is sent secondly
4. During production of NH_3,K_2O is used as a catalytic promoter for the catalyst iron dust
5. Dalton's law on partial pressure is applied for extraction of essential oil trough stem distillation

22. NH_3 was allowed to distribute between water and chloroform and $25cm^3$ of aqueous layer was titrated with $0.4moldm^{-3}$ Hcl and the consumed Hcl Volume was $40.0cm^3$. If the distribution coefficient of NH_3 between H_2O and $CHCl_3$ is 25, what would be the consumed Volume of $02.moldm^{-3}$ Hcl to titrate $20cm^3$ from the $CHCL_3$ Layer?

1. $3.2cm^3$ 2. $12.8cm^3$ 3. $6.4cm^3$ 4. $16.4cm^3$ 5. $26.2cm^3$

23. Steam distillation principle would be used to separate the constituents from

1. A mixture of petrol and kerosine
2. A mixture of petrol and diesel
3. A mixture of water and alcohol
4. A mixture of water and cinnamon oil
5. A mixture of petrol and gasoline

24. Which of the following in not a reaction relevant for photochemical smog?

1. $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$
2. $NO_2(g) \longrightarrow NO(g) + O_2(g)$
3. $NO(g) + O(g) \longrightarrow NO_2(g)$
4. $O(g) + O_2(g) \longrightarrow O_3(g)$
5. $O(g) + O_3(g) \longrightarrow OH(g)$

25. Which of the following reaction would be occur when con H_2SO_4 is added to the regent bottle in the experiment to determine the dissolved [$O_2(g)$] in water through winkler method?

1. $MN^{2+}(aq) + 2OH^-(aq) \longrightarrow Mn(OH)_2(S)$
2. $2Mn(OH)_2(S) + O_2(g) \longrightarrow 2MNO_2 + 2H_2O$
3. $MNO_2 4H^+ + 2I^- \longrightarrow Mn^{2+} + I_2 + 3H_2O$
4. $I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$
5. $H^+ + IO_3^- \longrightarrow I_2 + H_2O$

26. A compound was dissolved in water and NH_4 was ad to portion of that solution. A green precipitin was obtained. When excess dilute NH_4 was added precipitin remained unchanged. Another portion from the above was taken and H_2O_2 and NaoH were added to then a yellow solution was formed when was added to another portion of the above solution a gas was evolved and that gas decolorized the acidic $KMNO_4$ Solution Forming a turbidity the initial compound would be,

1. NiS 2. $NiSo_3$ 3. FeS 4. Cr_2S_3 5. $Cr_2(SO_4)_3$

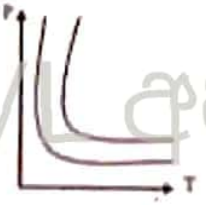
27. Which of the following compounds does not produce O_2 through thermal decomposition

1. SnO_2 2. PBO_2 3. K_2MNO_4 4. $KClO_4$ 5. CrO_3

28. Which of the following reaction sis not including as a step the born-harber cycle fro formation of $Mgcl_2$

1. $Mg(g) \longrightarrow Mg^+(g) + e$
2. $Mg^{2+}(g) + Cl^-(g) \longrightarrow MgCl_2(s)$
3. $Mg(s) \longrightarrow Mg(g)$
4. $Cl_2(g) \longrightarrow 2Cl(g)$
5. $Cl(g) + e \longrightarrow Cl^-(g)$

29. What is the curve that show the relationship between P and T, of and ideal gas with N1 and N2 (N2>N1) as Number of molecules in a constant volume?

1. 

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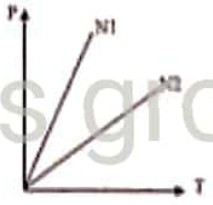
3. 

