Please check that this question paper contains 09 questions and 02 printed pages within first ten minutes.

[Total No. of Questions: **09**]
Uni. Roll No. .....

[Total No. of Pages: **02**]

Program: **B.Tech.**
Semester: **1st**
Name of Subject: **Chemistry**
Subject Code: **BSC-105**
Paper ID: **15933**

Time Allowed: 02 Hours

Max. Marks: 60

NOTE:

1) Each question is of 10 marks.
2) Attempt any six questions out of nine
3) Any missing data may be assumed appropriately

Q1. (a) What is demineralisation? Explain with reference to Principle, Chemical reactions and advantages. (5)

(b) Explain boiler corrosion due to dissolved oxygen? How it can be prevented? (5)

Q2. (a) Define equivalent and non-equivalent protons. How n-propyl chloride can be distinguished from isopropyl chloride? (5)

(b) What is the main consideration in choosing a solvent for ultraviolet spectroscopy? Name of three commonly used solvents. How does solvent effect the UV spectrum in case of shift in n to π^* transitions? (5)

Q3. Draw a phase diagram of one component system. Label it and discuss the importance of various curves, areas and triple point. Why is the triple point different from the normal melting point of ice? (10)

Q4. (a) What is the principle difference between infrared spectroscopy and UV-Visible spectroscopy? (5)

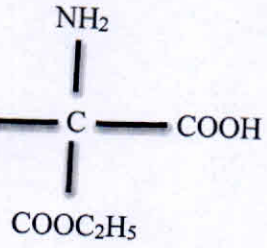
(b) Calculate the amount of lime and soda required for softening one million litres of water containing: Ca^{2+}= 90 ppm, Mg^{2+}= 42 ppm, HCO_3^- = 396.5 ppm and KCl = 20.8

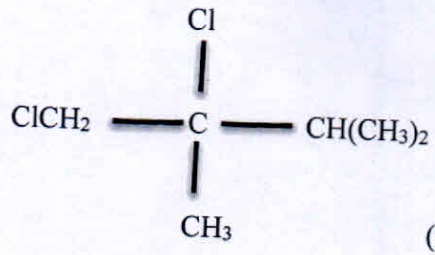
P.T.O.

ppm. $FeSO_4.7H_2O$ added as coagulant with amount of 14 ppm. The purity of lime is 91% and that of soda is 97.2%. (5)

Q5. (a) What is peroxide effect? Explain it by example and discuss its mechanism. (5)

(b) Assign R and S configurations to the following compounds by giving stepwise suitable reasons:

(i) 

(ii) 

(5)

Q6. (a) Write down the cell reaction and calculate the value of free energy change of the following cell at 298 K:

$Zn\ (s)\ |\ Zn^{2+}(0.1\ M)\ \|\ Cu^{2+}(0.175\ M)\ |\ Cu\ (s)$

{Given $E°(Zn^{2+}|\ Zn) = -0.76\ V$ and $E°(Cu^{2+}|\ Cu) = 0.34\ V$} (5)

(b) Discuss the various possible confirmations of cyclohexane with order of relative stabilities. (5)

Q7. (a) On the basis of band structure of solids, differentiate between the conductors and semiconductors. (5)

(b) With the help of a suitable example, explain the splitting of *d*-orbitals, when a transition metal ion is placed in octahedral field of strong and weak field ligands. (5)

Q8. (a) Explain how chlorination of water leads to killing of microorganisms. (5)

(b) Calculate the solubility of $AgCl$(s) in (*i*) pure water and (*ii*) a solution of 0.1 M $NaCl$ at 25 °C. [$K_{sp}\ (AgCl) = 2.8 \times 10^{-10}$] (5)

Q9. (a) Define compressibility factor. Briefly explain how real gases show deviations from ideal behaviour? (5)

(b) Write a short note on "London Forces". (5)

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SOLUTION

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ANSWERS

Ans1. a) Demineralisation is a process of removal of all the cations and anions from water. 1M + 2M (Def^n + Principle)

$2RH^+ + Ca^{2+}/Mg^{2+} \longrightarrow R_2Ca^{2+}/R_2Mg^{2+} + 2H^+$

$ROH + Cl^- \longrightarrow RCl^- + OH^-$ 1M

So, H^+ & OH^- combine to form H_2O

$H^+ + OH^- \rightarrow H_2O$
(Demineralized H_2O)

Advantages are:

(i) The process can be used to soften highly acidic or alkaline water.

