



# ***INTER & INTRA MOLECULAR REARRANGEMENT***

**By Doctoral Students**

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- ❖ Molecular Rearrangement
- ❖ Carbonium ion Rearrangement
- ❖ Pinacole & Related Rearrangement
- ❖ Schmidt Rearrangement

## REARRANGEMENT REACTION

The reactions which proceed by a rearrangement or reshuffling of the atoms groups in the molecule to produce a structural isomer of the original substance are called Rearrangement reactions.

Most are migrations from an atom to an adjacent one (called 1,2-shifts),but some are over longer distances.



## Classification :

### Intermolecular rearrangement :

- Reactions which involve migration of group between two molecules.
- In which the migration group gets completely detached and is later on reattached are called intermolecular rearrangements.

Eg : Aromatic rearrangements

### Intra molecular rearrangement :

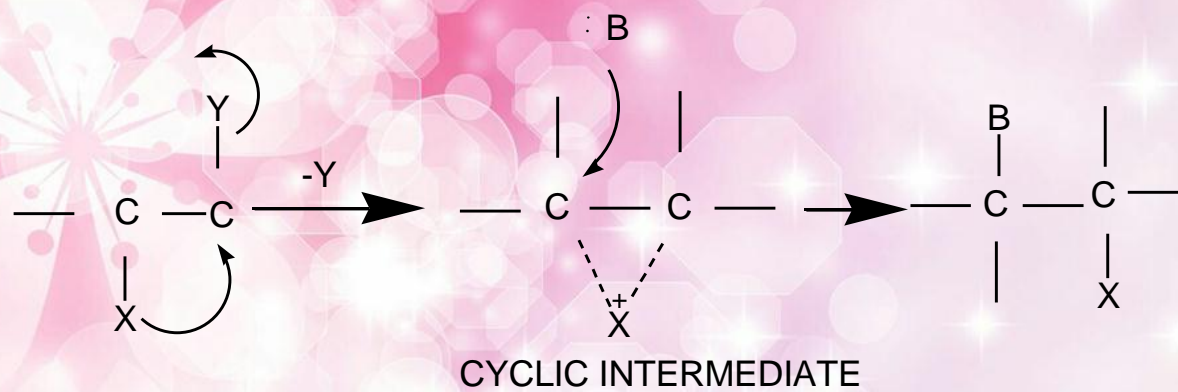
- Reactions which involve rearrangement within the same molecule

Those rearrangements in which the migration group is never fully detached from the system

