Chemistry Answer sheet

Section – A

Question no: 01 [Each 1 M]

1. C) Remains same
2. C) 0.5 M $Al_2(SO_4)$
3. a) -18.69 kcal
4. c) Ag NO_3
5. a) 1800 S
6. a) Formation of slag
7. b) Thiosulphuric acid

Question no: 02

1)

i. X-ray crystallography study of ice shows that it has hexagonal three dimensional crystal structure formed by intermolecular hydrogen bonding, which leave almost half the space vacant, unoccupied ……………………..1/2 M
ii. X-ray studies of liquid water shows that structure of liquid water and solid ice are almost identical. ………………………1/2
iii. However on melting of ice some of the hydrogen bonds are broken and some of the empty spaces are occupied by water molecules. and astonishingly density of liquid water molecule become more than solid water ……………………..1/2M
iv. Hence ice floats on water. This is due to more empty space in hexagonal structure of ice…….1/2 M

2)

Statement:
The solubility of a gas in a liquid at constant temperature is proportional to the pressure of the gas above the solution. If S is the solubility of the gas in mol dm^{-3}, then according to Henery's law,

$$S \propto P \quad \text{i.e} \quad S = KP$$

Where P is the pressure of the gas in atmosphere,
K is constant of proportionality and has the unit of mol dm^{-3} atm^{-1} ………………..1M

Explanation
When carbonated soft drink beverage bottle is sealed with cap, it is pressurized by a mixture of air and carbon dioxide. Due to high partial pressure of carbon dioxide the amount of carbon dioxide in dissolved state is very high in soft drink. When the cap is removed the excess of carbon dioxide and air sealed in the bottle escapes, external pressure decreases, solubility of carbon dioxide decreases and it escape producing effervescence. ………………………………..1M

3)

Relation between ΔH and ΔU

$\Delta H = \Delta U + p\,\Delta V$ OR $\Delta H = \Delta U + \Delta n\,RT$

Where ………………..1M

Δn is the difference between the number of moles of gaseous products and gaseous reactants

Condition under which ΔH =ΔU

1. When the reaction is carried out in a closed vessel so that the volume of the system remains constant, ΔV = 0.
2. When the reactions involved only solids and liquids.
3. In the reactions in which the number of moles of gaseous reactants consumed is equal to the number of moles of gaseous products produced at constant temperature and pressure , then Δn =o … ………………………...1M

4)

Electrochemical series

The arrangement of electrodes (metal or non metal in contact with their ions) with the electrode half reactions in order of decreasing standard potential is called electrochemical series…………………………1M

Application

i. To determine the relative strength of oxidizing agents in terms of E^o values
ii. To determine the relative strength of reducing agents in terms of E^o values
iii. Identifying the spontaneous direction of reaction
iv. To calculate the E^o cell ……………………………………………………………………………………………….1M

5)

Salt bridge

……1/2M

It is an U shaped galss tube containing a saturated solution of an electrolyte such as KCl or NH_4NO_3 and 5% agar solution. The salt bridge is prepared by filling the glass tube with a hot saturated solution of the salt and agar solution and allowing it to cool. The cooled mixture sets to solid so that the solution does not come out on inverting the tube …………1/2

Function

i. It provides an electrical contact between the two solutions and thereby completes the electrical circuit.
ii. It prevents the mixing of electrode solutions
iii. It maintains electrical neutrality in both the solutions by a flow of ions.

…………1M

6)

Order	Molecularity
1. It is the sum of the exponents to which the concentration terms in the rate law are raised.	1. It is the number of reactant molecules taking part in an elementary reaction.
2. It is purely an experimental property indicating the dependence of observed reaction rate on the concentration of reactants	2. It is theoretical property indicating the number of reactant molecules involved in each act leading to reaction.
3. It may be integer, fraction or zero	3. It is always an integer and never be a fraction or zero
4. It may change with experimental condition	4. It does not change with experimental conditions.
5. It is the property of both elementary and complex reactions.	5. It is the property of only elementary reactions and has no meaning for complex reactions.

