Solution

CHEMISTRY

Class 12 - Chemistry

Section A

1. Select and write the correct answer:

(i) **(d)** boron

Explanation: {

boron

(ii) **(d)** $1.585 \times 10^{-3}\ mol\ dm^{-3}$

Explanation: {

$pOH = 14 - pH = 14 - 11.2 = 2.8$

$pOH = -\log_{10}\left[OH^{-}\right]$

$\therefore \log_{10}[OH] = -pOH = -2.8$

$= -2 - 0.8 - 1 + 1 = -3 + 0.2 = \bar{3}.2$

$\left[OH^{-}\right] = \text{Antilog}_{10}\,\bar{3}.2 = 1.585 \times 10^{-3}\ mol\ dm^{-3}$

(iii) **(b)** $k = -\frac{1}{t}\ln\frac{[A]_t}{[A]_0}$

Explanation: {

$k = -\frac{1}{t}\ln\frac{[A]_t}{[A]_0}$

(iv) **(a)** 5.916 BM

Explanation: {

Mn^{2+} ion $= [Ar]3\ d^5$

$\mu = \sqrt{n(n+2)}BM = \sqrt{5(5+2)} = 5.916BM$

(v) **(c)** 6

Explanation: {

6

(vi) **(b)** secondary butyl chloride

Explanation: {

HCl always adds across the double bond of an alkene according to Markownikoff's rule even in presence of peroxide.

$$\underset{\text{But-1-ene}}{CH_3 - CH_2 - CH = CH_2} + HCl \xrightarrow{\text{Peroxide}} \underset{\substack{2-Chlorobu\tan e \\ (sec-Butyl\ chloride) \\ (major\ product)}}{CH_3 - CH_2 - \underset{\displaystyle Cl}{\underset{|}{CH}} - CH_3}$$

(vii) **(c)** Glycerol

Explanation: {

$$\underset{\displaystyle OH}{\underset{|}{CH_2}} - \underset{\displaystyle OH}{\underset{|}{CH}} - \underset{\displaystyle OH}{\underset{|}{CH_2}}$$

Glycerol or Glycerine (Propane-1,2,3-triol)

(viii) **(c)** Uracil

Explanation: {

Uracil

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

Explanation: {

zero waste technology

(x) **(a)** Ketone

Explanation: {

Ketone

2. Answer the following:

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(i) Silver nanoparticles are used to remove E.coli bacteria from water.

(ii) **Ethanamine from methyl cyanide:**

Methyl cyanide on Mendius reduction gives ethanamine.

$$\underset{\text{Methyl cyanide}}{CH_3 - C \equiv N} + 4[H] \xrightarrow{\text{Na/Ethanol}} \underset{\text{Ethanamine}}{CH_3 - CH_2 - NH_2}$$

(iii) An equimolar mixture of enantiomers (dextrorotatory and laevorotatory) is called racemic modification or racemic mixture.

(iv) The radioactive element of group 16 is polonium.

(v) The name of a hexadentate ligand is ethylenediaminetetraacetate ion (or EDTA).

(vi) Semipermeable membrane is a film such as cellophane which has pores large enough to allow the solvent molecules to pass through them.

(vii) The sign convention of work done during expansion of gas is **negative** i.e., - **W**.

(viii) Net cell reaction during discharge:

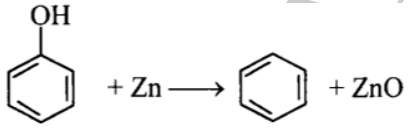
$$Pb_{(s)} + PbO_{2(s)} + 4H^+_{(aq)} + 2SO^{2-}_{4(aq)} \longrightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$$

OR

$$Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)} \longrightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$$