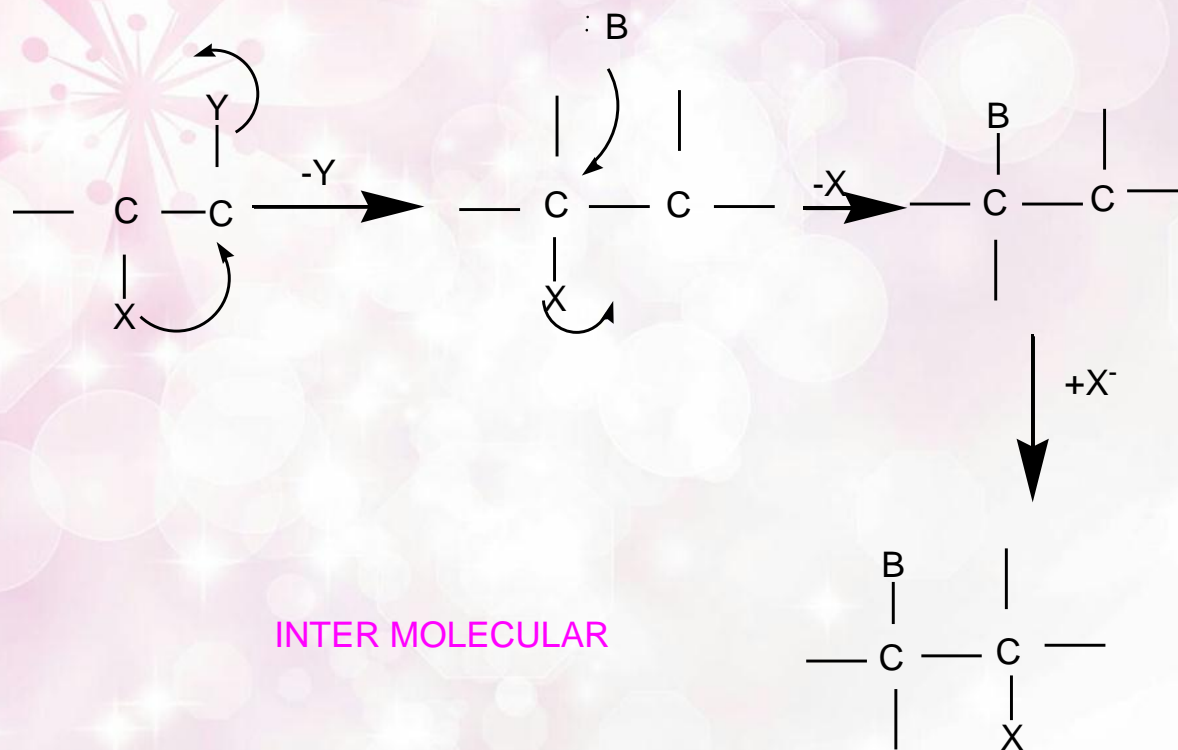
Eg: Nucleophilic rearrangement

Electrophilic rearrangement

Free radical rearrangement



INTRAMOLECULAR



## **NUCLEOPHILIC REARRANGEMENT :**

- ❖ Migrating group migrating towards electro defficient atoms.

## **ELECTROPHILIC REARRANGEMENT:**

- ❖ migrating group migrates towards electron rich centre.

## **FREE-RADICAL REARRANGEMENT:**

- ❖ those reactions in which migrating group moves to a free-radical centre.

## **AROMATIC REARRANGEMENT:**

- ❖ Migrating towards aromatic nucleus.



# NUCLEOPHILIC REARRANGEMENT

Migrating group migrates from a carbon atom to an adjacent electron deficient atom which is generally C, N, O.

➤ rearrangement to electron deficient *CARBON* atom(carbonium ion rearrangement)

Eg: Pinacole-pinacolone rearrangement

Wagner-meerwein rearrangement

Benzilic acid rearrangement

➤ rearrangement to electron deficient *NITROGEN* atom

E.g.: Schmidt rearrangement.

Hofmann rearrangement

➤ rearrangement to electron deficient *OXYGEN* atom

E.g.: Baeyer villager reaction

Cumene hydroperoxide rearrangement

## CARBONIUM ION REARRANGEMENT:

- In this case electron deficient atom is carbon the intermediate is known as carbonium ion rearrangement. And the reaction of this class is known as carbonium ion Rearrangement.



*with change in c-skeleton*

E.g.; Pinacole-pinacolone rearrangement

Wagner-meerwein rearrangement

Benzilic acid rearrangement

Wolf rearrangement

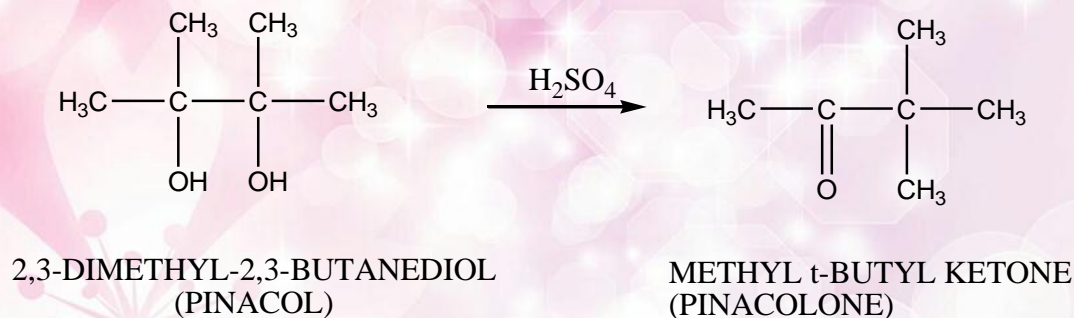
*with out change in skeleton*

E.g.: allycyclic rearrangement



# PINACOLE-PINACOLONE REARRANGEMENTS

- The conversion of pinacols(1,2-glycols) to ketones or aldehydes means of acids is known as pinacol rearrangements.

