Solution

CHEMISTRY

Class 12 - Chemistry

Section A

1. Select and write the correct answer:

(i) **(a)** 5

Explanation: {

5

(ii) **(c)** HSO_4^-

Explanation: {

HSO_4^-

(iii) **(d)** $-\frac{1}{2} \times \frac{d[A]}{dt}$

Explanation: {

$-\frac{1}{2} \times \frac{d[A]}{dt}$

(iv) **(d)** Zn^{2+}

Explanation: {

Zn^{2+}

(v) **(b)** $[PtBr_2(NH_3)_4]\,Br_2$

Explanation: {

$[PtBr_2(NH_3)_4]\,Br_2$

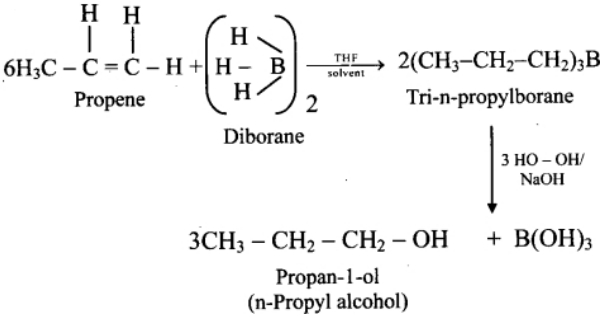
(vi) **(d)** n-butane

Explanation: {

$$CH_3 - \underset{\substack{Ethyl\\ bromide}}{CH_2} - Br \xrightarrow[\Delta]{\text{alc. KOH}} \underset{\substack{Ethene\\ (B)}}{CH_2 = CH_2} \xrightarrow{HBr} \underset{\substack{Ethyl\\ bromide\\ (C)}}{CH_3 - CH_2 - Br} \xrightarrow[Wurtz\ synthesis]{Na/ether} CH_3 - CH_2 - \underset{\substack{n-Butane\\ (D)}}{CH_2 - CH_3}$$

(vii) **(c)** propan-1-ol

Explanation: {



(viii) **(b)** Acetic anhydride

Explanation: {

Acetic anhydride

(ix) **(d)** zero waste technology

Explanation: {

zero waste technology

(x) **(d)** acetal

Explanation: {

acetal

2. Answer the following:

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(i) 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.

(ii) Hinsberg's reagent is: $C_6H_5SO_2Cl$

(iii) Chloroform when exposed to air and light forms a poisonous compound phosgene so it is stored in dark coloured air tight bottles.

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

(v) $[Pt(NH_3)_4Cl_2]\,Cl_2$

(vi) The net spontaneous flow of solvent molecules into the solution or from more dilute solution to more concentrated solution through a semipermeable membrane is called osmosis.

(vii) A property which depends on the amount of matter present in a system is called an **extensive property**.

(viii) A reference electrode is defined as an electrode whose potential is arbitrarily taken as zero or is exactly known.

Section B

3. i. **Lanthanoid contraction:**

As we move along the lanthanoid series, there is a decrease in atomic and ionic radii. This steady decrease in the atomic and ionic radii is called lanthanoid contraction.

ii. **Effects of lanthanoid contraction:**

Since the ionic size increases from La^{3+} to Lu^{3+} basicity of hydroxides decreases. La(OH)$_3$ is the strongest base while Lu(OH)$_3$ is the weakest base.

4. i. The boiling point of liquid is the temperature at which its' vapour pressure equals the applied pressure.

ii. The formula to determine molar mass of a solute using freezing point depression method is

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

5. **Advantages of nanoparticles and nanotechnology:**

i. Revolution in electronics and computing.

ii. Energy sector:

a. Nanotechnology will make solar power more economical.

b. Energy storage devices will become more efficient.

iii. Medical field:

a. Manufacturing of smart drugs, helps cure faster and without side effects.

b. Curing of life threatening diseases like cancer and diabetes.

