Q. No. 2 Part (i) **Fe^{2+} as a catalyst:**

Fe^{2+} ion is used as a catalyst in following reaction:

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

Mechanism:

Step1: $S_2O_8^{2-} + 2Fe^{2+} \longrightarrow 2SO_4^{2-} + 2Fe^{3+}$

Step2: $2I^- + 2Fe^{3+} \longrightarrow I_2 + 2Fe^{2+}$

Fe^{2+} ion is used in first step but is regenerated in second step thus Fe^{2+} ion acts as a catalyst in the given reaction.

Q. No. 2 Part (ii) **Acidic nature of SO_3:**

SO_3 is an acidic oxide, thus it reacts with base such as NaOH to form sodium sulphate (Na_2SO_4).

$$SO_3 + 2NaOH \longrightarrow Na_2SO_4 + H_2O$$

SO_3 also reacts with CaO (basic oxide) to form calcium sulphate ($CaSO_4$)

$$SO_3 + CaO \longrightarrow CaSO_4$$

SO_3 reacts vigorously with water in order to produce sulfuric acid (H_2SO_4).

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

Q. No. 2 Part (iii) **Chemical Equation:**

(a) $2NaOH + Cl_2O \longrightarrow 2NaOCl + H_2O$

(sodium hypochlorite)

(b) $PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$

(phosphorous acid)

(c) $Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O_2$

(sodium hydroxide

Q. No. 2 Part (iv) **$KMnO_4$ reactions:**

(a) $FeSO_4$:

$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + MnSO_4 + 3H_2O + 5[O]$

$(2FeSO_4 + H_2SO_4 + [O] \longrightarrow Fe_2(SO_4)_3 + H_2O) \times 5$

$2KMnO_4 + 8H_2SO_4 + 10FeSO_4 \longrightarrow K_2SO_4 + 8H_2O + 5Fe_2(SO_4)_3$

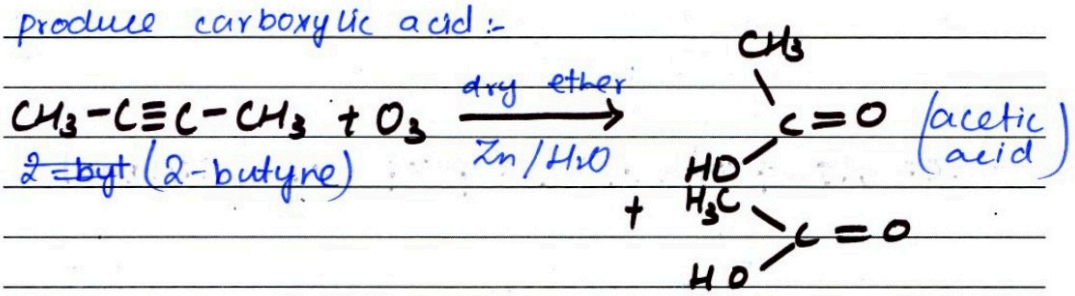
(b) Mohr salt:

$2KMnO_4 + 7H_2SO_4 + 10(NH_4)_2SO_4.FeSO_4.6H_2O$

$\longrightarrow K_2SO_4 + MnSO_4 + 10(NH_4)_2SO_4 + 5Fe_2(SO_4)_3 + 67H_2O$

Q. No. 2 Part (ix) **Ozonolysis of Alkynes:**

Alkynes undergo ozonolysis upon reaction with ozone in the presence of **dry ether** followed by a reaction with boiling H_2O and Zn in order to produce carboxylic acid:-



Ozonolysis of 2-butyne produces two molecules of acetic acid.

$CH_3-C\equiv C-CH_3 + O_3 \xrightarrow{Zn/H_2O} 2\,CH_3COOH$

Q. No. 2 Part (v) **Isomerism:**

(a) 1-Chloro propane and 2-chloropropane:
(Positional Isomerism)

(b) Butanone and Butanal:
(Functional group isomerism)

(c) Diethyl ether and methyl propyl ether
(Metamerism)

Q. No. 2 Part (vi) **Coal and Petroleum: A source of organic compound**

Coal: Coal is formed by the decaying of trees in the Earth's crust under high temperature and pressure over many years. It is a source of many organic compounds. Upon **destructive distillation** (pyrolysis), coal produces coal tar, coal gas, coke, ammonical liquor. Coal tar upon fractional distillation produces many other compounds.