(ii) The treated water is very good for use in high pressure boilers. 1M

b) Boiler corrosion due to dissolved O_2 :-

$4Fe + 4H_2O + 2O_2 \longrightarrow 4Fe(OH)_2$

$4Fe(OH)_2 + O_2 \longrightarrow 2[Fe_2O_3 \cdot 2H_2O]$ 2M
Rust

Prevention method:

i) By adding hydrazine (N_2H_4), sodium sulphite (Na_2SO_3) or sodium sulphide (Na_2S), all these consume O_2 by reacting as:

$2Na_2SO_3 + O_2 \rightarrow 2Na_2SO_4$

$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$

$Na_2S + 2O_2 \rightarrow Na_2SO_4$ 3M

ii) By mechanical de-aeration.

Def^{n} → 2.5M

Ans2 a

i) $\overset{a}{CH_3} - \overset{b}{CHCl} - \overset{a}{CH_3}$ (Isopropyl chloride)

Two kinds of Protons
∴ 2 Signals

ii) $\overset{a}{CH_3} - \overset{b}{CH_2} - \overset{c}{CH_2} - Cl$ (n-Propyl chloride)

Three kinds of Protons
∴ 3 Signals.

] 2.5M

b Requirements are:] 1.5

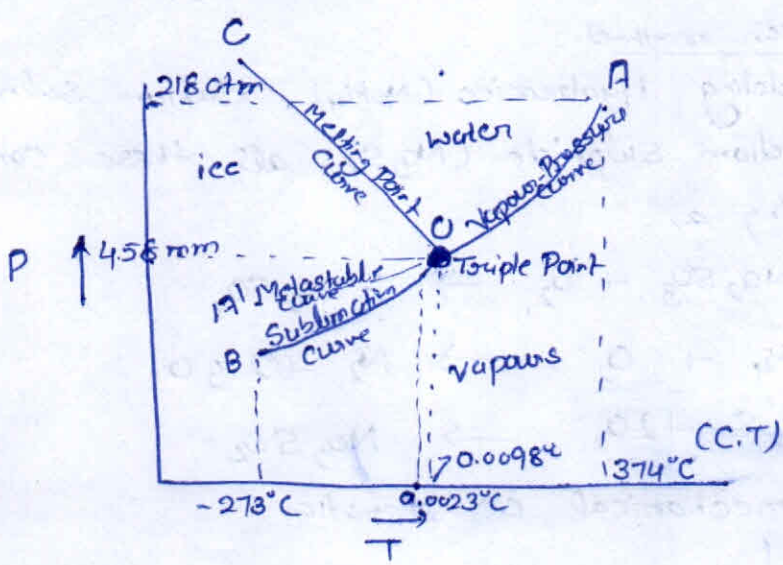
i) It should be transparent in the wavelength region under examination

ii) It should be less polar so that it has minimum interaction with the solute molecules and has no effect on the fine structure of absorption bands and the position of absorption bands.

Examples: 95% ethanol, hexane, methanol, water, ether] 1.5

– If a gp is more polar in the ground state than in the excited state, ↑ the polarity of the solvent shifts the absorption to shorter wavelength] 2

Ans3 a



3M

Curves:

Curve OA	Curve OA'	Curve OB	Curve OC
F = C-P+2	F = C-P+2	F = C-P+2	F = C-P+2
= 1-2+2	= 1-2+2	= 1-2+2	= 1-2+2
= 1	= 1	= 1	= 1

2 M

$\therefore F = 1$

univariant system

Areas: Three areas AOB, BOC & COA 2M

$F = C - P + 2$

$= 1 - 1 + 2 = 2$

Triple Point O 2M

$F = C - P + 2$

$= 1 - 3 + 2 = 0$ 1M

Triple point of water in the phase diagram at which all the three phases i.e, solid, liquid & gas (vapours) (ice, liquid water & water vapours) exist together at 0.0098°C & 4.58 mm pressure. It is different from normal M.P of ice bcz at the normal M.P of ice (0°C, 1 atm pressure) only ice & water exist together.

Ans4 a UV-spectroscopy involves the absorption of light in the visible and ultraviolet regions of light which takes place due to transitions from one electronic energy level to another energy level within a molecule. for each 1M

IR spectroscopy involves the absorption of light in the near infrared region which take place due to various type of stretching & bending vibrations in a molecule.

