Solution

CHEMISTRY

Class 12 - Chemistry

Section A

1. Select and write the correct answer:

(i) **(c)** 2
Explanation: {
2

(ii) **(c)** 0.04242
Explanation: {
$c = 0.01M = 1 \times 10^{-2}M$
$K_b = \dot{\alpha}^2 c$
$\alpha = \sqrt{\frac{K_b}{c}}$
Hence, $\alpha = \sqrt{\frac{1.8 \times 10^{-5}}{1 \times 10^{-2}}} = \sqrt{1.8 \times 10^{-3}} = \sqrt{18 \times 10^{4}}$
$= 4.242 \times 10^{-2} = 0.04242$

(iii) **(c)** $2B + C \rightarrow 3A$
Explanation: {
$2B + C \rightarrow 3A$

(iv) **(a)** Ag
Explanation: {
Ag

(v) **(a)** number of possible ligands around metal ion in complex
Explanation: {
number of possible ligands around metal ion in complex

(vi) **(a)** $3^\circ > 2^\circ > 1^\circ$
Explanation: {
$3^\circ > 2^\circ > 1^\circ$

(vii) **(d)** Phenol + Iodomethane
Explanation: {
Phenol + Iodomethane

(viii) **(a)** hydrogen bond
Explanation: {
hydrogen bond

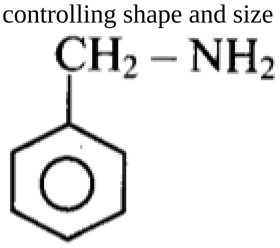
(ix) **(c)** silver
Explanation: {
silver

(x) **(c)** Trichloroacetic acid
Explanation: {
Trichloroacetic acid

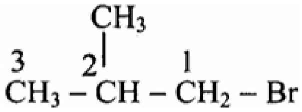
2. Answer the following:

(i) Nanotechnology is the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale.

(ii)

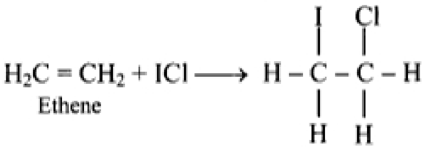


(iii)Structural formula:



IUPAC name: 1-Bromo-2-methylpropane

(iv)When ethene reacts with iodine monochloride, addition reaction occurs.



(v) Isomers which involve exchange of ligands between coordination and ionization spheres are called ionization isomers.

(vi)The boiling point of liquid is the temperature at which its' vapour pressure equals the applied pressure.

(vii)**Enthalpy of a system** is sum of internal energy of a system and the energy equivalent to pressure-volume (PV) work.

(viii)**Resistivity** (ρ) is the resistance of conductor of unit length and unit cross sectional area.

Section B

3. i. Oxidation of I⁻ from aqueous solution of KI by acidified $K_2Cr_2O_7$ gives I_2. Potassium dichromate is reduced to chromic sulphate. Liberated I_2 turns the solution brown.

$K_2Cr_2O_7 + 6KI + 7H_2SO_4 \longrightarrow 4\ K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3I_2$

ii. When $H_2\ S$ gas is passed through acidified $K_2Cr_2O_7$ solution, $H_2\ S$ is oxidised to pale yellow precipitate of sulphur. Simultaneously, potassium dichromate is reduced to chromic sulphate, which is reflected as colour change of solution from orange to green.

$K_2Cr_2O_7 + 4H_2SO_4 + 3H_2\ S \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3\ S$

4. i. For very dilute solutions, the osmotic pressure follows the equation,

$\pi = \frac{n_2RT}{V}$ ...(1)

ii. If the mass of solute in V litres of solution is W_2 and its molar mass is M_2, then $n_2 = \frac{W_2}{M_2}$.