Petroleum: Petroleum or crude oil is a black, thick, sticky liquid that seaps out of Earth's crust. Upon **fractional distillation**, petroleum produces many useful fractions such as fuel gas, gasoline, naphtha, kerosene, lubricating oil and many other hydrocarbons.

Thus coal and petroleum are important sources of organic compounds.

Q. No. 2 Part (vii) **Oxides of Nitrogen and sulphu**

(a) oxides of nitrogen (NO_x):

- **Sources:** (i) burning of fossil fuels in cars and industry (ii) forest fires (iii) volcanic eruption (iv) activity of nitrifying bacteria (v) lightening.
- **Environmental Impact:** ⇒ Decreased visibility due to brownish coloured NO_2 gas.
  ⇒ respiratory and lung issues. ⇒ decreased plant growth.

(b) oxides of sulphur (SO_x):

- **Sources:** (i) volcanic eruption.
  (ii) burning of fossil fuels and coal.
  (iii) roasting of sulphur ores.
- **Environmental Impact:** ⇒ Causes acid rain
  ⇒ yellowing of plants.

Q. No. 2 Part (viii)

Addition polymer	Condensation polymer
• The combination of alkene monomers to form a polymer is called addition polymer.	• The polymerisation of monomers into polymers with elimination of small molecules e.g. NH_3, H_2O.
• These are called chain growth polymers.	• These are called step growth polymers.
• Does not involve elimination of small molecules.	• Involves elimination of small molecules.
• e.g. polyethene.	• e.g. Nylon-6,6

$$n(CH_2=CH_2) \xrightarrow[TiCl_4]{Al(C_2H_5)_3} \{(CH_2-CH_2)\}_n$$

(monomer) (polymer.

$$HOOC(CH_2)_4COOH + NH_2(CH_2)_6NH_2 \rightarrow \{CO(CH_2)_4CONH(CH_2)_6NH\}_n$$

Q. No. 2 Part (x) **Basic strength of amine:**

- The basic strength of amine increases upon the attachment of electron donating group **(alkyl group)**. Due to **electron releasing effect** of alkyl group, the charge density of N-atom increases and amine becomes more basic. This is why primary amine is more basic than ammonia.
- **Secondary amine** has two alkyl groups attached to nitrogen atom thus it has greater basic strength than primary amine.
- **Tertiary amine** although has three alkyl groups but due to **steric hindrance** of the three bulky groups, the approach of proton to nitrogen is hindered.

basic strength: secondary amine > primary amine > tertiary amine.

Thus basic strength of tertiary amine reduces.

Q. No. 2 Part (xi) **Order of reactivity of alcohol:**

With respect to the cleavage of O–H bond, primary alcohols are most reactive:

tertiary alcohol < secondary alcohol < primary alcohol.

$R-OH \xrightarrow{\text{electrophile}} R-O^- + H^+$

The order of reactivity for Ethanol, 2-methyl,2-propanol and 2-propanol ~~is~~ with respect to O–H cleavage is

2-methyl-2-propanol < 2-propanol < ethanol

Thus 2-methyl-2-propanol being tertiary alcohol is least reactive and ethanol being primary alcohol is most reactive. When an electrophile attacks on alcohol, O–H bond is cleaved.

Q. No. 2 Part (xii) **Alternative to CFCs:**

~~HFCs~~ CFCs are the compounds which release harmful chlorine radicals in stratosphere that decomposes O_3 into O_2. They cause ozone depletion.

Hydrofluorocarbons (HFCs): HFCs are used as an alternative to CFCs as a refrigerant.

Example: 1,1,1,2-tetrafluoroethane ~~CF_3~~ CHF_3CH_2F

Benefits: (i) HFC don't have any chlorine atom thus they do not release harmful chloride radicals in the atmosphere. Hence they don't cause ozone depletion.