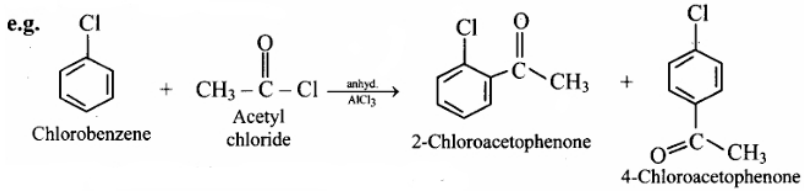
Section B

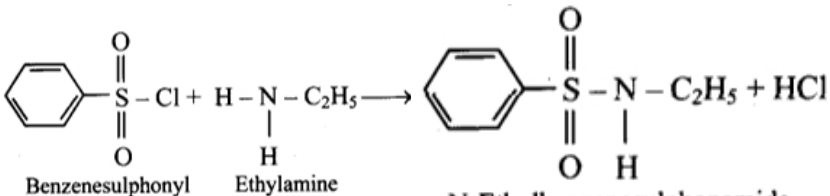
3. The various steps involved in the extraction of pure metals from their ores are as follows:
   i. Concentration of ores
   ii. Conversion of ores into oxides or other desired compounds
   iii. Reduction of ores to form crude metals
   iv. Refining of metals
4. i. **van't Hoff factor** (i) is defined as the ratio of colligative property of a solution of electrolyte divided by the colligative property of nonelectrolyte solution of the same concentration.
   ii. The van't Hoff factor is related to degree of ionization as follows:
   $i = 1 + \alpha(n-1)$
   or $\alpha = \frac{i-1}{n-1}$
   where, $\alpha =$ Degree of ionization/dissociation
   $i =$ van't Hoff factor
   $n =$ Moles of ions obtained from ionization of 1 mole of electrolyte.
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. When phenol is treated with zinc dust, it gets reduced to zinc dust.



Phenol Benzene

7. **Friedel-Craft's acylation:** It is carried out by treating haloarene with acyl chloride in presence of anhydrous $AlCl_3$ as a catalyst.



8. **Limitations of Arrhenius theory:**
   i. Arrhenius theory accounts for properties of different acids and bases but is applicable only to aqueous solutions.
   ii. It does not account for the basicity of compounds such as NH_3 and Na_2CO_3 which do not have OH group.
9. 

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10. Given: $\Delta H^\circ = -224\ kJ$

$\Delta S^\circ = -153\ J\ K^{-1} = -0.153\ kJ\ K^{-1}$

To find: Temperature (T) at which the change over from spontaneous to nonspontaneous will occur.

Formula: $T = \frac{\Delta H^\circ}{\Delta S^\circ}$

Calculation: $T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{-224\ kJ}{-0.153\ kJ\ K^{-1}} = +1464\ K$

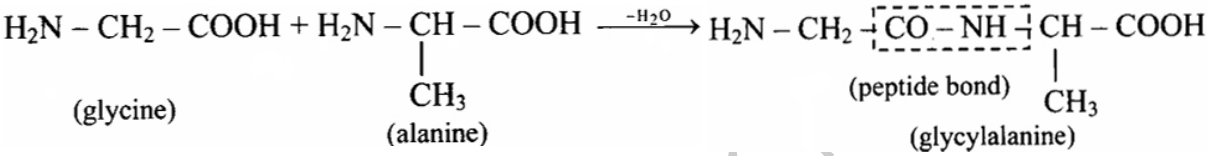
Since ΔH° and ΔS° are both negative, the reaction is spontaneous at low temperatures. A change over will occur at **1464 K**.

The reaction is spontaneous **below 1464 K**.

Temperature (T) at which the change over from spontaneous to nonspontaneous will occur is **1464 K.**

11. i. α-Amino acids are carboxylic acids having an amino $(-NH_2)$ group bonded to the α-carbon, that is, the carbon next to the carboxyl $(-COOH)$ group.

ii. The reaction showing the formation of peptide bond is as follows:



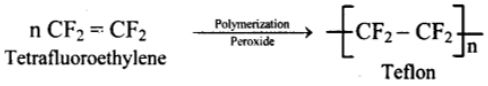
12. **Conditions of spontaneity:**

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

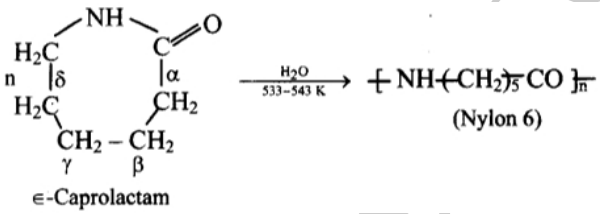
ii. $\Delta G > 0$, the process is nonspontaneous.

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

13. i.



ii.