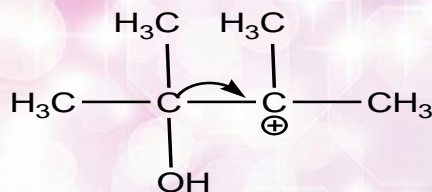
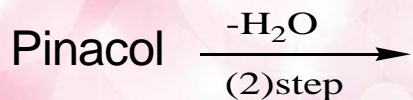
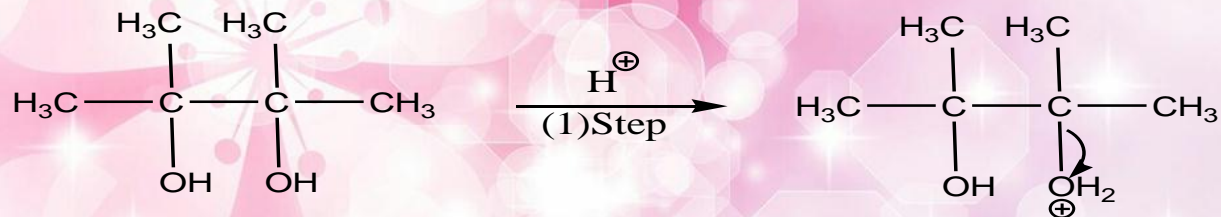


## MECHANISM :

The reaction involves four steps:-

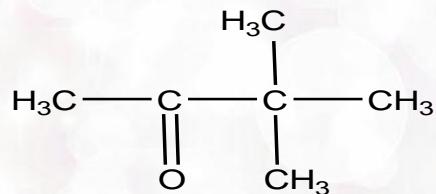
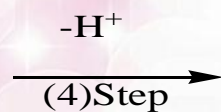
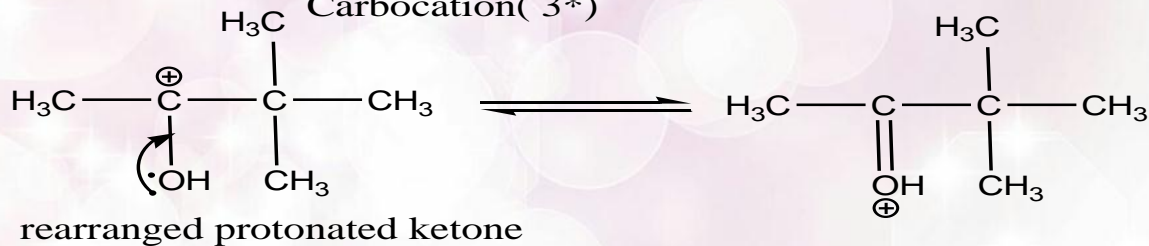
- 1. protonation of hydroxyl group
- 2. Loss of water to form a carbocation
- 3. 1,2-shift of  $:\text{H}$ ,  $:\text{R}$  or  $:\text{Ar}$  to form a more stable cation
- 4. Loss of  $\text{H}^+$  to form the final product

# Mechanism:



Carbocation( 3\*)