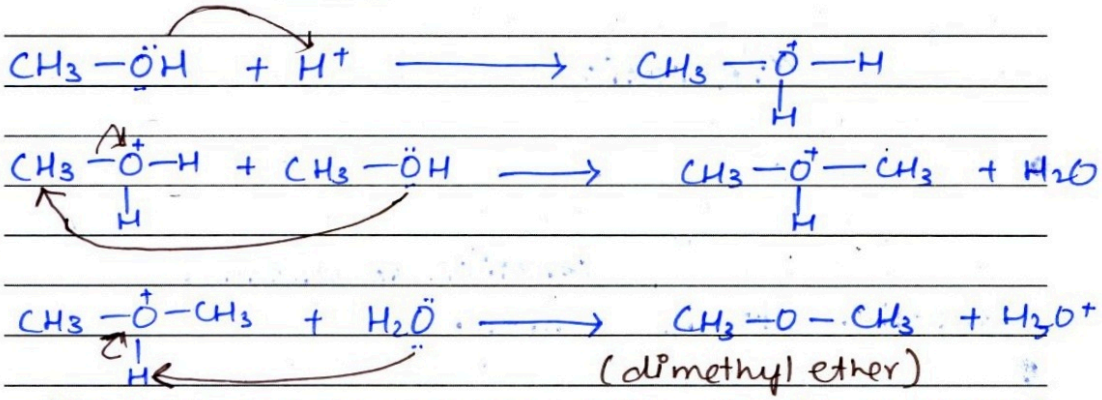
(ii) HFC contain **C–H** bond which is relatively reactive and gets broken therefore the HFCs or hydrofluorocarbons do not persist or remain in environment for longer periods.

Q. No. 2 Part (xiii) **Mechanism of Ether formation**

General reaction:

$$2CH_3OH \xrightarrow[140°C]{\text{conc. } H_2SO_4} CH_3OCH_3 + H_2O$$

Mechanism: step 1:



Alcohols undergo dehydradation in the presence of conc. H_2SO_4 and 140°C to form ether

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Q. No. 2 Part (xiv) **Amphoteric nature BeO:**

BeO is amphoteric in nature which means it can react with both acid and base.

(i) reaction with acid: BeO reacts with acid such as HCl to form salts $BeCl_2$:

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

(ii) reaction with base: BeO reacts with alkali such as NaOH to form sodium beryllate.

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

Q. No. 3 (Page 1)

Mass Spectrometry:

Definition: Mass spectrometry is a technique that uses a device called **mass spectrometer** in which ions of isotopes and molecules are produced, they are separated on the basis of their **m/e ratio** and their relative abundance is measured.

- Mass spectrometer is also used to identify and separate different isotopes of element and to determine their **relative abundance** and **relative atomic masses.**
- It is also extensively used to determine structure of organic compounds.

Working of mass spectrometer:

The working in mass spectrometer involves following steps:-

(i) **Vapourization:** The sample is usually injected in gaseous form, however if liquid or solid sample is used, then it is first vapourized in **evaporation chamber.**

(ii) **Ionization:** Gaseous atoms and molecules are converted into positively charged ions by bombardment with high speed electrons (70eV)

(iii) **Acceleration:** The ions are then accelerated by applying them with an electric field of **negative potential (500-2000V)**