14. i. **Atomicity:** Oxygen is a diatomic molecule (O_2) while others are polyatomic molecules such as $P_4,\ S_8$.

ii. **Magnetic property:** Oxygen is paramagnetic while others are diamagnetic.

iii. **Oxidation state:** Oxygen shows -2, -1, and +2 oxidation states while other elements show -2, +2, +4, +6 oxidation states. Oxygen cannot exhibit higher oxidation state due to absence of vacant d orbitals.

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. **Metal deficiency defect:**

i. This defect is possible only in compounds of metals that show variable oxidation states.

ii. In some crystals, positive metal ions are missing from their original lattice sites. The extra negative charge is balanced by the presence of cation of the same metal with higher oxidation state than that of missing cation.
e.g. In the compound NiO, one Ni^{2+} ion is missing creating a vacancy at its lattice site. The deficiency of two positive charges is made up by the presence of two Ni^{3+} ions at the other lattice sites of Ni^{2+} ions. The composition of NiO then

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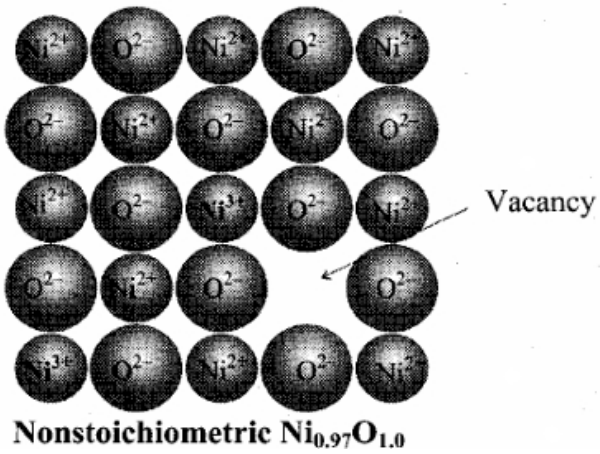
becomes $Ni_{0.97}O_{1.0}$.



Nonstoichiometric $Ni_{0.97}O_{1.0}$

17. i. 20 g of calcium (atomic mass $= 40\ g\ mol^{-1}$) corresponds to $\frac{20}{40} = 0.5$ mole of Ca

The half reaction for reduction is

$Ca^{2+}_{(aq)} + 2e^- \longrightarrow Ca_{(s)}$

$\therefore 0.5$ mole of Ca is produced by passage of $0.5 \times 2 = 1$ mole electrons.

Charge on 1 mole electrons is 1 Faraday.

Thus, 1 Faraday of electricity will be required to produce 20 g of Ca from molten $CaCl_2$.

ii. 40 g of Al (atomic mass $= 27\ g\ mol^{-1}$) corresponds to $\frac{40}{27} = 1.48$ mole of Al

The half reaction for reduction is

$Al^{3+}_{(aq)} + 3e^- \longrightarrow Al_{(s)}$

1 mole of Al is produced by passage of 3 mole electrons.

$\therefore 1.48$ mole of Al is produced by passage of $1.48 \times 3 = 4.44$ mole electrons.

Charge on 4.44 mole electrons is 4.44 Faraday.

Thus, 4.44 Faraday of electricity will be required to produce 40 g of Al from molten Al_2O_3.

i. 1 Faraday of electricity will be required to produce 20 g of Ca from molten $CaCl_2$.

ii. 4.44 Faraday of electricity will be required to produce 40 g of Al from molten Al_2O_3.

18. i. **Conversion of propene into 1-bromopropane:** Propene on reaction with hydrogen bromide in the presence of peroxide follows anti-Markovnikov's rule and forms 1-bromopropane as a major product.

$$\underset{\text{Propene}}{CH_3 - CH = CH_2} + HBr \xrightarrow{\text{peroxide}} \underset{\substack{\text{n-Propyl bromide}\\ \text{(1-Bromopropane)}\\ \text{(Major product)}}}{CH_3 - CH_2 - CH_2Br}$$

ii. **Conversion of propene into 2-bromopropane:** Addition of hydrogen bromide to propene gives 2-bromopropane as a major product according to Markovnikov's rule.

$$\underset{Propene}{CH_3 - CH = CH_2} + HBr \xrightarrow{Markownikoff's\ rule} \underset{\substack{Isopropyl\ bromide\\ (2-Bromopropane)\\ (Major\ product)}}{CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_3}$$

19. Given: $\Delta H^\circ = +57.24\ kJ, \Delta\ S^\circ\ = 175.8\ J\ K^{-1} = 0.1758\ kJ\ K^{-1}$

To find: Temperature (T) at which reaction become spontaneous

Formula: $T = \frac{\Delta H^\circ}{\Delta S^\circ}$

Calculation: $T = \frac{\Delta H^\circ}{\Delta S^\circ}$

$= \frac{57.24\ kJ}{0.1758\ kJ\ K}$

$= 325.6\ K$ (Using log table)

Since ΔH° and ΔS° are both positive, the reaction is spontaneous at high temperatures. A change over will occur at 325.6 K.