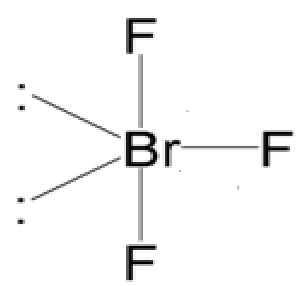
…………………………..Each point ½ M

7)

Sometime, it is possible to separate two sulphide ores by adjusting the proportion of oil to water or by using depressants ………………………………….1M

For example, to separate PbS and ZnS from the ores, NaCN is used as depressant. It selectively prevents ZnS from coming to the froth and PbS is removed along with the froth. ……………………..1M

8)



1. In BrF_3, Br is the central atom. It has seven electrons in the valence shell. These electrons of bromine form electron pair bonds with three fluorine atoms. Still bromine possesses four electrons in valence shell.
2. Therefore, there are three bond pairs and two lone pairs, by the concept of VSEPR theory, these bond pairs will occupy the corner of a trigonal pyramid. Two lone pairs will occupy the equatorial position to minimize lone pair – lone pair and the bond pair-bond pair repulsions.
3. These repulsions are greater than bond pair-bond pair repulsion. The axial fluorine atoms will bent towards equatorial fluorine atoms in order to minimize the lone pair-lone pair repulsion. It results into the bent T- structure of BrF_3

[Each point ½ M ; Structure ½ M]

Question no: 03

1)

(i) According to Fajan's Rule, bigger ions more are polarised than the smaller ion by a particular cation. Hence metal fluorides are more ionic than metal chlorides.

(ii) ClO_4^- is more resonance stabilised than SO_4^{2-} since dispersal of negative charge is more effective in ClO_4^- as compared with SO_4^{2-}. Therefor perchloric acid is stronger than sulphuric acid.

(iii) $2KI + Cl_2 \longrightarrow 2KCl + I_2$

Excess $5Cl_2 + I_2 + 6H_2O \longrightarrow 2HIO_3 + 10\ HCl$ (Colourless).

……….Each point 1M

2)

Unit cell of fcc type gold contain $= \frac{1}{8}\times 8 + 6\times\frac{1}{2} = 4$ atoms ½ M

Mass of unit cell of fcc type $= 4\times\frac{197}{6.022\times10^{23}} = 130.85\times10^{-23}$ g 1/2M

Density of gold $= 19.3$ g cm^{-3} ½ M

Density $= \frac{\text{mass of unit cell}}{\text{volume of unit cell}}$

Hence, volume of unit cell, $V = \frac{130.85\times10^{-23}\ g}{19.3\ g\ cm^{-3}} = 6.78\times10^{-23}\ cm^3$

Now $V = a^3 = 6.78\times10^{-23}\ cm^3$ 1/2M

where a is the edge of unit cell.

Hence $a = \sqrt[3]{6.78\times10^{-23}\ cm^3} = 4.08\times10^{-8}$ cm 1/2M

for fcc type unit cell

$a = \sqrt{8}\ r$

Hence $r = \frac{a}{\sqrt{8}} = \frac{4.08\times10^{-8}\ cm}{\sqrt{8}} = 1.44\times10^{-8}$ cm ½ M

$= 144$ pm.

3) Mass of solute, $W_2 = 8g = 8 \times 10^{-3}kg$, $K_f = 4.9K\ kg\ mol^{-1}$, $\Delta T_f = 1.62K$, $W_1 = 100g = 0.1kg$ ½ M

$$\Delta T_f = \frac{W_2 \cdot K_f}{M_2 \cdot W_1}$$

Hence $$M_2 = \frac{W_2 \cdot K_f}{W_1 \cdot \Delta T_f} = \frac{8 \times 10^{-3}kg \times 4.9K\ kg\ mol^{-1}}{0.1kg \times 1.62K}$$ 1/2M