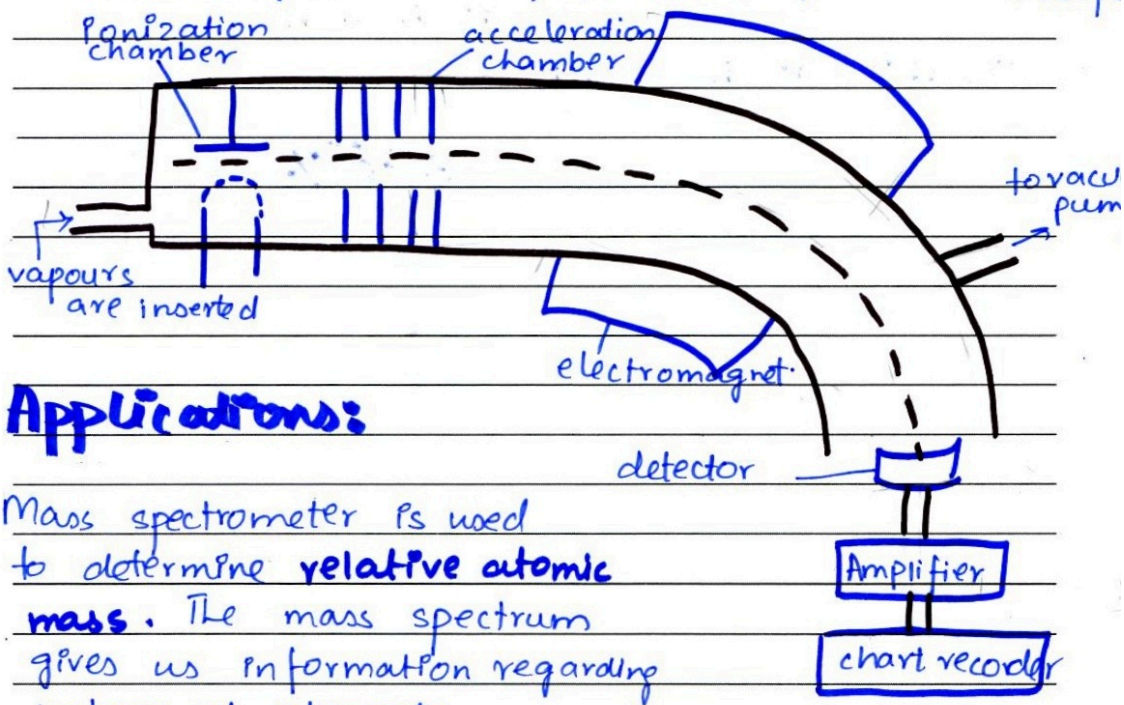
(iv) **Deflection:** The positively charged ions are deflected by applying them with ass

~~electric f~~ variable magnetic field.

The **angle of deflection** is inversely proportional to the m/e ratio of ion.

(v) Detection: The ions are detected with the help of a detector. Detector is an electronic multiplier which can **count the number of ions striking it.**

The detector is kept constant and magnetic field is varied in order to focus ions onto the detector. Detector is an **electronic counter** whose function is to generate electric current directly proportional to the number of ions stricking it. The electric current signal is amplified and fed into oscillo-scope



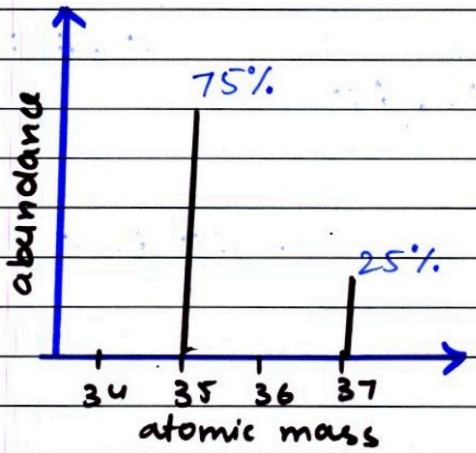
Applications:

Mass spectrometer is used to determine **relative atomic mass**. The mass spectrum gives us information regarding isotopes of elements.

Q. No. 3 (Page 3) **Mass spectrum of Cl:**

The mass spectrum shows peaks, number of peaks gives us the number of possible isomers. The height of peak indicates abundance of isotopes.

Mass spectrum of Cl shows two isotopes Cl-35 and Cl-37. their peaks are in ratio 2:1



relative atomic mass = $\frac{75 \times 35 + 37 \times 25}{100}$

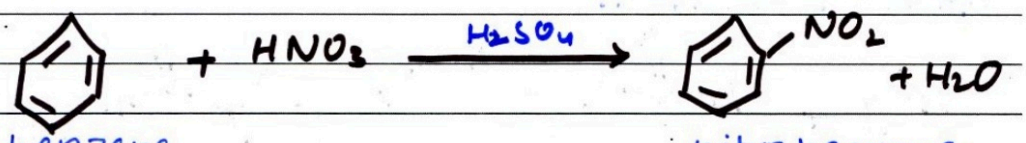
$= 35.5$

Thus relative atomic mass of Cl is 35.5...

