The Solid State

EXERCISE-I (MHT CET LEVEL)

Q.1 (2)
Graphite is covalent solid.

Q.2 (3)

Q.3 (1)

Q.4 (2)

Q.5 (3)
4 atom are present in fcc.

$$So, V = 4\left[\frac{4}{3}\pi r^3\right] = \frac{16}{3}\pi r^3$$

Q.6 (2)

Q.7 (2)

Q.8 (4)

Q.9 (4)
Number of atoms per unit cell–1
Atoms touch each other along edges

Hence $\frac{a}{2}$

(r = radius of atom and a–edge length)

Therefore % fraction $= \frac{\frac{4}{3}\pi r^3}{(2r)^3} = \frac{\pi}{6}$

Q.10 (1)

Q.11 (4)

Q.12 (3)

Q.13 (3)

Q.14 (2)

Q.15 (4)

$$\rho = \frac{Z \times M}{N_o \times a^3},$$

$$2.7 = \frac{Z \times 27}{6.02 \times 10^{23} \times (4.05)^3 \times 10^{-24}}$$

$\therefore$ Z=4
Hence it is face centred cubic unit lattice.
Again $4r = a\sqrt{2} = 5.727\text{Å}$
$\therefore r = 1.432\text{Å}$

Q.16 (2)
In bcc structure,
no. of atoms at corner = 1/8 × 8 = 1
no. of atom at body centre = 1
therefore, total no of atom per unit cell = 2.

Q.17 (2)

$$d = \frac{ZM}{N_A a^3} \Rightarrow 6.25 = \frac{Z \times 120}{6 \times 10^{23} \times \left(4 \times 10^{-8}\right)^3}$$

Q.18 (1)

Q.19 (4)

Q.20 (4)

Q.21 (1)

Q.22 (2)

Q.23 (3)

Q.24 (3)
No change in density.

Q.25 (1)
The number of Fe^{3+} ions replacing x Fe^{2+} ions $= \frac{2x}{3}$ vacancies of cations

$= x - \frac{2x}{3} = x/3$

But x/3 =1–0.94=0.06,
x=0.06×3=0.18=18%

Q.26 (2)

Q.27 (1)

Q.28 (1)

Q.29 (4)

Q.30 (3)

EXERCISE-II (NEET LEVEL)

Q.1 (4)
Amorphous solids have short range order but no sharp in melting point.

Q.2 (1)
Solid $NaCl$ is a bad conductor of electricity because ions are not free to move.

Q.3 (1)
Amorphous solids neither have ordered arrangement (*i.e.* no definite shape) nor have sharp melting point like crystals, but when heated, they become pliable until they assume the properties usually related to liquids. It is therefore they are regarded as super-cooled liquids.

Q.4 (4)
Amorphous solids neither have ordered arrangement (*i.e.* no definite shape) nor have sharp melting point like crystals, but when heated, they become pliable until they assume the properties usually related to liquids. It is therefore they are regarded as super-cooled liquids.

Q.5 (2)
Co-ordination numbers of Na^+ Å in NaCl is 6

Q.6 (3)
Rhombohedral crystal system

$a = b = c$, $\alpha = \beta = \gamma \neq 90^o$

ex – $NaNO_3$, $CaSO_4$, calcite $CaCO_3$, HgS

Q.7 (2)
Tetragonal system has the unit cell dimension
$a = b \neq c, \alpha = \beta = \gamma = 90°$.

Q.8 (3)
14 kinds of Bravais lattices (space lattices) are possible in a crystal.

Q.9 (1)
Space lattice of CaF_2 is face centred cubic.

Q.10 (1)
Face-centred cubic lattice found in KCl and $NaCl$.

Q.11 (3)
$58.5\, g\ NaCl = 1\, mole = 6.02 \times 10^{23}\ Na^+Cl^- units$.

One unit cell contains $4\ Na^+Cl^-$ units. Hence number of unit cell present

$$= \frac{6.02 \times 10^{23}}{4} = 1.5 \times 10^{23}.$$

Q.12 (2)

Density of unit cell $N = \frac{\text{unit cell atom} \times M}{a^3 \times N_o}$

Q.13 (1)

$$M = \frac{\rho \times a^3 \times N_0 \times 10^{-30}}{z}$$

$$= \frac{10 \times (100)^3 \times (6.02 \times 10^{23}) \times 10^{-30}}{4} = 15.05$$

No. of atoms in 100 g

$$= \frac{6.02 \times 10^{23}}{15.05} \times 100 = 4 \times 10^{25}..$$

Q.14 (2)
The system $ABC\,ABC$...... is also referred to as face-centred cubic or *fcc*.

Q.15 (2)
(In rock salt structure the co-ordination number of $Na^+ : Cl^-$ is $6:6$.

Q.16 (3)
Number of atoms in the cubic close packed structure = 8.

Number of octahedral voids $= \frac{1}{2} \times 8 = 4$.

Q.17 (1)
Co-ordination number in *HCP* and *CCP* arrangement is 12 while in *bcc* arrangement is 8.

Q.18 (1)
For body centred cubic arrangement co-ordination number is 8 and radius ratio (r_+ / r_-) is $0.732 - 1.000$.

Q.19 (3)
For tetrahedral arrangement co-ordination number is 4 and radius ratio (r_+ / r_-) is $0.225 - 0.414$.

Q.20 (2)
Every constituent has two tetrahedral voids. In *ccp* lattice atoms

$$= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$$

$\therefore$ Tetrahedral void $= 4 \times 2 = 8$,

Thus ratio $= 4 : 8 :: 1 : 2$.

Q.21 (3)

The value of ionic radius ratio is 0.52 which is between $0.414 - 0.732$, then the geometrical arrangement of ions in crystal is octahedral.

Q.22 (1)
Let the units of ferrous oxide in a unit cell $= n$, molecular weight of ferrous oxide

$(FeO) = 56 + 16 = 72\, g\, mol^{-1}$,

$$\text{weight of } n \text{ units } = \frac{72 \times n}{6.023 \times 10^{23}}$$

Volume of one unit $= (\text{length of corner})^3$

$$= (5 \mathring{A})^3 = 125 \times 10^{-24}\, cm^3$$

$$\text{Density} = \frac{\text{wt. of cell}}{\text{volume}},\ 4.09 = \frac{72 \times n}{6.023 \times 10^{23} \times 125 \times 10^{-24}}$$

$$n = \frac{3079.2 \times 10^{-1}}{72} = 42.7 \times 10^{-1} = 4.27 \approx 4$$

Q.23 (2)
Cl^- ions in $CsCl$ adopt BCC type of packing.

Q.24 (2)
$r_+ / r_- = \frac{180}{187} = 0.962$ which lies in the range of $0.732 - 1.000$, hence co-ordination number = 8 *i.e.* the structure is $CsCl$ type.

Q.25 (2)
The Ca^{2+} ions are arranged in (ccp) arrangement, i.e. Ca^{2+} ions are present at all corners and at the centre of each face of the cube. the fluoride ions occupy all the tetrahedral sites. This is 8 : 4 arrangement i.e., each Ca^{2+} ion is surrounded by $8F^-$ ions and each F^- ion by four Ca^{2+} ions.

Q.26 (4)
All the given statements are correct about *F*-centres.

Q.27 (1)
As each Sr^{2+} ion introduces one cation vacancy, therefore concentration of cation vacancies = mol % of $SrCl_2$ added.

Q.28 (3)
$AgBr$ exhibits Frenkel defect due to large difference in the size of Ag^+ and Br^- ions.

Q.29 (3)
ue to high co-ordination number.

EXERCISE-III (JEE MAIN LEVEL)

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (4)
Rubber, P lastics and glass, all are amorphous solids so

Q.2 (1)
Zns is ionic erystal

Q.3 (1)
LiF iso an ionic crstal

Q.4 (1)
A solid having no definite shape is called Amorphous

Q.5 (1)
In Bravais lattices, each point has identical surroundings.

Q.6 (1)
Refer Theory.

Q.7 (1)
In B.C.C

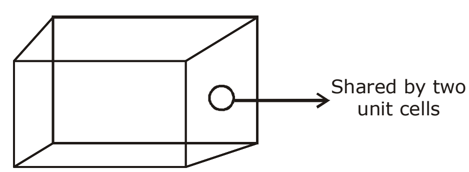
$4r = a\sqrt{3}$

$2r = 1.73.$

$2 \times 1.73 = a\sqrt{3}$

Q= 200×10^{-12} m = 200 pm

Q.8 (2)



Q.9 (2)

$4r = a\sqrt{2}$

$$a = \frac{4r}{\sqrt{2}} = \frac{4 \times 1.28}{\sqrt{2}} \text{ Å } = 3.62 \text{ Å}$$

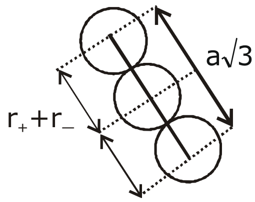
Q.10 (2)

$$r_+ + r_- = \frac{a\sqrt{3}}{2} = \frac{480 \times \sqrt{3}}{2}$$

$r_+ + 225 = 240\sqrt{3}$
$r_+ = 240 \times 1.732 - 225$
$r_+ = 190.68$ pm

Q.11 (1)

$r_+ + r_- = \frac{a\sqrt{3}}{2} = \frac{387}{2}\sqrt{3}$
$= 335.15$ pm



Q.12 (1)

for X, $8 \times \frac{1}{8} = 1$

for Y, $6 \times \frac{1}{2}$

so AB_3

Q.13 (4)
Total body diagonal = 4
two atoms in each body diagonal
so total number of atoms = 4×2=8
and 8 atom on each corner, So its contribution will be

$= \frac{1}{8} \times 8 = 1$

so total number of atoms = 8+1=9

Q.14 (3)
→ Cu → ccp so 4 atoms
→ Ag is at edge centre

each edge has its contribution $\frac{1}{4}$ so, total number of silver.

$= \frac{1}{4} \times 12 = 3$

→ Au is present at the body so its contribution will be 1 .
so formula will be
$Cu_4 Ag_3 Au$.

Q.15 (3)

for X, $6 \times \frac{1}{8} = \frac{3}{4}$

for Y, $6 \times \frac{1}{2} = 3$

so $X_{3/4} Y_3$ or $X_3 Y_{12}$ or XY_4

Q.16 (2)
6 face centred atom contbriution

$= 6 \times \frac{1}{2} = 3$ atom

and 3 atom
and 3 atoms are enclosed
so total number of enclosed atom in the unit cell
= 3 +3 = 6 atom

Q.17 (3)
$a = 2\sqrt{2}\,r$

$\therefore v = a^3 = 16\sqrt{2}\,r^3 = 16 \times \sqrt{2} \times (2 \times 10^{-8})^3 = 1.8 \times 10^{-22}$ cm^3

Q.18 (3)
Z is ccp so its total number 4.
X atom occupy tetrahedral void so its
total number will be 8
$X_8Z_4 = X_2Z$

Q.19 (3)
In ABB AABB A, there is no close packing as there are repeated planes adjacent to each other.

Q.20 (3)
I & II represent octahedral holes.

Q.21 (1)
O is in ccp so total number of atom 4

A is occuped in $\frac{1}{6}$ of T.V. so $\frac{8}{6}$

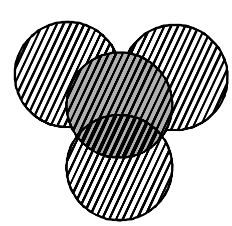
B is occupied in $\frac{1}{3}$ of O.V so $\frac{4}{3}$

$A_{\frac{8}{6}} B_{\frac{4}{3}} O_4 = A_{\frac{4}{3}} B_{\frac{4}{3}} O_4$
or ABO_3

Q.22 (1)
Refer theory.

Q.23 (3)
entre of edge is octehedral vold so

Q.24 (3)
By the formation of tetrahedral void



Q.25 (1)
a=5.14 A°
structure is like NaCl
so, $4r^{-} = a\sqrt{2}$

$r^{-} = \frac{5.14 \times 1.414}{4}$

$r^{-} = 1.815$ A°

Q.26 (3)

$\rho = \frac{zM}{N_A . a^3} \Rightarrow 3.18 = \frac{4 \times 78}{N_A . a^3}$

$\Rightarrow a^3 = 16.3 \times 10^{-23}$

$\Rightarrow a = 5.46 \times 10^{-8}$ cm

$= 546 \times 10^{-10}$ cm

$a = 546 \times 10^{-12}$ m

$= 546$ pm

Q.27 (4)

(II) $\frac{r_+}{r_-} = \frac{0.2}{0.95} = 0.21$

coordination no. = 3

(I) True (II) False (III) True (IV) False

Q.28 (2)

The structure of sodium chloride crystal is F.C.C.

Q.29 (2)

Since Ag^+ (cation) is smaller than Cl^- (anion) & hence cation is present in voids.

In CaF_2, F^-_{anion} is smaller.

Q.30 (1)

Ions are displaced from one place to another.

EXERCISE-IV

Q.1 6

$\frac{r^+}{r^-} = \frac{88}{200} = 0.44$

so CN is 6.

Q.2 FCC

$10.6 = \frac{z \times 108}{6.02 \times 10^{23} \times \left(144 \times 10^{-10}\right)^3}$

so z = 4

Q.3 908

For *bcc*, $d = \frac{\sqrt{3}}{2} a$ or $a = \frac{2d}{\sqrt{3}} = \frac{2 \times 4.52}{1.732} = 5.219$Å = 522 pm

$\rho = \frac{Z \times M}{a^3 \times N_0 \times 10^{-30}} = \frac{2 \times 39}{(522)^3 \times (6.023 \times 10^{23}) \times 10^{-30}}$

$= 0.91$ g / cm^3 = 910 kg m^{-3}

Q.4 8

Co–ordination number of atom in B.C.C. is 8.

Q.5 4

Q.6 6

It is a fact.

Q.7 12

In a face centred cubic lattice the number of nearest neighour for a given lattice point 12

Q.8 4

$Z = \frac{V \times N_0 \times d}{M} = \frac{4.2 \times 8.6 \times 8.3 \times 10^{-24} \times 6.023 \times 10^{23} \times 3.3}{155} = 3.84$

$= 4$

Q.9 4

Corrdination atom number of NaCl is 6.

Q.10 9

Total body diagonal = 4

two atoms in each body diagonal

so total number of atoms = 4×2=8

and 8 atom on each corner, So its contribution will be

$= \frac{1}{8} \times 8 = 1$

so total number of atoms = 8+1=9

Q.11 (1) **Q.12** (2) **Q.13** (2) **Q.14** (2) **Q.15** (2)
Q.16 (1)

PREVIOUS YEAR'S

MHT CET

Q.1 (1) **Q.2** (3) **Q.3** (4) **Q.4** (3) **Q.5** (1)
Q.6 (3) **Q.7** (1) **Q.8** (2) **Q.9** (4) **Q.10** (2)
Q.11 (4) **Q.12** (1) **Q.13** (2) **Q.14** (1) **Q.15** (2)
Q.16 (4) **Q.17** (3) **Q.18** (2) **Q.19** (2) **Q.20** (1)
Q.21 (4) **Q.22** (2) **Q.23** (4) **Q.24** (2) **Q.25** (3)
Q.26 (3)

NEET/AIPMT

Q.1 (3,4)

Frenkel defect is favoured in those ionic compounds in which there is large difference in the size of cations and anions.

Non-Stoichiometric defects due to metal deficiency is shown by Fe_xO where x = 0.93 to 0.96.