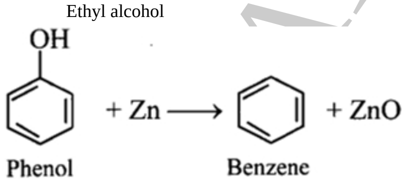
Substituting the value of n_2 in equation (1), we get $\pi = \frac{W_2}{M_2}\frac{RT}{V}$

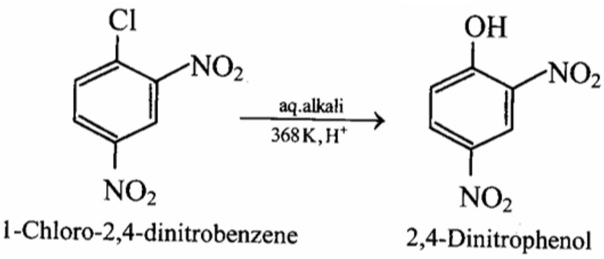
$\therefore M_2 = \frac{W_2RT}{\pi V}$

This formula can be used for the calculation of molar mass of a nonionic solute (i.e., nonelectrolyte), by osmotic pressure measurement.

5. Nanochemistry is the combination of chemistry and nanoscience which deals with designing and synthesis of materials of nanoscale with different size and shape, structure and composition and their organization into functional architectures.

6. i. $\underset{\text{Ethyl alcohol}}{2\mathrm{CH_3 - CH_2 - OH}} \xrightarrow{\text{2Na}} \underset{\text{Sodium ethoxide}}{2\mathrm{CH_3 - CH_2 - O^-Na^+}} + \mathrm{H_2}\uparrow$

ii. 

7. 

8. Relationship between pH and pOH :

The ionic product of water is given as:

$K_w = \left[H_3O^+\right]\left[OH^-\right]$

Now, $K_w = 1 \times 10^{-14}$ at 298 K

Thus, $\left[H_3O^+\right]\left[OH^-\right] = 1.0 \times 10^{-14}$

Taking logarithm of both the sides, we write

$\log_{10}\left[H_3O^+\right] + \log_{10}\left[OH^-\right] = -14$

$-\log_{10}\left[H_3O^+\right] + \left\{-\log_{10}\left[OH^+\right]\right\} = 14$

Now, $pH=-\log_{10}\left[H_3O^+\right]$ and
$pOH=-\log_{10}\left[OH^-\right]$
$\therefore pH+pOH=14$

9. $\mathrm{CH_3-CH_2-N^+(CH_3)_3}I^- \xrightarrow[\Delta]{\mathrm{Ag_2O/H_2O}} \mathrm{CH_3-CH_2-N^+(CH_3)_3I^-} \xrightarrow[\Delta]{\mathrm{A_{g2}O/H_2O}}$

Ethyltrimethyl ammonium iodide — Ethyltrimethyl ammonium iodide

$CH_3-CH_2-N^+(CH_3)_3OH^- \xrightarrow{\Delta} CH_2=CH_2+(CH_3)_3N+H_2O$

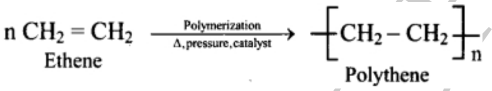
Ethyltrimethyl ammonium hydroxide — Ethylene (B) — Trimethyl amine

10. $W=-P_{\text{ext}}\Delta V=-P_{\text{ext}}\left(V_2-V_1\right)$
$W=-1.2bar\left(20dm^3-15dm^3\right)$
$=-1.2bar\times 5dm^3=-6dm^3$ bar
Now, $1dm^3$ bar $=100\ J$
Hence, $W=-6dm^3$ bar $\times\frac{100\ J}{1dm^3\text{ bar}}=-600J$
The work done is **-600 J**.

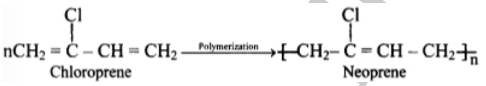
11. i. The potential aldehyde and ketone groups imparts reducing properties to sugars.
ii. If the potential aldehyde and ketone group(s) of one or two monosaccharide unit(s) is(are) not involved in formation of the glycosidic bond, sugar is called a reducing sugar. i.e., maltose
iii. If the potential aldehyde and ketone groups of both the monosaccharide units are involved in formation of the glycosidic bond, sugar is called a non-reducing sugar. i.e., sucrose

12. Enthalpy of sublimation is the enthalpy change for the conversion of one mole of solid directly into vapour at constant temperature and pressure.
Enthalpy of fusion ($\Delta_{\text{sub}}H$) is related to enthalpy of vaporization by the following equation.
$\Delta_{\text{sub}}H=\Delta_{\text{fus}}H+\Delta_{\text{vap}}H$
Where $\Delta_{\text{fus}}H$ is enthalpy of fusion and $\Delta_{\text{vap}}H$ is enthalpy of vaporization.