(b)

Impurities (in ppm)	Hardness	Lime req.	Soda req.
$Ca^{2+} = 90$	$\frac{90 \times 100}{40} = 225$	–	225
$Mg^{2+} = 42$	$\frac{42 \times 100}{24} = 175$	175	175
$HCO_3^- = 396.5$	$\frac{396.5 \times 100}{61} = 650$	325	-325
$FeSO_4.7H_2O = 14$	$\frac{14 \times 100}{278} = 5.04$	5.04	5.04
Total		Lime = 505.04	Soda = 80.04

8M

Lime requirement for softening of 1 million Litres of water = 1M

$$\frac{74}{100} \times 505.04 \times \frac{100}{91} \times \frac{10^6}{10^6} = 410.69 \text{ kg}$$

Soda requirement for softening of 1 million Litres of water = 1M

$$\frac{106}{100} \times 80.04 \times \frac{100}{97.2} \times \frac{10^6}{10^6} = 87.29 \text{ kg}$$

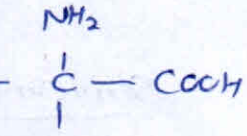
Ans5 a Peroxide Effect 1+2+2

$$CH_3-CH=CH_2 + HBr \xrightarrow{\text{Peroxides}} CH_3CH_2CH_2Br$$

Propene

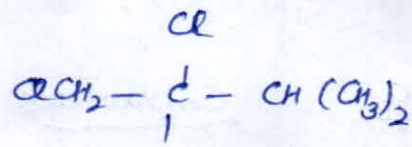
1-Bromopropane

a

i) 

R

2.5 M

ii) 

S

2.5 M

Ans.6

a Reaⁿ are:

$Zn(s) \longrightarrow Zn^{2+} + 2e^-$

$Cu^{2+} + 2e^- \longrightarrow Cu(s)$

Overall reaⁿ is

$Zn(s) + Cu^{2+} \longrightarrow Zn^{2+} + Cu(s)$ 1M

Acc. to Nernst Eqⁿ

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{n} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$ 2M

$$E_{cell} = 1.1 - \frac{0.059}{2} \log \frac{0.1}{0.175}$$

$E_{cell} = 1.107\ V$ 1M

$\Delta G = -nFE_{cell}$

$= -2 \times 96500 \times 1.107$ 1M

$= -213.68\ kJ$

b Conformations of cyclohexane are

i) Chair conformation

ii) Boat conformation 3M

iii) Twist boat or Skew boat conformation

iv) Half chair conformation.

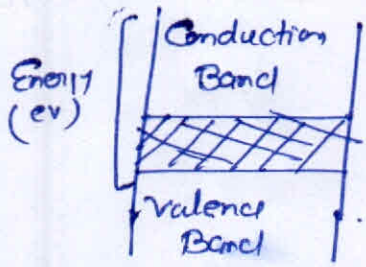
2M

Chair form > Twist boat > Boat form > Half-chair Conformation

Ans 7 a

Conductors

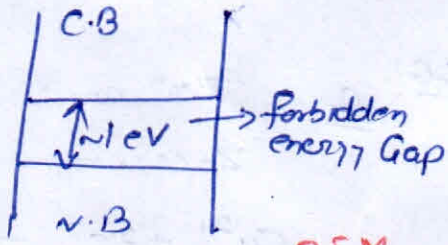
The conduction in metals is only due to the electrons



2.5M

Semiconductors

Forbidden energy gap is of order of 1 ev



2.5M

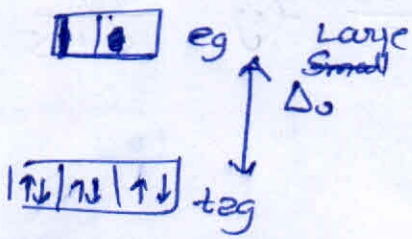
b

Example $[CoCNH_3)_6]^{3+}$ & $[CoF_6]^{3-}$

NH_3 → Strong Ligand.

F^- → weak field Ligand

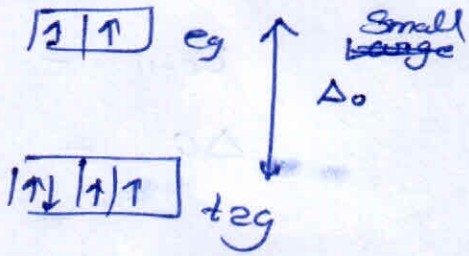
d^6 Cobalt in $[CoCNH_3)_6]^{3+}$ & $[CoF_6]^{3-}$ is in +3 O.S.