Q.2 (1)

For BCC lattice : Z = 2, $a = \frac{4r}{\sqrt{3}}$

For FCC lattice : Z = 4, $a = 2\sqrt{2}\, r$

$$\therefore \frac{d_{25°C}}{d_{900°C}} = \frac{\left(\frac{ZM}{N_A a^3}\right)_{BCC}}{\left(\frac{ZM}{N_A a^3}\right)_{FCC}} = \frac{2}{4}\left(\frac{2\sqrt{2}r}{\frac{4r}{\sqrt{3}}}\right)^3 = \left(\frac{3\sqrt{3}}{4\sqrt{2}}\right)$$

Q.3 (1)

For BCC lattice : $Z = 2, a = \frac{4r}{\sqrt{3}}$

For FCC lattice : $Z = 4, a = 2\sqrt{2}\,r$

$$\therefore \frac{d_{25°C}}{d_{900°C}} = \frac{\left(\frac{ZM}{N_A a^3}\right)_{BCC}}{\left(\frac{ZM}{N_A a^3}\right)_{FCC}} = \frac{2}{4}\left(\frac{2\sqrt{2}r}{\frac{4r}{\sqrt{3}}}\right)^3 = \left(\frac{3\sqrt{3}}{4\sqrt{2}}\right)$$

Q.4 (3)

Number of atom per unit cell in hcp = 6
Number of octahedral void in hcp = 6
Number of anions per unit cell = 6

cation occupy 75% of octachedral void $= 6 \times \frac{75}{100} = \frac{9}{2}$

C : A
9/2 :6
9 : 12
3 : 4
Fomula of octahedral = C_3A_4

Q.5 (4)
Q. 6 (3)
Q.7 (3)
Q.8 (4)

Acc. to Bohr's atomic model

$r \propto \frac{n^2}{z}$ 3rd orbit of Li^{+2} $n_1=3$ $Z_1 = 3$

$\Rightarrow$ 2nd orbit of He^+ $n_2 =2$ $Z_n = 2$

$$\frac{(r^3)_{Li+2}}{(r^2)_{He+}} = \frac{n_1^2}{n_2^2} \times \frac{Z_2}{Z_1}$$

$$\frac{(r^3)_{Li^{+2}}}{105.8pm} = \frac{3\times3}{2\times2} \times \frac{2}{3}$$

$$(r_3)_{Li_{+2}} = 158.7\text{ pm}$$

Q.9 (4)

$$d = \frac{Z\times M}{N_A \times a^3} \Rightarrow 8.9 = \frac{4\times M}{6.022\times10^{23}\times(3.608\times10^{-8})^3}$$

$$M = \frac{8.92\times6.022\times10^{23}}{4}\times46.96\times10^{-24}$$

M = 63.1 g/mol (Molar Atomic Mass)
M = 63.1 μ (Atomic Mas)

Q.10 (1)

(i) Statement-1 is correct because in point defects of ionic solid electrical neutrality is essential condiation (given question is excample of metal deficiency defect)
(ii) Statement-2 is correct because In Frenkel defect cation dislocate from lattice site to interstitial position.
(iii) Both statement are correct but statement-2 is not correct explanation of statement-1

JEE Main

Q.1 [1]

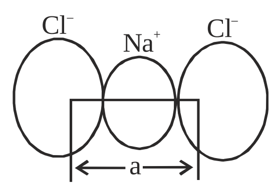
For NaCl Z = 4 & M = 58.5 gram

$$d = \frac{z\times M}{N_A \times \text{volume}}$$

$$43.1 = \frac{4\times58.5}{6\times10^{23}\times(a)^3}$$

$$a^3 = \frac{4\times58.5}{6\times43.1}\times10^{-23}$$

$= 0.9 \times 10^{-23}cm^3$
$= 0.9 \times 10^{-24}cm^3$
$A = 2.08 \times 10^{-8}$ cm



$$d_{Na^+ + Cl^-} = \frac{a}{2} = \frac{2.08\times10^{-10}}{2}m$$

= 1

Q.2 **[3]**

$A = 8\text{ (corner)} \times \frac{1}{8} + 4\text{ (face centre)} \times \frac{1}{2}$

$\Rightarrow 1 + 2 = 3$
B = 4 [in all octahedral void]
Formula $\Rightarrow A_3B_4 \Rightarrow A_xB_y$
x = 3

Q.3 [85]
Q.4 (4)

Q.5 **(43)**

hcp lattice - x atom
Number of x-atom=6
Teterahedral voids-y atom

Number of y-atom = 2/3 T.H.V. = 2/3 × 12 = 8

Percentage of element $x = \frac{\text{No. of x atoms}}{\text{total Atoms}} \times 100$

$= \frac{6}{14} \times 100 = 42.85\%$

= 43 (nearest integer)

Q.6 (566)

Ionic radii of cation (A^+) = r_+ = 102 pm

Ionic radii of anion (B^-) = r_- = 181 pm

For cubic close packing :

Edge length (a) = $2r_+ + 2r_-$ ($\because$ cations are present in octahedral voids)

$= (2 \times 102) + (2 \times 181) = 566$ pm

Q.7 (22)

$$d = \frac{z \times M}{N_A \times a^3}$$

$$6 = \frac{2 \times M}{N_A \times 3^3 \times 10^{-24}}$$

$$6 = \frac{M}{8.1} = M = 8.1 \times 6 = 48.6 \text{ gm/mole}$$

$\therefore$ 180 g of sample contains $= \frac{180}{48.6} \times 6 \times 10^{23} = 22.22 \times 10^{23}$

Q.8 (87)

$$d = \frac{z \times M}{N_A \times \text{volume}}$$

$$9.03 = \frac{4 \times M}{6.02 \times 10^{23} \times \left(4 \times 10^{-8}\right)^3}$$

M = 86.97 gram

M $\simeq$ 87

Solutions

EXERCISE-I (MHT CET LEVEL)

Q.1 (4)

$$\text{Molarity (M)} = \frac{\text{wt} \times 1000}{\text{mol.wt} \cdot \times \text{vol(mL)}}$$

$$2 = \frac{\text{wt}}{63} \times \frac{1000}{250}$$

$$\text{wt.} = \frac{63}{2}\text{g}$$

$$\text{wt. of 70\% acid} = \frac{100}{70} \times 31.5 = 45\,\text{g}$$

Q.2 (3)
When equal weights of different solutes are present in equal volumes of solution the molarity is inversely related to molecular mass of the solute. Mol. mass of NaCl is less than KCl. Hence, molarity of NaCl solution will be more.

Q.3 (1)

$$\text{N} = \frac{3 \times 1000}{53 \times 100} = 0.566\,\text{N}$$

For H_2SO_4 sol. $N_1 = 0.1, V_1 = 100\,\text{mL}$

For Na_2CO_3 sol. $N_2 = 0.566$

Now apply $N_1 V_1 = N_2 V_2$

$$V_2 = \frac{N_1 V_1}{N_2} = \frac{0.1 \times 1000\,\text{mL}}{0.566} = 176.66\,\text{mL}$$

Q.4 (3)

$$\text{wt. of } NH_3 = 26g = \frac{26}{17}\text{ g eq} = 1.\ 53\text{ g eq}$$

vol. of .soln.= 100 mc = 0.1 L

$$\therefore \text{ Normality} = \frac{1.53}{0.1} = 15.3\text{ N}$$

Q.5 (1)
Let the amount of $Na_2\,CO_3$ Present in the mixture be xg. Na_2SO_4 will not react with H_2SO_4. Then

$$\frac{x}{53} = \frac{20 \times 0.1 \times 10}{1000} \therefore x = 1.06g$$

$$\therefore \text{ Percentage of } Na_2CO_3 =$$

$$\frac{1.06 \times 100}{1.25} = 84.8\%$$

Q.6 (3)
$M_1V_1 = M_2V_2$
$(0.025\,\text{M})\,(0.050\,\text{L}) = (M_2)\,(0.025\,\text{L})$
$M_2 = 0.05\,\text{M}$
but, there are 2 H's per H_2SO_4 so $[H_2SO_4]$ $= 0.025\,\text{M}$

Q.7 (1)

Milli moles of $Pb(NO_3)_2 = 25 \times 0.15$

$= 3.75m.\text{moles}$

Milli moles of $Al_2(SO_4)_3 = \frac{1}{3} \times 3.75 = M \times 20$

$M = 0.0625 = 6.25 \times 10^{-2} M$

Molar mass of $Al_2(SO_4) = \mathbf{\frac{1}{3} \times 3.75} = M \times 20$

$\Rightarrow M = 0.0625 = 6.25 \times 10^{-2}$ M

Q.8 (2)
1 molal solution means 1 mole of solute dissolved in 1000 g solvent.

$\therefore n_{solute} = 1$ $\quad w_{solvent} = 1000\,\text{g}$

$$\therefore n_{solvent} = \frac{1000}{18} = 55.56$$

$$x_{solute} = \frac{1}{1 + 55.56} = 0.0177$$

Q.9 (1)

Q.10 (1)

Q.11 (3)

Q.12 (4)

Q.13 (3)

Q.14 (4)

Q.15 (1)
Raoult's law $P_1 = P_1^{\circ}\, x_1$
Henry law $P = K_H.x$

Q.16 (4)

Q.17 (3)

In pressure cooker, pressure is high thus, the boiling point of water increases, resulting cooking time is less than other open pots.

Q.18 (2)

Q.19 (1)

Q.20 (4)

Q.21 (4)

Q.22 (4)

Q.23 (3)

Q.24 (3)

Q.25 (1)

$$\Delta T_f = 0.3^o C$$

$$\Delta T_f = \frac{K_f \times W_B \times 1000}{M_B \times W_A}$$

$$0.3 = \frac{1.86 \times W_B \times 1000}{62 \times 5000}$$

$$\therefore W_B = 50g$$

The amount used should be more than 50 g.

Q.26 (3)

$$\Delta T_f = K_f m = 5.12 \times \frac{1}{250} \times \frac{1000}{51.2} = 0.4K$$

Q.27 (2)

$$m = \frac{1000 \times k_b \times w}{W \times \Delta T_b}$$

or $k_b = \frac{m \times W \times \Delta T_b}{1000 \times w} = \frac{100 \times 100 \times \Delta T_b}{1000 \times 10}$

$= \Delta T_b$

Q.28 (4)

$$\Delta T_b = K_b.m \Rightarrow 3.63 \times \frac{0.616/154}{15} \times 1000;$$

$$T_b = 61.7 + 0.968$$

$$= 62.67°C$$

Q.29 (1)

Q.30 (3)

Q.31 (2)

pH = 2

$$\left[H^+\right] = 0.01M = Cx = 0.1x$$

x=0.1

i = 1 + x = 1.1

$$\pi = i\frac{n}{V}RT = iMRT = 1.1 \times 0.1RT = 0.11RT$$

Q.32 (1)

Q.33 (2)

Q.34 (4)

Q.35 (2)

Q.36 (1)

Q.37 (4)

Q.38 (4)

$\Delta T_f = K_f \times m \times i.$ Since K_f has different values for different solvents, hence even if the m is same ΔT_f will be different.

Q.39 (4)

$$Ca(NO_3)_2 \Leftrightarrow Ca^{2+} + 2NO_3^-$$

1-0.710.72×0.7

$$(\therefore \alpha = \frac{70}{100} = 0.7)$$

$\therefore$ i = 1–0.7 + 0.7 + 2 × 0.7 = 2.4

$$n_2 = \frac{7}{164} = 0.042$$

$$n_1 = \frac{100}{18} = 5.55$$

$$\frac{P^O - P_S}{P^O} = \frac{n_2 \times i}{n_1 + n_2}, \frac{760 - P_S}{760}$$

$$= \frac{0.042 \times 2.4}{5.55 + 0.042}$$

$$\therefore P_S = 746 mm\, Hg.$$

Q.40 (4)

When an electrolyte dissociates van't Hoff factor i is greater than 1 and when it associates the i is less than 1.

Q.41 (3)

Q.42 (1)

Q.43 (1)

Q.44 (4)

Q.45 (4)

Q.46 (2)

Q.47 (1)

Q.48 (1)

Q.49 (4)

Q.50 (4)

Q.51 (4)

EXERCISE-II (NEET LEVEL)

Q.1 (4)

$M = \frac{w}{m \times V(l)}$; $0.25 = \frac{w}{106 \times 0.25}$; $w = 6.625 \ gm$

Q.2 (3)

$m = \frac{18 \times 1000}{180 \times 500} = 0.2\,m$

Q.3 (2)

$\frac{1}{10} = \frac{63 \times 2}{126 \times V}$

$V = 10\,L$

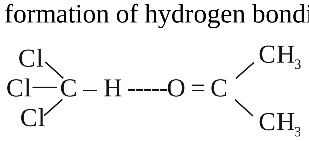
Q.4 (3)

mole = molarity × V(L)

= 3 × 1 = 3 mole

Q.5 (1)

$CHCl_3$ & acefone show negativ deviation due to the formation of hydrogen bonding



Q.6 (1)

Equation of ideal solution following Raoult's law

Q.7 (3)

$P_s = 92\left(\frac{1}{5}\right) + 31\left(\frac{4}{5}\right)$

Q.8 (2)

lower the B.P. higher will be V.P.

Q.9 (3)

$P = K_H . x$

Q.10 (4)

Q.11 (1)

$P_S = P_A{}^\circ x_A$ $\qquad$ A → solvent

Q.12 (3)

$y_A = \frac{P_A{}^\circ x_A}{P_A{}^\circ x_A + P_B{}^\circ x_B}$

Q.13 (4)

$C_2H_5I + C_2H_5OH$ show positive deviation from raoult's law

Q.14 (4)

CS_2 intercept the polar bonding in acetone

Q.15 (1)

For the ideal solution ΔH_{mix} and $\Delta V_{mix} = 0$.

Q.16 (1)

$K_4[Fe(CN)_6]$ dissociates as $4K^+ + [Fe(CN)_6]^{4-}$, thus 1 molecule dissociates into five particles in the similar way $Al_2(SO_4)_3$ also gives five particles per molecule.

Q.17 (2)

Benzoic acid dimerises due to strong hydrogen bonding.

Q.18 (2)

due to association of molecule.

Q.19 (2)

$P_1 = P^0{}_1 x_1$

Q.20 (3)

$\frac{P^\circ - P_s}{P^\circ} = x(\text{solute})$

$$\frac{50-45}{50}=0.1=x_s$$

Q.21 (2)

Q.22 (2)

$$\frac{P^\circ-P_s}{P_s}=\frac{w_B}{M_B\times w_A}\times M_A$$

$$\frac{0.3}{17.24}=\frac{20}{M}\times\frac{18}{100};\ M=206.8$$

Q.23 (2)

$BaCl_2$ furnishes more ions than KCl and thus shows higher boiling point $T_1>T_2$.

Q.24 (2)

For $NaCl \quad i=2$

$\Delta T_f=2K_f m=2\times1.86\times1=3.72$

$T_s=T-\Delta T_f=0-3.72=-3.72°C$

Q.25 (2)

$$\text{Isotonic solution}=\frac{w_1}{m_1V_1}=\frac{w_2}{m_2V_2}$$

$$=\frac{w_1}{342\times1}=\frac{6}{60\times1}=\frac{342\times6}{60}=34.2.$$

Q.26 (3)

$$\pi=CRT,\ C=\frac{\pi}{RT}=\frac{0.0821}{0.821\times300}=0.33\times10^{-2}.$$

Q.27 (1)

$$\pi=\frac{w}{m}\times RT=\frac{0.1}{1}\times0.0821\times273$$

Q.28 (1)

Q.29 (3)

$BaCl_2 \Rightarrow Ba^{2+}+2Cl^-=3$ ion

$NaCl \Rightarrow Na^++Cl^-=2$ ion

Glucose ⇒ No ionisation

$\therefore\ BaCl_2>NaCl>$ Glucose

Q.30 (2)

NaCl gives maximum ion hence it shows lowest freezing point

EXERCISE-III (JEE MAIN LEVEL)

Q. 1 (3)

Mole of $H_2O=\frac{36}{18}=2$

Mole of glycerine $=\frac{46}{92}=0.5$

total mole $=2+0.5=2.5$

Mole fractions of glycerine $=\frac{n_1}{n_1+n_2}=\frac{0.5}{2.5}$

$X_0=0.2$ Ans.

Q.2 (4)

Molality of $BaCl_2=0.1\times0.25=0.025$

by calculation we get the values of (D)

Q.3 (2)

$\frac{5.0\text{gm}}{10^6\text{gm}}$ of solutions

so concentration of solution = 5 ppm

Q.4 (3)

V.P. depends on temperature.

Q.5 **(2)**

Non volatile substance has no V.P.

Q.6 (3)

$$\frac{P^0-Ps}{P^0}=0.2$$

As we know relative lowering of v.p. is equal to the mole fraction of the solute so (I) is correct it doesn't depend upon the number of moles so (II) is wrong mole fraction of solvent will be 0.8 so number of moles of solvent will be 4 so (III) will be correct, (IV) will be also wrong so I & III will be correct

so answer (3)

Q.7 (2)

Acc. of Rault's law $P=P_A+P_B$

for non volatile solute $=P_B=0$

$P_s=P_A$

$P_s=P^0_A X_A$ $\quad X_A$ = mole fractions of solvent $=N_1$

so $P=P_0N_1$ $\quad P^0_A=P_0$.

Q.8 (1)

$$P=100\times\frac{2}{5}+300\times\frac{3}{5}$$

$=40+180=220$

Q.9 (3)

Initially A = 3 mole ; B = 2 mole

$$600 = \frac{3}{5}P_A^0 + \frac{2}{5}P_B^0 \text{ ...... } 1$$

finally A= 4.5 mole ; B = 2 mole and c = 0.5 mole

$$630 = \frac{4.5}{7}P_A^0 + \frac{2}{7}P_B^0$$

$$P_A^0 = 940$$

$$P_B^0 = 90$$

Q.10 (4)

For ideal solution $\Delta H = 0,\ \Delta V = 0, \Delta S_{mix} \neq 0$. Obey Raoult's law.

Q.11 (3)

for a ideal solution $\Delta G\text{ mix} < 0$.

Q.12 (2)

According to Raoult's law

$P_T = (0.08 \times 300 + 0.92 \times 800)$ torr $= (24 + 736)$ torr $= 760$ torr $= 1$ atm

$P_{exp.} = 0.95$ atm < 1 atm

Hence solution shows -ve deviation

so $\Delta H_{mix} < 0$, and $\Delta V_{mix} < 0$.

Q.13 (1)

It shows negative deviation from Raoult's law

p_s (actual) = 580 torr

p_s (Raoult) $= 0.4 \times 300 + 0.6 \times 800 = 600$ torr.

Q.14 (2)

$\pi = iCRT$

$K_3[Fe(CN)_6] = 3k^+ + [Fe(CN)_6]^{3-}$

$(1-\alpha)\ 3\alpha \qquad \alpha$

$i = (1 + 3\alpha)$

$$3.94 = (1 + 3\alpha) \times \frac{1}{10} \times 0.0821 \times 300$$

$\alpha = 0.2$

so 20%

Q.15 (2)

$\pi\alpha$ No. of partial/ion.

$BaCl_2 = 3,\ NaCl = 2$ glucose = 1

So. order of $\pi = BaCl_2 > NaCl >$ glucose.

Q.16 (4)

As benzoic acid dimerises so number of moles decreases so osmotic pressure of benzoic acid is less than benzene. so answer (4)

Q.17 (2)

$$\text{R.L.V.P.} : \frac{P_A^0 - P_s}{P_A^0} = X_B$$

$$X_B = \frac{10-9}{10} = \frac{1}{10}$$

$$X_B = \frac{n_B}{n_A + n_B} = \frac{n_B}{n_A + n_B} = \frac{\frac{W_B}{M_B}}{\frac{W_A}{M_A} + \frac{W_B}{M_B}}$$

$$M_B = \frac{900}{10} = 90.$$

Q.18 (3)

Lowering of V.P. is colligative property

thus, $i_{K_2SO_4} = 1 + (y-1)x = 1 + 2x = 3$

$\therefore$ If $\dfrac{\Delta p}{p^\circ} = \dfrac{n_1 i}{n_1 i + n_2}$

$$\frac{10}{50} = \frac{3n_1}{3n_1 + 12} = \frac{n_1}{n_1 + 4}$$

$n_1 = 1$

Q.19 (3)

$$\frac{P^0 - P}{P^0} = X_{solute}$$

$$P^0 - P \propto X_{solute}$$

$$\frac{10}{20} = \frac{0.2}{X_{solute}}$$

$$\Rightarrow X_{solute} = 0.4 \Rightarrow X_{solvent} = 0.6$$

Q.20 (2)

Sol. (1) $NaCl \rightarrow Na^+ + Cl^-$

$\Delta T_b = K_b \times ms$

$\Delta T_b = 2K_b \times m$

elavation of b.p. will be double in case of NaCl not b.p.

(2) Will be correct because b.p. elavation will be double here in comprasion to glucose.

(3) Elavation of b.p. is colligative property not b.p.

so answer (2).

Q.21 (3)

100% dissociation

$\Delta T_f = (0.0054) = i\,K_f\,m$

$= i \times 1.86 \times 0.001$

$= i = 3$

$= 3$ particles $[MA_6]\,A_2$

Q.22 (1)

$1.04 = 0.52 \times m$

$\Rightarrow\ m = 2$

$$2 = \frac{P^0 - 750}{750} \times \frac{1000}{18}$$

$\Rightarrow \quad P^0 = 777 = P_{atm}$

$P^0 = P_{atm}$ (because at T water boils)

So at T : $P^0 = P_{atm}$

because when water boils V.P. become equals to atmospheric pressure

Q.23 (1)

$\pi = CRT$ $7.40 = n \times 0.0821 \times 300$

$\pi = \frac{n}{v}RT$ $n = \frac{7.4}{0.0821 \times 300} = 0.3.$

Q.24 (4)

For isotonic solution $\pi_1 = \pi_2$; $C_1 = C_2$; $n_1 = n_2$

$\frac{W_1}{M_1} = \frac{W_2}{M_2} \Rightarrow \frac{10.5}{M} = \frac{180}{30} \Rightarrow M = \frac{10.5 \times 180}{30} = 63$

Q.25 (3)

As number of moles is maximum in case

urea > glucose > sucrose

$\pi = CRT$

It depends on number of moles

so osmotic pressure

$P_2 > P_1 > P_3$

i.e.,

EXERCISE-IV

Q.1 ($V_{final} = 5.V_{original}$)

Let original volume of solution = V_1

Volume of solution after dilution = V_2

$$\pi_1 = C_1, RT_1 \Rightarrow \frac{w_B RT_1}{V_1}$$

$$\pi_2 = C_2\, RT_2 \Rightarrow \frac{w_B RT_2}{V_2}$$

$$\frac{\pi_1}{\pi_2} = \frac{V_2\, T_1}{V_1\, T_2}$$

$$\frac{V_2}{V_1} = \frac{\pi_1}{\pi_2} \times \frac{T_2}{T_1}$$

$$\frac{500}{105.3} \times \frac{298}{283}$$

= 5 (app)

$\therefore \ V_2 = 5V_1$

Hence solution is diluted to 5 times

Q.2 2048 g/mol

Solute - B, Solvent -A

$$\Delta T_f = \frac{K_f \times w_B \times 1000}{m_B \times w_A}$$

$$0.10 = \frac{5.12 \times 2.40 \times 1000}{m_B \times 60}$$

$m_B = 2048$ gm mol^{-1}

Q.3 64.0 g/mol

Solute - B, Water - A

$\Delta T_b = 100.130 - 100$

$= 0.130$

$$\Delta T_b = K_b \times \frac{w_B \times 1000}{m_B \times w_A\,(gm)}$$

$$0.130 = 0.513 \times \frac{3.24 \times 1000}{m_B \ x \ 200}$$

$m_B = 64$ gm mol^{-1}

Q.4 (1)

$$y_A = \frac{P_A^0 X_A}{P_A^0 X_A + P_B^0 X_B}$$

$$y_A = \frac{1}{1 + \frac{P_B^0 X_B}{P_A^0 X_A}}$$

$$y_A = \frac{1}{1+(3)(3)} = \frac{1}{10} = 0.1$$

Q.5 3

$\frac{P^o - P}{P^o} = 0.05 = X_B$

Where X_B = mole fraction of solute.

Molality = $\frac{1000 \times X_B}{(X_A \times M_A)} = 1000 \times 0.05 / 0.95 \times 18 = 2.92 \approx$ 3.0

Q.6 3

$Ca(NO_3)_2 \rightarrow Ca^{2+} + 2NO_3^-$ it gives three ions hence the Van't Hoff factor = 3.

Q.7 (4)

Pressure cooker reduces the cooking time because it increases the boiling point inside the cooker.

Q.8 (4)

Both statements are correct.

Q.9 **(1)**
in Benzene acetic acid gets dimerize as benzene is non-polar in nature, while in water, acetic acid gets ionize because water is polar. So both statements is correct and reason explains the assertion.

Q.10 **(2)**
$H_2C_2O_4 \cdot 2H_2O$ contains two molecules of water, hence it is a dihydrate organic acid. The molar mass of $H_2C_2O_4 \cdot 2H_2O$ is 126 g mol^{-1}

equivalent mass = $\frac{126}{2} = 63$

Normality = $\frac{\text{mass}}{E_w \times V_{\mu_r}} = \frac{1.575 \times 1000}{63 \times 250}$

= 0.1 N
So both statement are correct but reason is not the correct explaination of assertion.

Q.11 (3)
(P) Solution of mixture of acetone and chloroform show negative deviation.
(Q) ΔT_b i.e. elevation in boiling point is proportional to molality which is proportional to mole fraction of solute.
(R) Copper ferrocyanide acts as artificial semi-permeable memberane.
(S) Camphor is volatile in nature.

Q.12 (1)
(a) $P^O - P_S$ represent lowering of vapour pressure.
(b) $P^O \times X_A = P_A$ (Raoult's law)
(c) Mixture which boils like pure solvent is constant boiling mixture called as azeotropic mixture.

(d) Van't Hoff factor = $\frac{\text{Observed colligative property}}{\text{Normal colligative property}}$

PREVIOUS YEAR'S

MHT CET

Q.1 (1)	**Q.2** (1)	**Q.3** (3)	**Q.4** (1)	**Q.5** (2)
Q.6 (2,4)	**Q.7** (1)	**Q.8** (4)	**Q.9** (3)	**Q.10** (2)
Q.11 (4)	**Q.12** (3)	**Q.13** (3)	**Q.14** (2)	**Q.15** (2)
Q.16 (1)	**Q.17** (3)	**Q.18** (3)	**Q.19** (1)	**Q.20** (3)
Q.21 (1)	**Q.22** (3)	**Q.23** (4)	**Q.24** (4)	**Q.25** (4)
Q.26 (1)	**Q.27** (4)	**Q.28** (1)	**Q.29** (1)	**Q.30** (1)
Q.31 (1)	**Q.32** (2)	**Q.33** (4)	**Q.34** (3)	**Q.35** (2)
Q.36 (3)	**Q.37** (1)	**Q.38** (4)	**Q.39** (2)	**Q.40** (4)
Q.41 (3)	**Q.42** (3)	**Q.43** (3)	**Q.44** (4)	**Q.45** (4)
Q.46 (1)	**Q.47** (3)	**Q.48** (2)	**Q.49** (3)	

Q.50 (2)
The formula used to determine the molar mass of solute from depression in freezing ponit is

$$M_2 = \frac{1000 \times K_f \times W_2}{\Delta T_f \times W_1}$$

Where , W_2 = weight of solute
W_1 = weight of solute
K_1 = molal depression constant

Q.51 (2)
Given $p^o = 17.53$, $p_s = 17.22$
and W = 17.10

$$\frac{p^o - p_s}{p^o} = \frac{n}{n+N} = \frac{\frac{w}{m}}{\frac{w}{m} + \frac{W}{M}}$$

$$\because \quad \frac{w}{m} << \frac{W}{M}$$

$$\therefore \quad \frac{p^o - p_s}{p^o} = \frac{w/m}{W/M} = \frac{w}{m} \times \frac{M}{W}$$

$$\frac{17.53 - 17.22}{17.53} = \frac{17.10}{m} \times \frac{18}{100}$$

$$\Rightarrow m = \frac{17.10 \times 18 \times 17.53}{0.31 \times 100} = 174.05$$

174 is nearest to the molecular weight of glucose ($C_6H_{12}O_6$), thus the substance X can be glucose.

Q.52 (2)	**Q.53** (1)	**Q.54** (3)	**Q.55** (3)	**Q.56** (4)
Q.57 (3)	**Q.58** (3)			

NEET

Q.1 (1)
The maximum boiling azeotrope is shows by negative deviation solution so it is H_2O and HNO_3 mixture

Q.2 (3)
For ideal solution
$\Delta G_{mix} < 0$ at constant T and P
$\Delta S_{mix} > 0$ at constant T and P
$\Delta V_{mix} = 0$ at constant T and P
$\Delta H_{mix} = 0$ at constant T and P

Q.3 (4)
Q.4 (2)
Q.5 (2)
Q.6 (4)
Q.7 (1)

$$m = \frac{\text{Moles of solute}}{\text{Weight of solvent(g)}} \times 1000$$

$$1 = \frac{0.5}{\text{Weight of solvent (g)}} \times 1000$$

Weight of solvent (g) = 500 g

JEE MAIN

Q.1 **(54)**

Osmotic pressure = 7.47 bar

Temp=300K

conc.(g/lit)=? i=1 for glucose

π=i C RT

7.47=1×C×0.0821×300

C=0.3 mole/lit

Conc. =0.3×180=54 g /lit

= 54

Q.2 [20]

Initial moles of H_2SO_4 (in/Lit.) = 0.02

In 50% solution moles of H_2SO_4 = 0.01

Added moles of H_2SO_4 = 0.01

Total moles of H_2SO_4 in resulting solution = 0.02

= 20 × 10^{-3} moles

= 20 milimoles

= 20

Q.3 (98 or 99)

$\Delta T_f = iK_f m$

$$0.24 = I \times 1.80 \left[\frac{0.5 \times 1000}{74.6 \times 99.5}\right]$$

$$i = \frac{1781.448}{900}$$

i=1.479

i=(1+(n–1)α); n=2 for KCl

So, 1.98=1+α

α =0.9=98%

Q.4 (415)

π = CRT

$$\pi = \frac{2(\text{gm}) \times 1000(\text{ml})}{60 \times 10^3(\text{gm}) \times 200(\text{ml})} \times 0.083 \times 300$$

π = 0.004149

π = 415 × 10^{-5} bar

$\because$ 1 bar = 10^5 pascal

π = 415 Pa

Q.5 **(14)**

Given: Vapour pressure of liquid A = 50 torr (at 25°C)

Vapour pressure of liquid B = 100 torr (at 25°C)

Mole fraction of liquid A = 0.3

Mole fraction of liquid B = $\frac{x}{17}$

$y_A + y_B = 1$ $x_A + x_B = 1$

$P_T = P_A + P_B$

$P_T = x_A P_A^0 + x_b P_B^0$

$P_T = 0.3 \times 50 + 0.7 \times 100$

= 85

$$\Rightarrow y_B = \frac{P_B}{P_t}$$

$$\Rightarrow \frac{x}{17} = \frac{0.7 \times 100}{85}$$

$$\Rightarrow x = \frac{70 \times 17}{85} = 14$$

$\boxed{x = 14}$

Q.6 (45)

$\Delta T_b = ik_b m$

$\Delta T_b = T_b^0 - T_b^0 = 373.535 - 373.15 = 0.385$

i = 1

$\Delta T_b = ik_b \times m$

K_b = 0.52 Kkg mol^{-1}

$$0.385 = 1 \times 0.52 \times \frac{2.5 \times 1000}{M \times 75}$$

$$M = \frac{1300}{75 \times 0.385} = 45 \text{ g/mol.}$$

Q.7 (330)

π = CRT

5.03 × 10^{-3} = C × 0.083 × 300

C = 0.202 × 10^{-3} M

Moles of protein = 0.202 × 10^{-3} × 0.5

= 10^{-4} × 1.01

$$1.01 \times 10^{-4} = \frac{2.5}{M}$$

M (molar mass of protein) = 24752

$$\therefore \text{No. of glycine units} = \frac{24752}{75} 330.03$$

Q.8 **(5)**

m = d × V = 1.02 × 1.2 = 1.224 g

moles = 0.0204 mole in 2L

So molality = 0.0102 mol / kg

$T_f = i \times K_f \times m$

i = 1 + α

0.0198 = (1 + α) × 1.85 × 0.0102

α = 0.049 = 5 %

Q.9 (3:1)

m = 1.5

$\because \Delta T_b = iK_b m, \Delta T_f = iK_f m$

ΔT_b = 4K

ΔT_f = 4 K

$4 = \Delta T_b = i \times K_b \times 1.5$ .... (i)

$4 = \Delta T_f = i \times K_f \times 4.5$ .... (ii)

$$\frac{K_b}{K_f} = \frac{4.5}{1.5} = 3$$

Ratio = 3 : 1

Q.10 **(D)**

42.12% (w/v) solution of NaCl i.e.,
42.12 gm NaCl in 100 ml solution

$$M = \frac{n}{V(ltr)} = \frac{42.12}{58.5} \times \frac{1000}{100}$$

M=7.2
1 ltr sol = 7.2 mole
Number of milli moles = 7.2 × 1000
= 7200 milli moles

$$\text{Coagulation value} \Rightarrow \frac{\text{No of milli mole of electron}}{\text{Volume of solution}}$$

$$= \frac{7200}{1} = 7200 \text{ mm for 10 hours}$$

$10 \text{ hr} \rightarrow 7200$

$$1\text{hr} \rightarrow \frac{7200}{10}$$

$2\text{ hr} \rightarrow 720 \times 2$

$\Rightarrow 1440$ milli moles / ltr

Q.11 (8)

Q.12 [1221]

Let mole fraction of $CO_2 = x_1$

$$x_1 = \frac{p}{K_H}$$

$K_H = 1.67$ k bar $= 1.67 \times 10^3$ bar
p = 0.835 bar

$$x_1 = \frac{0.835}{1.67 \times 10^3}$$

$$x_1 = \frac{n_1}{n_1 + n_2} = \frac{n_1}{n_1 + \frac{1000}{18}} = 0.5 \times 10^{-3}$$

$$\frac{n_1}{n_1 + 55.55} = 0.5 \times 10^{-3}$$

$n_1 = 0.5 \times 10^{-3} n_1 + 27.77 + 10^{-3}$
$n_1(1 - 0.5 \times 10^{-3}) = 27.77 \times 10^{-3}$

$$n_1 = \frac{27.77 \times 10^{-3}}{0.99995}$$

$n_1 = 0.027$ mole

wt of CO_2 dissolved $= 0.027 \times 44$
$= 1.221$ gm
$= 1221 \times 10^{-3}$ gm
x = 1221 Ans

Q.13 **[2]**

initial concentration of $CH_3COOH = 0.2$
initial millimoles of $CH_3COOH = M \times V(ml) = 0.2 \times 200 =$ 40 millimole
final remaining millimoles of $CH_3COOH = 0.1 \times 200 = 20$ millimole
Change in millimole = 40 – 20 = 20 millimole
$\because$ 0.6 g wood charcoal adsorbed = 20 millimole CH_3COOH

$\therefore$ 1 g wood charcoal adsorbed $= \frac{20}{0.6}$ millimole CH_3COOH

Mass of CH_3COOH (Per gm of charcoal) $= \frac{20}{0.6} \times 60 \times 10^{-3}$ g
= 2 g

Q.14 **(d)**

$\Delta T = ik_f m$

$$0.2 = i \times 1.86 \times \frac{0.7}{93} \times \frac{1000}{42}$$

$$i = \frac{0.2 \times 93 \times 6}{1.86 \times 100}$$

i = 0.60

$2A \Rightarrow A_2$

$1 - \alpha \qquad \frac{\alpha}{2}$

$$i = 1 - \alpha + \frac{\alpha}{2}$$

$$i = 1 - \frac{\alpha}{2}$$

$$1 - \frac{\alpha}{2} = 0.60$$

$\alpha = 0.80$

Q.15 (1)

Given that
$k_H = 46.82$ k bar $= 46.82 \times 10^3$ bar
Partial pressure of $O_2 = pO_2 = 0.920$ bar
X = mole fraction of dissolved gas

$$= \frac{\text{mole of } O_2}{\text{mole of dissolved } O_2 + \text{mole of water}} \approx \frac{\text{mole of } O_2}{\text{mole of water}}$$

$$\text{Mole of water} = \frac{1000}{18} \quad (\because \text{ mass of 1000 ml water} = 1000 \text{ gm})$$

According to Henry's law :

$$P_{O_2} = k_H \times X$$

$$0.920 = 46.82 \times 10^3 \times \frac{\text{mole of } O_2}{1000/18}$$

Mole of $O_2 = \frac{0.920}{46.82\times18} = 1.09\times10^{-3} \approx 1\times10^{-3}$

mili moles of $O_2 = 1$

Q.16 15

$\Delta T_f = K_f m$

$= 3.9\times\frac{10.2}{176\times150}\times1000$

$= 1.51\ K$

$= 15\times10^{-1}\ K$

$x = 15$

Q.17 (2)

$\pi A = \pi B \rightarrow$ Isotoric

$C_1RT = C_2RT$

$C_1 = C_2$

$\frac{2}{M_A}\times\frac{1}{100} = \frac{8\times1}{M_B\times100} \Rightarrow \frac{2}{M_A}\times\frac{1}{100} = \frac{8\times1}{M_B\times100}$

$\frac{M_A}{M_B} = \frac{1}{4}$

$M_B = 4M_A$

Q.18 (3)

Conc of formic acid = 0.5 ml/lit.

$\Delta T_f = 0.0405$

Density = 1.05 gm/ml

$D = \xrightarrow[v]{mass} \Rightarrow 1.05 = \frac{mass}{0.5}$

Mass of HCOOH = 1.05 × 0.5 = 0.525 gm/lit

$\text{Molarity} = \frac{0.525}{46}\text{moles / lit.}$

$\Rightarrow \Delta T_f = i\times k_f\times\text{molality} = 0.0405 = i\times1.86\times\frac{0.525}{46}$

$i = \frac{0.0405\times46}{1.86\times0.525} = 1.9$

Q.19 (3)

NH_4OH	+	HCl	$\rightarrow NH_4Cl + H_2O$
m.moles 20 × 0.1		40×0.05	↓
2		2	2 m.moles
0		0	$[NH_4Cl] = \frac{2}{60} = \frac{1}{30}$

$\mathbf{P}^{OH} = \frac{1}{2}\left[\mathbf{P}^{kw} + \mathbf{P}^{kb} + \log C\right]$

$= \frac{1}{2}\left[14 + 5 + \log\frac{1}{30}\right]$

$= \frac{1}{2}[19 - 1 - 0.4771]$

$= \frac{1}{2}[18 - 0.4771]$

$= 9 - 0.23$

$P^H = 5 + 0.23$

Q.20 (2)

$\frac{(\Delta T_f)_A}{(\Delta T_f)_B} = \frac{K_f\cdot m_A}{K_f m_B} = \frac{M_B}{M_A} = \frac{1}{4}$

$\frac{M_A}{M_B} = 4$

Q.21 [54]

800 ml of 0.5 M nitric acid

M moles of nitric acid

= V × M

= 800 × 0.5

= 400 m mol

Mass of Nitric acid before heating

$= 400\times10^{-3}\times63$

= 25.2 gm

Mass of Nitric acid after heating

= 25.2 – 11.5

= 13.7 gm

Volume of solution after heating

$= \frac{800}{2} = 400\ ml$

$M_{final} = \frac{mole}{V_{solution}}$

$= \frac{13.7/63}{400}\times1000$

= 0.54365

$= 54.365\times10^{-2}$

$= x\times10^{-2}$

$x \approx 54$

Q.22 [1]

Molality = 1m	molality = 2m
$\Delta T_b = 3k$	$\Delta T_f = 6k$
∵ Solvent is same	
$\Delta T_b = K_b m_1$	$\Delta T_f = K_f m_2$
$\frac{\Delta T_b}{\Delta T_f} = \frac{K_b}{K_f}\times\frac{m_1}{m_2}$	$\frac{3}{6} = \frac{K_b}{K_f}\times\frac{1}{2}$
$\frac{K_b}{K_f} = \frac{1}{1}$	
$K_b : K_f = 1 : 1$	= 1 : X

So, X = 1

Q.23 **(3 or 6)**

Mass of water solvent = 100 g

$P^0 = 23.76$ mm Hg.

$$P_S = \frac{P^0}{2} = \frac{23.76}{2} \text{ mm Hg}$$

No of moles of solute =?

$$\frac{p^0 - ps}{p_s} = \frac{n}{N} \rightarrow \text{ for all types solution}$$

$$\frac{23.76 - \frac{23.76}{2}}{\frac{23.76}{2}} = \frac{n}{N} = \frac{n}{\frac{100}{18}}$$

$$1 = \frac{n}{5.55}$$

$$N = 5.55$$

Ans.: 6

Q.24 (80)

Mass of solvent = d × v = 0.8 × 62.5

= 50 g

$\Delta T_f = K_f \times m$

$$0.9 = 2\left[\frac{1.8 \times 1000}{M_{solute} \times 50}\right]$$

$M_{solution}$ = 80 g/mole

Electrochemistry

EXERCISE-I (MHT CET LEVEL)

Q.1 (3)

$$\wedge_m = \frac{1000k}{0.1} = \frac{1000\times 3.75\times 10^{-4}}{0.1} = 3.75$$

$$\alpha = \frac{\wedge_m}{\wedge_m^\infty} = \frac{3.75}{250} = 1.5\times 10^{-2}$$

$K_a = C\alpha^2 = 0.1 \times (1.5 \times 10^{-2})^2 = 2.25 \times 10^{-5}$

Q.2 (4)

Q.3 **(Bonus)**

Q.4 (1)

Q.5 (c)

Q.6 (2)

Q.7 (4)

Q.8 (1)

The more the reduction potential, the more the oxidising power.

Q.9 (4)

Q.10 (4)

Q.11 (1)

Q.12 (3)

Q.13 (3)

Q.14 (1)

Q.15 (2)

Q.16 (1)

More is $E°_{RP}$, more is the tendency to get itself reduced or more is oxidising power.

Q.17 (3)

$\Delta G = 2.303\ RT \log K$

$-nFE° = -2.303\ RT \log K$

$$\log K = \frac{nFE°}{2.303RT}$$

$$= 0.4342\frac{nFE°}{RT} \quad ......(i)$$

$$\text{In } K = \frac{nFE°}{RT}$$

$$K = e^{\frac{nFE°}{RT}} \quad ......(ii)$$

Q.18 (2)

$$E^\circ_{cell} = \frac{0.059}{2}\log K_c$$

or $$\frac{1.10\times 2}{0.59} = 1\log K_c$$

$\therefore$ $K_c = 1.9 \times 10^{37}$

Q.19 (4)

Q.20 (4)

Q.21 (4)

Q.22 (1)

Q.23 (1)

$$Zn(s) + 2H^+ + (aq) \rightarrow Zn^{2+}(aq) + H_2(g)$$

$$E_{cell} = E°_{cell} - \frac{0.059}{2}\log\frac{[Zn^{2+}][H_2]}{[H^+]^2}$$

Addition of H_2SO_4 will increase $[H^+]$ and E_{cell} will shift toward RHS.

Q.24 (4)

Decreases as reaction shift in backward direc tion

Q.25 (3)

$$2Cu^+ \longrightarrow Cu^{+2} + Cu$$

$$2e^- + Cu^{+2} \longrightarrow Cu;\ E_1^0 = 0.34V;...(i)$$

$$e^- + Cu^{+2} \longrightarrow Cu^+;\ E_2^0 = 0.15V;...(ii)$$

$$Cu^{+2} + e^- \rightarrow Cu\ ;\ E_3^0 = ...?(iii)$$

Now, $\Delta G_1^0 = -nFE_1^0 = -2\times 0.34F$

$\Delta G_2^0 = -1\times 0.15F,\ \Delta G_3^0 = -1\times E_3^0 F$

Again, $\Delta G_1^0 = \Delta G_2^0 + \Delta G_3^0$

$\Rightarrow -0.68F = -0.15F - E_3^0 F$

$0 \Rightarrow E_3^0 = 0.68 - 0.15 = 0.53V$

$E^0_{cell} = E^0_{cathode}\left(Cu^+ / Cu\right) - E^0_{anode}(cu^{+2}/cu^+)$

$= 0.53 - 0.15 = 0.38V.$

Q.26 (2)
The mass of the substance deposited when one Faradau of charge is passed through its solution is equal to gram equivalent weight.

Q.27 (2)
The oxidation potential

$\propto \frac{1}{Concentration \text{ of ions}}$ and reduction

Potential $\propto$ concentration of ions. The cell voltage can be increased by decreasing the concentration of ions around anode or by increasing the concentration of ions around cathode

Q.28 (3)
$Pt|H_2(640\text{ mm})|HCl|H_2(510\text{ mm})|Pt$

$E^\circ_{cell} = 0$

$(p_1)H_2(g) \longrightarrow 2H^+ + 2e^-$

$2H^+ + 2e^- \longrightarrow H_2(g)(p_2)$

$\underset{(p_1)}{H_2(g)} \rightarrow \underset{(p_2)}{H_2(g)}$

$E^\circ_{cell} = E^\circ_{cell} - \frac{0.0591}{n} \log \frac{p_2}{p_1}$

$= 0 - \frac{0.0591}{2} \log \frac{510}{640}$

$= 2.91 \times 10^{-3}$ V

Q.29 (1)

Q.30 (1)

Q.31 (4)
In electrolytic purification cathode of pure metal and anode is of impure metal.

At anode : $M \rightarrow M^{n+} + n\bar{e}$

At cathode : $M^{n+} + n\bar{e} \rightarrow M$.

The pure metal is thus deposited at cathode.

Q.32 (3)
In electrolytic cell the cathode is of higher reduction potential.

Q.33 (3)
On electrolysis of $CuSO_4$
(i) Using Pt electrode – pH decrease due to formetion of H_2SO_4
(ii) Using Cu $\rightarrow$ No change in the solution
(iii) pH increase due to formetion of KOH

Q.34 (2)

Q.35 (4)

Q.36 (4)

Q.37 (1)

Amt. deposited $= -\frac{E.wt \times Q}{96500}$:

$107.870 = \frac{107.870}{96500} \times Q;$

$\therefore$ Q 96500C

Q.38 (3)

$m = \frac{E.wt \times Q}{96500}$

$\therefore E \cdot wt = \frac{m \times 96500}{Q}$

$= \frac{22.2 \times 96500}{2 \times 5 \times 60 \times 60} = 60.3$

Oxidation state $= \frac{\text{At wt.}}{\text{Eq. wt.}} = \frac{177}{60.3} = 3$

Q.39 (4)

At cathodes : $Fe^+ + 2e^- \rightarrow Fe;$

$Fe^{3+} + 3e^- \rightarrow Fe$

$(E_{Fe})_1 = \frac{\text{At. wt.}}{2}; (E_{Fe})_2 = \frac{\text{At. wt.}}{3}$

Hence, $\frac{(E_{Fe})_1}{(E_{Fe})_2} = \frac{3}{2}$

Q.40 (1)

By Faraday's Ist Law, $\frac{W}{E} = \frac{q}{96500}$

(where q = it = charge of ion)
we know that no of equivalent

$= \frac{W}{E} = \frac{it}{96500} = \frac{1 \times 965}{96500} = \frac{1}{100}$

(where i = A, t=16×60+5=965sec.)

Since, we know that

$$\text{Normality} = \frac{\text{no. of equivalent}}{\text{Volume(litre)}} = \frac{\frac{1}{100}}{1} = 0.01N$$

Q.41 (4)
No. of moles of

$$Ag^+ = \frac{15\times60\times1.25\times10^{-3}}{96500}\times\frac{1}{1} = 0.0116\times10^{-3}$$

$$\therefore [Ag^+] = \frac{1.16\times10^{-5}}{96,500} = 1.16\times10^{-4}$$

Q.42 (3)

Q.43 (2)

Q.44 (4)

Q.45 (4)

Q.46 (3)

Q.47 (3)

Q.48 (2)

Q.49 (2)

Q.50 (1)

Q.51 (3)

Q.52 (3)

Q.53 (1)
Efficieney of fuel cell is:

$$\eta = \frac{-nFE_{cell}}{\Delta H}\times100$$

Q.54 (2)

Q.55 (1)

Q.56 (2)

Q.57 (3)

Q.58 (3)

Q.59 (4)

$$\text{Solublity} = \frac{conductivity\times1000}{A_{eq}}$$

$$= \frac{3.06\times10^{-6}\times1000}{1.53} = 2\times10^{-3}$$

$$K_{SP} = S^2 = 4\times10^{-6}$$

EXERCISE-II

Q.1 (3)
In the electrolytic cell electrical energy change into chemical energy.

Q.2 (3)
Velocities of both K^+ and NO_3^- are nearly the same in KNO_3 so it is used to make salt-bridge.

Q.3 (3)

$$E^o = E^o_{Ag^+/Ag} + E^o_{Cu/Cu^{2+}} = 0.80 - 0.34 = +0.46V.$$

Q.4 (4)
$Cu + FeSO_4 \rightarrow$ No reaction Because Cu has $E^oCu^{2+}/Cu = 0.34$ *volt* and Fe has $E^oFe^{2+}/Fe = -0.44$ *volt.*

Q.5 (1)
More negative is the reduction potential, higher will be the reducing property, *i.e.* the power to give up electrons.

Q.6 (4)
Ag will not react due to lower reactivity

Q.7 (2)
IUPAC convention

Q.8 (2)

$$\Delta G^o = \frac{-2\times1.1\times96500}{1000} = 212.3$$

Q.9 (4)

$$\Delta G^o = -nFE^o$$

$$\Delta G^o = -2.303\,RT\log K\ ;\ nFE^o = 2.303\,RT\log K$$

$$\log K = \frac{nFE^o}{2.303\,RT} = \frac{2 \times 96500 \times 0.295}{2.303 \times 8.314 \times 298}$$

$$\log K = 9.97 = K = 1 \times 10^{10}.$$

Q.10 (2)

For this cell, reaction is: $Zn + Fe^{2+} \rightarrow Zn^{2+} + Fe$

$$E = E^0 - \frac{0.0591}{n}\log\frac{c_1}{c_2};\ E^0 = E + \frac{0.0591}{n}\log\frac{c_1}{c_2}$$

$$E^{\circ} = 0.2905 + \frac{0.0591}{2}\log\frac{10^{-2}}{10^{-3}} = 0.32\ V.$$

$$E^0 = \frac{0.0591}{2}\log K_c;\ \log K_c = \frac{0.32 \times 2}{0.0591} = \frac{0.32}{0.0295}$$

$$\therefore K_c = 10^{\left(\frac{0.32}{0.0295}\right)}$$

Q.11 (2)

$$E^o_{\text{cell}} = \frac{2.303\ RT}{nF}\log K = \frac{0.0591}{n}\log K_c\ at\ 298K.$$

Q.12 (1)

$$E_{cell} = E^o - \frac{RT}{nF}\ in\frac{[\text{Product}]}{[\text{Reactant}]}$$

Q.13 (3)

In between dilute H_2SO_4 and platinum electrode O_2 gas evolve at anode over $S_2O_8^{-2}$

Q.14 (1)

In fused $NaCl$ chloride ions are oxidized at anode and it is called oxidation.

Q.15 (4)

In the absence of electric field the ions in the solution move randomly due to thermal energy.

Q.16 (1)

When platinum electrodes are dipped in dilute solution H_2SO_4 than H_2 is evolved at cathode.

Q.17 (1)

Wt. of Ag deposited $= Eq.wt\ of\ Ag = 108\ gm$

Wt. of Ni deposited $= Eq.wt.of\ Ni = 29.5\ gm$

Wt. $of\ Cr$ deposited $= Eq.wt.of\ Cr = 17.3\ gm$.

Q.18 (4)

$$Pb + PbO_2 + 2H_2SO_4 \underset{\text{Recharge}}{\overset{\text{Discharge}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O.$$

Sulphuric acid is consumed on discharging.

Q.19 (4)

Fuel cells are more efficient, free from pollution and they function till reactants are active.

Q.20 (2)

Electro chemical process in which metal is oxidised

Q.21 (4)

Rusting of iron is catalysed by $[H^+]$.

Q.22 (2)

Equival conductivity = $ohm^{-1}\ cm^2$

Q.23 (2)

HCl gas in water solution ioniger, so, it is good conductor of electricity in ionic form

Q.24 (2)

Electrolytic conduction resistance decreases with increasing temperature.

Q.25 (1)

Strong electrolyte ionise completely at all concentrations and the number of ions does not increase on dilution. A small increase in $\wedge_m$ with volume on dilution is due to the weakening of electrostatic attraction between the ions on dilution.

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (1)

In galvanic cell/electro chemical cell electrical energy is produced due to some chemical reaction.

Q.2 (1)

Reduction and electronation take place at cathode elctrode, so it become positive electrode.

Q.3 (3)

Salt bridge complete the electrical circuit and minimises the liquid - liquid junction potential.

Q.4 (4)

$E^0_{Cu^{2+}/Cu} = 0.34$ $\quad$ $E^0_{Fe^{2+}/Fe} = -0.44$ volt

So Cu can't displace Fe^{2+}.

Q.5 (4)

Cu can't displace Al^{3+} ion from aluminium nitrate.

Q.6 (3)

Lower S.R.P. containing ion can displace higher S.R.P. containing ion.

Q.7 (2)

Q.8 (1)
E^0 is intensive property and it do not depend on mass of F_2 taking part.

Q.9 (4)
For spontaneous reaction in every condition
$E_{cell} > 0$, $\Delta G < 0$ and Q (reaction quotient) < K (equilibrium constant).

Q.10 (3)
$Hg_2^{2+} + 2e^- \longrightarrow 2Hg$, 0.789 Volt
$Hg \longrightarrow Hg^{2+} + 2e^-$, –0.854 Volt
$Hg_2^{2+} \longrightarrow Hg + Hg^{2+}$, –0.065 Volt
$\Delta G = -2\times(-0.065)\times 96500 = -8.314 \times 298 \ln K_{eq.}$; $K_{eq.} = 6.3\times10^{-3}$

Q.11 (4)
$A_{(s)} + B^{2+}_{aq.} \longrightarrow A^{2+}_{aq.} + B_{(s)}$, $\Delta H° = -285$ KJ
Assuming Δs to negligible , $\Delta G° = \Delta H° = -285\times10^3\times0.84$
$= -2\times E°\times 96500$
$E° = 1.24$ Volt

Q.12 (1)

$$E = E^0 - \frac{0.0591}{n}\log\frac{[Product]}{[Reactant]}$$

if $\frac{[Product]}{[Reactant]} = 1$ then $E = E^0$.

Q.13 (1)

$$E = 1.1 - \frac{0.0591}{2}\log\frac{0.1}{0.1} \Rightarrow E = 1.10 \text{ Volt}$$

Q.14 (2)
Anode
$H_2 \longrightarrow 2H^+ + 2e^-$
Cathode
$2e^- + Cl_2 \rightarrow 2Cl^-$
$H_2 + Cl_2 \rightarrow 2H^+ + 2Cl^-$
$[(H^+)^2(Cl^-)^2] = K_{eq.}$

$$E_{cell} = E° - \frac{0.0591}{2}\log(H^+)^2(Cl^-)^2$$

$= E° - 0.0591\log[H^+][Cl^-]$

Q.15 (3)
In this Cl^- will oxidise to give Cl_2,Na^+ reduction potential has lower potential than water reduction polenlid so water will reduce to give H_2.

Q.16 (1)
As electron flows from anode to a cthode and so current flows from cathode to anode in outer drcuit

Q.17 (3)
In this Cl^- will oxidise to give Cl_2 Na^+ water reduction potential has higher potential than that of water reduction potential, so water will reduce to give H_2.

Q.18 (1)
Cathode
$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
Anode
$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

Q.19 (4)

$8H^+ + 5e^- + MnO_4^- \longrightarrow Mn^{+2} + 4H_2O$
(1 mole)
5 mole e^- = 5 Faraday.

Q.20 (1)
Since to deposit 1 mole of aluminium 3 columb of electricity is required, as the alency of silver is + 1 so 3 mole of silver will be deposited by 3C of electricity

Q.21 (2)
gm equivalent of Al = gm eq. of Cu = gm eq. of Na
3 = 3 = 3
3/3/ = 3/2 = 1
1 : 1.5 : 3

Q.22 (2)
Z = w/it
w in gm
it in columb.
so z = gm/columb

Q.23 (4)
Since KCl has the n-factor of 1 so 1 faraday of electricity will liberate one mole of metal from a solution.

Q.24 (3)
$Na^+ + e^- \longrightarrow Na(s)$
1mole 1 Faraday
$Al^{3+} + 3e^- \longrightarrow Al(s)$
1 Faraday

No. of mole of Al = $\frac{1}{3}$ mole.

Q.25 (1)
H_2–O_2 fuel cell

At anode : $2OH^- + H_2 \longrightarrow 2H_2O + 2e^-$

At cathode : $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$

Q.26 (1)

Discharging reaction

$Pb(s) + PbO_2(s) + 2H_2SO_4\,(aq) \longrightarrow 2PbSO_4\,(s) + 2H_2O.$

Q.27 (2)

$K = 0.3568\ \Omega\ cm^{-1}$

conductance = $0.0268\ \Omega^{-1}$

$K = G \times 1/A$

$0.3568 = 0.0268 \times 1/9$

$13.31\ cm^{-1}$

Q.28 (3)

Higher the dilution higher will be the equivalent conductance

Q.29 (4)

Molar conductivity α no. of ions per mole of electrolyte.

Q.30 (1)

For strong electrolyte

$$\lambda_M^C = \lambda_M^\infty - b\sqrt{C}$$

EXERCISE-IV

Q.1 (2)

At cathode:

$$H_2O + e^- \rightarrow \overset{\Theta}{O}H + \frac{1}{2}H_2(\text{one})$$

At anode:

$$3HCOO^{\Theta} \rightarrow 2CO_2 + H_2(\text{two})$$

H_2 and CO_2 at anode and H_2 at cathode. So, number of gases as in (2)

Q.2 419 S cm^2 equivalent^{-1}

$$\lambda_{eq} = \frac{k \times 1000}{N}$$

$$k = \frac{1}{R} \times \frac{l}{A} = \frac{1}{210} \times 0.88 \qquad \Rightarrow \lambda_{eq} = \frac{0.88 \times 1000}{210 \times 0.01} = 419$$

S $cm^2\,eq^{-1}$

Q.3 60 %

Both are in series

$$\text{Eq. of Cu} = \text{Eq of NaOH} = \frac{31.75}{31.75} = 1$$

Eq. of NaOH = Eq. of NaCl = 0.6

$$\%\ \text{Efficiency} = \frac{0.6}{1} \times 100 = 60$$

Q.4 pH = 4

$$\text{Ecell} = - -\frac{.0591}{1}\log\frac{x}{1}$$

$$\frac{0.2361}{0.0591} = -\log_{10} x = x = 10^{-4}\,M \qquad \text{p H} = 4$$

Q.5 5

$$8H^+ + 5e^- + MnO_4^- \longrightarrow Mn^{+2} + 4H_2O$$

(1 mole)

5 mole e^- = 5 Faraday.

Q.6 3

Since to deposit 1 mole of aluminium 3 columb of electricity is required, as the alency of silver is + 1 so 3 mole of silver will be deposited by 3C of electricity

Q.7 2

Since magnesium has the n-factor 2 so the number of faraday rquired to genereate 1 mole of Mg will be 2 .

Q.8 190

$AgA \rightleftharpoons Ag^+ + A^-\,;\ 3 \times 10^{-14}$

$\qquad S_1 + S_2 \quad S_1$

$AgB \rightleftharpoons Ag^+ + B^-\,;\ 1 \times 10^{-14}$

$\qquad S_1 + S_2 \quad S_2$

$S_1 + S_2 = 2 \times 10^{-7}\,;\ S_1 = 1.5 \times 10^{-7}$

$S_2 = 0.5 \times 10^{-7}$

$$375 \times 10^{-10} = K_{Ag^+} + K_{A^-} + K_{B^-}$$

$$= \frac{(\Lambda_{Ag^+})(M_{Ag^+})}{1000} + \frac{(\Lambda_{A^-})(M_{A^-})}{1000} + \frac{(\Lambda_{B^-})(M_{B^-})}{1000}$$

$= 60\,(S_1 + S_2) + 80\,S_1 + \Lambda_B\ -S_2$

After putting value of S_1 & S_2

$\Lambda_{B^-} = 270$

PREVIOUS YEAR'S

MHT

Q.1 (3)
Q.2 (4)
Q.3 (4)
Q.4 (1)
Q.5 (3)
Q.6 (2)
Q.7 (4)
Q.8 (2)

Q.9 (4)
Q.10 (3)
Q.11 (1)
Q.12 (4)
Q.13 (2)

Q.14 (4)
Q.15 (3)
Q.16 (1)
Q.17 (1)
Q.18 (1)
Q.19 (1)
Q.20 (2)
Q.21 (1)
Q.22 (2)
Q.23 (3)
Q.24 (3)
Q.25 (4)
Q.26 (1)
Q.27 (Bonus)
Q.28 (1)
Q.29 (2)
Q.30 (2)
Q.31 (3)
Q.32 (3)
Q.33 (2)
Q.34 (2)
Q.35 (1)
Q.36 (4)
Q.37 (3)
Q.38 (2)
Q.39 (2)
Q.40 (2)
Q.41 (4)
Q.42 (2)
Q.43 (4)

Equivalent mass of copper

$= \frac{\text{Atomic mass}}{\text{valency}} = \frac{63.5}{2} = 31.75$ Amount of copper deposited by 0.05F

$= 0.05 \times 31.75 = 1.5875 \simeq 1.59\,g$

Q.44 (4)

Conductivity $(\sigma) = \frac{1}{\text{Resistivity}(\rho)}$

in Sl unit, $(\sigma) = \frac{1}{\text{ohm m}} = Sm^{-1}$

Q.45 (2)

Species with more negative E° (Standard reduction potential) generally acts as reducing agent while with less negative value , E° act as oxidising agent Thus the overall reaction is

$Ag^{+} + Fe^{2+} \rightarrow Fe^{3+} + Ag$

The value of EMF will be,

$\Delta E° = E°_{oxidation} - E°_{reduction}$

$= -0.3995 - (-0.7120)$

$= +0.3125\,V$

Q.46 (1)

Galvanic cell is an electrochmical cell that converts the chemical energy of a spontaneous reaction into electrical energy.

Q.47 (2)
Q.48 (4)
Q.49 (3)
Q.50 (3)

NEET

Q.1 (4)

$$\overset{+1}{HBrO} \longrightarrow \overset{0}{Br_2}, E^0_{HBrO/Br_2} = 1.595V$$

$$\overset{+1}{HBrO} \longrightarrow \overset{+5}{BrO_3^-}, E^0_{BrO_3^-/HBrO} = 1.5V$$

E^0_{Cell} for the disproportionation of HBrO,

$$E^0_{Cell} = E^0_{HBrO/Br_2} - E^0_{BrO_3^-/HBrO}$$

$= 1.595 - 1.5$

$= 0.095\,V = +ve$

Hence, option (3) is correct answer.

Q.2 (3) Nernst equation :

$$E^{\Theta}_{cell} = E^{\Theta}_{cell} \frac{-0.059}{n} \log Q_c$$

at equillibrium Ecell = 0, Qc =Kc

$$E^{\Theta}_{cell} = \frac{-0.059}{n} \log K_c \qquad \text{Value of } E^{\Theta}_{cell} = 0.59\,V$$

$$0.59 = \frac{0.059}{1} \log K_c \qquad \text{Value of } n = 1$$

Kc = antilog 10

$Kc = 1 \times 10^{10}$

Q.3 (1) The standard Gibb's energy $(\Delta_r G°) = -nFE^{\Theta}_{cell}$

Value of n = 2

$\Delta G° = -2 \times 96500 \times 0.24 = -46320J$

$= 46.32\,kJ$

Q.4 (4)

Q.5 (1)

Q.6 (2)

Q.7 (1)

Q.8 (Bonus) $Ni(s) + 2Ag^{+}$ (0.001 M) $\rightarrow Ni^{+2}$ (0.001M) + 2Ag(s)

$$E_{cell} = E^{o}_{cell} - \frac{0.059}{n}\log\frac{\left[Ni^{+2}\right]^{1}}{\left[Ag^{+}\right]^{2}}$$

$$E_{cell} = 10.5 - \frac{0.059}{2}\log\frac{10^{-3}}{(10^{-3})^{2}}$$

$$= 10.5 - \frac{0.059}{2}\log 10^{+3} = 10.5 - \frac{0.059}{2}\times 3 = 10.4115\text{ V}$$

(Calculated answer is not given in options)

Q.9 (4)

Reduction

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4H_2O;$$

$$E^{o}_{MnO_4^-/Mn^{+2}} = 1.510\text{ V}$$

$$\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O \qquad ;E^{o}_{O_2/H_2O} = 1.223\text{V}$$

Reduction

Cathode

$$2MnO_4^- + 16H^+ + 10_e^- \rightarrow 2Mn^{+2} + 8H_2O; E^{o}_{RP} = 1.510\text{V}$$

Anode :

$$5H_2O \rightarrow \frac{5}{2}O_2 + 2Mn^{+2}2\frac{5}{2}O_2 + 3H_2O;$$

$$E^{o}_{cell} = (SRP)_{Cathode} - (SRP)_{Andoe}$$

$$E^{o}_{cell} = 1.510\text{V} - 1.223\text{V}$$

$= 0.287$ V

Yes the given cell reaction in possible.

Q.10 (3)

SRP :

$$E^{o}_{Zn^{2+}/Zn} < E^{o}_{Fe^{2+}/Fe} < E^{o}_{Cu^{2+}/Cu} < E^{o}_{Ag^{+}/Ag}$$

Reactivity order : Zn > Fe > Cu > Ag

In case of displacement reaction, more reactive metals (lower SRP) can displace less reactive metals (higher SRP) from their salt solution.

$CuSO_{4(ag).} + 2Ag_{(s)} \rightarrow Cu_{(s)} + Ag_2SO_{4(aq.)}$

Option (3)

Reaction is not possible

as Ag is less reactive metal compare to Cu.

JEE MAIN

Q. 1 [23] Fe^{+3} + I^- $\rightarrow I_2 + Fe^{+2}$

Cathode anode

$$E^{o}_{cell} = E^{o}_{cathode} - E^{o}_{anode}$$

$= 0.77 - 0.54$

$= 0.23$

$= 23 \times 10^{-2}$ V

$= 23$

Q.2 (C) Lowest value of $\left(\frac{\delta E}{\delta T}\right)_P$ will be preferred to be used as reference electrode.

Q.3 (983) $E^{0}_{cell} = E^{0}_{sn^{+2}/sn} - E^{0}_{cu^{2+}/cu}$

$= -0.14 - 0.34 \Rightarrow -0.48$

$$E_{cell} = E^{0}_{cell} - \frac{0.059}{2}\log\frac{\left[cu^{2+}\right]}{\left[sn^{2+}\right]}$$

$$\Rightarrow -0.48 - \frac{0.059}{2}\log\frac{10^{-2}}{10^{-3}}$$

$\Rightarrow -0.48 + 0.029\log 10$

$= -0.5095$

$\Delta G = -n + E_{cell} = +2 \times 96500 \times 0.50$

$= 98333.5$ J

$\Delta G = 983.3 \times 10^{-1}$ kJ mol^{-1}

Q.4 (14)

Q.5 (6F) $14H^+ + Cr_2O_7^{2-} + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$

$14H^+ + Cr_2O_7^{2-} + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O$

$\therefore$ Quantity of electricity = 6F

Q.6 (127) Reaction at anode

$2H_2O \rightarrow O_2(g) + 7H^+ + 4e^-$

At cathode $2H^+ + 2e^- \rightarrow H_2(g)$

$$\text{Number of equivalent} = \frac{i\times t}{96500}$$

$$= \frac{0.1\times 2\times 60\times 60}{96500}$$

$= 0.00746$

$$V_{O_2} = \frac{0.00746}{4}\times 22.7$$

$= 0.0423$

$$V_{H_2} = \frac{0.00746}{2}\times 22.7$$

$= 0.0846$

$\boxed{V_{Total} = 127\text{ ml}}$

Q.7 (16) $Sn^{2+} + 2e^- \rightarrow Sn\ \Delta G_1^0 = +2 \times 0.140 \times F$

$Sn^{+4} + 4e^- \rightarrow Sn\ \Delta G_2^0 = \mathbf{-4 \times 0.01 \times F}$

$Sn^{4+} + 2e^- \rightarrow Sn^{+2}\ \Delta G_3^0 = -2 \times E^0_{Sn^{4+}/Sn^{2+}} \times F$

$\Delta G_3^0 = \Delta G_2^0 - \Delta G_1^0$

$-2 \times E^0 \times F = -(0.04 + 0.28) \times F$

$E^0 = 0.16$ volt $= 16 \times 10^{-2}$.... V

Q.8 [266]

$R = 1750\ \Omega$; $k = 0.152 \times 10^{-3}\ \Omega^{-1}cm^{-1}$

Conductivity = cell constant × conductance

$0.152 \times 10^{-3} = \text{cell constant} \times \frac{1}{1750}$

cell constant $= 266 \times 10^{-3}\ cm^{-1}$

$= 266$

Q.9 (5)

$\text{Anode} \rightarrow H_2(g) \rightarrow 2H^+(aq) + 2e^{\ominus}$

$\text{Cathode} \rightarrow Cu^{+2}(aq) + 2e^{\ominus} \rightarrow Cu(s)$

Overall Reaction $H_2(g) + Cu^{+2}(aq) \rightarrow 2H^+(aq) + Cu(s)$

$$E^o_{cell} = E^o_{Cu^{+2}/Cu} - E^{\circ}_{H^+/H_2} = 0.34 - 0 = 0.34V$$

$$E_{cell} = E^{\circ}_{cell} = \frac{0.06}{2}\log\frac{[H^+]^2}{[Cu^{+2}]}$$

$0.576=0.34+0.03[-\log(H^+)^2-\log[Cu^{+2}]]$

$0.576=0.34+0.03[2pH+\log[Cu^{+2}]]$

$0.236=0.03[2pH+\log_{10}10^{-2}]$

$0.236=0.03[2pH-2]$

$7.86=2pH-2$

$\frac{7.86}{2} = pH - 1$

$pH=3.93+1=4.9=5$

Q.10 (3)

Q.11 (1)

$$\Lambda_{m1} = \frac{K \times 1000}{M}$$

$$\Lambda_{m1} = \frac{K \times 1000}{\frac{10 \times 10^3}{20}} = 2K$$

$$\Lambda_{m2} = \frac{K \times 1000}{20 \times 10^{+3}/80} = 4K$$

$$\frac{\Lambda_{m1}}{\Lambda_{m2}} = \frac{2K}{4K} = \frac{1}{2}$$

$2\Lambda_{m1} = \Lambda_{m2}$

Q.12 [2]

$Zn|Zn^{+2}||Sn^{+x}|Sn$

$E = 0.081V, q = 10^{-2}$

$$0.081 = E^o - \frac{0.0591}{n}\log Q$$

$$0.801 = 0.771 - \frac{0.66}{n}\log 10^{-2}$$

$$0.03 = \frac{-0.06 \times -2}{n} = \frac{0.12}{n}$$

$N = 0.12/0.03 = 4$

Total e^- trensfer = 4

Q.13 [3]

$Fe_3O_4 \rightarrow$ one mole Fe

Oxidation no. of iron in $Fe_3O_4 = +\frac{8}{3}$

For 1 mole Fe, $\left(\frac{8}{3} \times 3\right)$ mole of e^- are required

Charge of one mole $e^- = 1F$

So, change of $\left(\frac{8}{3} \times 3\right)$ mole of $e^- = \frac{8}{3} \times 3F = 8F$

$= 8F$

Q.14 (2) $KI \rightarrow K^+ + I^-$

(Strong electrolyte)

On dilution molar conductivity Inc. steeply

$H_2CO_3 \rightleftharpoons 2H^{\otimes} + CO_3^{-2}$

[Weak electrolyte]

On dilution molar conductivlty Inc. Steeply

Q.15 (1000)

Given that : $-\frac{\ell}{A} = 129\ m^{-1}$

Case I : Concentration of KCl solution = 74.5 ppm

Resistance $(R_1) = 100\ \Omega$

For solution 1

$$k_1 = \frac{1}{R_1} \times \frac{\ell}{A}$$

$$= \frac{1}{100} \times 129 = \frac{129}{100}$$

Molar conductivity $\Rightarrow \wedge_1 = k_1 \times \frac{1000}{M_1}$

M_1 = Molarity of 1st solution

Case II : Concentration of KCl solution = 149 ppm

Resistance (R_2) = 50Ω

For solution 2 :

$$k_2 = \frac{1}{R_2} \times \frac{\ell}{A}$$

$$= \frac{1}{50} \times 129 = \frac{129}{50}$$

Molar conductivity $= \wedge_2 = k_2 \times \frac{1000}{M_2}$

M_2 = Molarity of 2[nd] solution

$$\frac{\wedge_1}{\wedge_2} = \frac{k_1 \times \frac{1000}{M_1}}{k_2 \times \frac{1000}{M_2}} = \frac{k_1}{k_2} \times \frac{M_2}{M_1}$$

$$= \frac{k_1}{k_2}\frac{(ppm)_2}{(ppm)_1} \left(\because \frac{(ppm)_2}{(ppm)_1} = \frac{M_2}{M_1} \right)$$

$$= \frac{129/100}{129/50} \times \frac{147}{74.5} = 1 = 1000 \times 10^{-3}$$

Q.16 [34]

$$\text{Anode:} Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$$
$$\text{Cathode:} \left[Ag^+ + e^- \rightarrow Ag(s) \right] \times 2$$
$$\overline{Cu(s) + 2Ag^+(aq.) \rightarrow Cu^{2+}(aq.) + 2Ag(s)}$$

$$Ecell = E^0_{cell} - \frac{0.06}{2} \log \frac{\left[Cu^{2+}\right]}{\left[Ag^+\right]^2}$$

$$0.43 = E^0_{cell} - \frac{0.06}{2} \log \left(\frac{10^{-3}}{10^{-2}} \right)^2$$

$$0.43 = E^0_{cell} - 0.03 \log 10$$

$$E^0_{cell} - 0.46V$$

$$E^0_{cell} = E^0_{Ag+/Ag} - E^0_{Cu^{2+}/Cu}$$

$$E^0_{Cu^{2+}/Cu} = (0.80 - 0.46) = 0.34V = 34 \times 10^{-2}$$

Chemical Kinetics

EXERCISE-I (MHT CET LEVEL)

Q.1 (1)

$$\frac{1}{2}\frac{d\left[SO_4^{2-}\right]}{dt}=\frac{1}{3}\left(-\frac{d\left(I^-\right)}{dt}\right)$$

$$\frac{1}{2}\times\frac{d\left[SO_4^{2-}\right]}{dt}=\frac{1}{3}\times\frac{9}{2}\times10^{-3}$$

$$\therefore\frac{d\left[SO_4^{2-}\right]}{dt}=\frac{1}{3}\times10^{-3}\,mol\,Lit^{-1}s^{-1}$$

Q.2 (4)

Q.3 (2)

Q.4 (2)

Q.5 (3)

Q.6 (2)

Q.7 (2)

Q.8 (2)

$$o_3\xrightarrow{Fast}o_2+o,$$

$$o+o_3\xrightarrow{Slow}2o_2$$

From fast step, we have

$$k=\frac{[o_2][o]}{[o_3]}\ \ldots\text{(i)}$$

From slow step, we have

Rate = $k'[o_3][o]\ldots$(ii)

Put [o] from(i) in (ii)

$$r=\frac{k'[o_3]k[o_3]}{[o_2]}=k[o_3]^2[o_2]^{-1}$$

Note : Intermediates never represented in rate law equation.

Q.9 (2)

$$NH_4NO_2\rightarrow N_2+2H_2O$$

Volume of N_2 formed in successive five minutes are 2.75 cc, 2.40 cc and 2.25 cc which is in decreasing order. So rate of reaction is dependent on concentration of NH_4NO_2. As decrease is not very fast so it will be first order reaction

Q.10 (4)

In case of (II) and (III) keeping concentra tion of [A] constant, the concentration of [B] is double, the rate quadruples. Hence it is second order with respect to B. In case of I & IV Keeping the concentration of [B] constant, when the concentration of [A] is inreased four times, rate also increases four times. Hence, the order with respect to A is one. Hence

Rate = $k[A][B]^2$

Q.11 (1)

Unit of rate constant for second order reaction is L $mol^{-1}\,sec^{-1}$

Q.12 (1)

The order of reaction is $\frac{3}{2}$ and molecularity is 2.

Q.13 (2)

$Rate_1 = k[A]^x[B]^y$ ......(i)

$$\frac{Rate_1}{4}=k[A]^x[2B]^y \quad .....(ii)$$

or $Rate_1 = 4k[A]^x[2B]^y$

From (i) and (ii) we get

$$\frac{k[A]^x[B]^y}{4}=k[A]^x[2B]^y$$

$$\frac{[B]^y}{4}=[2B]^y$$

$$\text{or }\frac{1}{4}=\left(\frac{2B}{B}\right)\Rightarrow\frac{1}{4}=2^y$$

or $(2)^{-2}=2^y$

y = – 2.

Q.14 (4)

Q.15 (3)

Q.16 (4)

Q.17 (d)

Q.18 (1)

Q.19 (4)

Consider the reaction :-

$Cl_2 (aq) + H_2S\ (aq) \rightarrow S(s) + 2H^+ (aq) + 2Cl^- (aq)$

The rate equation for this reaction is rate = $K[Cl_2][H_2S]$

The rate equation indicates that the reaction is first order in chlorine and first order in hydrogen sulphide. The mechanism (A) is consistent with this rate equation.

(A) $Cl_2 + H_2S \rightarrow H^+ \rightarrow Cl^- + Cl^+ + HS^-$ (Slow)

$Cl^+ + HS^- \rightarrow H^+ + Cl^- + S$ (fast)

The mechanism (A) is not consistent with this rate equation.

(B) $H_2S \rightleftharpoons H^+ + HS^-$

(Fast equilibrium)

$Cl_2 + HS^- \rightarrow 2Cl^- + H^+ + S$ (Slow)

Based on mechanism (B), the rate equation will be rate $= K[Cl_2][H_2S]^{1/2}$ and not rate $= K[Cl_2][H_2S]$ ....(1)

From slowstep rate = $k\,[Cl_2]\,[HS^{-1}]$ .... (ii)

From fast equilibrium step.

$$K = \frac{[H^+][HS^-]}{H_2S} = \frac{[HS^-]^2}{[H_2S]} (\because [H^+] \simeq [HS^{-1}])$$

Q.20 (4)

for a first order reaction, rate, $R = k[N_2O_5]$

$2.4 \times 10^{-5} = 3 \times 10^{-5} \times [N_2O_5]$

$$[N_2O_5] = \frac{2.4\times10^{-5}}{3\times10^{-5}} = 0.8\,\text{mol L}^{-1}$$

Q.21 (3)

The velocity constant doubles for every $10^\circ C$ rise in temperature.

Q.22 (4)

For P, if $t_{50\%} = x$

then $t_{75\%} = 2x$

This is true only for first order reaction So, order with respect to P is 1.

Further the graph shows that concentration of Q decreases whth time. So rate, with respect to Q, remains constant. Hence, it is zero order with respect to Q.

So, overall order is 1 + 0 = 1

Q.23 (1)

The intersection point indicates the half life of the reactant A when it is converted to B.

Q.24 (2)

Q.25 (3)

Q.26 (1)

Q.27 (2)

Q.28 (1)

Q.29 (4)

Q.30 (2)

Q.31 (3)

Q.32 (1)

Q.33 (1)

Q.34 (4)

Q.35 (4)

Q.36 (2)

Since the nature of reaction (i.e. exothermic or endothermic is not given,E_a for reverse reaction can be more or less.

Q.37 *(2)*

$$T_1 = 273 + 25 = 298K$$

$$T_2 = 273 + 60 = 333K$$

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.3R}\left(\frac{T_2 - T_1}{T_1T_2}\right)$$

$$\text{or } \log_e\frac{k_2}{k_1} = \frac{E_a}{R}\left(\frac{T_2 - T_1}{T_1T_2}\right)$$

$$\log_e\frac{2.1\times10^{-2}}{1.5\times10^{-3}} = \frac{E_a}{R}\left(\frac{35}{333\times298}\right)$$

$$\therefore E_a = \frac{298\times333}{35}\times R\times\log_e\frac{21}{1.5}$$

Q.38 **(1)**

As per Arrhenius equation $\left(k = Ae^{-E_a/RT}\right)$, the rate constant increases exponentially with temperature.

Q.39 (1)

Q.40 (2)

Q.41 (3)

Q.42 (a,d)

Q.43 (4)

Q.44 (1)

Q.45 (3, 4)

Q.46 (4)

Q.47 (4)

Q.48 (3)

Q.49 (1)
The increase in pressure shown the increase in conc. of Z. Rate of appearance of

$$Z = \frac{120-100}{5} = 4mm\,\text{min}^{-1}$$

Rate of disappearance of X_2=2× rate of appearance of Z

$$= 2 \times 4mm\,\text{min}^{-1} = 8mm\,\text{min}^{-1}$$

Q.50 (1)
Substance R Substance S
2k k rate constant
$t_{\frac{1}{2}}$ $2t_{\frac{1}{2}}$ Half life period

$$T = n \times t_{\frac{1}{2}}$$

where n = number of half life period

Amount of R left $= \frac{0.5}{(2)T/t_{\frac{1}{2}}}$

Amount of S left $= \frac{0.25}{(2)T/2t_{\frac{1}{2}}}$

Equating both $\frac{0.5}{0.25} = \frac{(2)T_{/t_{\frac{1}{2}}}}{(2)T_{/2t_{\frac{1}{2}}}}$

or $2 = (2)T/_{t_{\frac{1}{2}}}$

$\therefore T = 2t_{1/2}, 2t_{1/2}$ is half life of S and twice the half-life of R

Q.51 (2)
For first order reaction $[A] = [A_0]e^{-kt}$
∴ The concentration of reactants will exponentially decreases with time.

Q.52 (1)

Q.53 (3)

EXERCISE-II (NEET LEVEL)

Q.1 (2)
Rate of reaction continuously decreases with time.

Q.2 (4)
According to law of mass action.

Q.3 (2)
R = K[RCI], if [RCl] = 1/2, then rate = *R*/2.

Q.4 (3)
As reaction progressing the concentration of the reactants decreases and the concentration of the product increases.

Q.5 (2)
Rate = $K(A)^2(B)^1$ on doubling the active mass of *A* the rate of reaction increase 4 times.

Q.6 (4)
When volume is reduced to $\frac{1}{4}$, concentrations become four times.

Q.7 (1)
Increase in concentration of B = 5×10^{-3} mol l^{-1} Time = 10 sec

Rate of appearance of B = $\frac{\text{Increase of conc. B}}{\text{Time taken}}$ =

$$\frac{5 \times 10^{-3}\,\text{mol}\,l^{-1}}{10\,\text{sec}} = 5 \times 10^{-4}\,\text{mol}\,l^{-1}\,\text{Sec}^{-1}$$

Q.8 (3)
Order of reaction is sum of the power raised on concentration terms to express rate expression.

Q.9 (3)

$r = K[A]^m$ also $2r = K[4A]^m$, $\frac{1}{2} = \left(\frac{1}{4}\right)^m$

$\therefore m = \frac{1}{2}$

Q.10 (4)

Rate of reaction is quadrupled on doubling the concentration. Thus $\propto [A]^2$.

Q.11 (4)

The specific rate constant of a first order reaction depends upon the temperature of reaction.

Q.12 (2)

0.08 mol l^{-1} to 0.01 mol l^{-1} involves 3 half-life. So the t is 30 minutes

Q.13 (3)

$$t_{1/2} = \frac{0.693}{k}$$

Q.14 (3)

Unit of rate constant for second order reaction is mol^{-1} litre $time^{-1}$

Q.15 (1)

When in any chemical reaction, one of the reactant is present in large excess, then the second order reaction becomes first order reaction and is known as pseudo unimolecular reaction *e.g.*,

$$CH_3COOCH_3 + H_2O \xrightarrow{H^+} CH_3COOH + CH_3OH$$

in this reaction molecularity is 2 but order of reaction is found to be first order experimentally, so it is an example of pseudo unimolecular reaction.

Q.16 (2)

$$2NO_2(g) \quad + \quad F_2(g) \quad \rightarrow \quad 2NO_2F(g)$$

$t = 0$	$2P_O$	P_O	$2P_O + P_O = 3$ atm
$t = 0$	2 atm	1 atm	0
$P_O = 1$ atm			
$t = t$	0	0	2 atm

Q.17 (2)

$$A_2(g) \rightarrow B(g) + \frac{1}{2}C(g)$$

$t = 0$ 100mm 0 0

$t = 5mm$ $(100-x)$ x $\frac{x}{2}$

Total pressure $100 - x + x + \frac{x}{2} = 120$ $(x = 40)$

then Rate of disappearance of $A_2 = -\frac{d[A_2]}{dt} = \frac{40}{5} = 8$

Q.18 (2)

$$NH_4NO_2(aq) \longrightarrow N_2(g) + 2H_2O(\ell)$$

$$K = \frac{2.303}{t}\log\left(\frac{V_\infty - V_O}{V_\infty - V_t}\right) \Rightarrow V_0 = 0 \Rightarrow K = \frac{2.303}{20}\log\left(\frac{70-0}{70-40}\right)$$

$$= \frac{2.303}{20}\log\left(\frac{70}{30}\right) \qquad \Rightarrow K = \frac{2.303}{1200}\log\frac{7}{3}$$

Q.19 (2)

$$\% \text{ of } B = \frac{k_1 \times 100}{k_1 + k_2} = \frac{1.26 \times 10^{-4} \times 100}{12.6 \times 10^{-5} + 3 \times 10^{-5}} = 76.83\%.$$

$$\% \text{ of } C = \frac{k_2 \times 100}{k_1 + k_2} = \frac{3 \times 10^{-5} \times 100}{12.6 \times 10^{-5} + 3 \times 10^{-5}} = 23.18\%.$$

Q.20 (2)

Q.21 (3)

The definition of activation energy.

Q.22 (4)

All other are different forms of Arrhenius equation.

Q.23 (4)

Increase in the rate of reaction is determined by the increase in the number of effective collisions.

Q.24 (1)

Arrhenius suggested an equation which describes rate constant (K) as a function of temperature.

$$K = Ae^{-E_a/RT} \quad K = Ae^{-E_a/RT}$$

$$\text{In } K = \text{In } A - e^{E_a/RT}$$

Q.25 (2)

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3)

$$xA + yB \longrightarrow zC$$

$$\frac{-d}{dt}[A] = \frac{-d}{dt}[B] = 1.5\frac{-d}{dt}[C]$$

$$\Rightarrow \frac{-1}{3}\frac{-d}{dt}[A] = \frac{-1}{3}\frac{-d}{dt}[B] = \frac{1}{2}\frac{-d}{dt}[C]$$

$x = 3 \quad y = 3 \quad z = 2$

Q.2 (4)

$$\frac{d}{dt}[SO_3] = 100 \text{ gram / min} = \frac{100}{80} \text{ mole / min} = 1.25$$

mole/lit

$$\frac{-1}{2}\frac{d}{dt}[SO_2] = \frac{-d}{dt}[O_2] = \frac{1}{2}\frac{d}{dt}[SO_3]$$

$$\frac{-d}{dt}[O_2] = \frac{1.25}{2}\text{ mole/min} = \frac{1.25}{2}\times 32\text{ gram/min} = 20$$

gram/min

Q.3 (2)

$$-\frac{1}{3}\frac{d[D]}{dt} = -\frac{d[B]}{dt} = \frac{1}{2}\frac{d[C]}{dt} = \frac{1}{4}\frac{d[A]}{dt}$$

$$B + 3D \longrightarrow 2C + 4A$$

$$B + 3D \longrightarrow 4A + 2C$$

Q.4 (4)

$A(g) \rightleftharpoons 2B(g)$

$K_f = = 1.5 \times 10^{-3}\ s^{-1}$

At eq.^{m}, $R_f = R_b$

$K_f[A] = K_b[B]^2$

On solving : $K_b = 1.5 \times 10^{-11}$

Q.5 (4)

$$-\frac{d[BrO_3^-]}{dt} = k[BrO_3^-][Br^-][H^+]^2$$

So, on doubling the concentration of H^+ ion will increase the reaction rate by 4 times.

Q.6 (2)

$A + B \rightarrow C + D$

$k = 2.303 \times 10^{-3}\ sec^{-1}$

$$t = \frac{2.303}{k}\log\frac{1}{0.25} = \frac{2.303}{2.303\times10^{-3}}\log\frac{100}{25}$$

$= 10^3 \times (0.605) = 600$ sec

Q.7 (4)

$$k_1 = \frac{2.303}{t}\log\frac{100}{50} = \frac{2.303}{t}\log 2 = \frac{0.6955}{t}$$

$$k_2 = \frac{2.303}{t}2\log 5 = \frac{2.303}{t}\times 2\times 0.69 = \frac{3.22}{t}$$

$$\frac{k_2}{k_1} = 4.65$$

Q.8 (1)

sec^{-1}, $Msec^{-1}$

Q.9 (2)

$$t = \frac{2.303}{K}\log\frac{C_O}{C_t} \Rightarrow t = \frac{2.303}{K}[\log C_O - \log C_t]$$

$$\frac{Kt}{2.303} = \log C_O - \log C_t \Rightarrow \log C_t = \left(\frac{-K}{2.303}\right)t + \log C_O$$

So, slope = $\left(\frac{-K}{2.303}\right)$

Q.10 (2)

Equal amount of Rxn completed in equal time property as zero order Rxn, and unit as Rate constant mole $Litre^{-1}\ sec^{-1}$

Q.11 (2)

$t_{1/2} = 10$

No. of Half life $= \frac{60}{10} = 6$ half life

$$C_t = \frac{C_O}{(2)^n} = \frac{C_O}{(2)^6} = \left(\frac{C_O}{64}\right)$$

Q.12 (3)

As $t_{50\%}$ is constant. Hence order of reaction is 1.

$$t_{50\%} = \frac{0.693}{K}$$

$$n = 1,\ t_{1/2} = \frac{0.693}{K}$$

Q.13 (1)

by graph we can say $\log t_{1/2} = \log a$ $t_{1/2} = a$ .....(1)

$t_{1/2} \propto a$ then zero order Rxn $k \times t_{1/2} = \frac{a}{2}$ .....(2)

then $k = \frac{1}{2}$

Q.14 (1)

$$t_1 = \frac{2.303}{3K}\log\frac{100}{75}$$

$$t_2 = \frac{2.303}{2K}\log\frac{100}{25}$$

$$\Rightarrow \frac{t_1}{t_2} = \frac{0.311}{1} = 0.311 : 1$$

Q.15 (3)

$A_2 \rightarrow B + 2C$

$A_0 - x \quad x \quad 2x$

$A = A_0 e^{-kt}$

$A_0 - = \frac{A_0}{z}$ $\qquad V_1 = 2\ell$

$nx = \frac{A_0}{z}$ $\quad V_2 = 4\ell$

$[a] = \frac{0.05}{4} = 0.0125$

Q.16 (4)

$t_{1/2} \, \alpha \left(\frac{1}{a}\right)^{n-1}$

$\Rightarrow t_{1/2} \, \alpha \, (1)^{1-n}$

$\Rightarrow \frac{(t_{1/2})_1}{(t_{1/2})_2} = \frac{a_1}{a_2}$

$\Rightarrow \frac{235}{950} = \left(\frac{500}{250}\right)^{1-n}$

$\Rightarrow$ log23.5 – log95 = (1-n)log2

$\Rightarrow n = 3$

Q.17 (2)

Let $r = (1)^x (2)^y$

$$x = \frac{\log\left(\frac{r_1}{r_2}\right)}{\log\left(\frac{a_1}{a_2}\right)} = \frac{\log\frac{0.1}{0.1}}{\log\left(\frac{0.012}{0.024}\right)} = \frac{\log\left(\frac{1}{8}\right)}{\log\left(\frac{1}{2}\right)}$$

$x = 3$

$$y = \frac{\log\frac{r_1}{r_3}}{\log\left(\frac{b_1}{b_2}\right)} = \frac{\log\left(\frac{0.1}{0.1}\right)}{\log\left(\frac{0.035}{0.070}\right)} = \frac{\log(1)}{\log\left(\frac{1}{2}\right)}$$

$y = 0$

Q.18 (3)

m/L-sec = $[K_1][M/L]^3$

$[K_1] = L^2M^{-2}sec^{-1}$

$ML^{-1}sec^{-1} = [K_2][M/L]$

$[K_2] = sec^{-1}$

Q.19 (2)

In given sequence of Rxn $\frac{d[c]}{dt} = k_2[B] - K_3[C]$

Q.20 (2)

$\left(\frac{dx}{dt}\right) = k_1[A]^2[B]^1 - k_2[C]$

net rate is $2A + B \rightleftharpoons C$

Q.21 (4)

At temperature = ∞

Rate constant = Arrhenious constant.

Q.22 (1)

In a reaction, the threshold energy is equal to :

Activation energy + Normal energy of reactants.

Q.23 (1)

$\log K = 15 - \frac{10^6}{T}$

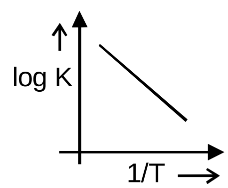
$\log A = 15$

$\Rightarrow A = 10^{15}$

Also, $\frac{E_a}{2.303R} = 10^6$

$E_a = 1.9 \times 10^4$ KJ

Q.24 (2)



When line cuts y axis

$\frac{1}{T} = 0 \Rightarrow \boxed{T = \infty}$

When it cut X -axis

$\log K = 0$

$\Rightarrow \log A = \frac{Ea}{2.303RT} \Rightarrow \boxed{T = \frac{Ea}{R \ln A}}$

Q.25 (1)

Q.26 (1)

Rate of reaction increases with increase of temperature whether it is endothermic or exothermic.

Q.27 (3)

$A + 2B + C \rightarrow D$

$A + B \xrightarrow{K_1} X$ (Rapid) ....(1)

$X + C \xrightarrow{K} Y$ (Slow) ....(2)

$Y + B \longrightarrow D$ (Fast) ....(3)

Rate = K[X][C] ....(4)

Since X is not in the orginal reaction, hence it has to be eliminated.

from eq^n (1), $K_1 = \frac{[X]}{[A][B]} \Rightarrow [X] = K_1[A][B]$

Putting this value in eq^n (4)

Rate = $KK_1[A][B][C]$

Rate = $K'[A][B][C]$
$\Rightarrow$ Order = 3

Q.28 (4)
$2A + B \rightarrow D + E$
$A + B \rightarrow C + D$ (Slow)
$A + C \rightarrow E$ (Fast)
$\Rightarrow$ Rate = $K[A][B]$
[As slowest step is rate determing step].

Q.29 (3)
All the reactins
$r = k[No][NOBr_2]$
Rate of reaction expression do not contain chtermediate
$\therefore r = k[NO]^2[Br_2]$
$2NO + Br_2 \rightarrow 2NOBr$

Q.30 (4)
Rate = $k_1 [M] [Z]$ .....(1)

from equation (1) $K_{eq} = \frac{[M]}{[x][y]}$.

$M = k_{eq} [x] [y]$ .....(2)
put the value of M from (2) to (1)
Rate = k_1 keg [x] [y] [z] Rate = k [x] [y] [z]

EXERCISE-IV

NUMERICAL VALUE BASED

Q.1 (3)

Fusion occur along BC.

For fusion, $\Delta q = 0.04 \times 30 \times 10^3$J

For fusion T = 400 K

$$\Delta S_{fus} = \frac{\Delta q}{T} = \frac{40 \times 30}{400} = 3 \text{ J/mol K}$$

Q.2 (7)

No.of equivalents of acid or base nuetralised completely = 80 / 1000

$\frac{80}{1000}$ equivalents give $\rightarrow$ 4.416 KJ

$\therefore$ 1 equivalent give $\rightarrow \frac{4.416}{80} \times 1000 = 55.2$ KJ

heat of ionisation of

Q.3 (9)

Q = mSdT

= 2500 × 0.45 = 1128 J

Now $\Delta E = \frac{q_p}{n} = \frac{1128}{3.5/28} = 9 \text{kJ mol}^{-1}$

Q.4 306 k

$$k_2 = \frac{0.693}{2h} \times \frac{h}{3600}$$
$= 9.63 \times 10^{-5}$

$$\log \frac{9.63}{3.46} = \frac{100}{2.303 \times 8.314 \times 10^{-3}} \left[\frac{T_2 - 298}{T_2 \times 298}\right]$$

$T_2 = 306$ K

Q.5 2000 K

$$\log 10^{12} - \frac{81.28}{2.303RT} = \log_{10} 10^{11} - \frac{43.10}{2.303RT}$$

$$1 = -\frac{43.10}{RT} + \frac{81.28}{RT} \times \frac{1}{2.303}$$

$$T = \frac{38.18}{2.30 \times 8.31 \times 10^{-3}} = 2000$$

Q.6 200

In order that cell reaction may be in equilibrium, E_{cell} must be zero

The half-cell reactions and cell reactions for one Faraday of electricity are as given below

$Ag_{(s)} + Br^- \longrightarrow AgBr_{(s)} + e$
(oxidation at LHE)

$AgCl_{(s)} + e \longrightarrow Ag_{(s)} + Cl^-$
(reduction at RHE)

$AgCl_{(s)} + Br^- \longrightarrow AgBr(s) + Cl^-$

(cell reaction)

$$E_{cell} = E^0_{cell} - 0.0591 \log \frac{[Cl^-]}{[Br^-]}$$

=

$$E^0_{AgCl_{(s)},Ag_{(s)},Cl^-} - E^0_{AgBr_{(s)},Ag_{(s)},Br^-} - 0.0591\log\frac{[Cl^-]}{[Br^-]}$$

...(i)

For the half cell $Ag_{(s)}$, $AgX_{(s)}$, X^- the half cell reaction (reduction) is

$AgX_{(s)} \rightleftharpoons Ag^+ + X^-, X^-$, $E^0 = 0.0591 \log K_{sp}$

$Ag^+ + e \longrightarrow Ag_{(s)}$, $E^0_{Ag^+,Ag}$

____

$AgX_{(s)} \longrightarrow Ag_{(s)} + X^-$, $E^0_{AgX,AgX^-} = ?$

$$0.0591 \log K_{sp} = E^0_{AgX,Ag,X^-} - E^0_{Ag^+,Ag}$$

$$\therefore E^0_{AgX,Ag,X^-} = 0.0591\log K_{sp} + E^0_{Ag^+,Ag}$$

So, equation (i) may be put as

$$E_{cell} = 0.0591\log K_{sp(AgCl)} + E^0_{Ag^+,Ag} - 0.0591\log K_{sp(AgBr)} - E^0_{Ag^+,Ag} - 0.0591\log\frac{[Cl^-]}{[Br^-]}$$

=

$$0.0591\left[\log(2\times10^{-10}) - \log(1\times10^{-12}) - \log\frac{[Cl^-]}{[Br^-]}\right]$$

$$= 0.0591\left(\log\frac{2\times10^{-10}}{1\times10^{-12}} - \log\frac{[Cl^-]}{[Br^-]}\right)$$

At equilibrium

$E_{cell} = 0$ so

$$\frac{[Cl^-]}{[Br^-]} = \frac{2\times10^{-10}}{1\times10^{-12}} = 200$$

PREVIOUS YEAR'S

MHT

Q.1	(3)
Q.2	(2)
Q.3	(1)
Q.4	(4)
Q.5	(4)
Q.6	(3)
Q.7	(3)
Q.8	(2)
Q.9	(2)
Q.10	(2)
Q.11	(3,4)
Q.12	(3,4)
Q.13	(1)
Q.14	(2)
Q.15	(2)
Q.16	(3)
Q.17	(1)
Q.18	(1)
Q.19	(2)
Q.20	(1)
Q.21	(1)
Q.22	(3)
Q.23	(1)
Q.24	(3)
Q.25	(2)
Q.26	(2)
Q.27	(2)
Q.28	(3)
Q.29	(3)
Q.30	(1)
Q.31	(3)
Q.32	(2)
Q.33	(4)
Q.34	(2)
Q.35	(2)
Q.36	(4)

For first order reaction

$$t = \frac{2.303}{k}\log\frac{a}{a-x}$$

where , t = time , k = rate constant
a = initial concentration
a – x = remaining concentration

$$\Rightarrow k = \frac{2.303}{23.03}\log\frac{0.08}{0.02} = \frac{1}{10}\log 4$$

$$= \frac{0.6020}{10} = 0.06020\,\text{min}^{-1}$$

Q.37 (4)
Among the given statements, (4) is not correct regarding the rate = k $[H_2][I_2]$ because overall order of the reaction is 2 not 1

Q.38 (2)

Q.39 (3)
For first order reaction

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{1.7} hr^{-1}$$

$k = 0.407 hr^{-1}$

Q.40 (3)

Q.41 (4)

Q.42 (1)

Q.43 (4)

Q.44 (3)

Q.45 (3)

NEET

Q.1 (2)

For first order reaction, $t_{1/2} = \frac{0.693}{k}$, which is independent of initial concentration of reactant.

For second order reaction, $t_{1/2} = \frac{1}{k[A_0]}$, which depends on initial concentration of reactant.

Q.2 (2)
Half life of zero order

$$t_{1/2} = \frac{[A_0]}{2K}$$

$t_{1/2}$ will be doubled on doubling the initial concentration.

Q.3 (3)
The 1st order reaction

$$\mathbf{t} = \frac{2.303}{k}\log\frac{a}{a-x}$$

$$= \frac{2.303}{k}\log\frac{100}{100-99}$$

$$= \frac{2.303}{k}\log 10^2$$

$$= \frac{2.303}{k}\times 2\times \log 10$$

$$\frac{2.303\times 2}{k} = \frac{4.606}{k}$$

Q.4 (3)
For the chemical reaction

Rate of reaction $= \frac{d(N_2)}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d(NH_3)}{dt}$

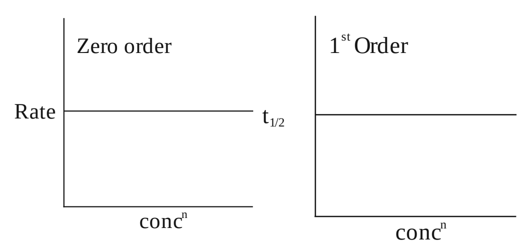
Q.5 (3)
Q.6 (2)
Q.7 (4)
Q.8 (1)
Q.9 (4)
Q.10 (1)
A $\rightarrow$ Products
Initial conic. $A_o = 0.1$ M
Conc. After 5 min $A_t = 0.001$ M
t = 5 min.
For first order reaction

$$K = \frac{2.303}{t}\log\left(\frac{A_0}{A_t}\right)$$

$$= \frac{2.303}{5}\log\left(\frac{0.1}{0.001}\right)$$

$K = 09212 \text{ min}^{-1}$

Q.11 (2)



(I) curve is suitable for zero order if y = rate and x = concentration because in case of zero order reaction rate is constant and does not depend on con^n.
(II) curve is suitable for first order if y = $t_{1/2}$ and x = conc^n because in case of first order $t_{1/2}$ does not depend on conc^n.

JEE MAIN

Q.1 [1]
$\gamma_1 A + \gamma_2 B \rightarrow \gamma_3 C + \gamma_4 D$

Given : $+\frac{d[D]}{dt} = \frac{-3}{2}\frac{d[B]}{dt}$

$$\Rightarrow \frac{-1}{2}\frac{d[B]}{dt} = \frac{+1}{3}\frac{d[D]}{dt}$$

$$-\frac{d[B]}{dt} = -2\frac{d[A]}{dt} \Rightarrow -\frac{1}{2}\frac{[B]}{dt} = \frac{-d(A)}{dt} + \frac{d[B]}{dt} = 9$$

mmol $dm^{-3}s^{-1}$

$$\frac{+d[C]}{dt} = \frac{20-10}{10} = 1\,\text{mmol}\,\text{dm}^{-3}\text{s}^{-1}$$

$$\frac{+d[C]}{dt} = \frac{1}{9} \times \frac{+d[D]}{dt}$$

$$1A + 2B \rightarrow \frac{1}{3}C + 3D$$

$$\Rightarrow 3A + 6B \rightarrow C + 9D$$

Rate of reaction $= \frac{+d[C]}{dt} = 1$ mmol dm^{-3}s^{-1}

$= 1$

Q.2 (3)

$$T_{90\%} = \frac{2.303}{k} \text{Log}(\frac{100}{10}) = \frac{2.303}{k} \log 10$$

$$T_{50\%} = \frac{2.303}{k} \text{Log}(\frac{100}{50}) = \frac{2.303}{k} \log 2$$

$$\frac{T_{90\%}}{T_{50\%}} = \frac{\log 10}{\log 2} \Rightarrow \frac{1}{0.3010} \Rightarrow 3.32$$

Q.3 (4)

Given $E_{cat} - E_{uncat} = 10$ kJ/mol

$T = 300$ K

$K = Ae^{Ea/RT}$

$$\frac{K_{cat}}{K_{incat}} = e^{\frac{-(E_{a\,cat} - E_{a\,incat})}{RT}}$$

$$\frac{K_{cat}}{K_{incat}} = e^{-\left(\frac{10\times10^3}{8.314\times300}\right)} = e^{-\left(\frac{10^4}{2494.2}\right)}$$

$$\frac{K_{cat}}{K_{incat}} = e^{-4}$$

$X = 4$

Q.4 (166)

Q.5 (16)

$$t_{67\%} = \frac{1}{k}\ln\left(\frac{100}{33}\right)$$

$$t_{50\%} = \frac{1}{k}\ln 2$$

$$\Rightarrow \frac{t_{67\%}}{t_{50\%}} = \frac{\log\left(\frac{100}{33}\right)}{\log 2}$$

$$\Rightarrow \frac{\log 3}{\log 2} = \frac{0.4771}{0.3} = 1.585$$

So $x = 15.85 \approx 16$

Q.6 (1)

$$\text{In}\left(\frac{K_2}{K_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\text{In}\left(\frac{K_2}{K_1}\right) = \frac{532611}{8.3}\left(\frac{10}{310\times300}\right)$$

$$\text{In}\left(\frac{K_2}{K_1}\right) = 6.9$$

$$\text{In}\frac{K_2}{K_1} = 3 \times \text{In}\,10$$

$K_2 = K_1 \times 10^3$

$K_1 = K_2 \times 10^3$

$\boxed{\text{So } x = 1}$

So answer will be 1.

Q.7 (216)

$K = (6.5 \times 10^{12}\ s^{-1})\ e^{-26000\ K/T}$

$K = Ae^{-Ea/RT}$

$$\frac{Ea}{RT} = \frac{26000}{T}$$

$$Ea = \frac{26000 \times 8.314}{1000}$$

$$Ea = 216.164 \approx 216$$

Q.8 (75)

$$t = \frac{t_{1/2}}{0.3}\log\frac{[A]_0}{[A]_t} \Rightarrow 83 = \frac{200}{0.3}\log\frac{[A]_0}{[A]_t}$$

$$0.125 = \log\frac{[A]_0}{[A]_t} \Rightarrow \frac{[A]_0}{[A]_t} = 1.333 \cong \frac{4}{3}$$

$$\therefore \frac{[A]_t}{[A]_0} \times 100 = \frac{3}{4} \times 100 = 75\%$$

Q.9 (59)

Given $T_1 = 300$ K; $T_2 = 309$ K.

$\frac{k_2}{k_1} = 2$ $R = 8.314$ J/K mol.

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303 \times 8.3}\left[\frac{1}{300} - \frac{1}{309}\right]$$

$$\log 2 = \frac{E_a}{19.16}\left[\frac{1}{300} - \frac{1}{309}\right]$$

$E_a = 59$ KJ/mol

Q.10 (200)

For first order reaction

$$K = \frac{0.693}{t_{1/2}}$$

[A]=4[B]

$$[A]_0\, e^{-k_A t} = 4[B]_0\, e^{-k_B t}$$

as $[A]_0 = [B]_0,\ e^{-k_A t} = 4e^{-k_B t}$

$$-k_A t = \ln 4 - k_B t$$

$$t(K_B - K_A) = 2\ln 2$$

$$t = \frac{2\times 0.693}{\left(\frac{0.693}{50} - \frac{0.693}{100}\right)} = \frac{2\times 100}{2-1} = 200\,\text{sec}$$

Q.11 (20)

$Fe_2(SO_4)_3 \rightarrow 2Fe$

w = Zit

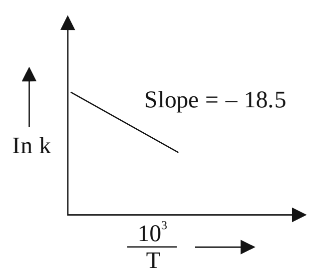
$$w = \left(\frac{E}{96500}\right)it$$

$$0.3482 = \left(\frac{56}{3\times 96500}\right)\times 1.5\times t$$

t = 1200 sec = 20 min

Q.12 (154)

$K = Ae^{-Ea/RT}$



$$\ln K = \ln A - \frac{Ea}{RT}$$

$$\ln K = \ln A + \left[\frac{-Ea}{1000R}\right]\frac{1000}{T}$$

Y=C+mx

$$\text{Slope} = -\frac{Ea}{1000R} = -18.5$$

E_a=18.5×1000×8.31

=153.8kJ/mol^{-1}

=154 (Nearest intager)

Q.13 [2]

$$\ln\frac{P}{P^0} = -kt$$

Slope = –k

K = 3.465 × 10^4

$$t_{1/2} = \frac{0.693}{K} = 0.2\times 10^{-4} = 2\times 10^{-5}$$

Q.14 [1]

$t_{\frac{1}{2}} = 240\,\text{sec},\quad p^o = 500\,\text{torr}$

$t_{\frac{1}{2}} = 4\,\text{min}\quad p^o = 250\,\text{torr}$

=4 × 60 = 240 sec

Order = 1, $t_{\frac{1}{2}}$ is independent of initial press.

Q.15 [2]

$A \rightarrow 2B + C$

$T_{1/2}$ = 100s[A] = 0.5 M

$T_{1/2}$ = 50s[A] = 1M

$$T_{1/2}\ \alpha\ \frac{1}{[C_0]^{n-1}}$$

$$\frac{(t_{1/2})_1}{(t_{1/2})_2} = \frac{[Co]_2^{n-1}}{[Co]_1^{n-1}}$$

$$\frac{100}{50} = \left(\frac{1}{0.5}\right)^{n-1}$$

$(2)^1 = (2)^{n-1}$

n – 1 = 1

n = 2; order = 2

Q.16 [2]

$$\left.\begin{array}{l}\text{Rate}_1 = K[40]^n = 0.135 \quad ...(1)\\ \text{Rate}_2 = K[20.1]^n = 0.033 \quad ...(2)\end{array}\right]\text{Order w.r.t No.}$$

Eq. (1) ÷ (2)

$$\frac{0.135}{0.033} = \left[\frac{40}{20.1}\right]^n$$

n = 2

Q.17 (3)

$AB_2 \rightarrow t_{1/2}$ = 200 sec

$T_{1/2}$ is independent of the initial concentration of AB_2, it means the order of reaction is one.

For first order reaction -

$$K = \frac{0.693}{t_{1/2}} = \frac{2.303}{t}\log\frac{a}{a-x}$$

$$\frac{0.693}{200} = \frac{2.303}{t}\log\frac{a}{\frac{20}{100}a}$$

$$\frac{0.693}{200} = \frac{2.303}{t}\log\frac{100}{20}$$

$$\frac{0.693}{200} = \frac{2.303}{t}\log 5$$

$$t = \frac{2.303\times 0.7}{0.693}\times 200 \qquad \because \log 5 \approx 0.7$$

= 465.25

≈ 465 sec

Q.18 [165]

First order reaction

$T_{1/2} = 70$ min

= 70 x 60 sec.

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{70\times 60} = 0.000165$$

$K = 165 \times 10^{-6}\,sec^{-1}$

Q.19 (100)

$A \longrightarrow B$

For first order reaction, $t_{1/2} = 0.3010$ min

$$\therefore K = \frac{0.693}{t_{1/2}} = \frac{0.693}{0.3010} = 2.303\ min^{-1}$$

$$C_t = C_0 e^{-Kt} \qquad \frac{C_0}{C_t} = e^{Kt} = e^{2.303\times 2}$$

$$\frac{C_0}{C_t} = e^{(\ln 10)^2} \qquad \frac{C_0}{C_t} = 100$$

Q.20 (40)

rate(r) = $k[x]^a[y]^b$

k = rate constant

Given that a = 1 : b = 0

For experiment I :

$r_I = k[0.1]^a\,[0.1]^b = 2 \times 10^{-3}$

$k[0.1]^1\,[0.1]^0 = 2 \times 10^{-3}$ ... (1)

for experiment II : -

$r_{II} = k[L]^1\,[0.2]^0 = 4 \times 10^{-3}$ ... (2)

Equation (2) ÷ Equation (1)

$$\frac{L}{0.1} = \frac{4\times 10^{-3}}{2\times 10^{-3}}$$

L = 0.2

For experiment III :

$r_{III} = k[0.4]^1\,[0.4]^0 = M \times 10^{-3}$ ... (3)

For experiment IV :

$r_{IV} = k[0.1]^1\,[0.2]^0 = 2 \times 10^{-3}$ ... (4)

Divide equation (3) by equation (4) :

$$\frac{0.4}{0.1} = \frac{M\times 10^{-3}}{2\times 10^{-3}}$$

M = 8

$$\frac{M}{L} = \frac{8}{0.2} = \frac{40}{1}$$

Ratio of M and L = 40

Q.21 (8)

$K = Ae^{-Ea/RT}$

$$\ln K = \ln A - \left(\frac{Ea}{R}\right)\frac{1}{T}$$

$$\text{Slope of graph} = \left(\frac{Ea}{R}\right) = \left(\frac{0.20}{5-0}\right)$$

Ea = 4 × 2 = 8 cal/mole

Q.22 (1)

$$t = \frac{1}{\lambda}\ln\left(\frac{a}{a-x}\right)$$

$$100 = \left(\frac{30}{\log 2}\right)\left[\ln\left(\frac{1}{\omega}\right)\right]$$

$$\frac{100\times \log 2}{30} = \log\left(\frac{1}{\omega}\right)$$

$$1 = \log\left(\frac{1}{\omega}\right)$$

$$\frac{1}{\omega} = 10$$

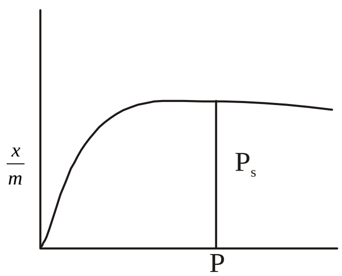
$\omega = 0.1\mu g$

Surface Chemistry

EXERCISE-I (MHT CET LEVEL)

Q.1 (4)
According to freundlich adsorption iso therm, at intermediate pressure, extent of adsorption

$$\frac{x}{m} = kP^{\frac{1}{n}} \text{ or } \log\frac{x}{m} = \log k + \frac{1}{n}\log P :$$



plot of $\log\frac{x}{m}$ vs log P is linear with slope $-\frac{1}{n}$

Q.2 (3)
The more the liquifiable nature of a gas, the more is the enthalpy of adsorption. Water is more liquifiable.

Q.3 (4)
At high pressure the extent of adsorption follows zero order kinetics.

Q.4 (3)

Q.5 (2)
According to Freundlich equation,

$$\frac{x}{m} \propto p^{\frac{1}{n}} \text{ or } \frac{x}{m} = Kp^{\frac{1}{n}}$$

$$\text{or } \log\frac{x}{m} = \log Kp^{\frac{1}{n}} \text{ or } \log\frac{x}{m} = K + \frac{1}{n}\log p$$

Q.6 (3)
Mass of O_2 absorbed per gram of adsorbent

$$= \frac{3.6}{1.2} = 3$$

Number of moles of O_2 absorbed per gram of adsorbent

$$= \frac{3}{32}$$

Volume of O_2 absorbed per gram of adsorbent
PV = nRT

$$V = \frac{nRT}{P}$$

$$= \frac{3}{32} \times \frac{0.821 \times 273}{1} = 2.1$$

Q.7 (2)

Q.8 (2)

Q.9 (1)

Q.10 (2)

Q.11 (3)

Q.12 (3)

Q.13 (4)

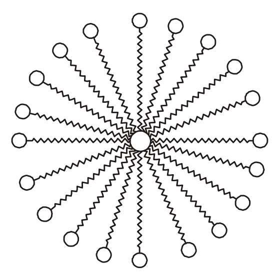
Q.14 (3)

Q.15 (3)

Q.16 (2)

Q.17 (3)

Q.18 (1)



0-Polarhead
n-Non-polar tail
(micelle)

Q.19 (1)

Q.20 (3)

Q.21 (3)

Q.22 (3)

Q.23 (4)

Q.24 (3)

Q.25 (1)

Q.26 (4)
Q.27 (4)
Q.28 (1)
Q.29 (1)
Q.30 (4)
Q.31 (3)
Q.32 (4)
Q.33 (4)
Q.34 (1)
Q.35 (2)
Q.36 (1)
Q.37 (1)
According to Hardy-Schulze rule, coagulation power of ions is directly proportaional to charge on ion.
∵ $Fe(OH)_3$ is positively charged colloid.
∴ It will be coagulated by anion.

(a) $Mg_3(PO_4)_2 \rightleftharpoons 3\,Mg^{2+} + 1PO_4^{3-}$

(b) $BaCl_2 \rightleftharpoons Ba^{2+} + 2Cl^-$

(c) $NaCl \rightleftharpoons Na^+ + Cl^-$

(d) $KCN \rightleftharpoons K^+ + Cl^-$.

Because PO_4^{3-} has highest charge among the given anions, therefore, $Mg_3(PO_4)_2$ is the most effective in the coagulation of $Fe(OH)_3$ solution.

EXERCISE-II (NEET LEVEL)

Q.1 (2)

Q.2 (2)

Q.3 (4)

Q.4 (3)

Q.5 (4)
Chemisorption first increases and then decreases with temperature.

Q.6 (2)
Adsorption is an exothermic process.

Q.7 (1)
$$\underset{(g)}{N_2} + \underset{(g)}{3H_2} \xrightarrow[\text{Mo promoter}]{Fe\text{ Catalyst}} \underset{(g)}{2NH_3}$$

Q.8 (4)
$$2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$$

Q.9 (2)
$$2SO_2 + O_2 \xrightarrow[As_2O_3(poison)]{Pt(Catalyst)} 2SO_3$$

Q.10 (2)
Inhibitors are also known as negative catalyst

Q.11 (4)
A catalyst is used to decrease the time required for the reaction hence it can decease or increase the rate of reaction.

Q.12 (4)

Q.13 (2)

Q.14 (1)

Q.15 (2)

Q.16 (2)
Lyophilic possesses solvent loving nature and thus a thin layer of dispersed phase is formed round sol particles

Q.17 (1)
Milk is a colloid of liquid (H_2O) dispersed in liquid (fat).

Q.18 (3)
Smoke is an example of solid dispersed in gas.

Q.19 (2)

Q.20 (4)
Gold no. is a measure of protective power of a lyophillic colloid.

Q.21 (4)
The ability of an ion to bring about coagulation of a given calloid depend upon both the magnitude and sign of its charge.

Q.22 (2)

Q.23 (2)

Q.24 (3)
AT (CMC) critical micellization concen-tration, the surfactant molecules associate to form miscelles. For soap CMC is 10^{-3} $mol/litre$

Q.25 (2)

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (4)
Activation energy is required for chemical adsorption.

Q.2 (2)
Adsorption is dependent on temperature.

Q.3 (2)
A gas with high critical temperature has high vander waal force due to which they are more easily liquefiable & hence more easily adsorb as adsorption decreases their energy

Q.4 (4)
Extent of adsorption increase with increase in critical temperature

Q.5 (1)
Accumulation substance on the surface of the other substance is known as adsorption.

Q.6 (2)
On increasing pressure more molecule will into contact with the surface of solid adsorbent.

Q.7 (4)
Finely divided iron is used as catalyst in manufacture of NH_3.

Q.8 (3)
Catalyst provides new path to the chemical reaction which has lower value of activation energy. Reactant and product with not be affected, so there will not be any change in state parameter like enthalpy and internal energy.

Q.9 (2)
For eg. Mn^{2+} auto catalyses $H_2C_2O_4 + HMnO_4 + H^+ \rightarrow Cr + Mn^{2+} + CO_2 + H_2O$

Q.10 (4)
Milk is emulsion

Q.11 (2)
colloids are heterogeneous in nature & hence consist of two phase.

Q.12 (2)
Emulsion :- $(\ell + \ell)$ dispersed phase & dispersion medium both are liquid

Q.13 (1)
Molecular size for colloidal range in 1nm–1000 nm.

Q.14 (3)
Lyophilic colloids do not move in presence of electric field due to uncharged nature.

Q.15 (2)
As_2S_3 colloid can be represented as $As_2S_3\ s^{2-}$ so it is negatively charged.

Q.16 (3)
Crystalloid & colloids differes in particle size & due to smaller size of crystalloid.

Q.17 (1)
Different colloidal particle will provide different colour to the sol.

Q.18 (3)
Alums due to the charged nature of colloidal particle & hence coagular impurities in muddy water as per shulze rule.

Q.19 (2)
Process by which precipitate is converted into colloid is known as peptisation.

Q.20 (3)
10 ml of 1 M NaCl contains NaCl = 10 × 1 = 10 milli mole
200 ml of As_2S_3 required NaCl for the coagulation = 10 milli mole
$\therefore$ 1000 ml of As_2S_3 required NaCl for the coagulation = 10 × 1000/ 200 = 50 milli mole

Q.21 (3)
Effectiveness of ion in coagulation $\propto$ charge on coagulating ion.

Q.22 (4)
Ferric hydroxide is a positive sol.

Q.23 (3)
Micelle is a associated form of colloid

Q.24 (2)
Liquid in liquid is known as emulsion.

Q.25 (1)
Loss of water from gel is known as synerisis.

EXERCISE-IV

NUMERICAL VALUE BASED

Q.1 50.0
Flocculation value of NaCl = 5 × 1
= 5 millimole for 100 ml
So for 1 litre value is 50 millimole.

Q.2 25.0
For 10 ml, 1 ml 10% NaCl is required so for 100 ml, 10 ml 10% NaCl will be required.
So gold number is 250.

Q.3 50
10 ml of 1 M NaCl contains NaCl = 10 × 1 = 10 milli mole
200 ml of As_2S_3 required NaCl for the coagulation = 10 milli mole
∴ 1000 ml of As_2S_3 required NaCl for the coagulatiofn = 10 × 1000/ 200 = 50 milli mole

Q.4 (4) **Q.5** (4) **Q.6** (3) **Q.7** (1) **Q.8** (4)
Q.9 (3)

PREVIOUS YEAR'S

MHT

Q.1 (3)

Q.2 (3)

Q.3 (1)

Q.4 (1)

Q.5 (3)

Q.6 (2)
Desorption is the process of removing an adsorbed substance from the surface of adsorbent, so that more adsorbate can occupy surface of adsorbent.

Q.7 (1)
Starch is an example of macromolecular colloid, in this type of colloid, the particles are themselves large molecules which on dissolution form size in the colloidal range.

Q.8 (3)
Sols of starch congo red sol and gelatin sol are the examples or negatively charged sol while methylene blue sol is positively charged sol

Q.9 (2)

Q.10 (2)

Q.11 (1)

Q.12 (1)

NEET

Q.1 (1)
• Coagulation of colloidal solution by using an electrolyte depends on the charge present (positive or negative) on colloidal particles as well as on its size.
• Coagulating power of an electrolyte depends on the magnitude of charge present on effective ion of electrolyte.

Q.2 (1,2)
In compare to 1.5 M Kl, 2M Kl is conc. Solution and In 2M Kl solution, extra K^+ion can lead coagulation so better option is 1.5 M Kl.

Q.3 (2)
Q.4 (4)
Q.5 (2)
Q.6 (2)
According to Hardy Schulze Rule statement 1 is correct. (the greater the valence of the flocculating ion added, the greater is its power to cause precipitation)
According to Hardy Schulze Rule statement 2 is incorrect.

JEE MAIN

Q.1 **(1)**
Statement I is correct and statement II also correct Emulsion of water in oil are unstable and sometime they separate into two layers on standing for stabilization of emulsion we added emulsifying agent as electrolyte.

Q.2 (3)
Micelle formation occurs above a certain conc. Known as CMC.

Q.3 (2)
The diameter of the dispersed particles is not much smaller than the wavelength of the light used. The intensity of scattered light depends on the difference between the refractive indice of the D.P. and D.M., In lyophobic colloids.

Q.4 **(a)**

Q.5 **(C)**

(The change of the surface of colloidal particles)
The zeta potential is a parameter that gives the direct information of the charge sign and some information stability and magnitude of charge.

Q.6 (3)

Q.7 (1)
∵ The colour of colloidal particles depends upon the size of particles.
Larger particles absorb the light of longer wavelength and therefore transmit light of shorter wavelength.

Q.8 (3)

[A] Dissolved substances can be removed from a collodial solution by diffusion through a parchment paper. correct

[R] Parchment paper : true solution passed and colloided solution cannot passed : incorrect

Q.9 (1)

Standard method for the preparation of lyophilic

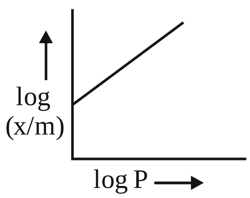
Q.10 (3)

Freundlich adsorption theorem

$$\frac{x}{m} = kp^{(1/n)}$$

$$\log\left(\frac{x}{m}\right) = \log K + \frac{1}{n}\log(P)$$

graph between log $\left(\frac{x}{m}\right)$ v/s log P



Q.11 (1)

Greater the value of critical temperature greater is adsorptioin as 'He' has least critical temperature so it is absorb least.