13. i. Polythene is obtained by polymerization of ethene under high pressure and temperature in presence of suitable catalyst.



ii. Neoprene is obtained by polymerization of chloroprene in presence of oxygen.



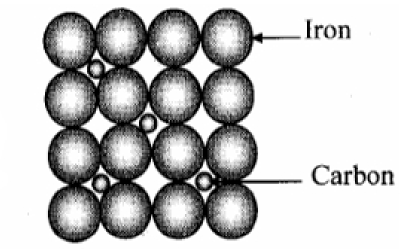
14. i. In Neon discharge lamps and signs. These signs are visible from the long distances and also in mist or fog.
ii. Mixture of Ne and He is used in certain protective electrical devices such as voltage stabilizers and current rectifiers.

Section C

15. i. Two or more solutions having the same osmotic pressure are said to be isotonic solutions.
e.g. For example, 0.1 M urea solution and 0.1 M sucrose solution are isotonic because their osmotic pressures are equal.
ii. If two solutions have unequal osmotic pressures, the more concentrated solution with higher osmotic pressure is said to be hypertonic solution.
e.g. For example, if osmotic pressure of sucrose solution is higher than that of urea solution, the sucrose solution is hypertonic to urea solution.
iii. If two solutions have unequal osmotic pressures, the more dilute solution exhibiting lower osmotic pressure is said to be hypotonic solution.
e.g. For example, if osmotic pressure of sucrose solution is higher than that of urea solution, the urea solution is hypotonic to sucrose solution.

16. In interstitial impurity defect, the impurity atoms occupy interstitial spaces of lattice structure.
e.g.: Stainless steel

In stainless steel, Fe atoms occupy normal lattice sites. The carbon atoms are present at interstitial spaces, as shown in the figure.



Stainless steel

Interstitial impurity defect

17. Given: Mass of Ag deposited $= 1.346 \times 10^{-3}\ kg = 1.346\ g$, Molar mass of $Ag = 108\ g\ mol^{-1}$

To find: Quantity of electricity required (in coulomb)

Formulae: i. Mole ratio $= \frac{\text{Moles of product formed in half reaction}}{\text{Moles of electrons required in half reaction}}$

ii. $W = \frac{I(A) \times t(s)}{96500(C/mole^{-})} \times$ mole ratio $\times$ molar mass

Calculation: The half reaction for the formation of Ag is,

$Ag^{+}_{(aq)} + e^{-} \longrightarrow Ag_{(s)}$

Using formula (i),

Mole ratio $= \frac{l\left(mol Ag^{2}\right)}{l(\,mole^{-})}$

Using formula (ii),

$W = \frac{1(\,A) \times t(\,s)}{96500\left(C/mole^{-}\right)} \times$ mole ratio $\times$ molar mass of Ag

$1.346g = \frac{Q(C)}{96500(C/mol\ e^{-})} \times \frac{1mol}{1mol\ e^{-}} \times 108g\ mol^{-1}$

$\therefore Q = 1202.7C$

Quantity of electricity required is 1202.7 C.

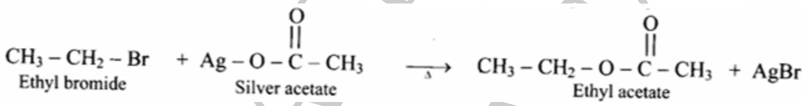
18. i. **Action of alcoholic solution of potassium hydroxide on ethyl bromide:**

Ethyl bromide undergoes dehydrohalogenation on treatment with alcoholic solution of potassium hydroxide yielding ethylene.

$$\underset{\text{Ethyl bromide}}{C_2H_5Br} + \underset{\text{(alc.)}}{KOH} \xrightarrow{\Delta} CH_2 = CH_2 + KBr + H_2O$$

ii. **Action of silver acetate on ethyl bromide:**

Ethanolic solution of silver acetate on heating with ethyl bromide gives ethyl acetate.