$$= 241.9 \times 10^{-3}\ kg\ mol^{-1}$$

Thus the actual experimental molecular mass of benzoic acid is 241.9

Theoretical, formula molecular mass of benzoic acid (C_6H_5COOH) is 122. Observed molecular mass is almo double the theoretical mass as it associates in benzene as,

$$2C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_2$$

Initial moles: m, o

Equilibrium moles: $m - m\alpha$, $\frac{m\alpha}{2}$ 1/2M

Total moles in solution $= m - m\alpha + \frac{m\alpha}{2} = m\left(1 - \frac{\alpha}{2}\right)$

$$i = \frac{\text{observed moles in solution}}{\text{theoretical mole}} = \frac{m\left(1-\frac{\alpha}{2}\right)}{m} \quad 1 - \frac{\alpha}{2}$$

$$i = \frac{\text{theoretical molecular mass}}{\text{observed molecular mass}} = \frac{122}{241.98} = 0.5041$$ 1/2M

Equating the two values of i

Hence, $$1 - \frac{\alpha}{2} = 0.5041$$ 1/2M

$$\frac{\alpha}{2} = 1 - 0.5041 = 0.4959$$

Hence, $$\alpha = 2 \times 0.4959 = 0.9918$$

Benzoic acid is associated to the extent of 99.18% 1/2M

4) The logarithmic form of Arrhenius equation is

$$\log_{10} k = \log_{10} A - \frac{E_a}{2.303RT}$$ 1M

Or $$\log_{10} \frac{A}{k} = \frac{E_a}{2.303RT}$$

$E_a = 85.2\ kJ\ mol^{-1} = 85.2 \times 10^3\ J\ mol^{-1}$, $T = 310K$, $A = 3.1 \times 10^{11}\ L\ mol^{-1}\ s^{-1}$

Hence, $$\log_{10} \frac{3.1\times10^{11}\ (L\ mol^{-1}\ s^{-1})}{k} = \frac{85.2\times10^3\ (\cancel{J}\ \cancel{mol}^{-1})}{2.303\times8.314\ (\cancel{J}\ \cancel{K}^{-1}\ \cancel{mol}^{-1})\times310(\cancel{K})}$$ 1M

$$= 14.354$$

That is $$\frac{3.1\times10^{11}\ (L\ mol^{-1}\ s^{-1})}{k} = \text{antilog}\ (14.354) = 2.26\times10^{14}$$

and $$k = \frac{3.1\times10^{11}\ (L\ mol^{-1}\ s^{-1})}{2.26\times10^{14}} = 1.372\times10^{-3}\ L\ mol^{-1}\ s^{-1}$$ 1

Question no: 04

1.

a) Nitrous oxide (N_2O) is called laughing gas, because when inhaled it produced hysterical laughter. It is prepared by gently heating ammonium nitrate.

$$NH_4NO_3 \longrightarrow N_2O + 2H_2O$$ …………………………2M

b) **Smelting:**

It is process of extracting the impure molten metal from its ore at a high temperature using suitable flux and a reducing agent ……………………………………..1M

Flux:

A flux is a chemical substance added to the concentrated ore during smelting in order to remove the gangue to form easily fusible slag. ………………………………….1M

c) The given reaction is

$$H_2N-NH_2(g) + H-H(g) \longrightarrow 2\,NH_2-H(g) \quad \Delta H° = -184\ kJ$$ 1M

$$\Delta H° = \sum\Delta H°(\text{reactant bonds}) - \sum\Delta H°(\text{product bonds}).$$
$$= 4\,\Delta H°(N-H) + \Delta H°(N-N) + \Delta H°(H-H) - 6\Delta H°(N-H)$$
$$= \Delta H°(N-N) + \Delta H°(H-H) - 2\,\Delta H°(N-H)$$ 1M

Hence, $1\,(mol) \times \Delta H°(N-N) = \Delta H° + 2\Delta H°(N-H) - \Delta H°(H-H)$

