Q. No. 2 (i)

Q. No. 2 (ii)

REASONS

i) **BeO is amphoteric**

BeO is amphoteric as it **reacts with** both **acids** (to form salts) and bases (to form beryllates).

$$BeO + 2HCl \longrightarrow BeCl_2 + H_2O$$

$$BeO + 2NaOH \longrightarrow Na_2BeO_2 + H_2O$$

ii) **BeO covalent, high melting point:**

Due to **small size of Be^{2+}**, BeO is covalent. Although it is covalent it has high melting point and harder than oxides of other group II elements as **it is polymeric.** Each Be atom is bonded to four O-atoms.

Q. No. 2 (iii) (a) $PbCl_2$ more stable

Reason: ~~According to Fajan's rule:~~ The stability of +2 oxidation ~~The smaller~~ state relative to +4 ~~de~~ increases as we move down from Ge to Pb, so for Pb +2 oxidation state is more stable than +4, that is why $PbCl_4$ is thermally unstable and $PbCl_2$ is stable. At room temperature

$$PbCl_4 \longrightarrow PbCl_2 + Cl_2$$

(b) CCl_4 no hydrolysis

Reason: As carbon belongs to 2nd period of periodic table so it does not have any d-orbital to accomodate the lone pair of electron shared by donor oxygen of water to form unstable intermediate compound. That is why CCl_4 doesn't undergo hydrolysis.

Q. No. 2 (iv) OXIDATION OF $[Cr(H_2O)_6]^{3+}$

When few drops of sodium hydroxide added:

$$\underset{\text{Hexaaquachromium(III) ion}}{[Cr(H_2O)_6]^{3+}} + 3OH^- \longrightarrow \underset{\text{Triaquatrihydroxochromium(III)}}{[Cr(H_2O)_3(OH)_3]} + 3H_2O$$

When excess of sodium hydroxide added:

$$[Cr(H_2O)_3(OH)_3] + 3OH^- \longrightarrow \underset{\text{Hexahydroxochromate(III) ion}}{[Cr(OH)_6]^{3-}} + 3H_2O$$

Oxidation with warm hydrogen peroxide:

$$2[Cr(OH)_6]^{3-} + 3H_2O_2 \longrightarrow \underset{\text{Yellow sol}}{2CrO_4^{2-}} + 2OH^- + 8H_2O$$

Q. No. 2 (v) **Fe^{+2} as catalyst**

General Reaction:

$$S_2O_8^{2-} + 2I^- \xrightarrow{Fe^{2+}} 2SO_4^{2-} + I_2$$

Mechanism:

$$S_2O_8^{2-} + Fe^{2+} \longrightarrow 2SO_4^{2-} + Fe^{3+}$$

$$Fe^{3+} + 2I^- \longrightarrow Fe^{2+} + I_2$$

Fe^{2+} acts as a catalyst as it is regenerated in the end. This is an example of transitional metal acting as catalyst due to variable oxidation states.

Q. No. 2 (vi) **FUNCTIONAL GROUP**

Definition:

"An atom or group of atoms in molecule that gives characteristic properties to the molecule."

Importance:

→ Functional groups serve as **basis of nomenclature** (naming) of organic compounds.

→ They serve **to classify** organic compounds into different classes. Compounds with same functional group belong to same class.

→ Functional groups are **site of chemical reactivity** in a molecule.

Q. No. 2 (vii)

Q. No. 2 (viii)

REACTIONS WITH 1-BUTENE

a) Br_2 / CCl_4

$$H_2C = CH - CH_2 - CH_3 + Br_2 \xrightarrow{CCl_4} H_2C(Br) - CH(Br) - CH_2CH_3$$

1, 2-dibromobutane

b) $Cl_2 + H_2O$

$$H_2C = CH - CH_2 - CH_3 + H_2O \xrightarrow{Cl_2} H_2C(Cl) - CH(OH) - CH_2 - CH_3$$

Halohydrin

c) $C_6H_5 - \overset{O}{\overset{\|}{C}} - O - OH$

$$H_2C = CH - CH_2 - CH_3 + C_6H_5 - \overset{O}{\overset{\|}{C}} - O - OH \longrightarrow H_2C - CH - CH_2 - CH_3 + C_6H_5COOH$$