19. Given: Amount of ideal gas = n = 1 mol

Initial volume = V_1 = 10 L

Final volume = V_2 = 15 L

To find: Work done (W_{max})

Formula: $W_{\max} = -2.303nRT \log_{10} \frac{V_2}{V_1}$

Calculation: Gas constant $= R = 8.314\ J\ K^{-1}\ mol^{-1}$

From formula,

$W_{\max} = -2.303nRT \log_{10} \frac{V_2}{V_1}$

$= -2.303 \times 1\ mol^{2} \times 8.314\ J\ K^{-1}\ mol^{-1} \times 300\ K \times \log_{10} \frac{15}{10}$

$= -2.303 \times 1 \times 8.314\ J \times 300 \times \log_{10} 1.5$

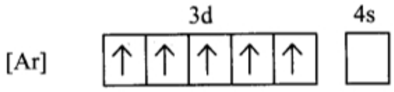
$= -2.303 \times 1 \times 8.314\ J \times 300 \times 0.1761$

$= -1011.5\ J$

$= -1.0115\ kJ$

The work done in the process is **-1.0115 kJ**.

20. i. For element with atomic number 25, the condensed electronic configuration for its divalent cation will be



There are 5 unpaired electrons, so $n = 5$.

$\therefore \mu = \sqrt{5(5+2)} = 5.92$ **BM**

$\therefore$ Spin only magnetic moment of the given ion is **5.92 BM**.

ii. a. Condensed electronic configurations of Ti^{4+} is: $[Ar]3\ d^0$

b. Ti^{4+} ion has completely empty d-orbitals i.e., no unpaired electrons are present. Thus, salts of Ti^{4+} are colourless, as d-d transitions are not possible.

21. Given: Solubility product $(K_{sp}) = 1.4 \times 10^{-11}$

To find: Solubility, S

Formula: $K_{sp} = x^x y^y\ S^{x+y}$

Calculation:

Solubility equilibrium of $Mg(OH)_2$ is:

$Mg(OH)_{2(s)} \rightleftharpoons Mg^{2+}_{(a)} + 2OH^-_{(aq)}$

$x = 1, y = 2$

$K_{sp} = x^x y^y\ S^{x+y} = (1)^1(2)^2\ S^{1+2} = 4\ S^3$

The molar solubility (S) of $Mg(OH)_2$ is

$S = \sqrt[3]{\frac{K_{sp}}{4}} = \sqrt[3]{\frac{1.4\times10^{-11}}{4}} = \sqrt[3]{3.5 \times 10^{-12}}$

$= 1.518 \times 10^{-4}\ moldm^{-3}$

Solubility (S) of magnesium hydroxide, $Mg(OH)_2$ is $1.518 \times 10^{-4}\ moldm^{-3}$.

22. i. Ionization isomers involve exchange of ligands between coordination and ionization spheres.

e.g. $\underset{\text{I}}{[\mathrm{Co(NH_3)_5SO_4}]\ \mathrm{Br}}$ and $\underset{\text{II}}{[\mathrm{Co(NH_3)_5Br}]\ \mathrm{SO_4}}$

ii. In compound (I), anion SO_4^{2-}, linked to Co is in the coordination sphere while Br^- is in the ionization sphere. In compound (II), anion Br^- is in the coordination sphere linked to Co while SO_4^{2-} is in the ionisation sphere.

iii. These complexes in solution ionize to give different ions.

$[Co(NH_3)_5SO_4]\ Br \longrightarrow [Co(NH_3)_5SO_4]^+ + Br^-$

$[Co(NH_3)_5Br]\ SO_4 \longrightarrow [Co(NH_3)_5Br]^{2+} + SO_4^{2-}$

Hence, (I) and (II) are examples of ionization isomers.