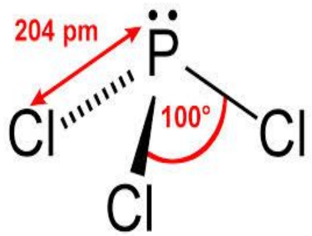
$$= -184(kJ) + 2(\cancel{mol}) \times 389(kJ\,\cancel{mol}^{-1}) - 1(\cancel{mol}) \times 435(kJ\,\cancel{mol}^{-1})$$
$$= -184(kJ) + 778(kJ) - 435(kJ) = +159\ kJ$$ 1M

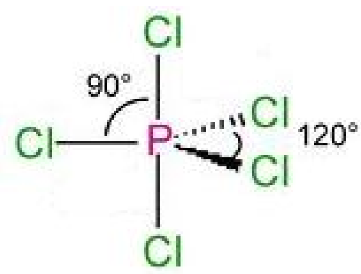
and $\Delta H°(N-N) = +159\ kJ\ mol^{-1}$.

Thus, N–N bond enthalpy is 159 $kJ\ mol^{-1}$.

OR

2. a)





Each structure 1M

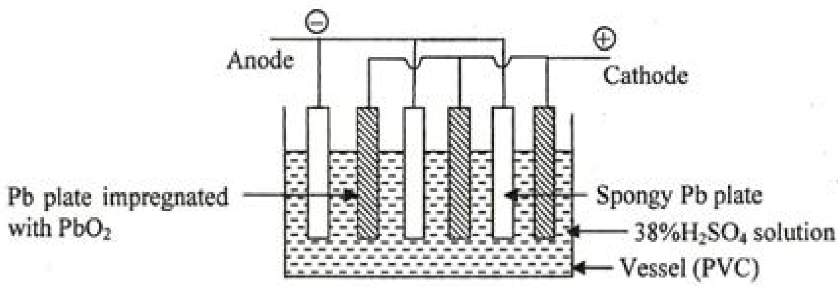
b) **Roasting:**

Roasting is a process in which ores are heated to a high temperature below their melting point in the presence of excess of air. ……………………….1M

Calcination:

Calcination is a process in which the ore is heated to a high temperature below its melting point in the absence of air or in a limited supply of air. ……………………..1M

c)



Working:

The cell works on the basis of charging and discharging.

i. **Discharging:** When Pb and PbO_2 electrodes are connected externally by metallic wire, the electrons are transferred from Pb to PbO_2 electrode, then chemical energy is converted into electric energy.

Cell Reaction:

a. **At Pb electrode (Anode):**
At Pb electrode, Pb dissolves giving Pb^{2+} ions, which combine with SO_4^{2-} ions of H_2SO_4 and form $PbSO_4$. [$2H_2SO_{4\,(aq)} \rightarrow 4H^+_{(aq)} + 2SO_4^{2-}{}_{(aq)}$]

$$Pb_{(s)} \rightarrow Pb^{2+}_{(aq)} + 2e^-$$
$$Pb^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow PbSO_{4\,(s)}$$
$$\overline{Pb_{(s)} + SO_4^{2-}{}_{(aq)} \rightarrow PbSO_{4\,(s)} + 2e^- \text{ (oxidation)}}$$

b. **At PbO_2 electrode (cathode):**
The electrons from Pb electrode are accepted by PbO_2 and PbO_2 reduces to $PbSO_4$ as

$$PbO_{2\,(s)} + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_{4\,(s)} + 2H_2O_{(l)} \text{ (reduction)}$$

Note: In this oxidation state of Pb is reduced from +4 to +2 by accepting two electrons.