(Any two advantages)

6. i. Ethanol reacts with thionyl chloride to form ethyl chloride.

$$\underset{\text{Thionyl chloride}}{CH_3CH_2OH} + SOCl_2 \xrightarrow{\Delta} \underset{\text{Ethyl chloride}}{CH_3CH_2Cl} + SO_2\uparrow + HCl\uparrow$$

ii. Ethanol reacts with mixture of red phosphorus and bromine to form ethyl bromide.

$$3CH_3CH_2OH + PBr_3 \xrightarrow{RedP+Br_2} \underset{\text{Ethyl bromide}}{3CH_3CH_2Br} + H_3PO_3$$

iii. Ethanol undergoes oxidation on reaction with acidified potassium dichromate to form acetic acid.

$$CH_3CH_2OH \xrightarrow{\text{Acidifice } K_2C_2O_7} CH_3CHO \xrightarrow{(0)} CH_3COOH$$

7. i. **Uses of CFCs:**

a. as refrigerants in fridge and air-conditioning, propellants in aerosol and solvents.

b. as blowing agents in making foams and packing materials.

ii. **Environmental effect of CFCs:**

CFCs are responsible for ozone depletion in stratosphere.

8. **Acid:** An acid is a substance that donates a proton $(H^+)$to another substance.

Base: A base is a substance that accepts a proton $(H^+)$from another substance.

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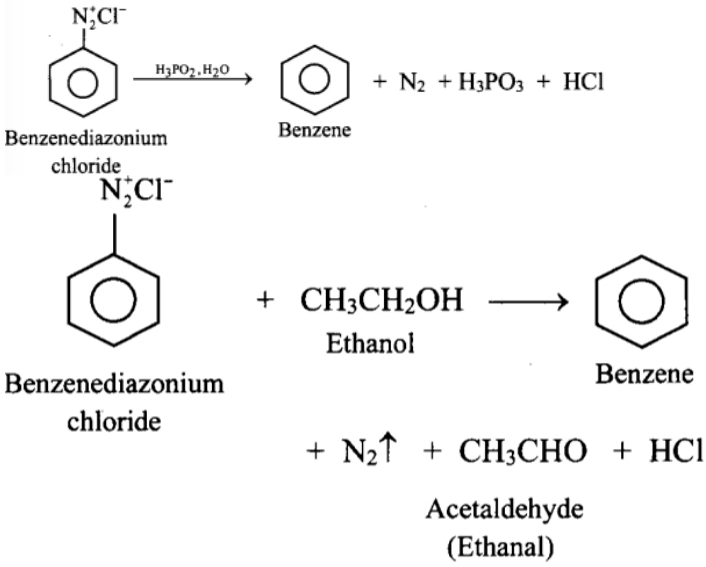
9. **Conversion of benzene diazonium chloride into benzene:**



10. $W = -P_{\text{ext}}\,\Delta V = -P_{\text{ext}}\,(V_2 - V_1)$

$W = -1.2bar\left(20dm^3 - 15dm^3\right)$

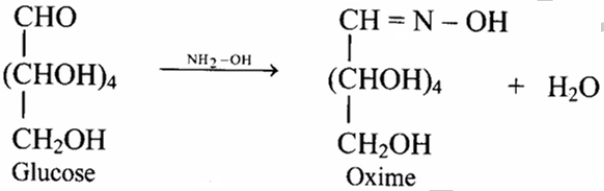
$= -1.2bar \times 5dm^3 = -6dm^3$ bar

Now, $1dm^3$ bar $= 100\ J$

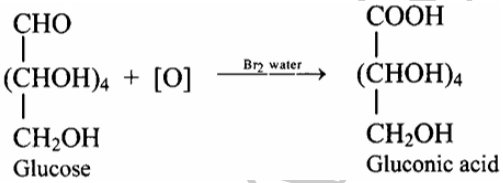
Hence, $W = -6dm^3$ bar $\times \frac{100\ J}{1dm^3\text{ bar}} = -600J$

The work done is **-600 J**.