Low Spin Complex
(Diamagnetic)
Strong field (NH_3)

2.5M

d^6

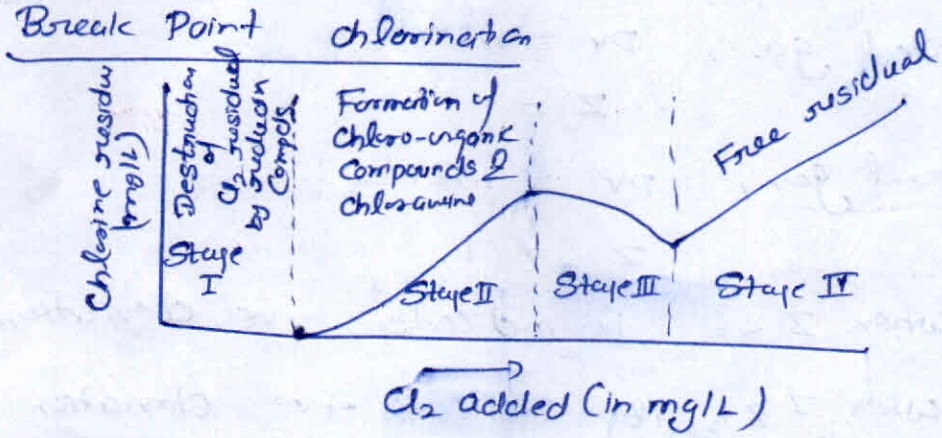


High Spin Complex
(Paramagnetic)
Weak field (F^-)

2.5M

Ans 8 a Chlorination

$$Cl_2 + H_2O \rightarrow HOCl + HCl.$$



1M
2M
2M

i) It completely destroys all the disease-producing bacteria.

ii) It prevents the growth of any weeds in water.

iii) It ensures complete destruction of organic compounds which impart colour, bad odour & unpleasant taste to water.

b i) $AgCl \rightleftharpoons Ag^+ + Cl^-$

Let, $[Ag^+] = s$, $[Cl^-] = s$

$$K_{sp} = [Ag^+][Cl^-]$$

2.5M

$$2.8 \times 10^{-10} = s \times s$$

$$\therefore s = 1.673 \times 10^{-5} \text{ mol/L}$$

ii) Solubility in 0.1 M NaCl

Let solubility of AgCl be x

$\therefore [Ag^+] = x$, $[Cl^-] = 0.1 + x = 0.1$ (x being very less)

$$K_{sp} = [Ag^+][Cl^-]$$

2.5M

$$2.8 \times 10^{-10} = x \times 0.1$$

$$x = 2.8 \times 10^{-9} \text{ mol/L}$$

Ans. 9 a Compressibility Factor

$$Z = \frac{PV}{nRT}$$

For ideal gas, $PV = nRT$

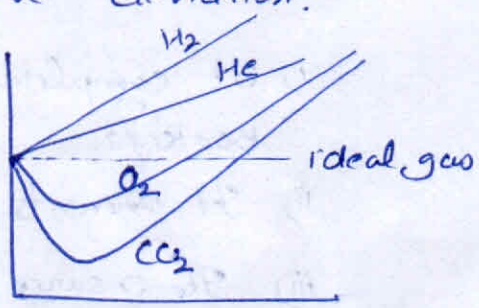
$\therefore Z = 1$ 2M

For real gas, $PV \neq nRT$

$Z \neq 1$

So, when $Z < 1$, it indicate -ve deviation

when $Z > 1$ it indicates +ve deviation.



3M

It is clear from figure that deviations are less at low P while at high P, Z is always greater than unity.

i) For N_2, O_2, CO_2, the value of Z is less than unity at low P & more than 1 at higher P. So these gases are more compressible at low P.

ii) For H_2 & He, the value of Z is always more than 1. So always show +ve deviations. These gases are less compressible at all pressures.

b London forces 8 steps 5M

In 1930 Fritz London explained the existence of forces of attraction between non-polar molecules. The two dipoles attract each other & the forces of attraction between induced dipoles & the original dipoles are known as London forces.