## 2012

**_Question 1_**
What is meant by the term 'forbidden zone' in reference to band theory of solids? [1]

**_Answer:_**
The energy gap between valance band and conduction is known as forbidden zone.

**_Question 2_**
Why is the adsorption phenomenon always exothermic? [1]

**_Answer:_**
As the adsorption progresses, the residual forces at the surface decreases resulting in the decrease of surface energy which appears as heat.

**_Question 3_**
Write the reaction involved in the extraction of silver after the silver ore has been leached with NaCN. [1]

**_Answer:_**
$2[Ag(CN)_2](aq) + Zn(s) \rightarrow [Zn(CN)_4]^{2-}(aq) + Ag(s)]$

**_Question 4_**
Although the H-bonding in hyfrogen fluoride is much stronger than that in water, yet water has a much higher boiling point than hydrogen fluoride. Why? [1]

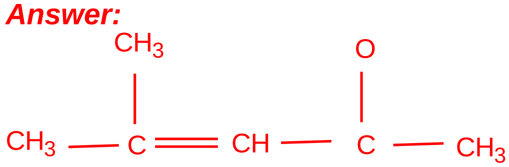
**_Answer:_**
This is because hydrogen bonding is multidimensional in water whereas in HF it is linear.

**_Question 5_**
Write the IUPAC name of the following compound: [1]

$$H_3C-CH=CH-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-CH_3$$

**_Answer:_**
Hex-4-en-3-ol

**_Question 6_**
Draw the molecular structure of the compound, 4-methylpent-3-en-2-one. [1]

**_Answer:_**


**_Question 7_**
Write the full forms of DNA and RNA. [1]

**_Answer:_**
DNA: Deoxyribonucleic acid

RNA: Ribonucleic acid

***Question 8***

What is meant by 'narrow spectrum antibiotics'? [1]

***Answer:***

Antibiotics which are mainly effective against gram-positive or Gram-negative bacteria are known as narrow spectrum antibiotics, *e.g.*, ampicillin G.

***Question 9***

a. Differentiate any two of the following terms: [2]

i. Van't Hoff factor

***Answer:***

May be defined as the ratio of normal molecular mass to observed molecular mass or the ratio of observed colligative property to calculated colligative property.

ii. Mole fraction

***Answer:***

Mole fraction may be defined as the ratio of number of moles of one component to the sum of moles all the components present in a solution.

iii. Ebullioscopic constant

***Answer:***

Ebuthoscopic constant may be defined as the elevation in boiling point when one mole of a non-volatile solute is added to 1000 grams of solvent.

b. State Raoult's law.

***Answer:***

It states that for a solution of volatile liquids the partial vapour pressure of each component in the solution is directly proportional to its mole faction.

OR

The density of water of a lake is 1.25 g $(mL)^{-1}$ and one kg of this water contains 92 g of $Na^+$ ions. What is the molarity of $Na^+$ ions in the water of the lake? (Atomic mass of Na=23.00 u)

***Answer:***

Number of moles of solute, $Na^+$ ions = $\frac{92g}{23\text{ g mol}^{-1}} = 4\text{ mol}$

$$\frac{\text{Mass of solution}}{\text{Density of solution}} = \frac{1000g}{1.25gmL^{-1}} = 800mL = \frac{800mL}{1000mL^{-1}} = 0.8L$$

$$\text{Volume of solution} = \frac{\text{Number of moles Na}^+\text{ ions}}{\text{Volume of solution in lite}} = \frac{4\text{ mol}}{0.8\text{ L}}$$

$= 5\text{ mol L}^{-1}$ or 5 m.

***Question 10***

Define the following terms: [2]

i. Order of a reaction

***Answer:***
The sum of the powers of the concentration of the reactants in the rate law expression is called the order of the reaction. For a general reaction

$$aA + bB \rightarrow \text{products}$$

Let rate = K $[A]^m[B]^n$
Order of the reaction = m + n

ii. Activation energy of a reaction

***Answer:***
The minimum extra energy absorbed by the reactant molecular so that their energy becomes equal threshold energy is called activation energy.
Activation energy = Threshold energy – Energy possessed by reactant molecular

### *Question 11*
Name one chief ore each of copper and aluminium. Name the method used for the concentration of these two ores. [2]

***Answer:***

| Metal | Chief ore | Method of concentration |
|---|---|---|
| Copper | Copper pyrite ($CuFeS_2$) | Froth floatation |
| Aluminium | Bauxite $[AlO_x(OH)_{3-2x}]$ where $0 < x < 1$ | Leaching |

### *Question 12*
Explain the following: [2]

i. The chemical reactivity of nitrogen is much less than that of phosphorus.

***Answer:***
As N ≡ N triple bond (941.4 $kJmol^{-1}$) is much stronger than p–p single bond (213 $kJmol^{-1}$), therefore nitrogen is much less reactive than phosphorus.