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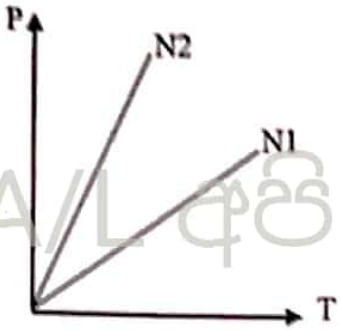

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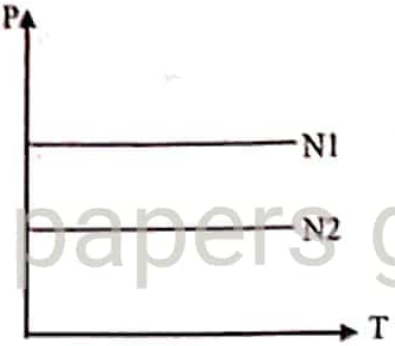


30. Following Reaction occurs in two steps

$2P + Q \longrightarrow R + S$

Step 1 : $P + Q \rightleftharpoons T$ (Fast) equilibrium Constant K

Step 2 : $P + T \longrightarrow R + S$ (Slow)

Order of the reaction is

1. 1 2. 2 3. 3 4. 4 5. 5

• For each of the question 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 you answer sheet, mark

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

Summary of 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. Correct Statements regarding S and P Blocks

a. All elements in group 1 except Li from nitride with N_2

b. K Produce KO_2 in the presence of excess O_2

c. Li reacts with N_2 to form LiN_3

d. Solubility of So_4^{2-} in group 2 increases down the group

32. Accurate order of strength of acidity of given compounds is

a. $RCOOH > R\text{-}OH > R\text{-}NH_2 > R - C = C\text{-}H$

b. $RCOOH > H\text{-}O\text{-}H > R\text{-}OH > R\text{-}C = C\text{-}H > R\text{-}NH_2$

c. $HClO_4 > HNO_3 > HCOOH > CH_3COOH$

d. $CH_3CH_2NH_2CL > CH_3CONH_2 > CH_3CH_2NH_2$

33. Compounds that does not convert red litmus to blue

a. CH_3NH_2CL b. $CH_3COO^-NA^+$ c. $C_6H_5NH_2HSO_4$ d. $CH_3CH_2NH_2$

34. Which statement /Statements is /are false about quantum numbers?

a. l=1 for electrons on p orbital

b. ml could be ½ for electrons in p orbitals

c. value of ml for and electron might be higher that l, by a value of 1

d. Spin quantum number for a given electron could be +½ or -½

35. Reactions that occur during production of TiO_2 form rutile,

a. $TiO_{2(S)} + C_{(S)} \rightarrow Ti_{(S)} + CO_{2(g)}$

b. $TiO_{2(S)} + C_{(S)} + 2Cl_2(g) \rightarrow TiCl_{4(g)} + CO_{2(g)}$

c. $TiCl_{4(g)} + O_{2(g)} \rightarrow Ti_{(s)} + TiO_{2(S)}$

d. $TiO_{2(S)} + C_{(S)} + 2Cl_2(g) \rightarrow TiCl_{4(g)} + CO_{(g)}$

36. Adverse effects of photochemical smog are

a. Reduction in harvest of agricultural crops

b. reduction in mechanical strength of rubber products

c. adverse health effect such as wheeze asthma and bronchitis

d. acid rains

37. Which Statements correct about electrolysis of a fused Na_2So_4 Solution using C electrodes?

a. $O_2(g)$ is liberated at the anode

b. $SO_2(g)$ is liberated at the anode

c. $S_2O_4^{2-}(l)$ is formed at the anode

d. Na(l) is formed at the cathode

38. Which statements are correct about CH_3COCH_2COOH?

a. $CH_3CH(OH)CH_2CH_2OH$ is formed when hydrolyzed using $LialH_4$

b. When $NaBH_4$ is added, $CH_3COCH_2CH_2OH$ is formed

c. Can be oxidized by $H^+/KMno_4$

d. $CH_3CH_2CH_2COOH$ is formed when Zn/Hg conc Hcl is added

39. Group that includes only dispersion forces as inter molecular forces

a. He,Ne,CCl_4, NO b. CO_2,Cis-2butene, Ccl_4,NO_2

c. NO_2^+, CO_2, Ccl_4,He d. CO_2,He,Ne,Ccl_4

40. Which is/are false about increasing temperature for the reaction given below?

$CH_4(g)+H_2O(g) \rightleftharpoons CO(g)+3H_2(g)\,;Ah=206\,kjmol^{-1}$

a. only the rate of the forward reaction is increased

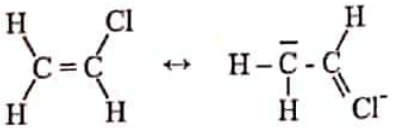
b. Only the rate of the reverse reaction is increased