23. $A + B \longrightarrow$ Products

As the reaction is first order in each of the reactants, the rate law for the above reaction is Rate $_1 = k[A][B]$

i. If the concentration of A is increased by factor 3, the new rate law becomes

$\text{Rate}_2 = k[3\ A][B]$

$\text{Rate}_2 = 3k[A][B]$

$\text{Rate}_2 = 3\ \text{Rate}_1$

The rate of reaction increases three times.

ii. If the concentration of A is halved and concentration of B is doubled, the new rate law becomes

$\text{Rate}_3 = k\left[\frac{1}{2}\ A\right]\ [2\ B]$

$\text{Rate}_3 = \frac{1}{2} \times 2k[A][B]$

$\text{Rate}_3 = k[A][B]$

$\text{Rate}_3 = \text{Rate}_1$

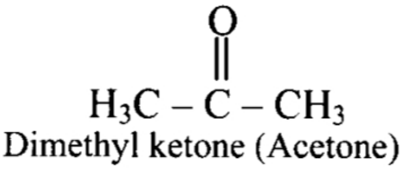
The rate of reaction remains the same.

24. Ketones are classified on the basis of nature of carbon skeleton bonded to carbonyl group into aliphatic and aromatic ketones.

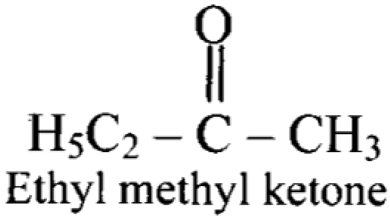
i. **Aliphatic ketones:**

The compounds in which carbonyl group is attached to two alkyl groups are called aliphatic ketones. On the basis of types of alkyl groups bonded to carbonyl carbon, aliphatic ketones are further classified as simple and mixed ketones.

a. **Simple or symmetrical ketones:** The ketones in which both the alkyl groups bonded to carbonyl carbon are identical, are called simple ketones or symmetrical ketones.

e.g. 

b. **Mixed or unsymmetrical ketones:** The ketones in which two alkyl groups bonded to carbonyl carbon are different, are called mixed ketones or unsymmetrical ketones.

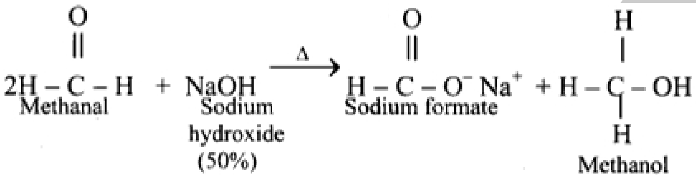
e.g. 

25. Sulphur dioxide is oxidised catalytically with oxygen to sulphur trioxide, in the presence of V_2O_5 catalyst.

$$\underset{\text{Sulphur dioxide}}{2SO_{2(g)}} + O_{2(g)} \xrightarrow{V_2O_5} \underset{\text{Sulphur trioxide}}{2SO_{3(g)}}$$

26. Answer the following:

(i) Cannizzaro reaction of methanal:



(ii) Chemical reaction for carbylamine test:

$$\underset{1^\circ\ \text{Amine}}{R-NH_2} + CHCl_3 + 3KOH \xrightarrow{\Delta} \underset{\text{Alkylisocyanide}}{R-NC} + 3KCl + 3H_2O$$

Section D

27. Answer the following:

(i) i. Arhennius equation is:

$k = Ae^{-E_a/RT}$

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

ii. For two different temperatures T_1 and T_2

$\log_{10} k_1 = \log_{10} A - \frac{E_a}{2.303RT_1}$ ...(1)

$\log_{10} k_2 = \log_{10} A - \frac{E_a}{2.303RT_2}$ ...(2)

where k_1 and k_2 are the rate constants at temperatures T_1 and T_2 respectively.

Subtracting Eq. (1) from Eq. (2),

$\log_{10} k_2 - \log_{10} k_1 = -\frac{E_a}{2.303R}\frac{1}{T_2} + \frac{E_a}{2.303R}\frac{1}{T_1}$

Hence,

$\log_{10}\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$= \frac{E_a}{2.303R}\left(\frac{T_2-T_1}{T_1\,T_2}\right)$

(ii) Gadolinium $(Gd, Z=64) = [Xe]4f^7 5\ d^1 6\ s^2$

(iii) Green chemistry is the use of chemistry for pollution prevention by environmentally conscious design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.