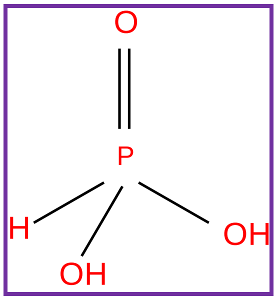
ii. $SF_6$ is kinetically inert.

***Answer:***
This is because in $SF_6$, sulphur is sterically protected by six fluorine atoms.

### *Question 13*
Draw the molecular structures of the following species: [2]

i. $H_3PO_3$

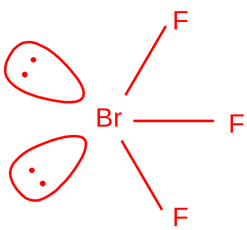
***Answer:***
$H_3PO_3$




ii. $BrF_3$

***Answer:***

$BrF_3$—Slightly bent T

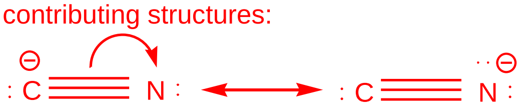



***Question 14***

What are ambident nucleophiles? Explain giving an example. [2]

***Answer:***

Nucleophiles which can attack through the different nucleophilic centres present in it are called ambident nucleophiles. For example, cyanide group is resonance hybrid of the following two contributing structures:




It can attack through carbon to form cyanide and through N to form isocyanide.

***Question 15***

Explain as to why [2]

i. Alkyl halides, through polar are immiscible with water.

***Answer:***

This is due to inability of alkyl halides to form intermolecular hydrogen bonds with water molecules.

ii. Grignard's reagents should be prepared under anhydrous conditions.

***Answer:***

This is because Grignard reagent forms alkanes by reacting with moisture.

$$RMgX + H_2O \rightarrow RH + Mg(OH)X$$

***Question 16***

Describe the following giving the chemical equation in each case: [2]

i. Carbylamines reaction

***Answer:***

Carbylamine reaction: Aliphatic and aromatic primary amines when heated with chloroform and ethanolic potassium hydroxide form carbylamines or isocyanides which are foul smelling substances. Secondary and tertiary amines do not show this reaction.

$$R\text{-}NH_2 + CHCl_3 + 3KOH(alc.) \xrightarrow{\Delta} RNC + 3KCl + 3H_2O$$

$$C_6H_5NH_2 + CHCl_3 + 3KOH\,(alc.) \xrightarrow{\Delta} C_6H_5NC + 3KCl + 3H_2O$$

Aniline Phenyl Isocyanide

ii. Hofmann's bromamide reaction

***Answer:***

Hoffmann's bromamide reaction: When a primary acid amide is heated with bromine in an aqueous or ethanolic solution of NaOH, a primary amine is obtained. The amine so obtained contains one carbon less than that present in the amide.

$$RCONH_2 + Br_2 + 4NaOH \rightarrow R\text{-}NH_2 + Na_2\,CO_3 + 2NaBr + 2H_2O$$

Acid amide

$$C_6H_5CONH_2 + Br_2 + 4NaOH \rightarrow C_6H_5NH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

Benzamide Benzene

diazonium chloride

***Question 17***

Complete the following reactionl equations: [2]

i. $C_6H_5N_2Cl + H_3PO_3 + H_2O \rightarrow$

***Answer:***

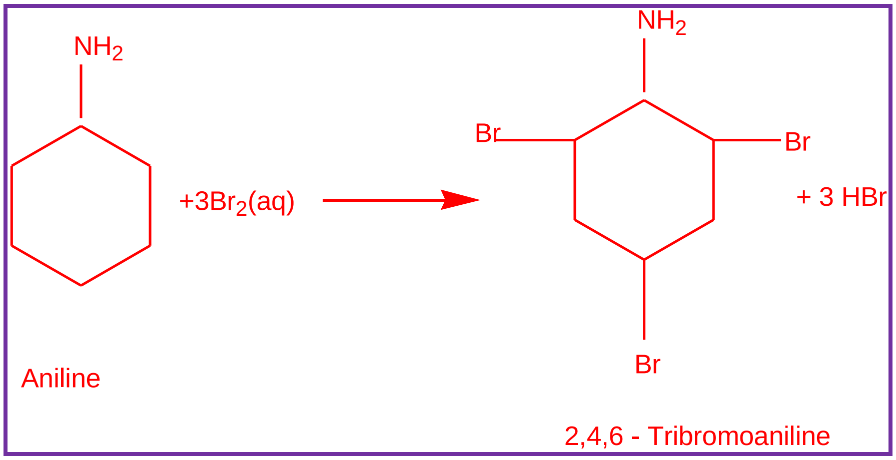
$$C_6H_5N_2Cl + H_3PO_3 + H_2O \rightarrow C_6H_6 + N_2 + H_3PO_3 + HCl$$

Benzene Benzene

diazoniumchloride

ii. $C_6H_5NH_2 + Br_2(aq) \rightarrow$

***Answer:***




***Question 18***

State the reason in each of the following cases: [2]

i. Soaps do not work well in hard water.