c. forward reaction is encouraged

d. Activation energy of the reaction is reduced

• In question Nos. 40 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 Correctlty Explains the first statement
(2)	True	True, but does not explain the first statement Correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First Statement	Second Statement
41.	K_2Co_3 is more water soluble than Na_2Co_3	K_2Co_3 Can not be produced using the method in solvay process
42.	When an aqueous solution of a weak base is diluted, fraction of dissociated base molecules is increased and PH in the medium is decreased	Dissociation of a weak base occurs keeping the dissociation constant at a constant value
43.	Vinyl Chloride show the resonance effect given below 	Vinyl Chloride does not undergo substitution of OH^- under normal conditions
44.	Amines are more basic than alcohols	Stability of alkyloxonium iron is higher than the stability of alkyl ammonium ion
45.	When $Mg^{2+}_{(aq)}$ is added to a solution that includes Ag^+ ions Ag is precipitated	Standard reduction potential of $Mg^{2+}_{(aq)}$ is higher than the standard reduction potential of Ag^+
46.	Steam distillation principal is applied during extraction of essential oil	Essential Oil and water mixture is an ideal solution that obeys roult law

	First Statement	Second Statement
47.	Highest Oxidation number of all elements in group 17 is +7	Valency shell electron configuration of group 17 elements is Ns^2np^5
48.	In Group analysis, NH_4CL is also added with NH_3 to precipitate AI^{3+}	When NH_4Cl is added to NH_4OH Containing solution, OH^- concentration in the medium is decreased
49.	In and ideal gas at a given pressure kinetic engery of all ideal gases are equal	Mean square velocity of gas depends only on the temperature
50.	When a small quantity of Naoh is added o the anode of the daniell cell, electro motive force of the cell is increased	E.M.F of cell increased when the concentration of the ions in the cathode is increased

WESTERN PROVINCIAL DEPARTMENT OF EDUCATION 02 E II

GENERAL CERTIFICATE OF EDUCATION ADVANCED LEVEL PREPARATION PROGRAMME - 2022

Subject - Chemistry | **Paper II** | **Time - 03 hours**

Universal gas constant : $R = 8.314\ JK^{-1}\ mol^{-1}$ Planck's constant : $h = 6.624 \times 10^{-34} Js$

Avagadro constant : $N_A = 6.022 \times 10^{23}\ mol^{-1}$ Velocity of constant : $c = 3 \times 10^{8}\ ms^{-1}$

Part A - Structured Essay

01. a. Answer the questions below by considering the following elements.

B, N, O, S, Cl, F

i. Which element forms the most acidic oxide?

.....

ii. Which element forms the most basic hydride?

.....

iii. Name **two** elements which form oxoanions as XO^-_2 and XO^-_3

.....

iv. Which element does not show a positive oxidation number in the compound when combined with oxygen?

.....

v. Which element forms the hydride with the highest boiling point?

.....

b. Hydrazoic acid (HN_3) can be prepared by acidifying an azide salt. Hydrazoic acid is a colourless, volatile (with an unpleasant smell) and explosive liquid at room temperature and pressure.

The skeleton of hydrazoic acid is H-N-N-N

i. Draw **all** the resonance structures which can be drawn for hydrazoic acid.

ii. Draw the **most unstable** resonance structure out of above in (i)

Explain you answer for (ii)

.....

.....

.....

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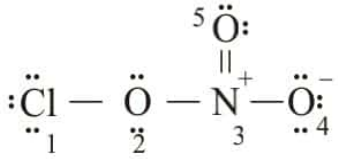
iii. Answer the following questions based on the given Lewis structure.



	Around the N atom	Around the O atom which attached to both Cl and N atoms
I. Electron pair geometry	.....	.....
II. Bond angle	.....	.....
III. Oxidation number	.....	.....

iv. Name the atomic orbitals which form σ and π bonds between N_3 an O_5 atoms.

σ bond N^3 ..... O^5 .....

π bond N^3 ..... O^5 .....

c. Complete the table by using the letters given for the description.