11. i. Glucose forms oxime on reaction with hydroxylamine.



ii. Glucose forms gluconic acid on reaction with bromine water.



12. **Conditions of spontaneity:**

i. $\Delta G < 0$, the process is spontaneous.

ii. $\Delta G > 0$, the process is nonspontaneous.

iii. $\Delta G = 0$, the process is at equilibrium.

13. i. The polymers which have only one type of repeating unit are called homopolymers. e.g. Polythene, polypropene, Nylon 6, polyacrylonitrile, Nylon 6,6.

ii. Polymers which are formed from polyfunctional monomers with the elimination of some small molecules such as water, hydrochloric acid, methanol, ammonia are called condensation polymers.

14. **Interhalogen compounds:**

i. An interhalogen compound is a compound formed by combination of atoms of different halogens.

ii. Interhalogen compounds can be represented as XX'_n, where, X is the halogen having larger size and is more electropositive, X' is the halogen having smaller size with more electronegativity and n is the number of atoms of X' attached to X . e.g. ClF, BrF_3

Section C

15. i. The boiling point elevation is directly proportional to the molality of the solution. Thus,

$\Delta T_b = K_b m$ ...(1)

ii. Suppose we prepare a solution by dissolving $W_2\ g$ of solute in $W_1 g$ of solvent.

Moles of solute in $W_1\ g$ of solvent $= \frac{W_2}{M_2}$

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where, M_2 is the molar mass of solute.

Mass of solvent $= W_1\ g = \frac{W_1\ g}{1000\ g/kg} = \frac{W_1}{1000}\ kg$

iii. The molality is expressed as,

$m = \frac{\text{Moles of solute}}{\text{Mass of solvent in } kg}$

$m = \frac{W_2/M_2\ mol}{W_1/1000\ kg}$

$m = \frac{1000\ W_2}{M_2\ W_1}\ mol\ kg^{-1}$ ...(2)

iv. Substituting equation (2) in equation (1), we get,

$\Delta T_b = \frac{1000\ K_b W_2}{M_2\ W_1}$

Hence, $M_2 = \frac{1000\ K_b W_2}{\Delta\ T_b W_1}$

16. i. A face-centred cubic (fcc) unit cell has particles (atoms) at the eight corners plus particles (atoms) at the centre of its six faces.

ii. Each particle present at the corner of a given unit cell is shared with seven other neighbouring unit cells. As a result, its contribution to the given unit cell is only $\frac{1}{8}$.

Thus, the number of atoms present at corners per unit cell $= 8$ corner atoms $\times \frac{1}{8}$ atom per unit cell $= 1$

iii. Each particle at the centre of the six faces is shared with one neighbouring cube. Thus, $\frac{1}{2}$ of each face particle belongs to the given unit cell.

Thus, the number of atoms present at faces per unit cell = 6 atoms at the faces $\times \frac{1}{2}$ atom per unit cell = 3

Therefore, the total number of atoms per unit cell $= 1 + 3 = 4$

Thus, fcc unit cell has total of 4 atoms per unit cell.

17. **Given:** Mass of copper deposited $(W) = 2.4\ g$, Current $(I) = 2.03\ A$

Molar mass of copper $= 63.5\ g\ mol^{-1}$

To find: Time (t)

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:

i. Stoichiometry:

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

Using formula (i), Mole ratio $= \frac{1\ mol}{2\ mole}$

ii. Using formula (ii),

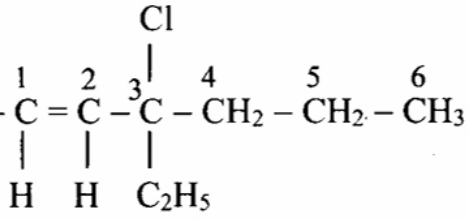
$W = \frac{I(A) \times t(s)}{96500(C/mole^-)} \times$ mole ratio $\times$ molar mass of Cu

$2.4g = \frac{2.03\ A \times t}{96500(C/\text{mol}\ e^-)} \times \frac{1\ mol}{2\ mole^-} \times 63.5\ g\ mol^{-1}$

$t = \frac{2.4 \times 96500(C = As) \times 2}{2.03A \times 63.5} = 3593\ s$

Time taken to produce 2.4 g of copper (Cu) at cathode is $3593s$.

18. i.



3-Chloro-3-ethylhex-1-ene

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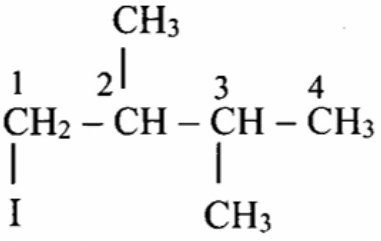
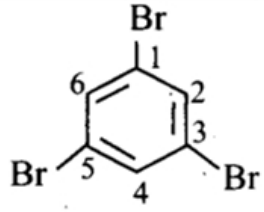
ii.



1-Iodo-2,3-dimethylbutane

iii.



1,3,5-Tribromobenzene

19. Given: $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)};\ K_p = 130,\ T = 510\ K, R = 8.314\ J\ K^{-1}\ mol^{-1}$

To find: ΔG° for reaction, $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$

Formula: $\Delta G^\circ = -2.303RT \log_{10}\ K_p$

Calculation: $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}; K_p = 130$

$\therefore 2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}; K_p = \frac{1}{130}$

$\Delta G^o = -2.303RTlog_{10}\ K_p$

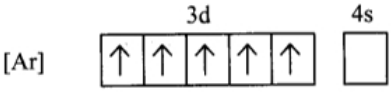
$= -2.303 \times 8.314 \times 510 \times \log_{10}\left(\frac{1}{130}\right)$

$= 20642.7\ J\ mol^{-1}$

$= 20.64\ kJ\ mol^{-1}$

ΔG° for reaction is $20.64 kJ\ mol^{-1}$.

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. **Lewis acid-base theory:**

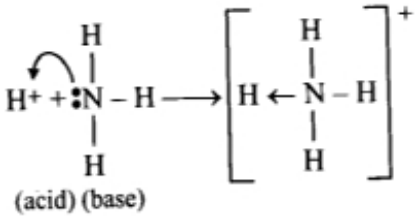
A more generalized acid-base concept was put forward by G.N. Lewis in 1923.

According to this theory, acids and bases are defined as follows:

Acid: Any species that accepts a share in an electron pair is called Lewis acid.

Base: Any species that donates a share in an electron pair is called Lewis base.

e.g.



In this example, NH_3 donates the electron pair which is accepted by H^+. Hence, NH_3 acts as a Lewis base and H^+ acts as a Lewis acid.

22. $[CoF_6]^{3-}$ **complex:**

Oxidation state of central metal Co is +3.

Valence shell electronic configuration of Co^{3+} is represented:

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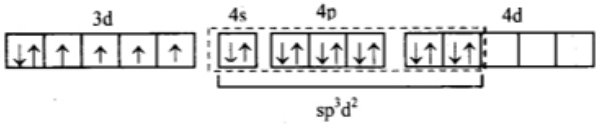
Complex is high spin that means pairing of electrons will not take place prior to hybridisation.

Configuration after complex formation:



i. **Hybridisation:** The hybridisation involved is $sp^3\ d^2$.

ii. **Magnetic properties:** The complex ion has four unpaired electrons and hence, it is paramagnetic.

iii. **Inner/Outer complex:** The d orbitals participating in hybridisation for this complex are nd. Therefore, it is an outer orbital complex.

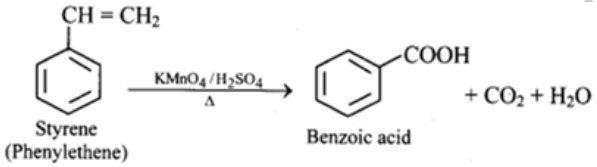
iv. **Geometry:** The complex is octahedral.