Q. No. 4 (Page 1) **Nitration and Friedel craft acylation:**

Nitration: The substitution of nitro (NO_2) group to benzene ring is known as nitration of benzene.

General reaction:



benzene nitro benzene.

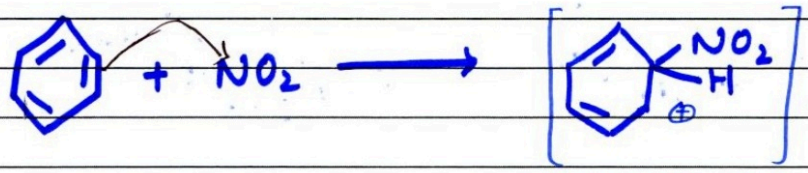
Mechanism:

(i) production of ~~no~~ electrophile:

$$HNO_3 + H_2SO_4 \longrightarrow NO_2 + HSO_4^- + H_2O$$

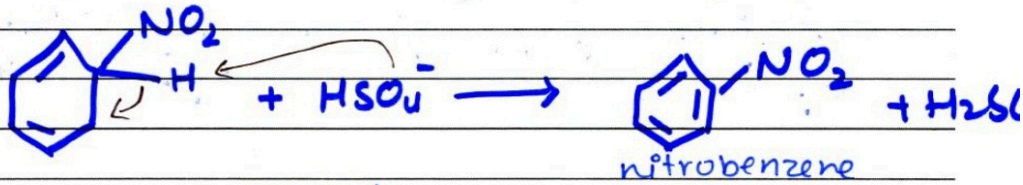
NO_2 acts as electrophile.

(ii) Formation of phenonium ion:



phenonium ion.

(iii) regeneration of catalyst:



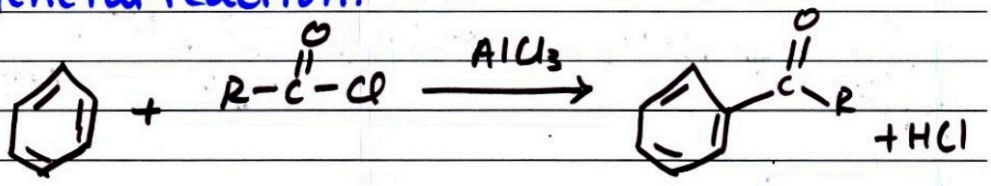
nitrobenzene

The catalyst (H_2SO_4) is regenerated)

Friedal craft Acylation:

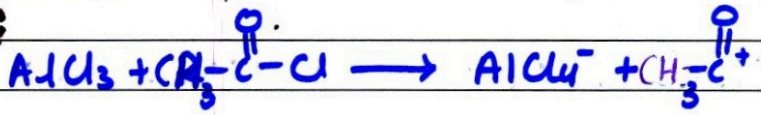
Benzene reacts with acyl halide in the presence of lewis acid catalyst to form substituted benzene. This is called Friedal craft acylation reaction.

General reaction:

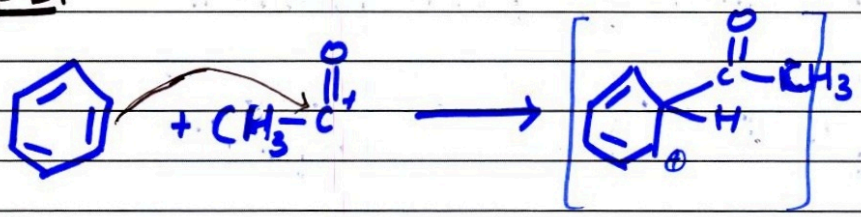


Mechanism:

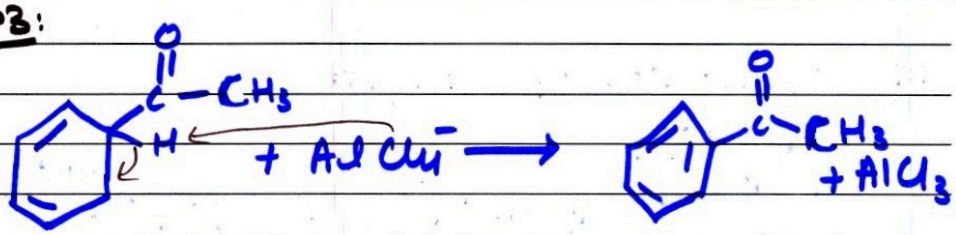
step 1:



step 2:



step 3:

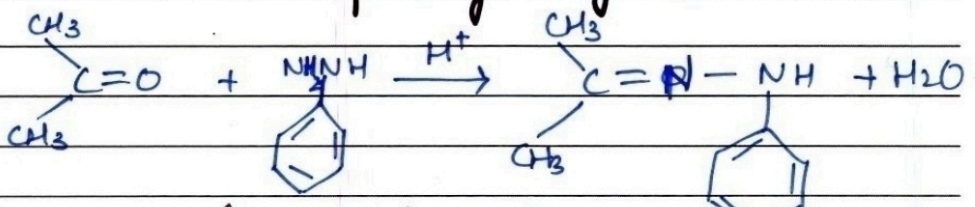


acetophenone.

Q. No. 4 (Page 3)

Q. No. 5 (Page 1) **Nucleophilic Addition reaction:**

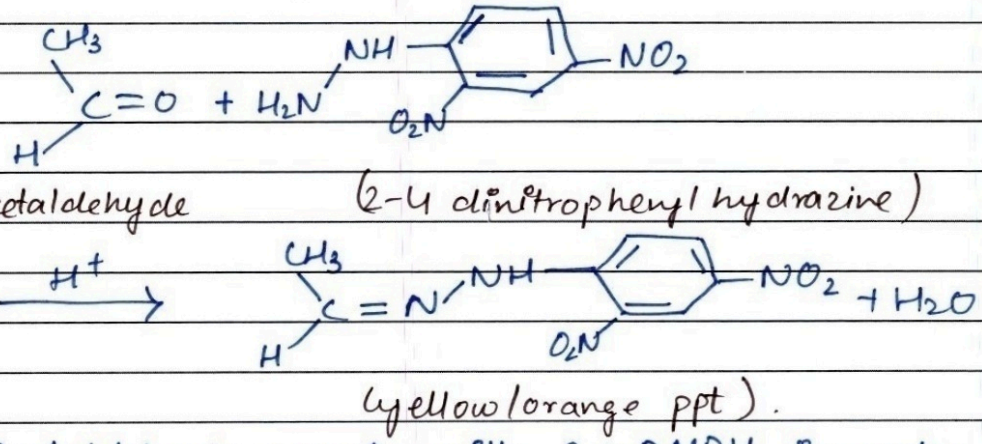
(a) Acetone and phenyl hydrazine:



acetone (phenyl hydrazine) acetone (phenyl hydrazone)

~~Then~~ Acetone reacts with phenyl hydrazine to form acetone phenyl hydrazone in an **acid catalysed nucleophilic addition reaction.**

(b) Acetaldehyde and 2,4-DNPH:



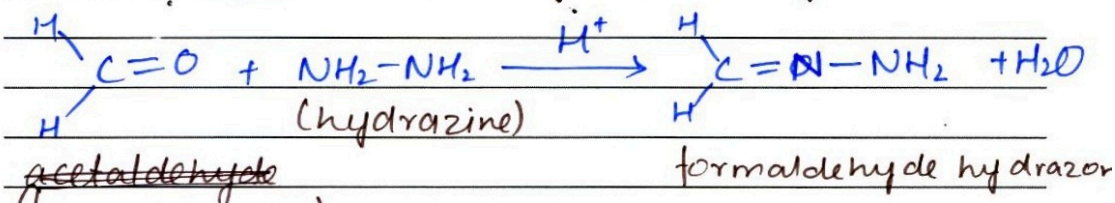
acetaldehyde (2-4 dinitrophenyl hydrazine)

(yellow/orange ppt).

Acetaldehyde reacts with 2,4 DNPH in order to give yellow/orange ppt of acetaldehyde, 2,4-dinitrophenyl hydrazone.

⇒ This is identification test for aldehyde and ketone.

Q. No. 5 (Page 2) (c) Formaldehyde and hydrazine



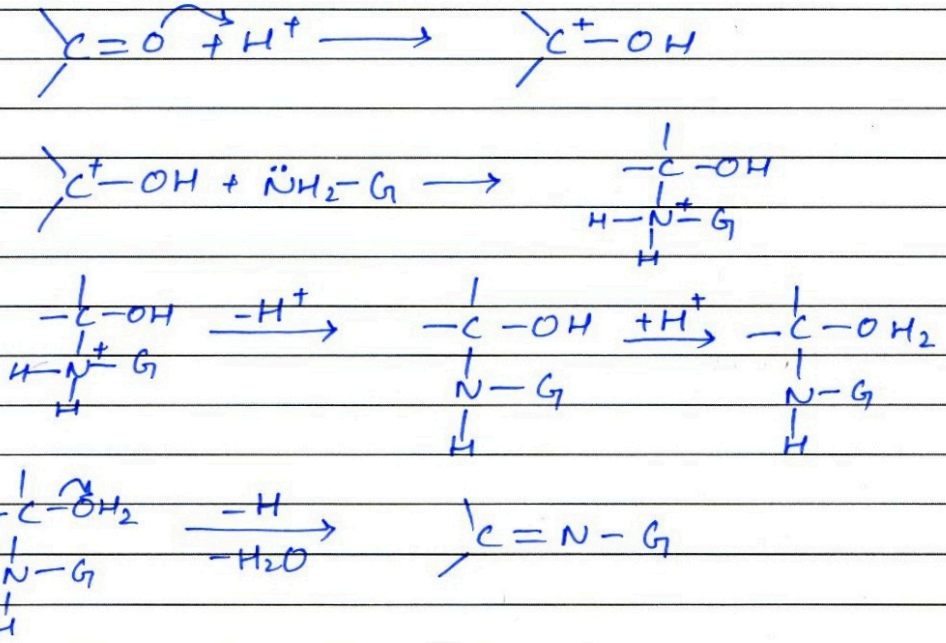
~~acetaldehyde~~
(formaldehyde)

formaldehyde hydrazon

Formaldehyde reacts with hydrazine to form formaldehyde hydrazone under acidic condition.

Mechanism of addition of ammonia derivatives:

Following is the general mechanism of addition of ammonia derivatives to carbonyl compounds:



Q. No. 5 (Page 3)

Q. No. 6 (Page 1) **Effect of pH, temperature and substrate concentration on enzymes:**

Enzymes are biological catalysts. Each enzyme requires specific conditions to work properly. Any change in enzyme conditions effects the catalytic activity of enzymes.

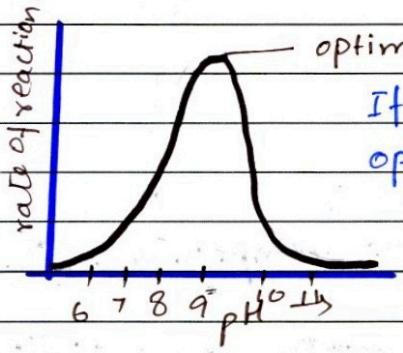
(i) Effect of change in pH:

All the enzymes work maximum at a narrow range of pH that is called **optimum pH.** The value of optimum pH is different for different enzymes.

optimum pH of pepsin = 2
(working in stomach)

optimum pH of trypsin = 9
(working in small intestine).

If there is any change in pH, the rate of reaction reduces. & Extreme changes in pH can permanently denature enzyme.



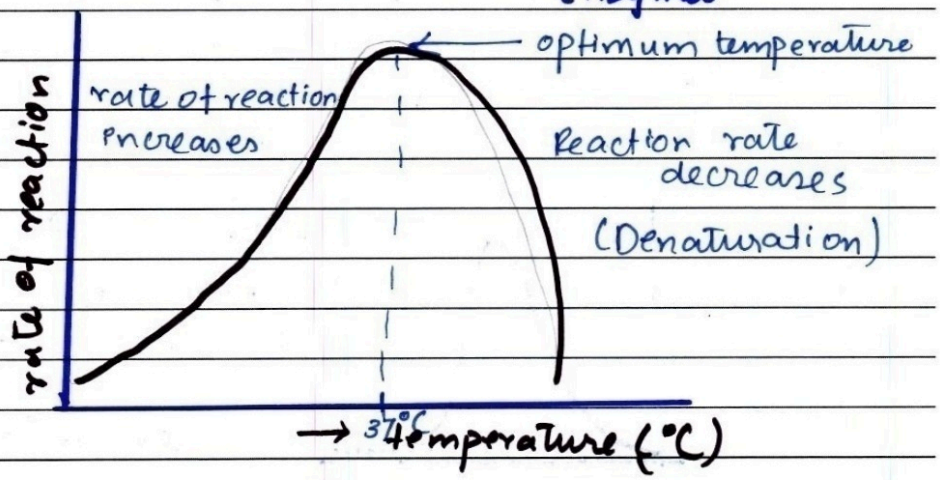
If pH is different than optimum pH, rate of enzyme catalysed reaction decreases.

(ii) Effect of temperature: All enzymes work best at a particular temperature, **optimum temper-ature.**

Q. No. 6 (Page 2) If temperature is less than or greater than optimum temperature, the rate of reaction reduces. **Explaination:**

- The rate of enzyme catalysed reaction increases with increase in temperature as **Kinetic energy** and **activation energy** is provided to enzyme. However this effect continues until optimum temperature, at which the catalytic activity of enzyme is **maximum.**
- If temperature is increased beyond optimum, **globular structure of enzyme is denatured** and specific shape of its active site is lost.

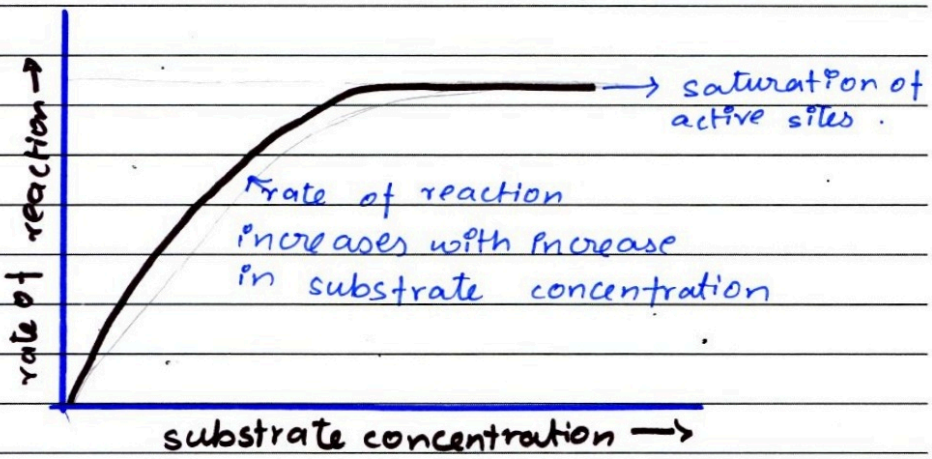
- **Optimum temp. for human enzymes = 37°C**
  Optimum temp. for some plant enzymes = 60°C

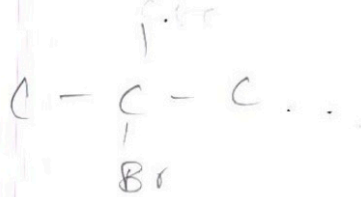


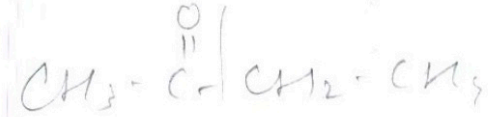
(iii) Effect of substrate concentration:

If enzymes are available in a medium then the rate of enzyme catalysed reaction increases

Q. No. 6 (Page 3) with increase in substrate concentration. However once all the **active sites** are fully occupied by substrate then the rate of reaction does not increase any further. This is known as **saturation of active sites.**







2 CH_3COOH