A - polar covalent bond
B - non-polar covalent bond
C - ionic bond
D - Hydrogen bond
E - London dispersion forces
F - permanent dipole – permanent dipole attraction forces
G - ion-permanent dipole attraction forces

Species	Type of bond in the species	Intermolecular interactions (if any)
XeF_4	.....	.....
$NaF_{(s)}$	.....	.....
$HCl_{(g)}$	.....	.....
$I_{2(s)}$	.....	.....

d. Arrange the following species according to the **ascending** order of the feature given within brackets.

i. Mg, Na, Al, Si (second ionization energy)

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

ii. H_2O , NH_3, C_2H_2, C_2H_5OH (acidity)

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

iii. OH^- , F^- , Cl^- , CH_3^- (basicity)

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

iv. Li^+ , Na^+ , Mg^{2+} , Al^{3+} (hydration enthalpy)

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

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02. Element **M** is a s - block element with the atomic number less than 20.

a. **M** burned in air and produced a solid mixture of **A** and **B** products. When this solid mixture is added to water, **A** produce a colourless basic gas **D**. **M** give a brick red colouration in flame test.

i. Write the chemical symbol of **M**.

.....

ii. Write the condensed electron configuration of **M**.

.....

iii. Identify the **A** and **B** solids and the **D** gas.

A ..... B ..... D .....

iv. Write the balanced chemical equations of **A**, **B** and **D** with water by using their standard symbols.

.....

.....

.....

v. Write a chemical test to identify the **D** gas.

.....

.....

.....

b. **'N'** is an anion which contain only **X** and **Y** elements in the ratio 1:2. Both **X** and **Y** elements belongs to the same period in p block and the electro negativity of **Y** is higher than that of **X**. Anion **N** act as a reducing agent.

i. Write the chemical formula of **N** (including its charge)

.....

ii. Draw the Lewis dot-dash structure of **N**.

.....

.....

.....

iii. An acidic $KMnO_4$ solution becomes colourless by reacting with **N**. Write the balanced ionic equation for this reaction.

.....

iv. Write the chemical formula of the compound **Q** where **M** is the cation and **N** is the anion.

.....

c. You are provided with bottles labelled as **A**, **B**, **C**, **D**, **E** and **F** which contain KI, Na_2S, K_2CO_3, HCl, $Zn(CH_3COO)_2$ and $AgNO_3$ aqueous solutions. (not in order). Each time two solutions were mixed in order to identify them,

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Mixed two solutions	Observation
D + E	Forms a yellow precipitate with both dilute and concentrated NH_3.
A + C	Forms a white precipitate which becomes a yellow solid once heated and again turns to white when cooled.
C + E	Forms a white precipitate. Decompose into constituent elements once heated.
E + F	Forms a black precipitate.
B + F	Forms gas with rotten egg smell
B + C	Evolve a colourless gas

i. Identify the compounds from A to F.

A ..... D .....

B ..... E .....

C ..... F .....

03. a. Write down the balance chemical equations for the following statements.

1. Standard atomization enthalpy of iodine

.....

2. Standard first electron gain enthalpy of bromine.

.....

3. Standard formation enthalpy of $AlBr_3$.

.....

4. Standard combustion enthalpy of C_2H_5OH.

.....

5. Standard second ionization enthalpy of calcium

.....

b. Consider the following reaction occur at 25 ^{0}C temperature.

$$AB_{(S)} \longrightarrow C_{(S)} + D_{(g)}$$

Following data of ΔH^0_f & S^0 were provide at 25 ^{0}C.

	ΔH^0_f / KJ mol^{-1}	S^0 / J mol^{-1}K^{-1}
$AB_{(S)}$	- 1208	100
$C_{(S)}$	- 600	50
$D_{(g)}$	- 500	170

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i. By a suitable calculation show that this reaction is not spontaneous at 25 ^{0}C.

ii. When the temperature is higher than T ^{0}C this reaction occurs spontaneously. Calculate the value of T.

c. Consider the aqueous solution of weak acid HF with the concentration 0.7 mol dm^{-3}.

(K_a(HF) = 7.0 x 10^{-5} mol dm^{-3})

i. Write the ionization reaction of HF in water at 25 ^{0}C.

ii. Write equilibrium constant expression for the above reaction in (i).

iii. A 50 cm^3 volume of above HF solution was mixed with distilled water and prepared a 250 cm^3 aqueous solution at 25 ^{0}C. Calculate the pH value of this dilute solution.