23.

	Order	**Molecularity**
i.	It is experimentally determined property.	It is theoretical entity.
ii.	It is the sum of powers of the concentration terms of reactants those appear in the rate equation.	It is the number of reactant molecules taking part in an elementary reaction.
iii.	It may be an integer, fraction or zero.	It is an integer.
iv.	It is not based on balanced chemical equation.	It is based on balanced chemical equation.

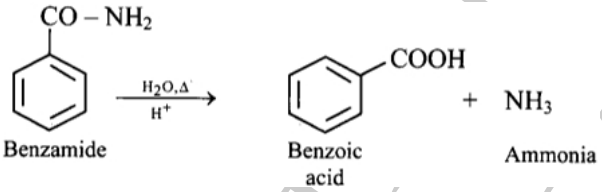
24. i. **Preparation of benzoic acid from styrene:**

Styrene on oxidation by $KMnO_4$ in dilute $H2SO_4$ gives benzoic acid.



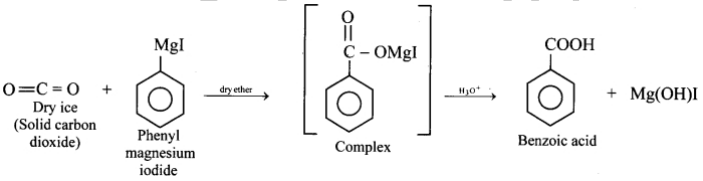
ii. **Preparation of benzoic acid from benzamide:**

Benzamide on hydrolysis in dilute acidic medium gives benzoic acid.



iii. **Preparation of benzoic acid from dry ice:**

When the solution of phenyl magnesium iodide in dry ether is added to dry ice (solid CO_2), it gives a complex (magnesium salt of carboxylic acid), which on acid hydrolysis gives benzoic acid.



25. i. **Atomic radii:** The atomic radii increase down the group, as a result of increase in the number of quantum shells.

ii. **Ionisation enthalpy:** The ionisation enthalpy decreases down the group due to increase in the atomic size. Group 16 elements have less ionization energy than corresponding group 15 elements.

iii. **Electronegativity:** The electronegativity decreases down the group. Oxygen has the highest electronegativity next to fluorine amongst all the elements.

iv. **Electron gain enthalpy:** The electron gain enthalpy becomes less negative down the group.

26. Answer the following:

(i) i. **IUPAC name:** 3-Methylcyclohexanone

ii. **IUPAC name:** Butane-2,3-dione

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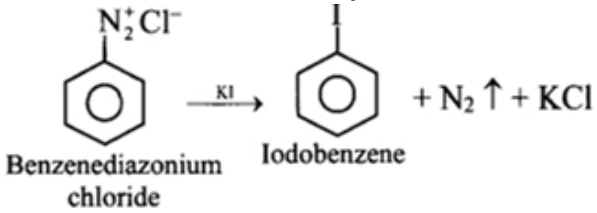
(ii) Benzene diazonium halide into aryl iodide:



Section D

27. Answer the following:

(i) Integrated rate law equation for zero order reaction:

For zero order reaction, $A \longrightarrow P$

the differential rate law is given by

rate $= -\frac{d[A]}{[A]} = k[A]^0 = k$ ...(1)

Rearrangement of Eq. (1) gives

$d[A] = -kdt \ \left(\because [A]^0 = 1\right)$

Integration between the limits

$[A] = [A]_0$ at $t = 0$ and $[A] = [A]_t$ at $t = t$ gives

$\int_{[A]_0}^{[A]_t} d[\ A] = -k\int_0^t dt$

or $[A]_t - [A]_0 = -kt$

Hence, $kt = [A]_0 - [A]_t$ ...(2)

(ii) **Zone of reduction (22 - 25 m near the top):**

Fe_2O_3 is reduced to spongy iron by CO.

$Fe_2O_3 + 3CO \xrightarrow{900\ K} 2Fe + 3CO_2$

Some amount of Fe_2O_3 is reduced to iron by carbon.