Net cell reaction:

$$Pb_{(s)} + PbO_{2\,(s)} + 2H_2SO_{4\,(aq)} \rightarrow 2PbSO_{4\,(s)} + 2H_2O_{(l)}$$

Thus in discharging of the cell, H_2SO_4 is converted into H_2O and the specific gravity of the acid falls

Diagram	1M
Cell rxn at anode	1M
Cell rxn at cathode	1M

Section – B

Question no: 05 **Each 1M**

1. A) Penicillin
2. D) 1,4
3. D) Dacron
4. A) 5
5. A) $MnSO_4$
6. B) Formic acid
7. D) $COOCH_3$

Question no: 06

1.
   For $[Mn(H_2O)_6]^{3+}$
   $\Delta_0 < P$: the electron remains unpaired and occupies **eg** level (High spin) ……………………….1M

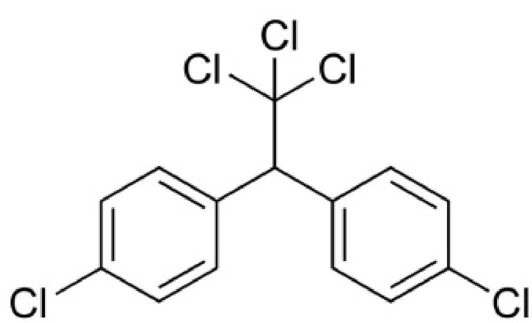
   For $[Mn(CN)_6]^{3-}$
   $\Delta_0 > P$: the electron occupies **t_2g** level and tends to pair (Low spin) ……………………1M

2. Dichromate ion is orange in acidic solution (pH < 7) and turn yellow in basic solution (pH > 7). It is due to interconversion of dichromate ion into chromate ion. following reaction take place

$$2\,Cr0_4^{2-}{}_{(yellow)} + 2\,H^+ \rightarrow Cr_2O_7^{2-}{}_{(orange)} + H_2O$$
$$Cr_2O_7^{2-}{}_{(orange)} + 2\,OH^- \rightarrow 2\,Cr0_4^{2-}{}_{(yellow)} + H_2O$$

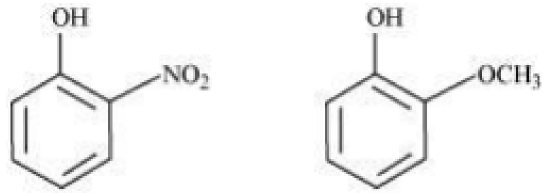
……………………..2M

3. p,p'-dichloro diphenyl trichloro ethane………………………………………………………………….1M



……………………………………………………………………………1M

4.



o – Nitrophenol o – Methoxyphenol

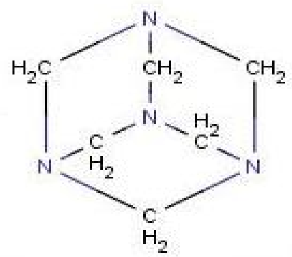
………………..1M

I. The nitro-group is an electron-withdrawing group. The presence of this group in the ortho position decreases the electron density in the O-H bond. As a result, it is easier to lose a proton. Also, the o-nitrophenoxide ion formed after the loss of proton is stabilized by resonance. Hence, ortho-nitrophenol is stronger acid.

II. On the other hand, methoxy group is an electron-releasing group. Thus, it increases the electron density in the O-H bond and hence, the proton cannot be given out easily. Therefor ortho nitrophenol is more acidic than ortho- methoxyphenol …………………1M

5. **Uses**

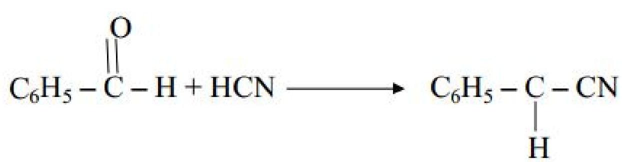
1) Is is used as internal urinary antiseptic
2) It is used in the production of plastics and drugs……………………………….1M

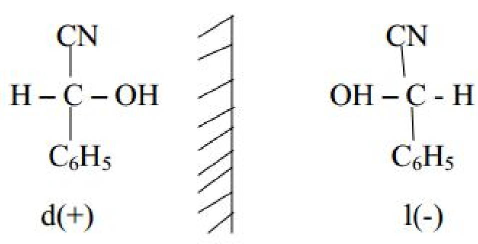


urotropin

……………………………1M

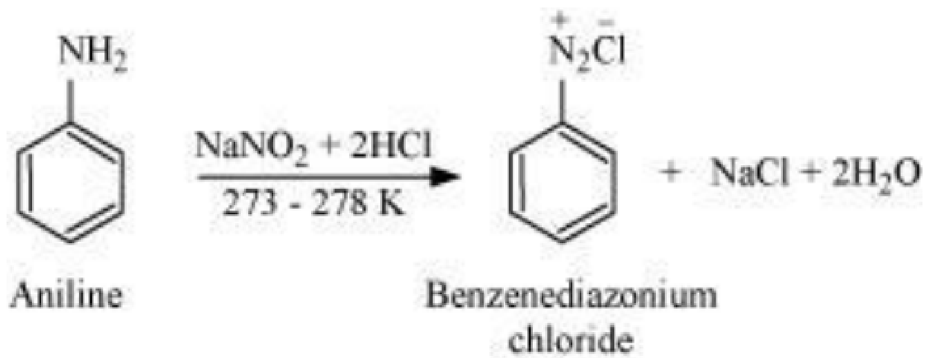
6. It is because we get two optical isomers which have same physical properties. Cannot be separated by fractional distillation ……………………………………………………………………….1M





………………………………………………….1M

7. Aromatic primary amines react with nitrous acid (prepared in situ from $NaNO_2$ and a mineral acid such as HCl) at low temperatures (273-278 K) to form diazonium salts. This conversion of aromatic primary amines into diazonium salts is known as diazotization.
For example, on treatment with $NaNO_2$ and HCl at 273–278 K, aniline produces benzene diazonium chloride, with NaCl and H_2O as by-products. …………………………1M



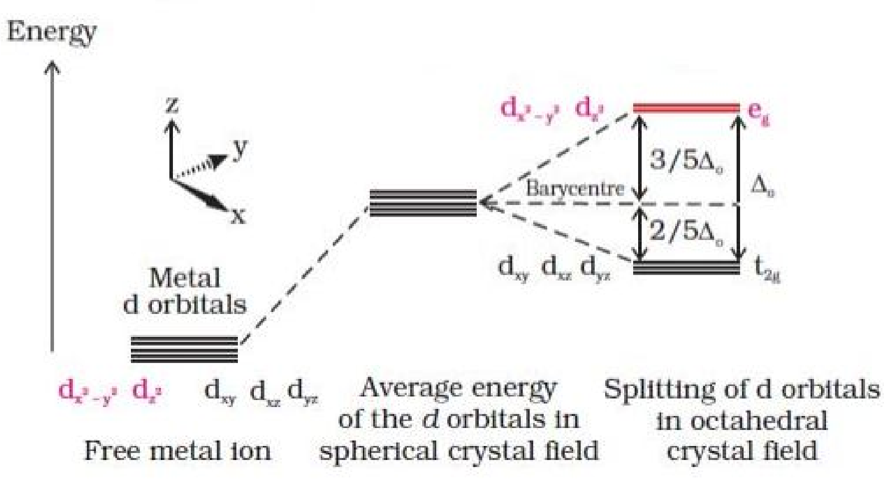
………………………………………………………………………………….1M

8. Thymine, Deoxyribose pentose sugar and Phosphoric acid

………………………..1M

Question no: 07

1)



d orbital splitting in an octahedral crystal field

……………………………………1M

1. In an octahedral complex, six ligands occupy their positions at the vertices of a regular octahedron with metal atom at the centre of the octahedron .
2. Among five d-orbital's, d_{x2-y2} and d_{z2} are axial orbital and have maximum electron density along the axes. Remaining three d-orbitals (d_{xy} d_{yz} d_{zx}) are planar orbital and posses maximum electron density in planes and in between the axes.
3. Therefore, d_{x2-y2} and d_{z2} orbital experience the maximum repulsion by the ligands while d_{xy} , d_{yz} and d_{zx} orbitals are less affected
4. As a result, the energy of d_{x2-y2} and d_{z2} orbital become much greater as compared to the remaining three d-orbitals. Thus the five degenerate d –orbital lose their degeneracy and split into two point groups-t_{2g} and e_g
5. T_{2g} group orbitals contains three degenerate orbitals as d_{xy},d_{yz} and d_{zx} whereas e_g group of orbitals contain two degenerate orbitals as d_{x2-y2} and d_{z2}.
6. Due to face to face repulsion the e_g group of orbital possesses higher energy than that of t_{2g} orbitals. The energy gap in between these two sets is Δ_0 or 10Dq

For d^4 ions, two possible patterns of electron distribution arise:

(i) If $\Delta o < P$, the fourth electron enters one of the eg orbitals giving the configuration $t^3{}_{2g}$ e^1g . Ligands for which $\Delta o < P$ are known as weak field ligands and form high spin complexes.

(ii) If $\Delta o > P$, it becomes more energetically favourable for the fourth electron to occupy a t_2g orbital with configuration $t^4{}_{2g}$ e^0g. Ligands which produce this effect are known as strong field ligands and form low spin complexes.

Explanation 2M

2)

(i) $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

(ii) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

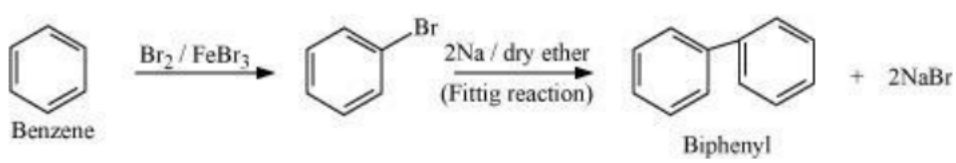
(iii) $2MnO_4^- + H_2O + I^- \rightarrow 2MnO_2 + 2OH^- + IO_3^-$

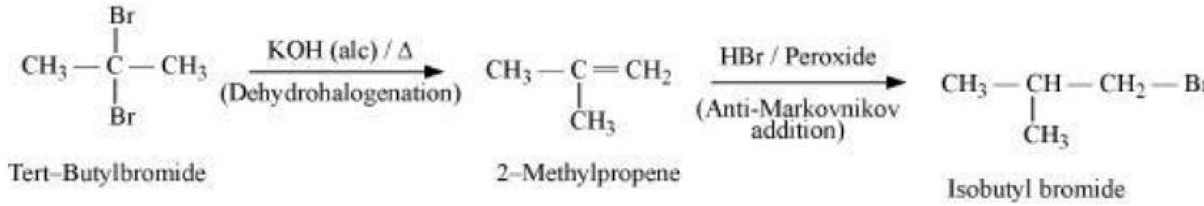
Each Rxn 1M

3)

a) $CH_3-CH_2-Cl \xrightarrow[\text{(Wurtz reaction)}]{\text{2 Na / dry ether}} CH_3-CH_2-CH_2-CH_3 + 2NaCl$

Chloroethane Butane

b) 

c) 

…………………………..Each Rxn 1M

4)

1-propoxypropane can be synthesized from propan-1-ol by dehydration. Propan-1-ol undergoes dehydration in the presence of protic acids (such as H_2SO_4, H_3PO_4) to give 1-propoxypropane.