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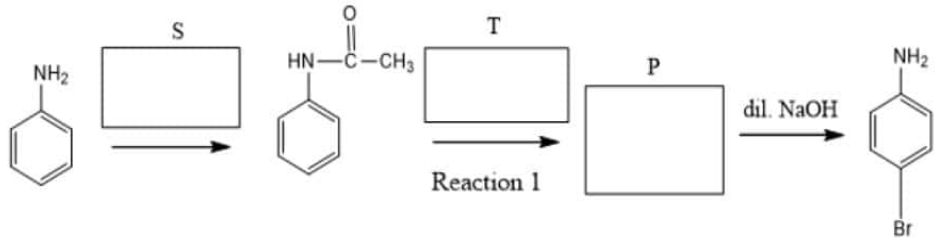
04. a. **A**, **B** and **C** are structural isomers having the molecular formula C_5H_8O. Only **A** shows the optical isomerism. None of these **A**, **B**, **C** isomers are diastereomers. All these compounds turn bromine solution to colourless and they all react with Tollens' reagent to give a silver mirror. By catalytic hydrogenation, both **B** and **C** compounds produce same compound **D** which is optically inactive. By Clemmenson reduction after hydrogenation, all **A**, **B** and **C** produce the same product **E**. Draw the structures of **A**, **B**, **C**, **D** and **E** in the boxes given below.

A B C

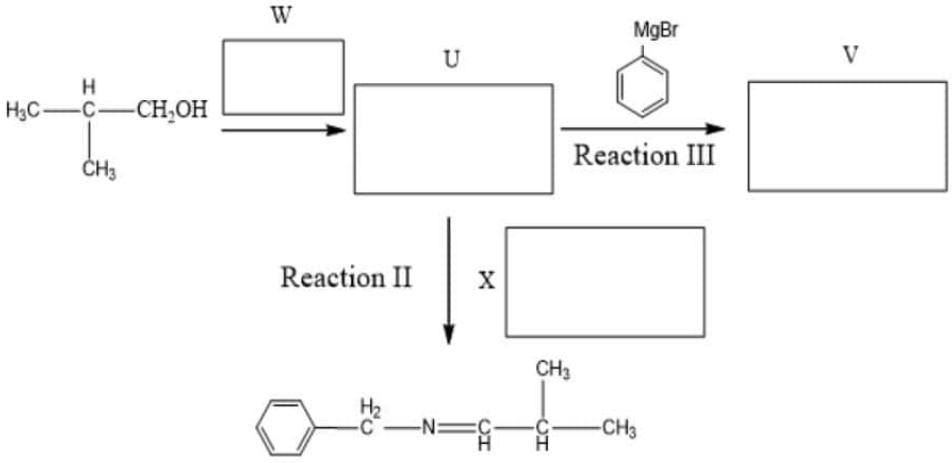
D E

b. Write the relevant structures (**P, U, V**) and reagents / catalysts (**S, T, W, X**) in the given boxes to complete the following reactions.

i.



ii.



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iii. Write the reaction type of above Reaction I, Reaction II and Reaction III.

Reaction I - .....

Reaction II - .....

Reaction III - .....

iv. Write the reaction mechanism for the Reaction II.

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Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$

Avagadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

Part - B

✹ **Answer two questions only.**

05. a. Following reaction was done at 298 K under 5 bar pressure.

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$$

Initially 5 mol from each NO_2 and N_2O_4 was added.

$\Delta fG^O\ (N_2O_{4(g)}) = 100\ kJ\ mol^{-1}$ and $\Delta fG^O\ (NO_{2(g)}) = 50\ kJmol^{-1}$

$\Delta rG = \Delta rG^O + 2.303RT \log Q^O p$

(ΔrG^O = Gibbs energy change of the reaction) at standard state.

i. Calculate ΔrG^O.

ii. Calculate $Q^O p$. (Reaction quotient at standard state)

iii. Calculate the ΔrG by using the above equation. (consider $ln\,(10) = 2.303$.

iv. If the reaction occurs under the initial pressure of 5 bar, deduce the direction of the reaction when it is getting closer to the equilibrium. ($K^0 p = 1$ bar)

v. Calculate the number of moles of NO_2 and N_2O_4 at the equilibrium.

If required, you can use following for the calculation. $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

When $ax^2 + bx + c = 0$

b. Saturated vapour pressures of n-hexane and n-heptane at 273 K are 45.5 mmHg and 11.4 mmHg in order. Vapour pressure of a mixture of n-hexane and n-heptane at 273 K is 37.3 mmHg.

i. Calculate the composition of n-hexane and n-heptane in the liquid phase as mole fraction.

ii. If the mole fraction of n-hexane at gaseous phase at 273 K is 0.75, what is the mole fraction of n-hexane in the liquid phase?

06. a. Following is a first order decomposition reaction occur in the gaseous phase.

$$(CH_3)_3\,CO\,O\,C\,(CH_3)_{3(g)} \longrightarrow 2CH_3CO\,CH_3 + C_2H_{6(g)}$$

Initial pressure of the system is 2.2×10^4 Pa and after 15 minutes pressure is 3.3×10^4 Pa.

i. Calculate the rate constant of the reaction.

ii. Calculate the half-life of the reaction.

iii. Calculate the pressure of the system after 9 minutes.

Note : For a first order reaction $log \dfrac{[A]_t}{[A]_0} = \dfrac{-kt}{2.303}$

$[A]_t$ = concentration at time t
$[A]_0$ = initial concentration
k = rate constant

b. i. A 200 cm^3 volume of an aqueous I_2 solution with a concentration 6.25×10^{-3} mol dm^{-3} is mixed with 1000 cm^3 of CCl_4 liquid. Then vigorously shake the mixture and let it come into an equilibrium at the temperature 't'. Once it reached the equilibrium, 50.0 cm^3 volume was taken out from the CCl_4 layer and titrate with a 0.05 mol dm^{-3} $Na_2S_2O_3$ solution. Used volume of $Na_2S_2O_3$ was 20.00 cm^3.

i. Calculate the I_2 concentration in the CCl_4 layer.

ii. Calculate the I_2 concentration in aqueous layer.

iii. Calculate the distribution coefficient of I_2 between CCl_4 and Water.

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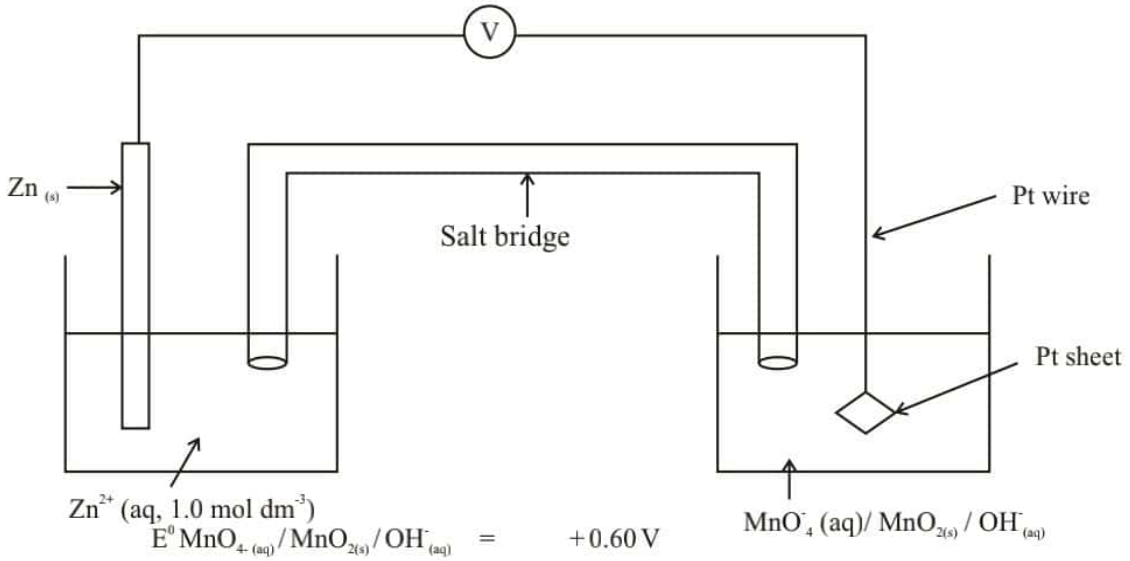
iv. If two 50.0 cm^3 potions of CCl_4 was used for the solvent extraction instead of 100.0 cm^3 potion of CCl_4, calculate the moles of I_2 extracted to the CCl_4 at the same temperature.