(3)step

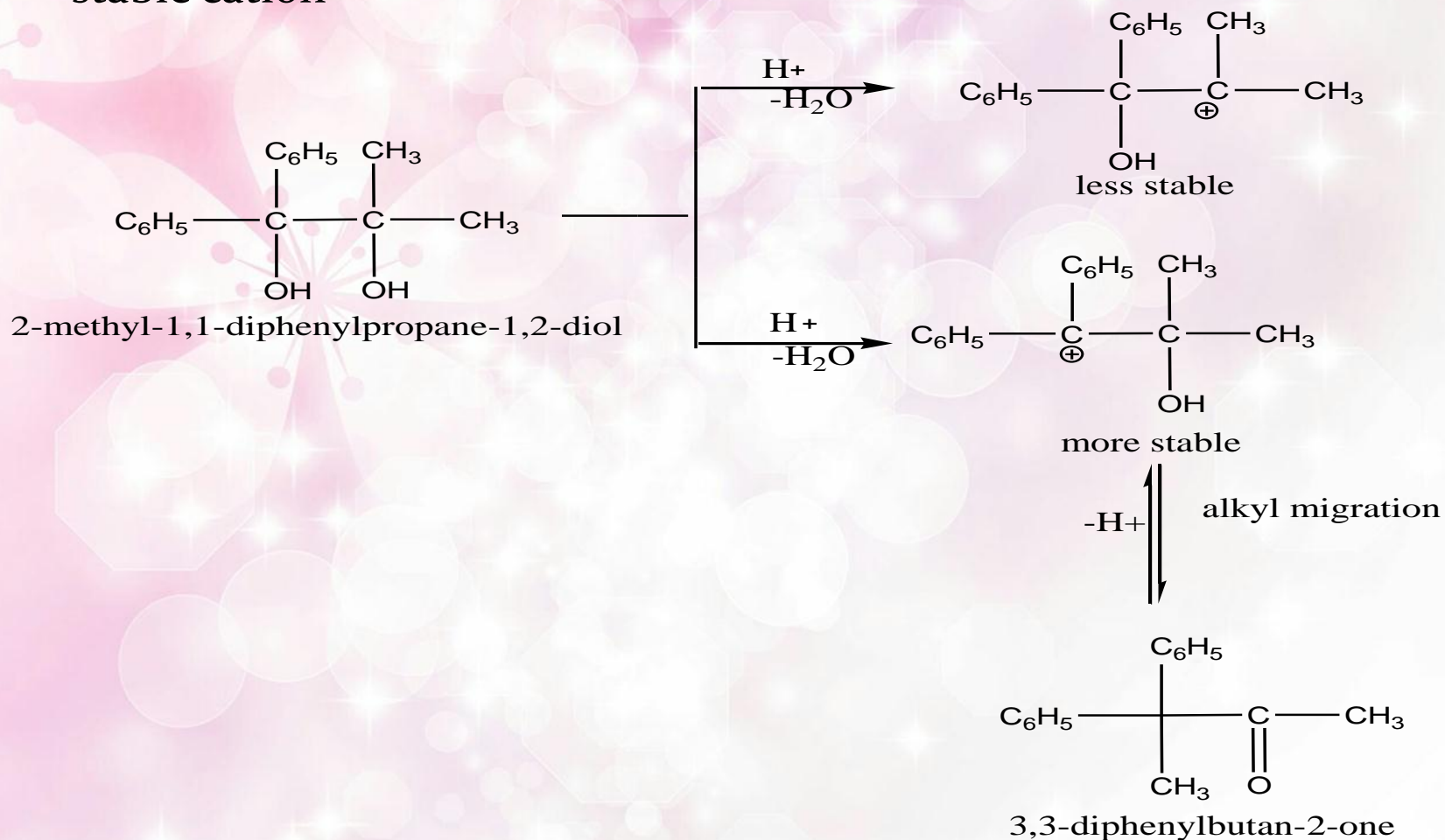


Pinacolone

# FEATURES OF PINACOLE REARRANGEMENT:

## 1). Stability of carbonium ion:

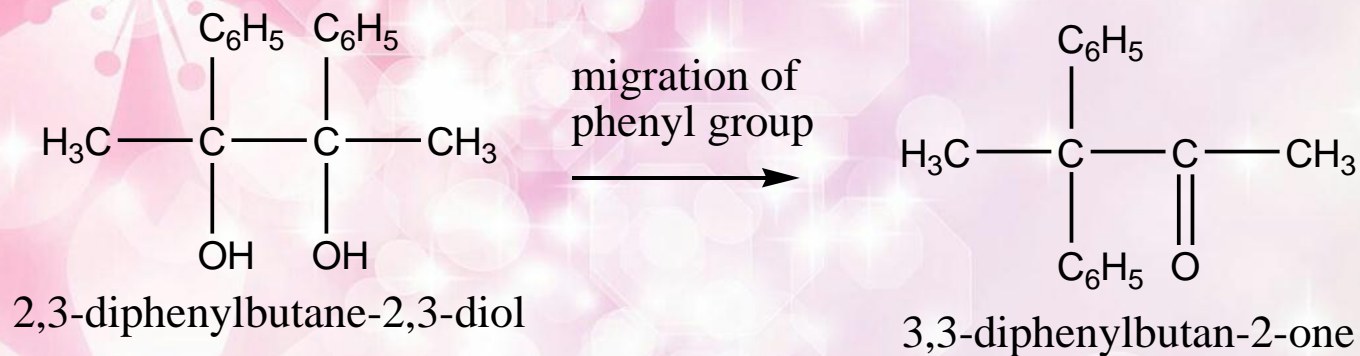
- when there is a choice as which hydroxyl group will be preferentially removed i.e., when two oh groups are different then that oh group will be removed which produces the more stable cation



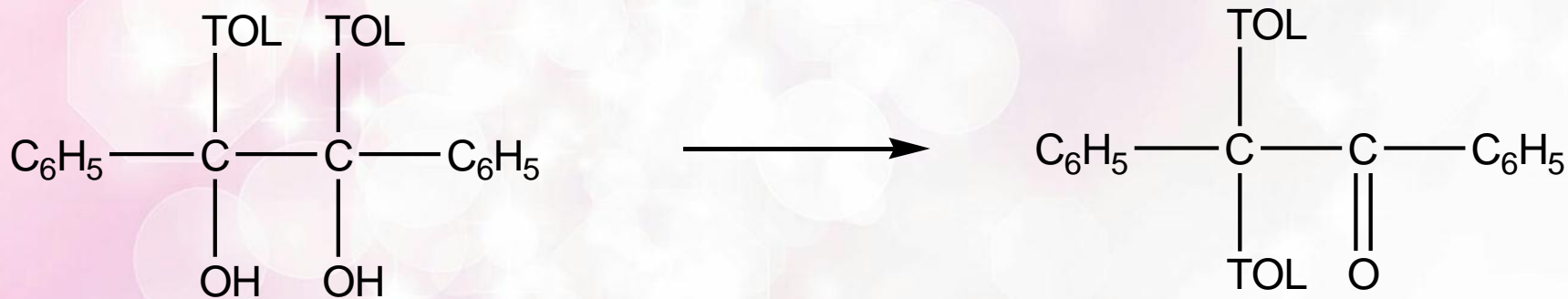


## 2). MIGRATORY APTITUDE:

When each of the carbon atoms of the glycol as an aryl and alkyl group, the more Nucleophilic (potentially electron-rich) aryl group preferentially migrates.



When the migratory competition is between two aryl groups, then the one which is better nucleophile (more powerful electron donor towards carbon) migrates Preferentially.



### 3).INTRA MOLECULAR MIGRATION:

- The migrating group migrates within the molecule, that is it never becomes free from the rest of the molecule as it retains its configuration in the product.

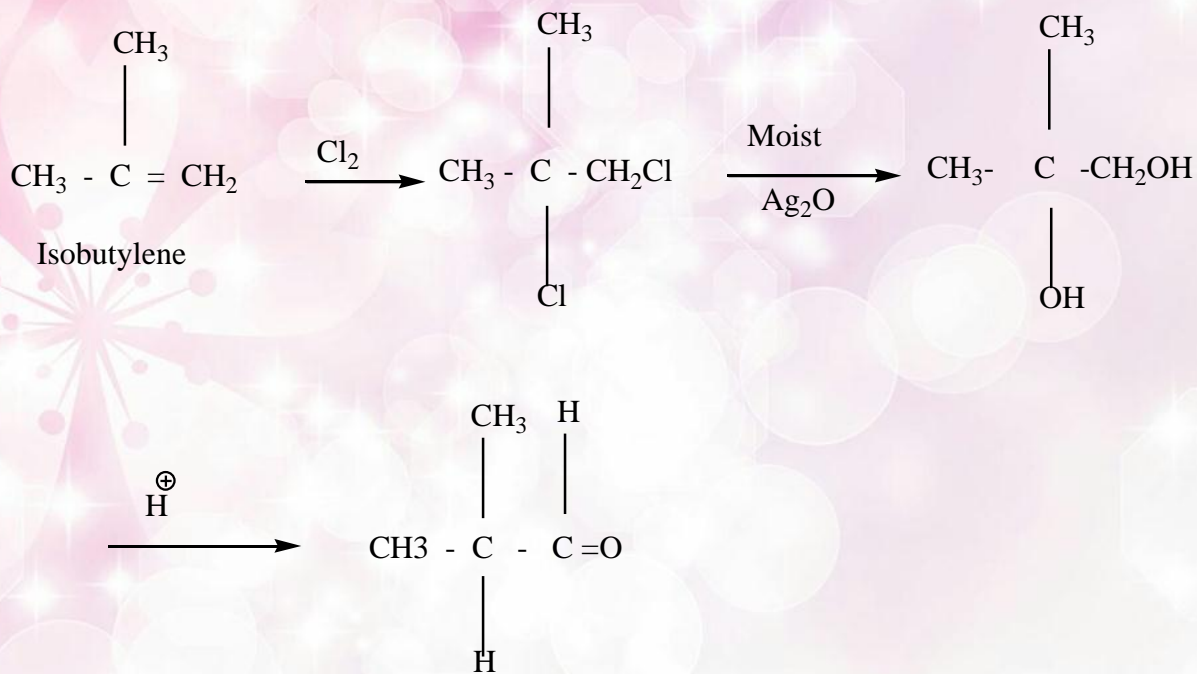
### 4).TRANS MIGRATION:

- The migrating group migrates to the opposite side of the leaving group which has important consequences in alicyclic system

# APPLICATIONS:

## 1.SYNTHESIS OF CARBONYL COMPOUNDS FROM ALKENES

Isobutyraldehyde may prepared on large scale from isobutylene

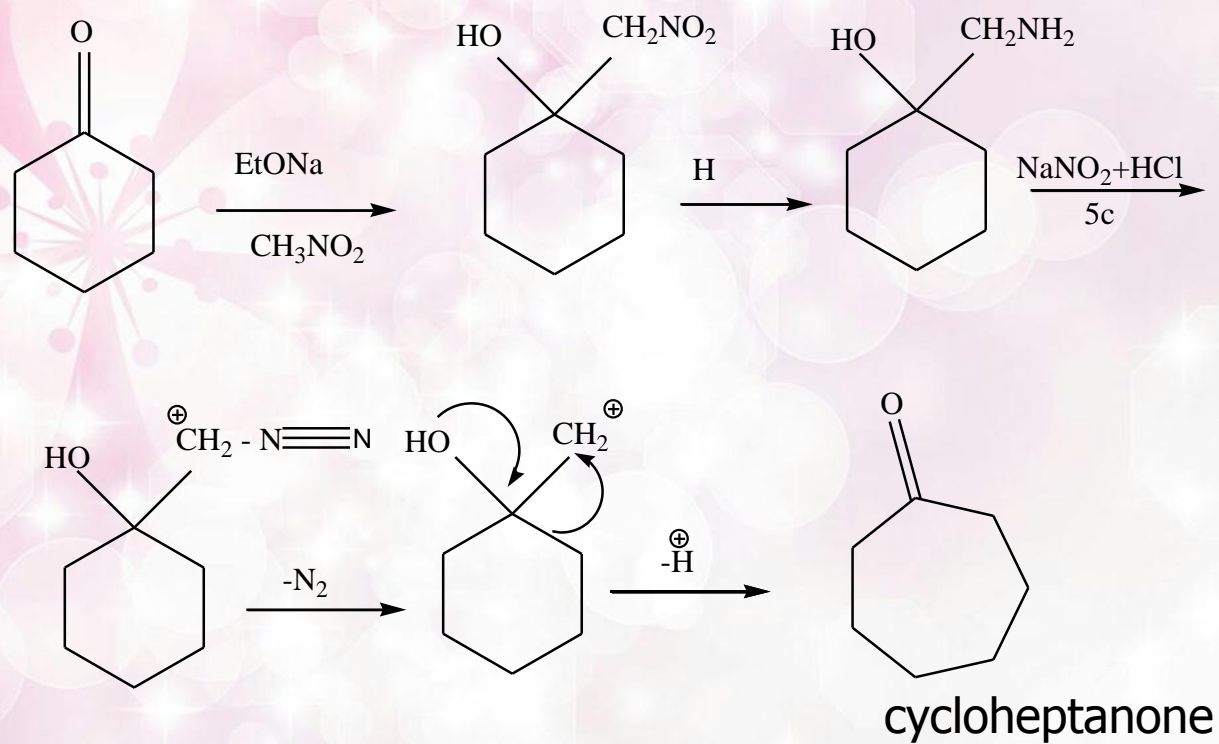


Dimethyl acetaldehyde  
(Isobutyraldehyde)