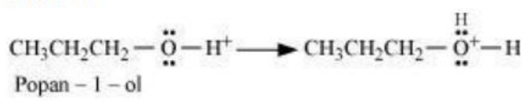
$$2CH_3CH_2CH_2-OH \xrightarrow{H^+} CH_3CH_2CH_2-O-CH_2CH_2CH_3$$

Propane-1-ol 1-Propoxypropane

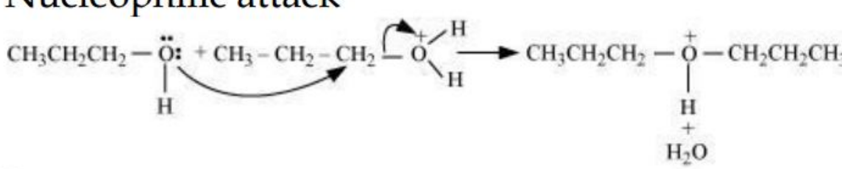
1M

The mechanism of this reaction involve the following three step

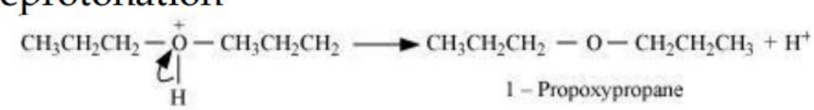
Step 1: Protonation



Step 2: Nucleophilic attack



Step 3: Deprotonation



Mechanism 2M

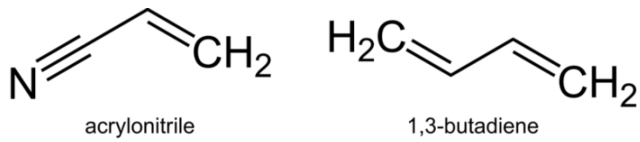
Question no: 08

1

a) a) Hexamethylenediamine and adipic acid

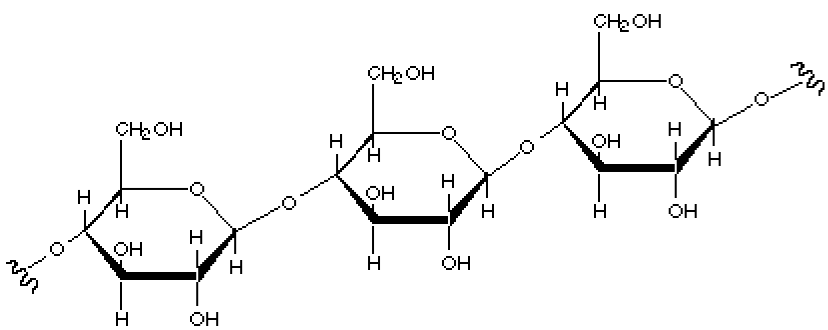
..........1M

b) 1, 3 – butadiene and acrylonitrile.



................1M

b)



Cellulose
poly (1,4'-O-β-D-glucopyranoside)

.............2M

c) Tollen's reagent = Ammoniacal Silver Nitrate

Fehlings solution = Sodium Potassium Tartarate. 1M

$BaSO_4$ acts as a catalytic poison which prevents further reduction of aldehyde to alcohol.

1M

OR

2.

A) Antiseptics are those antimicrobials which are applied to the living tissues such an wounds cuts, ulcers and diseased skin surfaces e.g. soframycine etc. these are not ingested like antibiotics.

1M

Disinfectants are applied to inanimate objects such as floors, drainage system instruments etc. e.g. phenol.

1M

b)

Alkyl halide e.g. C_2H_5X, $C_6H_5CH_2X$ etc. can be distinguished from aryl halide, C_6H_5X, by $AgNO_3$ test.

$$\text{Alkyl halide} + \text{aqKOH} + AgNO_3 \xrightarrow{HNO_3} \underset{\text{ppt.}}{AgX}$$

$$\text{Alylk halide} + \text{aqKOH} + AgNO_3 \xrightarrow{HNO_3} \text{NO ppt.}$$

Each rxn 1M

C)

$$\underset{(A)}{CH_3CONH_2} \xrightarrow{Br_2/KOH} \underset{(B)}{CH_3NH_2} \xrightarrow[HNO_2]{NaNO_2/HCl} \underset{(C)}{CH_3OH} \xrightarrow[Br_2]{\text{Red P/}} CH_3Br$$

Identification of each 1M