***Answer:***

In hard water soaps get precipitated as calcium and magnesium soap which being insoluble in water stick to the clothes as gummy mass.

ii. The use of the sweetner aspartame is limited to cold foods and drinks.

***Answer:***

This is because aspartame is unstable at cooking temperature.

***Question 19***

Iron has a body centred cubic (bcc) unit cell with a cell dimension of 286.65 pm. The density of iron is 7.874 g $cm^{-3}$. Use this information to calculate Avogadro's number. (Atomic mass of Fe=55.845 u) [3]

***Answer:***

Here, $z$ = 2, M = 56 g $mol^{-1}$, $d$ = 7.87 g $cm^{-3}$

$a$ = 286.65 pm = 286 .65 × $10^{-10}$ cm = 2.8

Substituting the values in the expression,

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

$$N_A = \frac{2 \times 56\ g\ mol^{-1}}{(286.65 \times 10^{-10} cm)^3 \times 7.87\ g\ cm^{-3}}$$

= 6.042 × 1023 $mol^{-1}$

OR

Silver crystallizes in face centered cubic (fcc) unit cell. If the radius of silver atom is 145 pm, what is the length of each side of the unit cell?

***Answer:***

For bcc unit cell, a = $2\sqrt{2}r$

$\therefore$ a = $2\sqrt{2}$ × 145 pm

= 2 × 1.414 × 145 pm

a = 410.06 pm.

***Question 20***

At $25^0$ C the structured vapour pressure of water is 3.165 kPa (23.75 mm Hg). Find the statured vapour pressure of a 5% aqueous solution of urea (carbamide) at the same temperature. (Molar mass of urea = 60.05 g $mol^{-1}$) [3]

***Answer:***

$W_{B} = 5g$, $W_A = 95g$ $M_B$ = 60.05 g $mol^{-1}$,
MA = 18 g $mol^{-1}$ P°A = 3.165 kPa
Substituting the values in the expression;

$$\frac{P_A^o - p}{P_A^o} = \frac{W_B \times M_A}{M_B \times W_A}\text{, we get}$$

$$\frac{3.165\,k\,Pa - P}{3.165\,k\,Pa} = \frac{5\,g\,18\,g\,mol^{-1}}{60.05\,g\,mol^{-1} \times 95g} = 0.015$$

*P* = 3.165 k Pa – 0.015 × 3.165 k Pa

*P* = 3.118 k Pa

***Question 21***

Consider the reaction: 2A + B → C+D [3]
Following results were obtained in experiments designed to study the rate of reaction:

| Exp. No. | Initial concentration (mol $L^{-1}$) | | Initial rate of formation |
|---|---|---|---|
| | [A] | [B] | [D] ($\frac{M}{min}$) |
| 1 | 0.10 | 0.10 | $1.5 \times 10^{-3}$ |
| 2 | 0.20 | 0.20 | $3.0 \times 10^{-3}$ |
| 3 | 0.20 | 0.40 | $6.0 \times 10^{-3}$ |

a. Write the rate law for the reaction.

***Answer:***

Let Rate = $k[A]^m [B]^n$
∴ $1.5 \times 10^{-3}$ mol $L^{-1}$ $min^{-1}$ = $K(0.1)m(0.1)\ n$ … (*i*)
$3.0 \times 10^{-3}$ mol $L^{-1}$ $min^{-1}$ = $K(0.2)m(0.2)\ n$ … (*ii*)
$6.0 \times 10^{-3}$ mol $L^{-1}$ $min^{-1}$ = $K(0.2)m(0.4)\ n$ …(*iii*)
Dividing equation (*iii*) by (*ii*), we get

$$\frac{6.0 \times 10^{-3}}{3.0 \times 10^{-3}} = \frac{K(0.2)^m (0.4)^n}{K(0.2)^m (0.4)^n}$$

$2 = 2n \Rightarrow n = 1$
Dividing equation (ii) by (i), we get

$$\frac{3.0 \times 10 - 3}{1.5 \times 10^{-3}} = \frac{k(0.2)^m (0.2)^n}{k(0.1)^m (0.1)^n}$$

$2 = 2^m 2^n = 2^m . 2$
$2^m = 1$ or $2^m = 2^0 \Rightarrow m = 0$
∴ Rate = $K[A]^\circ[B]^1$ or Rate = K[B]

b. Calculate the value of rate constant for the reaction.

***Answer:***

$$K = \frac{Rate}{[B]}$$

$$K = \frac{1.5 \times 10^{-3} mol\,L^{-1} min^{-1}}{0.1 mol\,L^{-1}}$$

c. Which of the following possible reaction mechanism is consistent with the rate law found in (a)?

i. $A + B \rightarrow C + E$ (slow)
   $A + E \rightarrow D$ (fast)

ii. $B \rightarrow C + E$ (slow)
   $A + E \rightarrow F$ (fast)
   $A + F \rightarrow D$ (fast)

***Answer:***

The reaction mechanism (II) is consistent with the rate law found in (a).