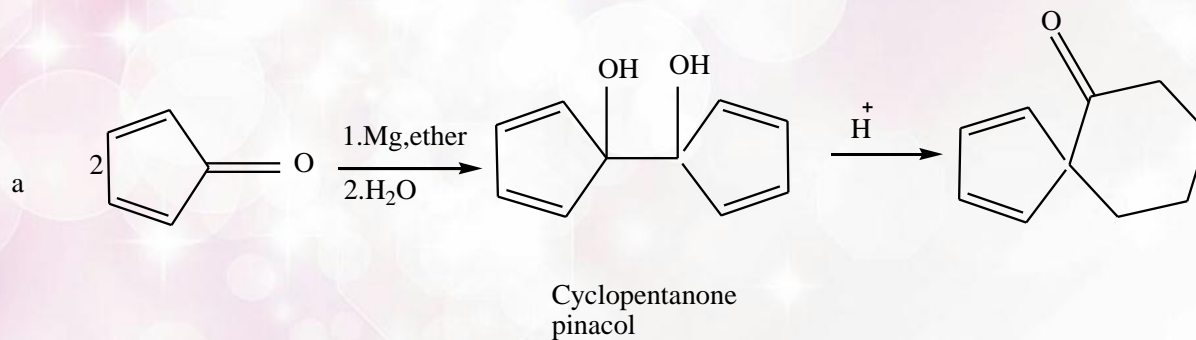
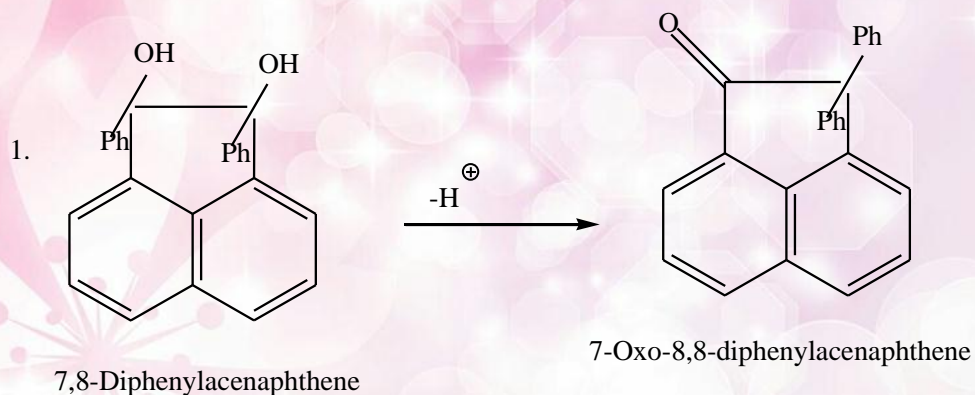
## 2. RING EXPANSION OF CYCLIC KETONES

Cyclohexanone can be converted to cycloheptanone in good yield



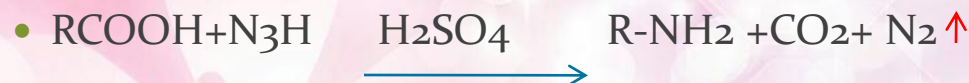
### 3.KETONES FROM CYCLIC DIOLS

Pinacol rearrangement has been employed to prepare ketones which are otherwise Inaccessible to synthesis

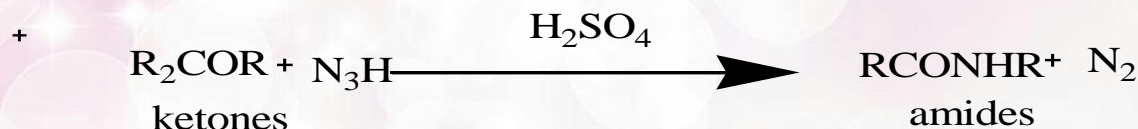
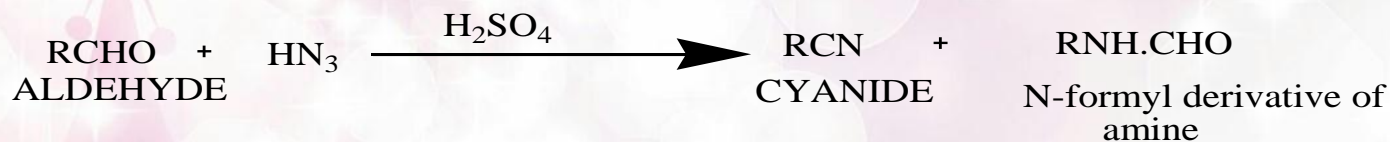


# SCHMIDT REARRANGEMENT

- Carboxylic acids react with hydrazoic acid in presence of concentrated sulphuric acid to give amine directly, the reaction is known as Schmidt reaction.