$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

(iii) The nanomaterial is a material having structural components with at least one dimension in the nanometer scale, that is, 1-100 nm.

28. Answer the following:

(i) When the gas expands in vacuum, there is no opposing force, that is, $P_{ext} = 0$.

The work done by a system during such expansion is $W = -P_{\text{ext}}\,\Delta V = 0$.

(ii) The chemical composition of Zieglar-Natta catalyst is triethyl aluminium with titanium tetrachloride or $[(C_2H_5)_3Al + TiCl_4]$.

(iii) A very large number of chemical reactions take place in our bodies. These are brought about at the physiological pH of 7.4 and the body temperature of $37^\circ C$ with the help of biological catalysts called enzymes. Chemically, enzymes are proteins.

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) i. Acetic acid on reaction with thionyl chloride or phosphorus trichloride gives acetyl chloride.

$$\underset{\text{Acetic acid}}{3CH_3COOH} + \underset{\substack{\text{Phosphorous}\\ \text{trichloride}}}{PCl_3} \xrightarrow{\Delta} \underset{\text{Acetyl chloride}}{3CH_3COCl} + H_3PO_3$$

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OR

$$\underset{\text{Acetic acid}}{CH_3COOH} + \underset{\text{Thionyl chloride}}{SOCl_2} \xrightarrow{\Delta} \underset{\text{Acetyl chloride}}{CH_3COCl} + HCl\uparrow + SO_2\uparrow$$

ii. Methyl cyanide on acid hydrolysis gives acetic acid.

$$\underset{\text{Methyl cycanide}}{\mathrm{CH_3-C\equiv N}} + 2\mathrm{H_2O} + \text{ dil. HCl} \xrightarrow{\Delta} \underset{\text{Acetic acid}}{\mathrm{CH_3-COOH}} + \mathrm{NH_4Cl}$$

30. Answer the following:

(i) i. $K_4\left[Fe(CN)_6\right]$

Oxidation state of Fe is +2 and ligands donate 12 electrons.

$Z = 26, X = 2, Y = 12$

EAN of $Fe^{2+} = Z - X + Y$

$= 26 - 2 + 12 = 36$

ii. $Cr(CO)_6$

Oxidation state of Cr is 0 and ligands donate 12 electrons.

$Z = 24, X = 0, Y = 12$

EAN of $Cr = Z - X + Y$

$= 24 - 0 + 12 = 36$

(ii) The strength of reducing agents increases as E° values decrease.

Hence, the reducing agents in the order of increasing strength are as follows:

$Cl^-_{(aq)}(1.36\ V) < Cu_{(s)}(0.34\ V) < Ni_{(s)}\ (-0.26\ V) < Al_{(s)}(-1.66\ V)$

(iii) Selenium reacts with magnesium metal to form magnesium selenide.

$$\underset{\text{Magnesium}}{\mathrm{Mg}} + \underset{\text{Selenium}}{\mathrm{Se}} \rightarrow \underset{\text{Magnesium selenide}}{\mathrm{MgSe}}$$

31. Answer the following:

(i) Action of hot HI on methyl isopropyl methyl ether:

$$\underset{\text{Isopropylmethylether}}{(CH_3)_2 - CH - O - CH_3} + 2HI \xrightarrow[\text{(conc)}]{\text{Hot } 373\ K} \underset{\text{Isopropyl iodide}}{(CH_3)_2 - CH - I} + \underset{\text{Methyl iodide}}{CH_3 - I} + H_2O$$

(ii) i. **Atomic radii:** The atomic radii and ionic radii increase down the group, as a result of increase in the number of quantum shells.

ii. **Ionisation enthalpy:** The ionisation enthalpy decreases down the group due to increase in the atomic size. Group 16 elements have less ionization energy than corresponding group 15 elements.

iii. **Electronegativity:** The electronegativity decreases down the group. Oxygen has the highest electronegativity next to fluorine amongst all the elements.

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