The reaction is spontaneous **above 325.6 K**

The reaction will become spontaneous **above 325.6 K.**

20. **Preparation of potassium dichromate:**

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i. In the industrial production, finely powdered chromite ore $(FeOCr_2O_3)$ is heated with anhydrous sodium carbonate (Na_2CO_3) and a flux of lime in air in a reverberatory furnace.

$4\,(FeO.Cr_2O_3) + 8Na_2CO_3 + 7O_2 \xrightarrow{\Delta} 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2.$

ii. Sodium chromate (Na_2CrO_4) formed in this reaction is then extracted with water and treated with concentrated sulphuric acid to get sodium dichromate and hydrated sodium sulphate:

$2Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_2O_7 + Na_2SO_4 \cdot H_2O$

iii. Addition of potassium chloride to concentrated solution of sodium dichromate precipitates less soluble orange-red coloured potassium dichromate, $K_2Cr_2O_7$.

$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$

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. **Cationic complex:** A positively charged coordination sphere or a coordination compound having a positively charged coordination sphere is called cationic complex or cationic sphere complex.
e.g. $[Zn(NH_3)_4]^{2+}$

ii. **Anionic complex:** A negatively charged coordination sphere or a coordination compound having negatively charged coordination sphere is called anionic complex or anionic sphere complex.
e.g. $[Fe(CN)_6]^{3-}$

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. There are four isomeric aldehydes having molecular formula $C_5H_{10}O$.

i. $CH_3 - CH_2 - CH_2 - CH_2 - CHO$

Pentanal
(n-valeraldehyde)

ii. $CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CHO$

2-Methylbutanal
(α-methyl butyraldehyde)

iii. $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CHO$

3-Methylbutanal
(β-methylbutyraldehyde)

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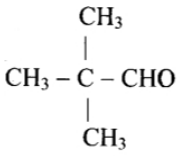
iv.


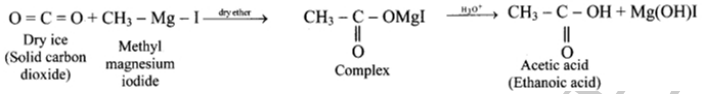
2,2-Dimethylpropanal
(α,α′-dimethylpropionaldehyde)

25. Some of the properties in which fluorine differs from rest of group 17 elements are listed below:
    i. Ionisation enthalpy, electronegativity, electrode potential all are higher for fluorine than expected trends shown by other halogens.
    ii. Ionic radii, covalent radii, and negative electron gain enthalpy are quite lower than expected.
    iii. Most of the reactions of fluorine are exothermic due to the short and strong bond formed by it with other elements.
    iv. It forms only one oxoacid (HOF) while other halogens form a number of oxoacids.
    v. Hydrogen fluoride is a liquid (b.p. 293 K) due to strong hydrogen bonding while other hydrogen halides are gases.
    vi. Fluorine exhibits -1 oxidation state only. However, Cl, Br and I exhibit $+1, +3, +5$ and +7 oxidation states as well.

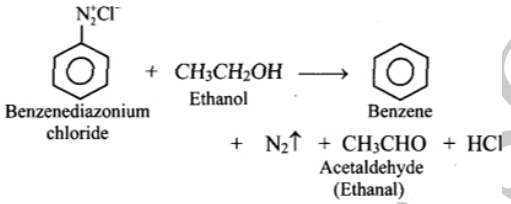
26. Answer the following:

(i) **Preparation of ethanoic acid from dry ice:**

When solution of methyl magnesium iodide (Grignard reagent) in dry ether is added to solid carbon dioxide (dry ice), it gives a complex, which on acid hydrolysis gives ethanoic acid or acetic acid.



(ii) **Action of benzene diazonium chloride on ethanol:**



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),

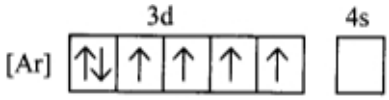
$\log_{10} k_2 - \log_{10} k_1 = -\frac{E_a}{2.303R}\frac{1}{T_2} + \frac{E_a}{2.303R}\frac{1}{T_1}$

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) For element with atomic number 26, the condensed electronic configuration for its divalent cation $\left(Fe^{2+}{}_{(aq)}\right)$ will be



There are 4 unpaired electrons, so $n = 4$.

$\therefore \mu = \sqrt{4(4+2)} = 4.90BM$

Therefore, spin only magnetic moment of the $Fe^{2+}{}_{(aq)}$ ion is 4.90 BM.

(iii) Carbon black is a nanostructured material that is used in car tyres to increase the life of tyres.

28. Answer the following:

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(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:

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

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

(ii) The process by which a network of cross links is introduced into an elastomer is called vulcanization.

(iii) Insulin controls blood sugar level.

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, $n = 4$.

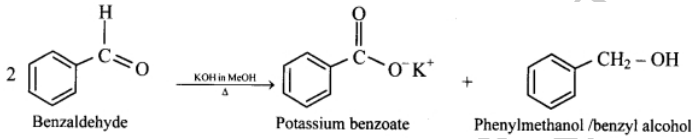
From formula,

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

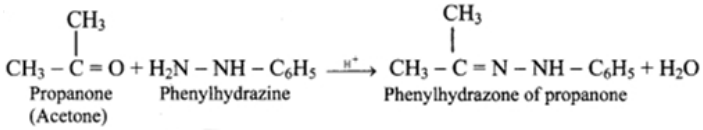
$$\therefore a^3 = \frac{63.5\ g\ mol^{-1} \times 4}{8.966\ g\ cm^{-3} \times 6.022 \times 10^{23}\ \text{atom}\ mol^{-1}} = 4.704 \times 10^{-23}\ cm^3$$

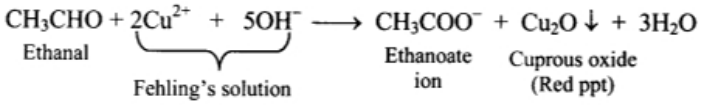
The volume of the unit cell is $4.704 \times 10^{-23}\ cm^3$.

(ii) i. Two molecules of benzaldehyde react in the presence of $50\% KOH$, the products formed are benzyl alcohol and potassium benzoate. The reaction is called Cannizzaro reaction.



ii. Propanone on reaction with phenyl hydrazine produces phenylhydrazone of propanone.





30. Answer the following:

(i) In coordination compound, the species surrounding the central metal atom or ion are called ligands. The ligands serve as electron donors.

e.g. In cisplatin, $Pt(NH_3)_2Cl_2$, two ammonia molecules and two chloride ions are ligands.

(ii) The SI unit of molar conductivity is Sm^2mol^{-1}.

(iii) Cryolite is Na_3AlF_6.

31. Answer the following:

(i) i. **Ethers** are compounds which contain an oxygen atom bonded to two alkyl groups or two aryl groups or one alkyl and one aryl group. Ethers are organic oxides and are considered as anhydrides of alcohols. Ethers are represented as $R - O - R'$ or $Ar - O - Ar'$ or $R - O - Ar$

ii. Ethers are classified based on whether the two alkyl/ aryl groups bonded to oxygen atom are same or different.

a. **Symmetrical ethers (simple ethers):** If the two alkyl groups or aryl groups attached to oxygen atom are same. ($R - O - R$ or $Ar - O - Ar$) e.g. $CH_3 - O - CH_3$ $C_6H_5 - O - C_6H_5$

b. **Unsymmetrical (mixed ethers):** If the two alkyl groups or aryl groups attached to oxygen atom are different. ($R - O - R'$ or $Ar - O - Ar'$) e.g. $CH_3 - O - C_2H_5$ $C_6H_5 - O - C_5H_5$

(ii) Oxygen is prepared by thermal decomposition of PbO_2 :

$$\underset{\text{Lead dioxide}}{2PbO_{2(s)}} \xrightarrow{\Delta} 2PbO_{(s)} + \underset{\text{Dioxygen}}{O_{2(g)}}$$

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