07. a. Consider the following Galvanic / Voltaic Cell.



$E^0 MnO_{4-(aq)} / MnO_{2(s)} / OH^-_{(aq)}$ = + 0.60 V

$E^0 Zn_{2+(aq)} / Zn_{(s)}$ = - 0.76 V

Mn = 55 g mol^{-1}, O = 16 $gmol^{-1}$

1F = 96500 C

Answer the following questions,

i. Write the anodic and cathodic half reactions.

ii. Write the complete cell reaction.

iii. Calculate the E^0 cell at 300 K temperature. Based on the sign of the Cell potential explain whether the reaction is spontaneous or non-spontaneous at 300 K.

v. At 300 K 965 A current flow through the cell within 900 seconds,

I. Calculate the amount of electric charges flowing through the cell.

II. Calculate the mass of MnO_2(s) produced.

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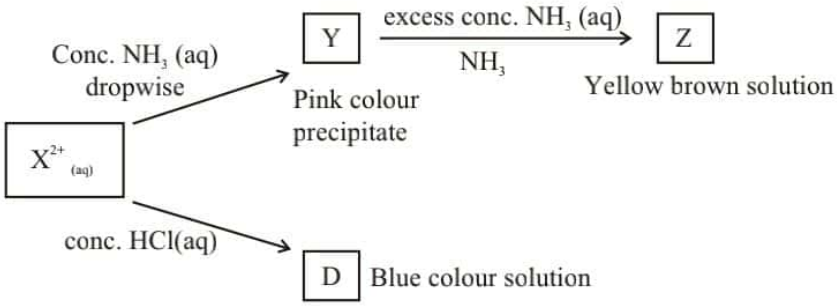
b. Element **X** belongs to the *d* block. X^{2+} ion shows following reactions.



X^{2+} ion with the coordination number six, produce A, B and C compounds with NH_3 and Cl^-. When 1 mol of each compound react with $AgNO_3$ separately, A, B and C produce precipitates as 1 mol, 2 mol and 3 mol in order.

i. Identify the metal X.

ii. What is the precipitate formed by above coordination compounds with $AgNO_3$?

iii. Write the chemical formula of B, C, D, Y, Z compounds.

iv. What is the shape of the A, B and C coordination complexes?

v. Draw the structure of C.

vi. What is the colour of the X^{2+} ion?

vii. Write the complete electron configuration of X^{2+} ion.

viii. Write the expected observations in following I and II.

I. When H_2S gas sent through a basic solution containing X^{2+} ion in the room temperature.

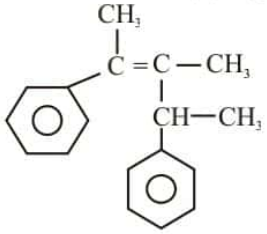
II. When hot concentrated HNO_3 is added to the mixture obtained from (I)

Part C

✹ **Answer two questions only.**

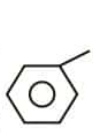
08. a. By using only the given materials and substances in the list, show how you would synthesize the following compound in **not** more than **seven (7)** steps.

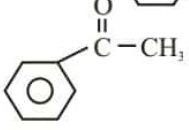
i.



List of materials and reagents

$LiAlH_4$, PCl_3, anhy. $AlCl_3$, Mg, CH_3OCH_3, H_2O, conc. H_2SO_4, CH_3COOH, C_6H_6

ii. I. Write down the products in the chemical reaction between  and CH_3CH_2MgCl

II. Write the mechanism for the reaction between  and CH_3CH_2MgCl

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III. 'Although nucleophilic substitution is the characteristic type of reaction for alky halides, it is not for phenyl halides'. Explain this statement.

b. i. Explain giving reasons which is more basic comparing aniline  and ethyl amine ($CH_3CH_2NH_2$).

ii. Using CH_3CH_2COOH as the only organic starting material, show how you would synthesize

in not more than 05 steps using the required reagents and reaction conditions.

09. a. Compound '**A**' is a green colour solid crystal. Following tests were done on A.