***Question 22***

Define the following terms giving one suitable example for each: [3]

i. Electrophoresis

***Answer:***

The movement of colloidal particles towards oppositely charged electrodes in an electric field is called electrophoresis.

ii. Micelles

***Answer:***

There are some substances such as soap which at low concentration behave as normal electrolytes, but at higher concentration exhibit colloidal behaviour due to the formation of aggregates. The aggregated particles thus formed are known as micelles or associated colloids.

iii. Peptization

***Answer:***

The process of converting a procipitate into colloidal solution by shaking it with dispersion medium in the presence of small amount of electrolyte is called peptization.

***Question 23***

Complete the following chemical equations:

i. $NH_4Cl(aq) + NaNO_2(aq) \rightarrow$

***Answer:***

$$NH_4Cl(aq) + NaNO2\,(aq) \rightarrow N_2\,(g) + 2H_2O(l) + NaCl(aq)$$

ii. $P_4 + NaOH + H_2O \rightarrow$

***Answer:***

$P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

iii. $\underset{\text{(Xenon in excess)}}{Xe(g)} + F_2(g) \xrightarrow[\text{1Bar}]{\text{673K}}$

***Answer:***

$\underset{\text{(Xenon in excess)}}{Xe(g) + F_2\,(g)} \xrightarrow[\text{1bar}]{\text{673K}} XeF_2\,(s)$

***Question 24***

Explain the following: [3]

i. The $\pi$-complexes are known for transition elements only.

***Answer:***

This is because the transition metals have empty d-orbitals into which the electron pairs can be denoted by ligands containing and electrons, e.g., $C_6H_6$, $C_2H_4$ etc

ii. Nickel (II) does not form low spin octahedral complexes.

***Answer:***

As only one inner *d*-orbital is available in nickel for bonding in the presence of strong ligand, *e.g.*, $C\overline{O}$., $C\overline{N}$.,

iii. $[Fe(CN)_6]^{4-}$ and $[Fe(H_2O)_6]^{2+}$ are of different colors in dilute solution.

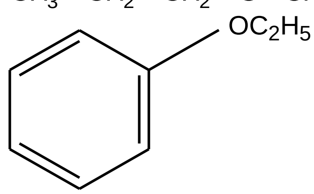
***Answer:***

In both the complexes, Fe is in +2 oxide state with $d^6$ configuration. As the ligands CN and $H_2O$ possess different crystal field splitting energy ($\Delta$O), they absorb different components of visible light for d-d transition. Hence, the transmitted colours are different in dilute solutions.

***Question 25***

State the products of the following reactions: [3]

i. $CH_3 - CH_2 - CH_2 - O - CH_3 + HBr \rightarrow$

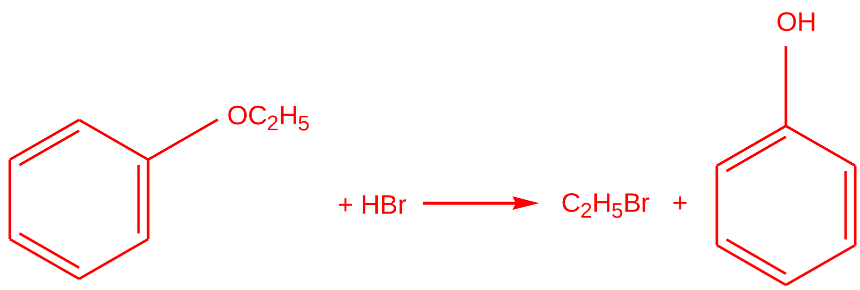
ii. 

+ HBr ⟶

iii. $(CH_3)_3C - OC_2H_5 \xrightarrow{HI}$

***Answer:***

i. $CH_3 - CH_2 - CH_2 - O - CH_3 + HBr \rightarrow CH_3 - CH_2 - Br - CH_3 - CH_2 - CH_2 - OH$

ii. 

iii. $(CH_3)_3C-OC_2H_5 \xrightarrow{HI} (CH_3)_3C-I + C_2H_5-OH$

***Question 26***

What is glycogen? How is it different from starch? How is starch structurally different from cellulose? [3]

***Answer:***

Glycogen is a polymer of $\alpha$-D-glucose. The carbohydrates are stored in animal body as glycogen. Starch is also a polymer of $\alpha$-D-glucose and consist of two components amylose and amylopectin. Amylose is linear chain polymer of $\alpha$-D –glucose. Both glycogen and amylopectin are branched chain polymer of $\alpha$-D-glucose but glycogen is more highly branched than amylopectin. Starch is the main storage polysaccharide of plants. Starch is a polymer of $\alpha$-D-glucose whereas cellulose is a polymer $\beta$–D–glucose.