28. Answer the following:

(i) When the gas expands in vacuum, there is no opposing force, that is, $P_{\text{ext}} = 0$. The work done by a system during such expansion is:

$W = -P_{ext}\Delta V = 0$.

Thus, no work is done when the gas expands freely in vacuum.

(ii) The monomer used in the preparation of nylon 6 is ε-caprolactam.

(iii) **Denaturation** is the process by which the molecular shape of protein changes without breaking the amide/peptide bonds that form the primary structure.

29. Answer the following:

(i) Given: Density $(\rho) = 8.966\ g\ cm^{-3}$, Molar mass of copper $= 63.5\ g\ mol^{-1}$

To find: Volume of the unit cell

Formula: Density $(\rho) = \frac{M \times n}{a^3 N_A}$

Calculation: For fcc unit cell, $n = 4$.

From formula,

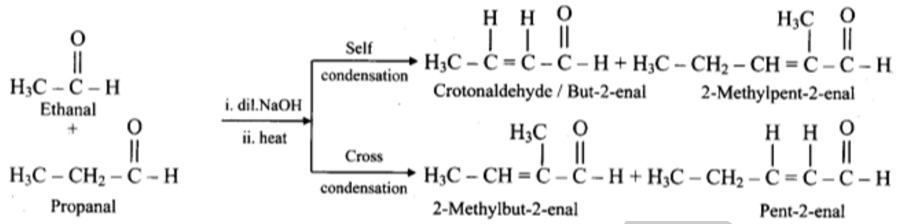
Volume of unit cell, $a^3 = \frac{M \times n}{\rho N_A}$

$$\therefore a^3 = \frac{63.5\ g\ mol^{-1} \times 4}{8.966\ g\ cm^{-3} \times 6.022 \times 10^{23}\ \text{atom}\ mol^{-1}} = 4.704 \times 10^{-23}\ cm^3$$

The volume of the unit cell is $4.704 \times 10^{-23}\ cm^3$.

(ii) **Aldol condensation between ethanal and propanal:**

A mixture of ethanal and propanal on reaction with dilute alkali followed by heating gives a mixture of four products.



30. Answer the following:

(i)

	Complex	Number of unpaired electrons	Geometry
a.	$[NiCl_4]^{2-}$	2	Tetrahedral
b.	$[Ni(CN)_4]^{2-}$	0	Square planar

(ii) Cell representation of standard hydrogen electrode is:

$H^+(1M)\,|H_2(\,g, 1\ atm)|\,Pt$

(iii) Acidic strength: $HOCl < HClO_2 < HClO_3 < HClO_4$.

31. Answer the following:

(i) i. **Ethyl alcohol into ethyl acetate:**

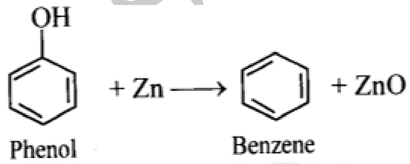
$$\underset{\text{Ethanol}}{C_2H_5 - OH} + \underset{\text{Acetic acid}}{HO - \overset{\overset{O}{||}}{C} - CH_3} \xrightarrow{\text{Conc. } H_2SO_4} \underset{\text{Ethyl acetate}}{CH_3 - \overset{\overset{O}{||}}{C} - OC_2H_5} + H_2O$$

OR

$$\underset{\text{Ethanol}}{C_2H_5 - OH} + \underset{\text{Acetyl chloride}}{Cl - \overset{\overset{O}{||}}{C} - CH_3} \xrightarrow{\text{pyridine}} \underset{\text{Ethyl acetate}}{CH_3 - \overset{\overset{O}{||}}{C} - OC_2H_5} + HCl$$

ii. **Phenol into benzene:**

When phenol is treated with zinc dust, it gets reduced to zinc dust.



(ii) Thiosulphuric acid:

Molecular formula: $H_2\ S_2O_3$

Structural formula: