JRG College of Pharmacy

JRG COLLEGE OF PHARMACY

UNIVERSITY SOLVED QUESTION

WITH ANSWER

Year : 2022-23

Subject : Pharmaceutical Organic Chemistry-I

Subject Code : 23PBP203

Subject In-Charge : Mr. Biswajit Biswal

Registration No: | | | | | | | | | | |

Total Number of Pages: 02

Course: B.Pharm
Sub Code: BP202T

2nd Semester Regular/Back Examination: 2022-23
SUBJECT: Pharmaceutical Organic Chemistry - I
BRANCH(S): Pharmacy
Time: 3 Hour
Max Marks: 75
Q.Code: M638

Answer Question No.1 (Part-1) which is compulsory, any seven from Part-II, and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) What is electromeric effect? Give example.
b) What are electrophiles and nucleophiles?
c) Give the IUPAC name of $CH_3CH_2CH_2CH_2COOC_2H_5$
d) What are the differences between molecular orbitals and hybridized orbitals?
e) Why formic acid is more acidic than acetic acid?
f) Write the structure and uses of hexamine.
g) What is the difference between Markovnikov and anti Markovnikov product?
h) Write an example of diene and dienophile.
i) Which qualitative test is used to detect esters?
j) Why formaldehyde undergoes Cannizzaro reaction but acetaldehyde does not?

Part-II

Q2 **Focused-Short Answer Type Questions- (Answer Any Seven)** **(5 x 7)**

a) Give chemical tests to differentiate between primary, secondary and tertiary alcohols.
b) Explain the comparative stability of primary, secondary and tertiary carbocations.
c) Write a short note on basicity of aliphatic amines and factors affecting it.
d) Write the structure and uses of citric acid, glycerol and acetyl salicylic acid.
e) Discuss aldol condensation reaction with example.
f) Discuss ozonolysis with example.
g) Write a short note on reactivity and stability of conjugated dienes.
h) Write the structure and uses of iodoform, benzyl benzoate and amphetamine.
i) Discuss structural isomerism in organic compounds.

Part-III

Long Answer Type Questions (Answer Any Two)

Q3 Define elimination reaction. Discuss the kinetics and mechanism of E1 and E2 reactions with suitable examples. **(10)**

Q4 Write three general methods of preparation and three important reactions of carboxylic acid. Explain the effect of substituents on acidity of carboxylic acids. **(10)**

Q5 Define and differentiate SN1 and SN2 reactions with suitable illustrations. Write a note on factors affecting SN1 and SN2 reactions. **(10)**

Q6 Discuss the principles/mechanisms and applications of Benzoin condensation and Perkin condensation. **(10)**

2nd semester; B.Pharm

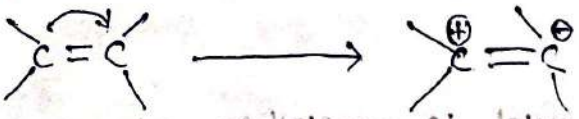
year : 2022-2023

Part-I sub:- Organic chemistry-I

1. (a) What is electromeric effect & give example.

Ans:- It is a temporary and reversible shift of electron in a multiple bond towards one of the bonded atom, formed polarised bond.

ex:-



electromeric effect in alkenes.

(b) What are the electrophile and nucleophile?

Ans:- Electrophile:- An electrophile is a species that accept an electron pair during a chemical reaction.

→ It can be +vly charged or neutral having electron deficient.

Nucleophile :- A nucleophile is a species that donate a pair of electron during chemical reaction.

→ It can be -vly charged or neutral having lone pair of electrons.

(c) Give IUPAC Name of $CH_3CH_2CH_2CH_2COOC_2H_5$.

Ans:- $CH_3CH_2CH_2CH_2COOC_2H_5$ - ~~ethyl-4-oxopentanate~~

IUPAC name - ethyl-4-oxopentanoate

(d) What is the difference between molecular orbitals & hybridized orbitals?

Ans:-

Molecular orbitals	Hybridized orbital
→ molecular orbitals formed by a linear combination of atomic orbital of different atom during molecule formation.	→ Hybridized orbitals are formed by at mixing atomic orbital of the same atom to explain the bonding in a molecule.
→ It involves the overlap of atomic orbital from two or more atoms.	→ It involves mixing atomic orbital of a single atom.
→ Types:- Bonding, Anti bonding, Non-bonding	→ Types:- sp, sp^2, sp^3d^2, sp^3d, Sp^2
→ Energy level:- They have distinct energy level determined by combination of atomic orbital	→ Energy level:- they have similar energy level.

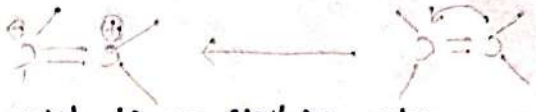
(e) Why formic acid is more acidic than acetic acid?

Ans:- formic acid is more acidic than acetic acid because,

(i) Presence of electron donating group in acetic acid :-

In acetic acid (CH_3-COOH), the methyl group is attached with the functional group, which is a electron donating group. It increases the electron density & +I effect.

(ii) Inductive effect :-



The inductive effect in formic acid is negligible, where as in acetic acid due to the presence of CH_3 methyl group reduce stability of acetic acid.

* These makes formic acid more acidic than acetic acid.

(f) Write str. & uses of hexamines?

Ans:- Structure:- $C_6H_{12}N_4$

Uses:- It is used in production of phenolic & powdery preparation of phenolic resin.

→ Used as solid fuel,

→ Used as food preservative.

→ Used as primary ingredient in making RDX.

(g) What is the difference between markonikov and anti markonikov product?

Ans:-

Markonikov :- In the addition of hydrogen halide (HCl, HBr, HI) to an asymmetrical alkene, the hydrogen atom attach to the carbon atom that have hydrogen atom and the other part attacks to the site having fewer H-atom.

eg:- $CH_3-CH=CH_2 + HBr \longrightarrow CH_3-\underset{Br}{\underset{|}{C}}H-CH_3$

Anti-markonikov :-

In a certain condition in the presence of H_2O_2 peroxide, the H-atom attacks the fewer H-atom containing carbon and the other part attach with the carbon atom having more H-atom.

$CH_3-CH=CH_2 + HBr \xrightarrow{H_2O_2} CH_3-CH_2-CH_2Br$

(h) write an examples of diene & dienophile?

Ans:- Diene :- 1,3- butadiene ($CH_2=CH-CH=CH_2$)

Dienophile:- $CH_2=CH_2$ (ethane)

(i) which quaelfative test are used to detect esters?

Ans:- Quaelfative test for ester:-

(i) Hydroxamic acid test

(ii) KOH soln test

(iii) Bromine water test.

(j) why formyl acetchyde undergo cannizaro reaction but acetaldehyde does not?

Ans:- we know that, the basic principle of cannizzaro reaction is that, the compound does not having α-H.

→ In the case of acetaldehyde, $CH_3-\overset{O}{\overset{\|}{C}}-H$ is having 3 α-H. but,

In formal dehyde $H-\overset{O}{\overset{\|}{C}}-H$ there is no α-H present in it.

so, formaldehyde undergoes cannizaro reaction but acetaldehyde does not.

Part-II

Q.3

(a) Give chemical test to differentiate between primary, secondary & tertiary alcohol.

Ans:-

Sodium metal test:-

Alcohol react with active metal like sodium and liberate H-gas that can be observed in the form of effervences.

$$2R-OH + 2Na \longrightarrow 2R-O^-Na^+ + H_2\uparrow$$

(Alcohol) (sodium alkoxide)

$$2CH_3OH + 2Na \longrightarrow 2CH_3-O^-Na^+ + H_2\uparrow$$

(methanol) (sodium methoxide)

Lucas test for 3° alcohol:-

- Lucas reagent zinc chloride in HCl

- $ZnCl_2 + HCl$

→ Lucas test is used to differentiate bet 1°, 2° & 3° alcohol.

→ In this test alcohol are treated with soln of HCl and zinc chloride to form alkyl halide.

(1) Primary alcohol :- Primary alcohol gives no reaction with lucas test.

$$CH_3-CH_2-OH \xrightarrow[ZnCl_2]{HCl} \text{No reaction.}$$

(2) Secondary alcohol :- secondary alcohol reacts with lucas test and reaction occures in appror. 5min & a cloudiness appear.

$$CH_3-\underset{CH_3}{\overset{|}{CH}}-OH + HCl \xrightarrow{ZnCl_2} CH_3-\underset{CH_3}{\overset{|}{CH}}-Cl$$

(3) Tertiary alcohol :- Tertiary alcohol react with lucas reagent & give instant reaction & an immediate cloudiness appear.

$$CH_3-\underset{CH_3}{\overset{CH_3}{\overset{|}{C}}}-OH + HCl \xrightarrow{ZnCl_2} CH_3-\underset{CH_3}{\overset{CH_3}{\overset{|}{C}}}-Cl$$

(b) Explain the comparative stability of 1°, 2° & 3° carbo cations.

Ans :-

Stability of carbocations :

$$3^\circ > 2^\circ > 1^\circ$$

explanation :-

(i) Inductive effect :-

Alkyl groups are electron donating group via the +I effect, stabilizing the possible charge on carbocation. The more alkyl group, the greater the stabilization.

- Tertiary : strong +I effect due to 3 alkyl group.
- secondary : moderate +I effect due to 2 alkyl group.
- Primary :- weak +I effect due to one alkyl group.

(ii) Resonance :-

carbocation that can can delocalize the +ve charge through resonance (ex. benzyl carbocation) are highly stabilized.

(iii) Hyperconjugation :-

It involves the delocalization of electron from the sigma (σ) bond of adjacent C-H bond in to empty p-orbital of the carbocation.

→ more alkyl group attached to the carbon increases the +ve charge of the carbon. hence stability is also increases.

✓ Tertiary carbocation has more alkyl group than 2° & 1°, so it is more stabilized than other.

✗ secondary carbocation is less stabilized in compare to 3° but more stabilized than 1°.

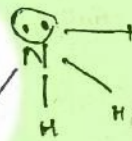
✓ primary carbocation is least stabilized carbocation.

(c) Write a short note on basicity of aliphatic amine & factor affecting it.

Ans:- Basicity of amines :-

Aliphatic amines are the derivatives of ammonia (NH_3).

→ Ammonia are basic in nature which donate lone pair because it contain a lone pair on 'N'.



$\ddot{N}H_3$

→ Aliphatic amine are also basic in nature, because it contain a lone pair on the 'N'.

$R-\ddot{N}H_2$

→ According to Lewis concept,

Those substance/element which accept lone pair are called Acid &

Those substance/element which donate lone pair are called Base.

→ A substance, which contain lone pair can donate it.

Basicity :-

The basicity of amine are depend on the stability of amine.

stability ↓ ⟶ Basicity ↑

→ It also depend upon the electron density

Lone pair ↑ → electron density ↑ ⟶ Basicity ↑

• So, Amines are basic in nature and its basicity depend upon the electron density & the stability of amine.

Factor affecting Basicity of Amines:-

(i) Inductive effect:-

The basicity increases as the alkyl group / electron donating group are attached to the nitrogen.

→ more is +I group more is basicity.

$R_3N > R_2NH > RNH_2$

(ii) Steric Hindrance:-

In aq. soln.

. Bulky alkyl group around the nitrogen can reduce the accesibility of lone pair and the basicity decrease.

→ It due to because the steric hindarcance reduce the solvation and protonation efficiency.

(iii) Solvation effect -

In normal state, the basicity trend is:

$R_3N \geq R_2NH > RNH_2$

but, in aqueous soln due to the steric hindrance the trend goes else,

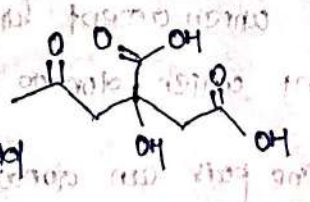
$RNH_2 > R_2NH > R_3N$

(d) Write the str. and uses of citric acid, glycerol, and acetyl salicylic acid.

Ans:- (a) Citric acid.

Str:-

• Organic tri carboxylic acid

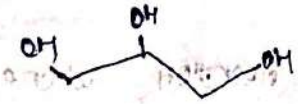


Uses:-

- It is used in pharmaceutical aid.
- It is used as anticoagulant.
- Used as acid Ane, flavouring & chelating agent.

(b) Glycerol :-

str :-

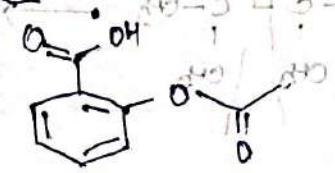


uses :-

- It is used as food sweetener in industries.
- It is used as ph. Humectant to improve smoothness, lubricant.

(c) Acetyl salicylic acid :-

str :-



uses :-

Used as Analgesic and antipyretic

(d) Define aldol condensation reaction with example.

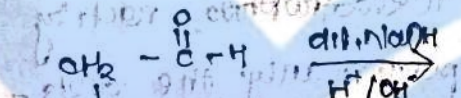
Ans :- Aldol condensation :-

Aldehyde or ketone having atleast one α-H undergoes an organic reaction in presence of dil. NaOH to form β-hydroxyaldehyde (Aldol) & the reaction is known as aldol condensation.

Mechanism :-

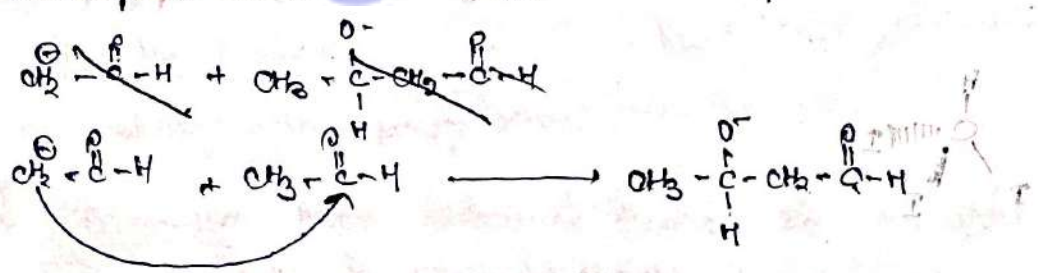
Step-1

Hydroxide act as a base & removes the acidic α-H from aldehyde.



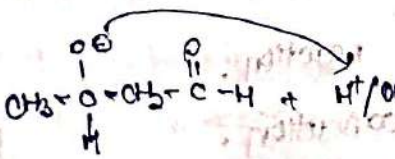
Step-2

Nucleophile attacks on aldehyde at electrophilic carbon atom



Step-3

removal of H^+ atom from the aldol.

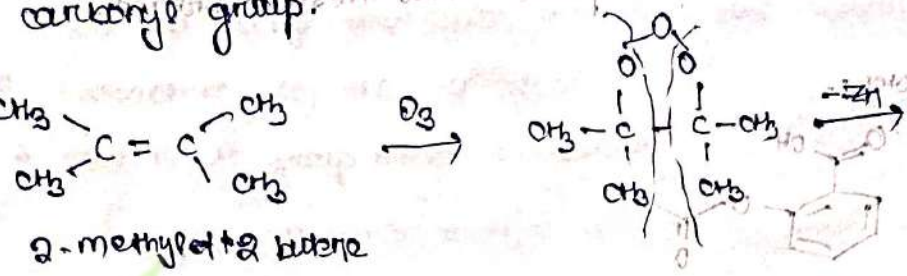


(Aldol)

(f) Discuss ozonolysis with example.

Ans:- Ozonolysis:-

Ozonolysis is an organic reaction where the unsaturated bond undergoes ozone and cleavage takes place. Multiple C-bond are replaced by carbonyl group.



2-methyl-2 butene

(g) Write a short note on reactivity and stability of conjugated diene.

Ans:- conjugated di-ene:-

A conjugated di-ene is a molecule containing two double bond separated by a single bond, allowing for delocalization of the (π) pi electrons across the entire system, which significantly increases its stability compared to isolated double bond. this enhanced stability is due to resonance where the electron can distributed across multiple positions, lowering the overall energy of the molecule.

- while more stable than non-conjugated di-ene, conjugated diene, are still reactive due to presence of nucleophile π electrophile, readily participating in electrophilic addition reaction, particularly the diels-Alder reaction.

(h) Write the str. and use of, Iodoform, benzyl benzoate, amphetamine.

Ans:- Iodoform:-

str:- CHI_3

uses:-

- It is used as disinfectant.
- It is used as organic solvent in many chemical reaction.
- It is used as antiseptic to treat minor skin condition.

Benzyl benzoate:-

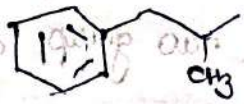
str:-

uses:-

It is used as anti-parasitic.

Amphetamine:-

str:-



uses:-

→ It is used for the treatment of depression and chronic pain.

(i) Discuss structural isomerism in organic compound.

Ans:- Structural isomerism:-

Structural isomerism are the compound which having same chemical formula but different chemical structure.

Types:-

(a) Chain isomerism:- same molecular formula but differ in the order in which C-atoms are bonded each other.

eg:- n-butane & isobutane

(ii) position isomerism:- same molecular formula but different in the position of functional group

eg. ethyl alcohol & dimethyl ether.

(iii) functional isomerism:- same molecular formula but differ in the functional group.

eg. diethyl ether & propyl ether.

(iv) Metamerism:- same molecular formula but unequal distribution of C-atom on either side of functional group.

eg. diethyl ether & propyl ether.

(v) Tautomerism:- same molecular formula, but and are the type of functional isomerism in which isomers are in dynamic equilibrium.

Part - III

Q.3 (a) Define elimination reaction. Discuss the kinetic and mechanism of E_1 & E_2 reaction with suitable examples.

Ans :- Elimination reaction :-

Elimination reaction is a type of organic reaction in which two substituent are removed from a molecule, forming a new π-bond, typically resulting in the formation of alkene or alkyne. The two groups are eliminated either from the same carbon atom or from adjacent carbons.

E_1 reaction (unimolecular elimination) :-

Kinetics :-

- Rate law :- The rate of the E_1 reaction depends only on the concentration of the substrate.

  Rate = K [substrate]

- The reaction is first order with respect to the substrate.

Mechanism :-

It occure in two step;

1. Ionisation (slow, rate determining step) :- The leaving group departs, forming a carbocation intermediate.

2. Deprotonation (fast step) :- A base removes a β-H from the adjacent carbon, resulting in the formation of a double bond (alkene).

$$CH_3CH(OH)CH_3 \xrightarrow{H^+} CH_3CH=CH_2 + H_2O$$

Characteristics :-

→ Favoured by weak base and polar protic solvent.

→ Rearrangement are possible due to formation of carbocation.

E_2 reaction (Bimolecular elimination) :-

· kinetics :-

Rate law :- the rate of E_2 reaction depends on both the substrate and base.

Rate = k [Substrate][Base]

→ the reaction is 2nd order.

Mechanism :-

E_2 occures in single step,

1. The base abstracts a β-H while leaving group departs simultaneously.
2. This leads to the formation of a π-bond / alkene.

example :-

$CH_3CH(Br)CH_3 \xrightarrow{KOH} CH_3CH=CH_2 + H_2O$

characteristics of E_2 :-

- Requires a strong base
- No carbocation intermediate forum.

(b) Write three general method of preparation and important reaction of carboxylic acid. Explain the effect of substituents on acidity of carboxylic acid.

Ans :- Method of preparation of C.A :-

(1) By oxidation of Aldehyde :-

when aldehyde oxidised in the presence of oxidizing agent, like KMnO4 it produce C.A.

$R\text{-}CHO \xrightarrow[KMnO_4]{[O]} R\text{-}COOH$

$CH_3\text{-}CHO \xrightarrow[KMnO_4]{[O]} CH_3\text{-}COOH$

(Acetaldehyde) (Acetic acid)

(II) By oxidation of 1° alcohol :-

When 1° alcohol oxidised in the presence of a oxidising agent like $K_2Cr_2O_7$ then produced C.A

$CH_3-CH_2OH + K_2Cr_2O_7 \longrightarrow CH_3COOH$

(ethanol) (acetic acid)

(III) By oxidation of alkenes :-

When alkenes treated with basic $KMnO_4$ under various condition, it oxidised to produced C.A.

$CH_3-CH=CH-CH_3 \xrightarrow[KMnO_4]{H_2O} CH_3-\overset{O}{\overset{\|}{C}}-OH + CH_3-\overset{O}{\overset{\|}{C}}-OH$

(But-2-ene) (Acetic acid)

CHEMICAL REACTION OF C.A :-

(I) Formation of acyl halides :-

C.A react with phosphorous pallide (PCl_5) to form acyl halides.

$R-COOH + PCl_5 \longrightarrow R-\overset{O}{\overset{\|}{C}}-Cl + POCl_3 + HCl$

$CH_3-COOH + PCl_5 \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-Cl + POCl_3 + HCl$

(Acetic acid) (Acyl halide)

(II) Formation of ester :-

C.A react with alcohol in the presence of strong acid to form ester.

$CH_3-\overset{O}{\overset{\|}{C}}-\boxed{OH + OH}-CH_3 \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-O-CH_3 + H_2O$

(acetic acid) (methyl acetate)

(III) Formation of anhydride :-

C.A under goes dehydration with P_2O_5 to form acid anhydride.

$CH_3-\overset{O}{\overset{\|}{C}}-\boxed{OH + OH}-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{P_2O_5} CH_3-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3 + H_2O$

(acetic acid) (Acetic anhydride)

Effect of substituent :-

Electronegativity and e⁻ withdrawing power of halogen substituent & strength of acid decreases in the order.

$FCH_2COOH > ClCH_2COOH > BrCH_2COOH > ICH_2COOH > CH_3COOH$

No. of reason : withdrawing chloro group and acid strength decreases the order

$Cl_3CCOOH > Cl_2CHCOOH > ClCH_2COOH > CH_3COOH$

(5) Define and differentiate SN_1 & SN_2 reaction with suitable illustration. Write a note on factor affecting SN_1 & SN_2 reaction.

Ans:-

SN^1 reaction :-

SN^1 stands for unimolecular nucleophile substitution reaction

- It is a two step process.
- The reaction follows 1st order of kinetics.
- The reaction takes place in the presence of weak base.
- Reactivity order : $3^\circ > 2^\circ > 1^\circ$

Step-1 :-

It is slow & rate determining step in which carbocation is formed.

$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Br \xrightarrow[\text{rate determining}]{\text{slow}} CH_3-\overset{CH_3}{\underset{CH_3}{C^{\oplus}}} \; Br^{\ominus}$$

Step-2 :-

Attack of nucleophile on carbocation.

$$CH_3-\overset{CH_3}{\underset{CH_3}{C^{\oplus}}} + OH^{\ominus} \xrightarrow{\text{Fast}} CH_3-\overset{CH_3}{\underset{CH_3}{C}}-OH$$

SN^2 reaction :-

SN^2 stands for nucleophile Bimolecular substitution reaction.

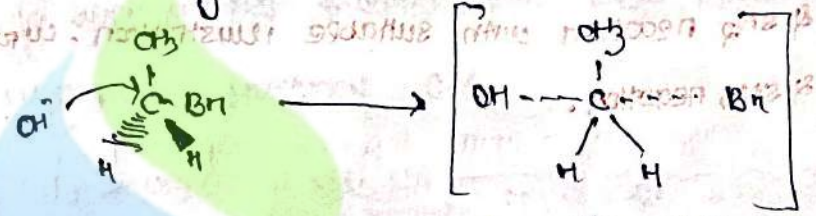
- It is a one step process.
- The reaction follows second order kinetics.

• formation of transition state takes place.

Reactivity order $3^\circ > 2^\circ > 1^\circ$

Mechanism of S_N2 reaction:-

In S_N2 reaction the nucleophile attacks on carbon atom of alkyl halide from backside which result in the formation of transition state & ultimately give product of opposite/ inverted configuration to that initial alkyl halide.



transition state

FACTORS AFFECTING S_N1 & S_N2 :-

There are following various factors that affect S_N1 & S_N2 reaction:

Nature of Alkyl halide:- Reactivity order of Alkyl halide for S_N1

$3^\circ > 2^\circ > 1^\circ$.

Reactivity order of Alkyl halide for S_N2.

$1^\circ > 2^\circ > 3^\circ$.

Nature of leaving group:- More easily the leaving group removed from carbon atom faster will be substitution reaction.

R-I > R-Br > R-Cl > R-F

Nature of solvent:- Generally polar protic solvents are used for S_N1 reaction.

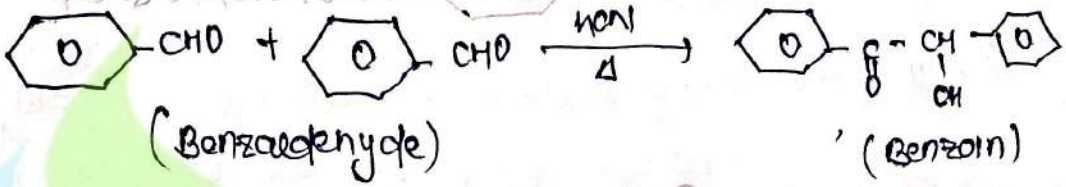
• Polar aprotic solvents are used for S_N2 reaction.

Q(b) Discuss the principle and mechanism and application of benzoin condensation and perkin condensation.

Ans :-

Benzoin condensation :-

In benzoin condensation two molecules of aromatic aldehyde react with each other in the presence of KCN to form benzoin.

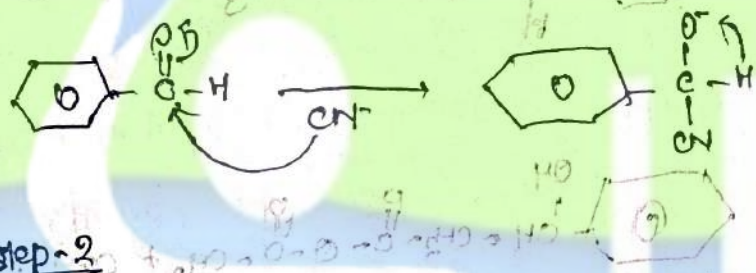


(Benzaldehyde) (Benzoin)

Mechanism :-

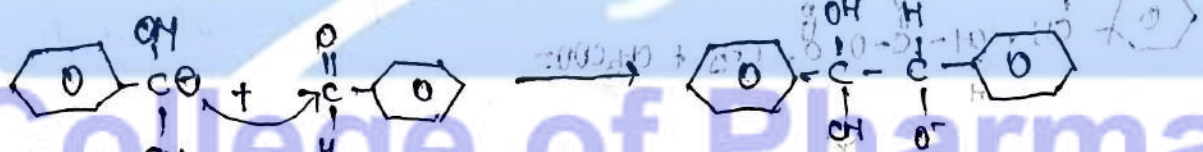
step-1

cyanide ion attacks on benzaldehyde to form carbocation.

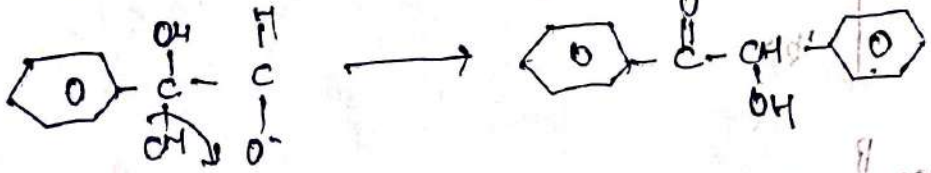


step-2

carbanion attacks on second benzaldehyde to form intermediate.

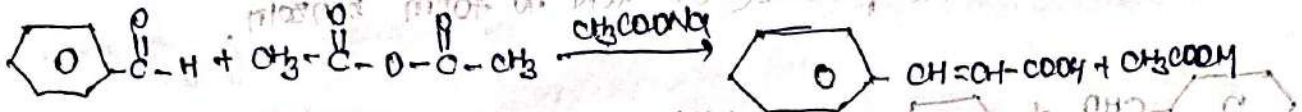


step-3



Perkin condensation :-

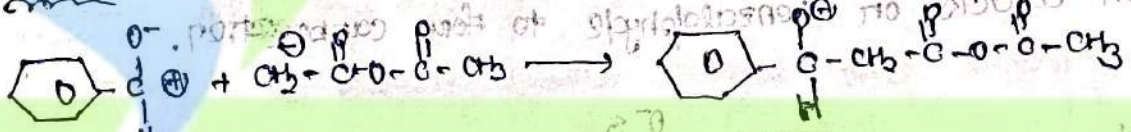
In perkin condensation aromatic aldehyde react with acetic anhydride in the presence of carboxylic acid salt to form α,β unsaturated acid & acetic acid.



Mechanism :-

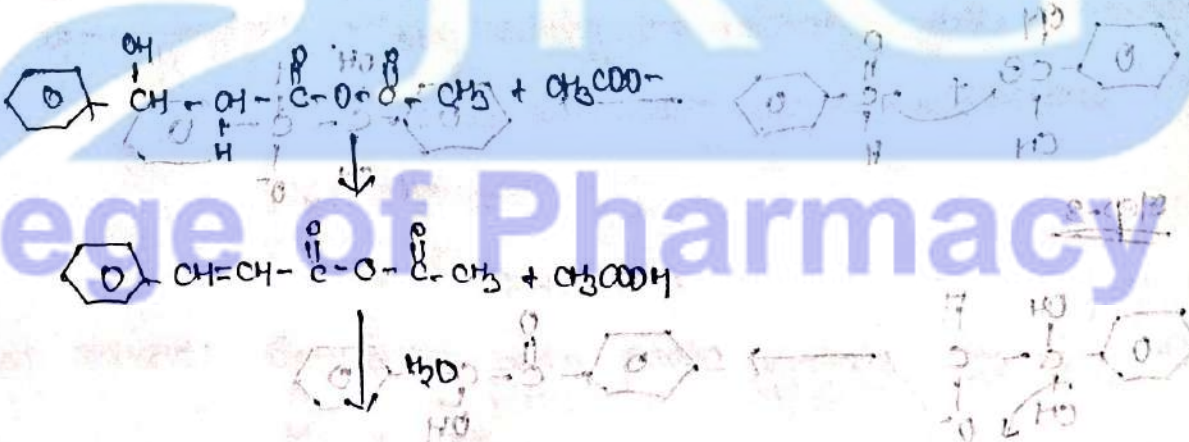
step-1 :-

step-2



step-3 :-

step-4 :-



(cinnamic acid) (acetic acid)