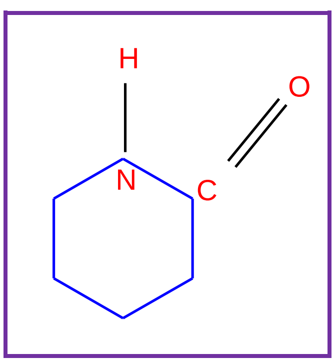
***Question 27***

Write the structure of the monomer of each of the following polymers: [3]

i. Nylon-6

***Answer:***

Monomer of Nylon-6 is amino caproic acid



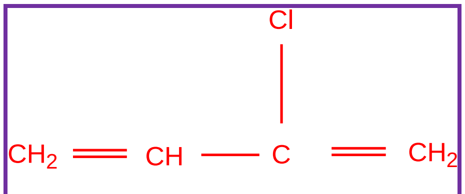

ii. Teflon

***Answer:***

Tetrafluoroethylene: $CF_2 = CF_2$

iii. Neoprene

***Answer:***




Chloroprene

***Question 28*** [5]

a. What type of battery is the lead storage battery? Write the anode and cathode reactions and the overall reaction occurring in a lead storage battery sending out an electric current.

***Answer:***

Lead storage battery is a secondary battery. The reactions occurring in lead storage battery when current is drawn from it are:

**Anode:** $Pb(s) + SO4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$

**Cathode:** $PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e- \rightarrow$

$PbSO_4(s) + 2H_2O(l)$

**Overall reaction:** $Pb(s) + PbO)\,2 + (s\,2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H\,_2O(l)$

b. A voltaic cell is set up at $25^0$ C with the half-cells.

$Ag^+(0.001\,M)\,|\,Ag$ and $Cu^{2+}(0.10\,M)\,|\,Cu$

What should be its cell potential? ( $E^0_{cell}$ = 0.46 V, Log $10^5$ = 5)

***Answer:***

**At Anode:** $Cu \rightarrow Cu^{2+} + 2e^-$

**At Cathode:** $Ag^+ + e^- \rightarrow Ag] \times 2$

**Cell reaction:** $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$

$$E^o_{cell} = 0.46\,V; [Ag^+] = 1\times10^{-3}\,M, [Cu^{2+}] = 0.1M : n = 2$$

Substituting the values in the equation:

$$E_{cell} = E^o_{cell} - \frac{0.059}{2}\log\frac{\left[Cu^{2+}\right]}{\left[Ag^+\right]^2}, \text{we get}$$

$$E_{cell} = 0.46\,V - \frac{0.059}{2}\log\frac{(0.1)}{(10^{-3})^2}$$

= 0.46 V – (0.0295 log 105) = 0.46V – 0.0295 × 5

= 0.3125 V

OR

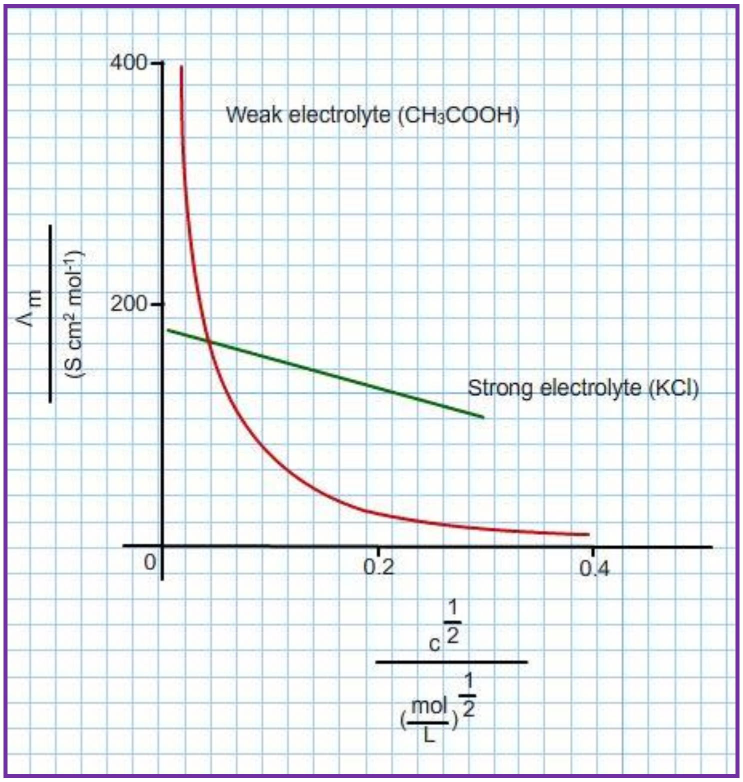
a. Define the term molar conductivity and explain how molar conductivity changes with solution concentration for weak and strong electrolytes.

***Answer:***

Molar conductivity of a solution at a given concentration is the conductance of the volume V of the solution containing one mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length.

$$A_m = k \times v = \frac{k \times 1000}{C}$$

Where k is the conductivity and *V* is the volume of solution containing one mole of the electrolyte and *C* is the molar concentration.




Molar conductivity increases with decrease in concentration or increase in dilution as the number of ions as well as the mobility of ions increases with increase in dilution. For strong electrolytes, the number of ions does not increase appreciably on dilution and only mobility of ions increases due to decrease in interionic attractions. Therefore, L*m* increases a little as shown in figure by a straight line. For weak electrolytes, number of ions as well as mobility of ions increases on dilution which results in a very large increase in molar conductivity, especially at infinite dilution (*i.e.*, concentration, C $\rightarrow$ 0) as shown by curve in figure.

b. A strip of nickel metal is placed in a 1-molar solution of $Ni(NO_3)_2$ and a strip of silver metal is placed in a 1-molar solutions are connected by a salt bridge and the two strips are connected by wires to a voltmeter.

i. Write the balanced equation for the overall reaction occurring in the cell and calculate the cell potential.

***Answer:***

**At Anode:** $Ni \rightarrow Ni^{2+} + 2e^-$

**At Cathode:** $Ag^+ + e^- \rightarrow Ag] \times 2$

**Cell reaction:** $Ni + 2Ag^+ \rightarrow Ni^{2+} + 2Ag$

$$E^o_{cell} = E^o_{cathode} - E^o_{anode}$$

$$= E^o_{Ag^+/Ag} - E^o_{Ni^{2+}/Ni} = 0.80\ V - (-0.25\ V)$$

$$E^o_{cell} = 1.05\ V$$

ii. Calculate the cell potential, E, at $25^0C$ for the cell if the initial concentration of $Ni(NO_3)_2$ is 0.100 molar and the initial concentration of $AgNO_3$ is 1.00 molar. [$E^0_{\frac{Ni^{2+}}{Ni}}$ = -0.25 V; $E^0_{\frac{Ag^+}{Ag}}$ =0.80 $E^0_{\frac{Ni^{2+}}{Ni}}$ ; Log $10^{-1}$ = -1]

***Answer:***

$$E_{cell} = E^o_{cell} - \frac{0.059}{n} \log \frac{[Ni^{2+}]}{[Ag^+]^2}$$

Here, $n$ = 2, $E^o_{cell}$ 1.05 V, $[Ni^{2+}]$ = 0.1 M, $[Ag^+]$ = 1.0 M

$$\therefore \quad E^o_{cell} = 1.05V \frac{0\ 059}{2} \log \frac{(0.01)}{(1)^2}$$

$$E_{cell} = 1.05V - 0.0295 \log 10^{-1} = 1.05 + 0.0295\ V$$

$$E_{cell} = 1.0795\ V$$

***Question 29*** [5]

a. Complete and balance the following chemical equations:

i. $Cr_2O_7^{2-} + I^- + H^+ \rightarrow$

***Answer:***

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

$$2I^{-} \rightarrow I_2 + 2e^{-}]\times 3$$

$$Cr_2O_7^{2-} + 6I^{-} + 14H^{-} \rightarrow 2Cr3^{+} + 3I_2 + 7H_20$$

ii. $MnO_4^{-} + SO_3^{2-} + H^{+} \rightarrow$

***Answer:***

$$Mno_4^{-} + 8H^{+} + 5e^{-} \rightarrow Mn^{2+} + 4H_2O]\times 2$$

$$SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^{+} + 2e^{-}]\times 5$$

$$Mno_4^{-} + 5SO_3^{2-} + 6H^{+} \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$$

b. Explain the following observations:

i. Transition elements and their compounds are known to act as catalysts.

***Answer:***
The catalytic activity of transition metals and their compounds is attributed to the following reasons: Due to their tendency to show variable oxidation states transition metals form instable intermediate compounds and provide a new path for the reaction with lower activation energy. In Some cases, the transition metals provide a suitable large surface area with free valencies on which reactants are adsorbed.

ii. The higher oxidation states are usually exhibited by the members in the middle of a series of transition elements.

***Answer:***
This is due to presence of maximum number of unpaired electrons in a transition metal which is present in the middle of a series.

iii. The metal-metal bonding is more frequently found with the second and third series of transition elements.

***Answer:***
In the same group of d-block elements, the 4d and 5d transition elements are larger in size than those of 3d elements. Hence, the valence electrons are less tightly held and form metal–metal bond more frequently.

OR

a. Calculate the number of unpaired electrons in the following gaseous state ions: [2]
$Mn^{2+}, Cr^{3+}, V^{3+}$ and $Fe^{2+}$
Which one of these is the most stable in aqueous solution?
(At. nos. V = 23, Cr=24, Mn=25, Fe = 26)

***Answer:***

| **Ion** | **Electronic Configuration** | **Number of Unpaired electrons** |
|---|---|---|
| $Mn^{2+}$ [Ar] | $3d^5 4s^0$ | 5 |
| $Cr^{3+}$ [Ar] | $3d^3 4s^0$ | 3 |
| $V^{3+}$ [Ar] | $3d^2 4s^0$ | 2 |
| $Fe^{2+}$ [Ar] | $3d^6 4s^0$ | 4 |

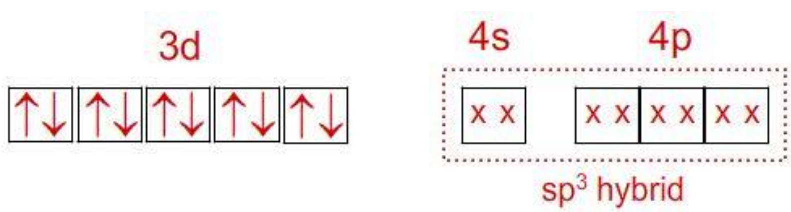
$Mn^{2+}$ ion is most stable in aqueous solution.

b. Explain the following: [3]

i. The transition metal ions are usually colored in aqueous solutions.

***Answer:***

$Ni(CO)_4$ : Tetracrabonyl nickel(o); Ni = $3d^8\ 4s^2$




X X = Electron pair from ligand CO

Structure = Tetrahedral; Magnetic behavior: Diamagnetic

ii. Cu (I) is not stable in an aqueous solution.

***Answer:***

$Cu^{2+}$ (aq) is much more stable than Cu(aq). This is because high negative enthalpy of hydration of $Cu^{2+(}$aq) easily compensates the high second ionisation enthalpy of copper. Due to his $Cu^{+}$(aq) undergo disproportionation as follows:

$$2Cu^{+}(aq) \rightarrow Cu^{2+}(aq) + Cu(s)$$

iii. The highest oxidation state of a transition metal is exhibited in its oxide or fluroride.

***Answer:***

This is due to high electronegativity oxygen and fluorine.

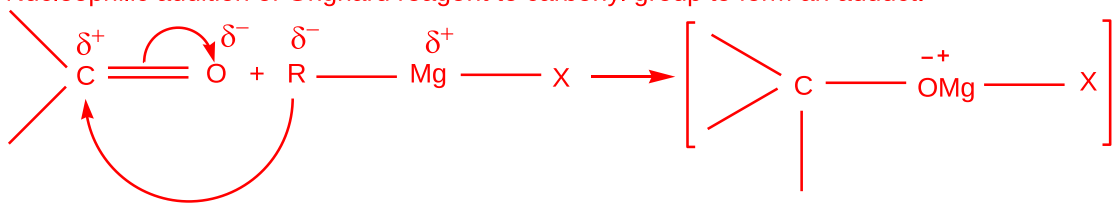
***Question 30***

a. Describe the mechanism of the addition of Grignard reagents to the carbonyl group of a compound to from an adduct which on hydrolysis yields an alcohol.: [2]

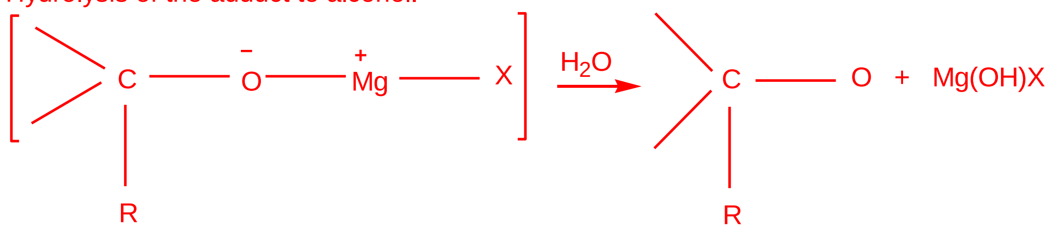
***Answer:***

**Mechanism:**

(i) Nucleophilic addition of Grignard reagent to carbonyl group to form an adduct.




(ii) Hydrolysis of the adduct to alcohol.



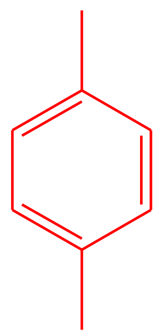

b. Draw the structures of the following compounds: [3]

i. 3-Methylbutanal

ii. Hexane-1, 6-dioic acid

iii. p-Nitropropiophenone

***Answer:***

| **Name of compound** | **Structure** |
|---|---|
| S–Methyl butanal | $CH_3 — CH — CH_2 — CHO$ (with $CH_3$ on CH) |
| Hexane–1, 6–dioic acid | $HOOC — CH_2 — CH_2 — CH_2 — CH_2 — COOH$ |
| P–Nitropropiophenone | $CO — CH_2 — CH_3$  $NO_2$ |

OR

a. illustrate the following reactions giving a suitable chemical equation for each: [2]

i. Cannizzaro's reaction

***Answer:***

**Cannizzaro reaction:** Aldehydes which do not have an–a hydrogen atom, undergo disproportionation reaction on treatment with concentrated alkali. In this reaction, one molecule of the aldehyde is reduced to alcohol while another is oxidised to salt of carboxylic acid.

$$2HCHO \xrightarrow{\text{conc.KOH}} \underset{\text{Methyl alcohol}}{CH_3OH} + \underset{\text{Potassium formate}}{HCO\overset{-}{O}\overset{+}{K}}$$

ii. Hell-Volhard-Zelinsky reaction

***Answer:***

**Hell-Volhard-Zelinsky reaction:** Carbosylic acids having an a-hydrogen are halogenated at the a-position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give a-halocarboxylic acids**.**

$$R-CH_2-COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } X_2/\text{Red P}} \underset{\alpha\text{-Halocarboxylic acid}}{R-\underset{X}{\underset{|}{CH}}-COOH} \ (X = Cl, Br)$$

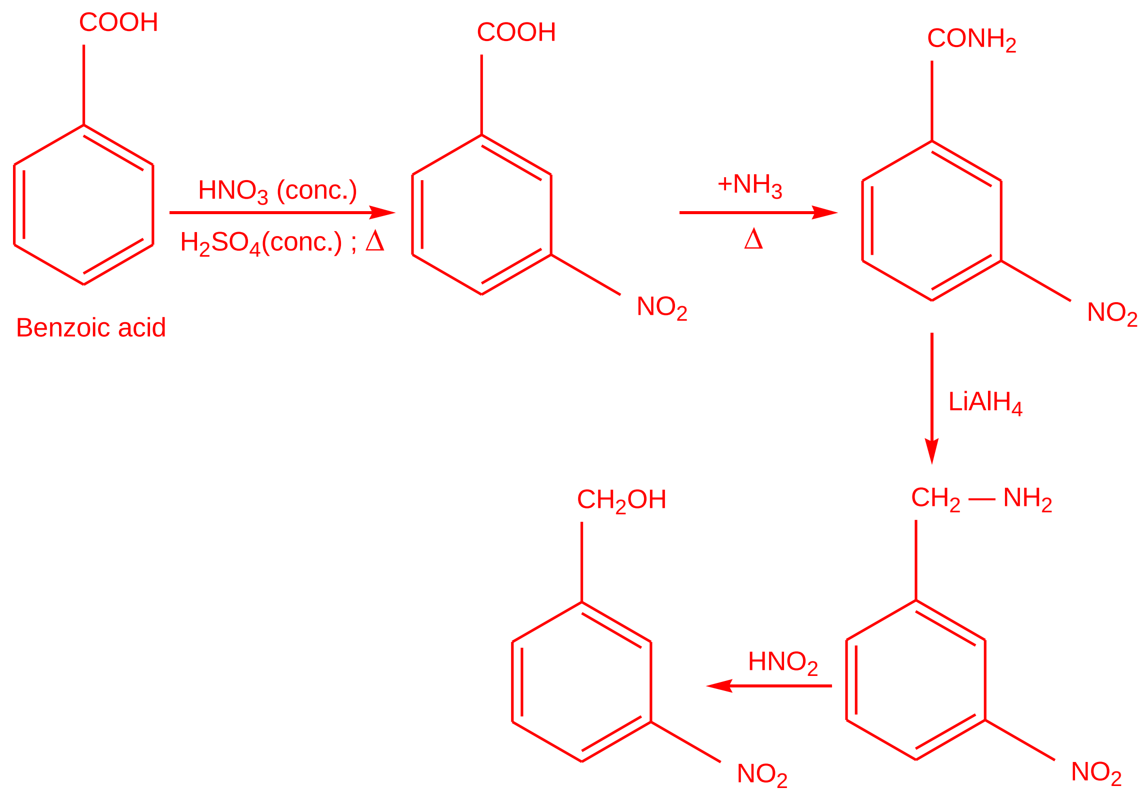
b. How would you bring about the following conversations? Write the complete equation in each case. : [3]

i. Ethanol to 3-hydroxybutanal
ii. Benzoic acid to m-nitrobenzyle alcohol
iii. Benzaldehyde to benzophenone.

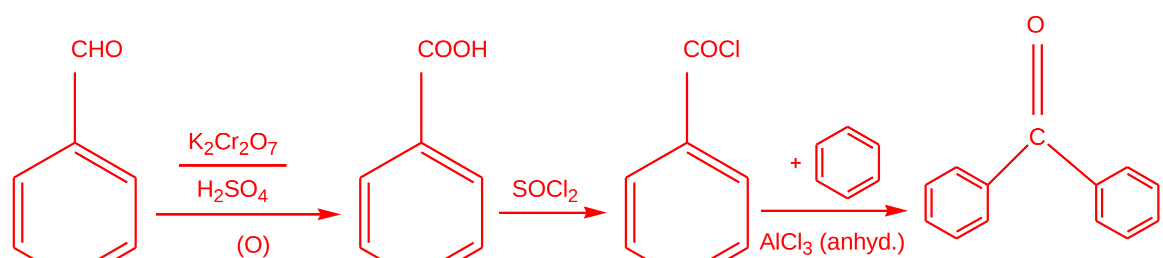
***Answer:***

i.

$$CH_3CHO \xrightarrow{\text{dil NaOH}} \underset{\text{3-Hydroxybutanol}}{CH_3-\overset{CH_3}{\overset{|}{CH}}-CH_2-CHO}$$




ii. p-Nitro benzyl alcohol




Benzophenone

iii. Benzaldehyde Benzoic acid