	Experiment	Observation
i.	dissolved in dil. H_2SO_4	does not evolve a gas
ii.	a drop of $KMnO_4$ was added to the above solution	purple colour of $KMnO_4$ disappeared.
iii.	Compound **A** was thoroughly heated	**B** and **C** two gases evolved with a pungent smell. A brown precipitate **D** remains.
iv.	**B** and **C** gases bubbled through a $K_2Cr_2O_7$ solution.	Orange colour solution turned to green colour.
v.	$Ba(NO_3)_2$ was added to the green colour solution produce in the step (iv)	White precipitate **E** was formed
vi.	The brown colour residue **D** was heated with charcoal in a reducing flame.	Produce a magnetic material

i. Identify the compounds from **A** to **E**.

ii. Write balanced chemical equations for the steps (ii), (iii), (iv) and (v).

b. Following procedure was carried out by a student to determine the Fe_2O_3 and Fe_3O_4 mass percentages in a mixture of Fe_2O_3, Fe_3O_4 with some inert impurities.

A mass of 8.0 g of the mixture (Fe_2O_3, Fe_3O_4, inert impurities) was reacted with the excess aqueous KI solution in acidic medium. From that all the ion in the mixture was reduced to Fe^{2+}. The resulting solution was diluted up to 50 cm^3 and obtained the solution **X**.
Step 1 – 7.20 cm^3 volume of 1 mol dm^{-3} $Na_2S_2O_3$ was used to react with the I_2 released by 10.00 cm^3 of **X** solution.
Step 2 – 4.20 cm^3 volume of 1 mol dm^{-3} $KMnO_4$ in acidic medium was used to completely titrate a 25.00 cm^3 solution of **X** containing Fe^{2+} ions
Calculate the mass percentages of Fe_2O_3 and Fe_3O_4 in the initial mixture. (Fe = 56.0)

10. a. Sweet toddy obtained by tapping the tender inflorescence of the coconut tree can be used as the starting material to produce both ethanol and vinegar. Alcohol is produced by the fermentation of sweet toddy.

i. What is happening during 'fermentation'?

ii. Write the two balanced chemical equations regarding the production of ethanol by fermentation.

iii. a. What is the method used to obtain rectified spirit with maximum of 97% ethanol from an aqueous ethanol solution?

b. What is the name of the physical-chemical law related to the above method?

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iv. Sketch a graph to show the variation of concentration in sucrose, ethanol and CH_3COOH in vinegar with time during first 48 hours of sweet toddy fermentation.

(x axis – time, y axis – concentration)

b. Vegetable oil, a renewable natural resource is used to produce soap and bio diesel.

i. Soap can be produced by hot process

I. What is the name of the first step in hot process?

II. What is the reagent used in that process?

III. What is the function (reaction type) of that reagent?

ii. There are five basic steps in producing bio diesel.

I. What is the name of the 3rd step where bio diesel is produced?

II. Why it is called as that in (I) ?

III. What is the common by-product of both bio diesel and soap production?

iii. Is that bio diesel 100% renewable fuel or not? Explain your answer.

c. Nitrogen is the main component in the atmosphere. Nitrogen is also involved with some main environmental problems.

i. Give one responsible of nitrogenous compound each for acid rain, global warming, depletion of ozone layer and photo-chemical smog.

ii. Write one natural/human activity where each of these gases added to the atmosphere.

iii. Explain how the acid rain occur and reduce the pH value of soil by the gas you mentioned above in (ii).

iv. Write main three water parameters which are affected by acid rains.

v. Define water hardness and write three cations which cause hardness in water.

d. When the dissolved oxygen level reduced to very low value, it can create an anaerobic condition in water. There are anaerobic conditions at the bottom of deep water bodies.

i. What is the 'titration method' used to determine the dissolved oxygen in water?

ii. What is the purpose of adding KOH and $MnSO_4$ in the above method?

iii. Following procedure was carried out to determine the dissolved oxygen content in a water sample taken from a 'water tank' ("wewa" / "Kulam")

In alkaline medium excess $MnSO_4$ was added to a 600 cm^3 of water sample from the water tank. It was mixed well and excess acidified KI was added. The liberated I_2 was titrated against 0.05 mol dm^{-3} $Na_2S_2O_3$ solution and the end point reading was 18.00 cm^3. Calculate the amount of dissolved oxygen in the tank in g dm^{-3}.