Q. No. 2 (ix) **TREND OF HALIDE IONS AS REDUCING AGENTS**

Trend:

$$I^- > Br^- > Cl^- > F^-$$

Reason:

For halide ion to act as reducing agent, it has to lose electrons. The bigger the halide ion, the farther the outer electrons are from the nucleus and the more they are screened from it by the inner electrons. Therefore, it becomes easier for halide ion to lose its electron due to less attraction between nucleus and outer electron. (as we move down group)

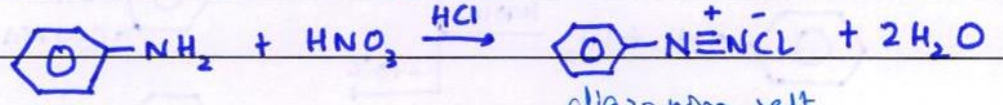
.....

Q. No. 2 (x) **DIAZONIUM SALTS**

Definition: "Diazonium salts are compounds containing the group $-N\equiv\overset{+}{N}\overset{-}{Cl}$."

Preparation (from Aniline):

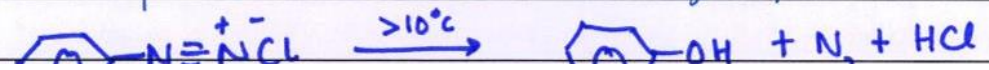
When aniline is heated with nitric acid in presence of HCl (below 10°C), diazonium salt is formed.



diazonium salt.

Above 10°C:

When this salt is heated above 10°C, salt decomposes to phenol and HCl and nitrogen gas.



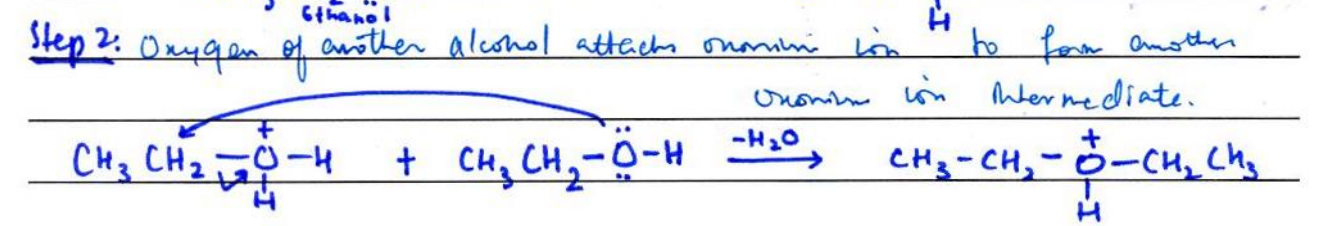
Q. No. 2 (xi)

DEHYDRATION OF ETHANOL

General Reaction: $CH_3CH_2OH \xrightarrow[140^\circ C]{H_2SO_4} CH_3CH_2-O-CH_2CH_3 + H_2O$

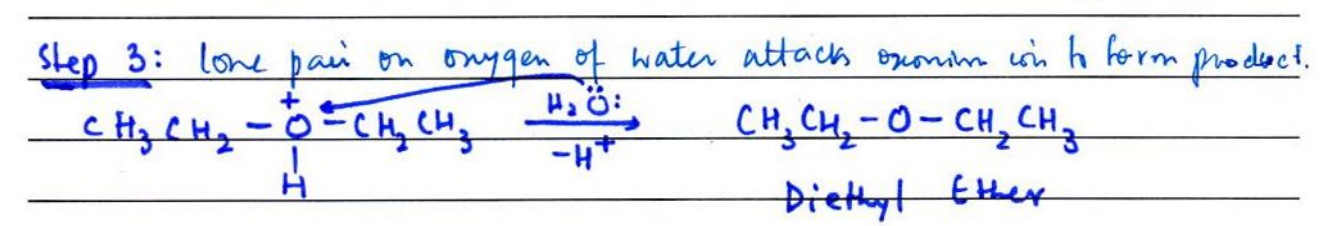
Mechanism:

Step 1: Acid/Base reaction. Protonation of oxygen of alcohol to make better leaving group. Oxygen accepts a proton to form oxonium ion.



Step 2: Oxygen of another alcohol attacks oxonium ion to form another oxonium ion intermediate.

Step 3: lone pair on oxygen of water attacks oxonium ion to form product.

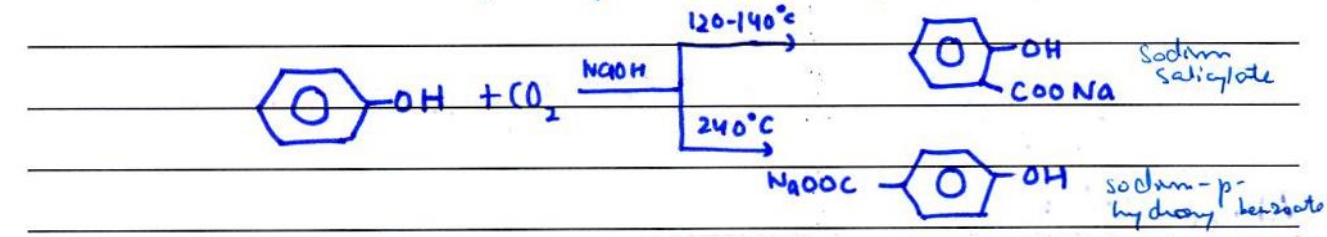


Q. No. 2 (xii)

KOLBE - SCHMITT

Definition: "It is the carbonylation of sodium salt of phenol."
The carbonation is called Kolbe-Schmitt reaction."

Reaction: At low temperature **Sodium salicylate** (sodium-o-hydroxy benzoate) and high temperature sodium-p-hydroxy benzoate forms.



Carbon of CO_2 acts as electrophilic center in this reaction.
Acidification of the salts gives corresponding hydroxyl benzoic acids.

Q. No. 2 (xiii) **TESTS FOR ALDEHYDES AND KETONES**

Fehling's Test: Fehling's solution (mild oxidising agent) is an alkaline solution of Cu^{2+} ions and sodium/potassium tartarate. When Fehling's solution is added to aldehyde red ppt of Cu_2O forms.

$$CH_3CHO + Cu^{2+} + OH^- + \text{sodium tartarate} \rightarrow \underset{\text{Red ppt}}{Cu_2O} + CH_3COO^- + H_2O$$

Aldehyde oxidises to salt of carboxylic acid and Cu^{2+} reduces to Cu^{+1}.
This test is not given by ketones.

Tollen's Test: When tollen's reagent (aqueous silver nitrate, ammonia, sodium hydroxide) ~~are~~ is added to aldehyde silver mirror (Ag) forms so it is also called 'silver mirror test.' This test is not given by ketones.

$$CH_3CHO + 2[Ag(NH_3)]^+ + OH^- \rightarrow CH_3COO^- + \underset{\text{silver mirror}}{2Ag} + 2NH_4^+ + 2NH_3$$

Q. No. 2 (xiv) a) **Acetamide to Ethyl amine**

$$CH_3-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{LiAlH_4} CH_3CH_2NH_2 + H_2O$$

b) **Acetyl chloride to acetic anhydride**

$$CH_3-\overset{O}{\overset{\|}{C}}-Cl + CH_3-\overset{O}{\overset{\|}{C}}-OH \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3 + HCl$$

c) **Calcium acetate to acetone**

$$(CH_3COO)_2Ca \xrightarrow{\text{distillation}} CH_3-\overset{O}{\overset{\|}{C}}-CH_3 + CaCO_3$$

Q. No. 2 (xv) **PREPARATION OF CH_3COOH**

a) **Grignard Reagent:** (Reaction with CO_2)

$$O=\overset{+\delta}{C}=O^{-\delta} + \overset{-\delta}{CH_3}\overset{+\delta}{Mg}Br \longrightarrow H_3C-\overset{O}{\overset{\|}{C}}-O^{-}MgBr \xrightarrow[H^+]{H_2O} H_3C-\overset{O}{\overset{\|}{C}}-OH$$

Carbon dioxide

b) **Nitrile:** (By hydrolysis)

$$\underset{\text{Methyl cyanide}}{CH_3-C\equiv N} + H_2O \xrightarrow[\text{heat}]{H^+} CH_3-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[\text{heat}]{H_2O/H^+} H_3C-\overset{O}{\overset{\|}{C}}-OH$$

c) **Alcohol:** (By oxidation)

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[50^\circ C]{K_2Cr_2O_7/H_2SO_4} CH_3CHO \xrightarrow[50^\circ C]{K_2Cr_2O_7/H_2SO_4} CH_3COOH$$

Q. No. 2 (xvi)

DNA	RNA
Pentose Sugar	
DNA contains deoxyribose sugar.	RNA contains ribose sugar.
Nitrogeneous Bases	
DNA has nitrogeneous bases: adenine, guanine, cytosine, thymine.	RNA has nitrogeneous bases: adenine, guanine, cytosine, uracil.
Strands	
DNA is double stranded. The two strands in DNA are twisted in double helix and held in position	RNA is single stranded. but chain can fold back to form helical loop.

Q. No. 2 (xvii) CLASSES OF PETROCHEMICAL RAW MATERIALS

OLEFINS:

Olefins consist of ethylene, propylene and butadiene. Ethylene and propylene are important sources of industrial chemicals and plastic products. Butadiene is used to make synthetic rubber.

Aromatics:

These include benzene, toluene, xylene. In oil refineries, aromatic hydrocarbons are prepared by catalytic reforming and similar processes.

Synthetic Gas:

Synthetic gas is a mixture of carbon monoxide and hydrogen to form ammonia and methanol. Ammonia is used to make fertilizer - urea. Methanol is used as solvent and chemical intermediate.

Q. No. 2 (xviii) **REFINING OF PETROLEUM**

Definition: "Refining of crude oil (petroleum) is the separation of crude oil mixture into various useful products (fractions)."

Fractional Distillation: "It is the process with the help of which a mixture of miscible liquids is separated from one another on basis of difference of boiling points by evaporation and condensation."

Principle: Principle of fractional distillation is based on **separation of substances on basis of their boiling point.**

Substances with high boiling point and low volatility boil out first.

Fractions with low boiling point and high volatility boil out next.

This process continues until residue is left behind.

Vapors of each fraction are collected and condensed separately.

Q. No. 2 (xix) **TYPES OF ELECTRONIC TRANSITIONS**

In 200-800 nm range:

$n \rightarrow \sigma^*$: Occurs in compounds having non-bonding electron pair
E.g. compounds having, N, O, S, Cl, etc.

$\pi \rightarrow \pi^*$: In unsaturated organic compounds.
E.g. C=C, C≡C, C≡N, N≡N, C=O.

$n \rightarrow \pi^*$: In compounds with non-bonding electron pairs on heteroatoms.
Require least energy and longer wavelength

Order of Energy:

$n \rightarrow \pi^* < \pi \rightarrow \pi^* < n \rightarrow \sigma^*$

In 150 nm (vacuum UV region):

$\sigma \rightarrow \sigma^*$: Electrons are tightly held and require high energy in range of 150 nm which is not found in UV region, so occurs in vacuum UV region.

The relevant question should be answered only in the allotted space and inside the outer mark

Q. No. 2 (xx)

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 3 (Page 1/6)

The relevant question should be answered only in the allotted space and inside the outer mark

Q. No. 3 (Page 2/6)

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 3 (Page 3/6)

Q. No. 3 (Page 4/6)

متعلقہ سوال کا جواب صرف مختص کردہ جگہ پر اور بیرونی نشان کے اندر دیا جائے۔

Q. No. 3 (Page 5/6)

The relevant question should be answered only in the allotted space and inside the outer mark

Space for diagram/rough work

Q. No. 3 (Page 6/6)

Q. No. 4 (Page 1/6) (b) INHIBITION OF ENZYMES

Enzyme: "Enzyme is a biological catalyst that alters speed of metabolic reactions in living bodies."

Inhibition of Enzymes:
"An inhibitor molecule binds to enzyme and reduces its catalytic activity. This phenomenon is called enzyme inhibition."

TYPES OF ENZYME INHIBITION

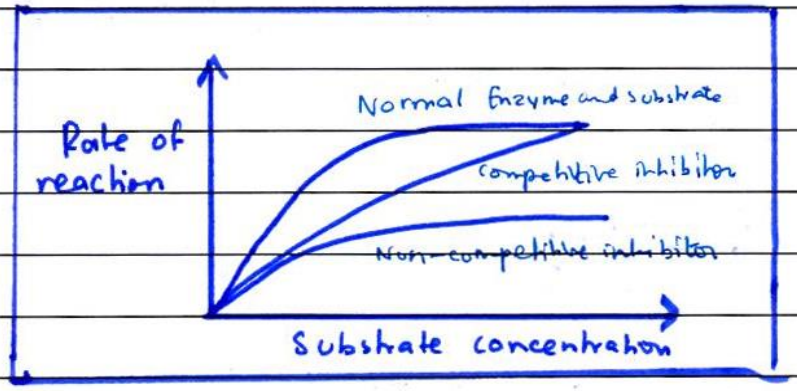
Irreversible Inhibition:
"When inhibitor reach with/interach with enzyme and forms strong covalent bonds with active site, it is called irreversible inhibition."
It is stable and irreversible.

Reversible Inhibition:
"The type of inhibition in which enzyme activity can be restored is reversible inhibition."

It is further of two types:
→ Competitive Inhibition
→ Non-competitive inhibition

Q. No. 4 (Page 2/6) → **Competive Inhibition**: Competitive inhibitor resembles normal substrate. It binds to ~~Inhibitor~~ enzyme in same way as ~~enzy~~ substrate does. When inhibitor is bind to active site, it does not allow substrate to bind to it, therefore enzyme can't catalyze reaction. Effect of this inhibitor can be overcome by increasing concentration of normal substrate so that there is more chance for it to bind to enzyme. compared to inhibitor.

→ **Non-competitive Inhibition**: It also reduces enzyme activity. Non-competitive inhibitor binds to enzyme on a **specific site**, It **does not bind to active site**. When inhibitor binds to second site (non-active site), it changes shape of enzyme **so that shape of active site is changed and substrate can no longer bind to enzyme.**



(a) GEOMETRICAL ISOMERISM

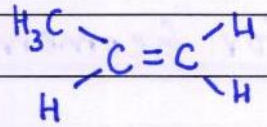
Statement:

"Restriction of rotation about double bond or single bond in cyclic compounds is not possible which results in geometrical isomerism or

Q. No. 4 (Page 3/6) **CONDITIONS:**

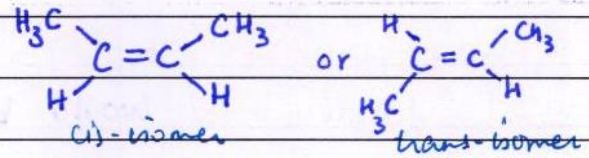
1) Alkenes: For alkenes to show geometrical isomerism, the two double bonded carbon atoms must be attatched to two different atoms or groups of atoms.

Examples: ⇒ **Propene**



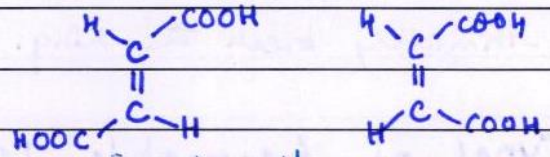
It **does not show** geometric isomerism because one of the double bonded carbon is attatched to same atoms (H).

⇒ **2-Butene**



2-Butene shows geometrical isomerism as both carbons attatched to two different groups.

⇒ ~~Ethane dicarboxylic acid~~
Butene dioic acid

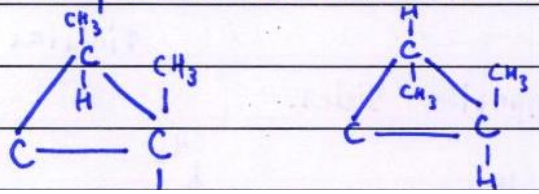


Fumaric acid Maleic acid

It shows geometrical isomerism.

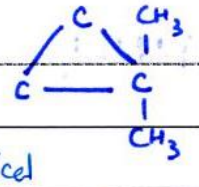
2) Cyclic Compounds: For cyclic compounds to show geometrical isomerism

→ they must contain two atoms (or groups) other than hydrogen in ring
→ these must be present on different carbon atoms in rings.



1,2-Dimethylcyclopropane

Q. No. 4 (Page 4/6)



1,1-Dimethylcyclopropane

This does not show geometrical isomerism as both groups are bonded to same carbon atoms.

Reason for Geometrical Isomerism:

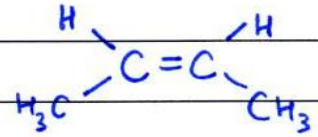
Alkenes: The carbon atoms of double bond are sp^2-hybridized. The presence of pi-bond locks each molecule in one position. The two carbon atoms and four atoms attached to them lie in same plane and their position in space is fixed. **Rotation** about double bond **would break the bond** so this restriction of rotation results geometrical isomerism.

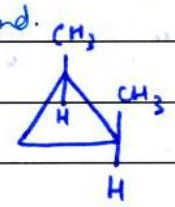
Cyclic compounds: They also show geometrical isomerism as rotation about bond would break the bond and ultimately break the ring.

Types of Geometric Isomers:

Cis-isomers: The isomers in which similar groups are on same side. of double bond.

Examples:





Trans-isomers: The isomers in which similar groups are on opposite sides. of double bond.

Q. No. 4 (Page 5/6) **Conversion of cis-isomer to trans-isomer:**

Cis-isomer can be converted to trans-isomer when **heated** to high temperature or **absorb light**. Heat provides energy (about 62 kcal/mol) to break pi-bond so rotation about sigma bond is possible. Upon cooling, reformation of pi-bond takes place giving mixture of trans and cis isomer.

Stability:

Trans-isomer is more stable than cis-isomer since cis-isomer has two bulky groups on same side so results **steric hindrance**.

The relevant question should be answered only in the allotted space and inside the outer mark

Space for diagram/rough work

Q. No. 4 (Page 6/6)

Q. No. 5 (Page 1/6)

(a) IODOFORM TEST

Statement:

"When carbonyl compounds containing CH_3-CHO (CH_3-CHO) group react with iodine in presence of alkali such as NaOH, it forms yellow crystalline solid called iodoform."

Reaction:

$$RCHO + I_2 + NaOH \longrightarrow RCOONa + \underset{\text{Yellow ppt}}{CHI_3} + NaI + H_2O$$

Explanation:

Primary Alcohols: In primary alcohols, only ethanol give this test positive.

$$CH_3CH_2OH + 4I_2 + 6NaOH \rightarrow CHI_3 + HCOONa + 5NaI + 5H_2O$$

Secondary Alcohols: Only secondary alcohols with $CH_3-\overset{OH}{\overset{|}{C}H}-$ give this test positive.

$$CH_3-\overset{OH}{\overset{|}{C}H}-CH_3 + 4I_2 + 6NaOH \rightarrow CHI_3 + CH_3COONa + 5NaI + 5H_2O$$

Tertiary Alcohols: Tertiary alcohols don't give this test.

Aldehydes: In aldehydes only, ethanal gives this test positive.

$$CH_3-\overset{O}{\overset{\|}{C}}-H + 3I_2 + 4NaOH \rightarrow CHI_3 + HCOONa + 3NaI + 3H_2O$$

Ketones: Only methyl ketones give this test positive.

$$CH_3-\overset{O}{\overset{\|}{C}}-R + 3I_2 + 4NaOH \rightarrow CHI_3 + RCOONa + 3NaI + 3H_2O$$

Q. No. 5 (Page 2/6) **Applications:** In this way,

- It is used to **distinguish** between **ethanol** from methanol and other primary alcohols.
- It is used to distinguish **secondary alcohols** ($CH_3-\overset{OH}{\overset{|}{C}}H-$) from other alcohols.
- It is used to distinguish **ethanal** from methanal and other aldehydes.
- It is used to distinguish **methyl ketones** from other ketones.

As NaOH is used, it is base catalyzed nucleophilic reaction.

(b) OZONE HOLE

Definition:

"Ozone hole is a hole (rupture) in ozone layer present in stratosphere which allows UV rays from sun to reach Earth's surface."
It results from depletion of ozone layer.

Explanation: In 1980, scientists discovered an ozone hole in the region over antartica.

Due to ozone hole, harmful ultraviolet rays from sun pass through hole and reach Earth's surface. These rays can cause skin cancer and destroy organic molecules necessary for life.

The presence of ozone in atmosphere is due to the fact that ozone in stratosphere is decreasing and ozone layer is getting thinner day by day.

Q. No. 5 (Page 3/6) **REASONS FOR FORMATION:**

1. Oxides of Nitrogen:

Oxides of nitrogen in atmosphere decompose O_3 to O_2 thus depleting ozone layer and contributing to ozone hole formation, and themselves regenerate.

$$NO + O_3 \rightarrow NO_2 + O_2$$
$$NO + O \rightarrow NO$$

The presence of these oxides in atmosphere is destroying ozone layer. These oxides destroy about **70% of ozone** in stratosphere. Greater the concentration of these oxides in atmosphere, greater will be ozone depletion.

2. Nuclear Tests:

Nuclear tests are being conducted worldwide which **generate high temperature.** At this high temperature **atmospheric nitrogen is favorably oxidized to NO** (NO destroys ozone as above).

3. Chloro-flouro carbons (CFCs):

Chloro-flouro carbons are chloro-flouro methanes like **freon-1 ($CFCl_3$) and freon-2 (CF_2Cl_2)** These are inert and do not react with other substances in atmosphere. They are used as refrigerant, firefighting reagent and solvents for cleaning electronic components. When they enter stratosphere, **they absorb ultraviolet radiation and breakdown to form free atomic chlorine** (radical) which decomposes O_3

Q. No. 5 (Page 4/6)

$$CF_2Cl_2 \rightarrow CF_2Cl^{\bullet} + Cl^{\bullet}$$
$$Cl^{\bullet} + O_3 \rightarrow ClO + O_2$$
$$ClO + O_3 \rightarrow Cl^{\bullet} + 2O_2$$

These reactions destroy ozone layer.

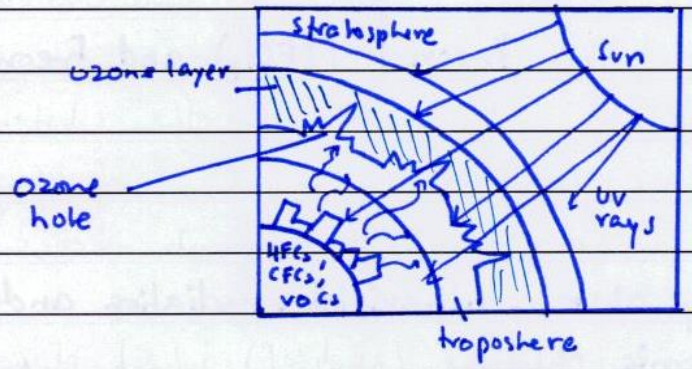
Protection of Ozone Layer:

Scientists are worried about gradual destruction of ozone layer by oxides of nitrogen and CFCs. In order to protect ozone layer, CFCs must be replaced by some new kind of substance that does not react with ozone so ozone layer can be saved.

Hydroflouro carbons:

An alternative of CFCs is HFCs or hydroflouro carbons (also called hydroflouroalkanes or hydroflouro methane). An example is **1,1,1,2-tetraflouroethane (CF_3CH_2F)** which is used as a refrigerant.

- An advantage of HFCs is that **they don't have any chlorine atoms so don't release damaging chlorine free radicals.**
- Moreover they contain **C-H bonds** that are relatively reactive so this means they breakdown quickly in atmosphere as compared to CFCs so **do not persist for long.**



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Q. No. 5 (Page 5/6)

The relevant question should be answered only in the allotted space and inside the outer mark

Space for Diagram/rough work

Q. No. 5 (Page 6/6)