- Schmidt reaction also occurs between ketones or aldehydes and hydrazoic acid.



Ketones  $\longrightarrow$  Substituted amides

- Aldehydes  $\longrightarrow$  Nitriles & N-formyl derivatives

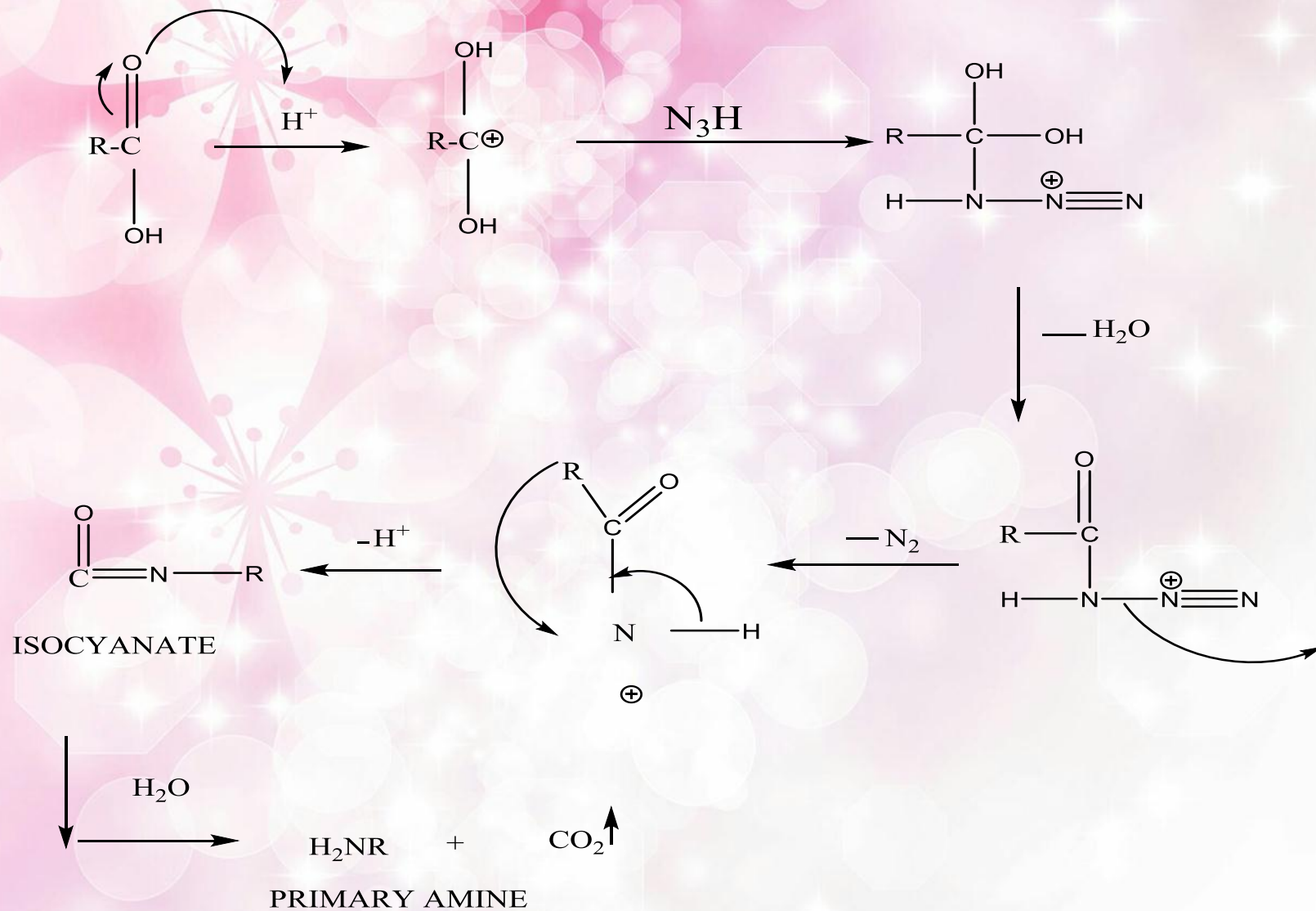


# Mechanism:

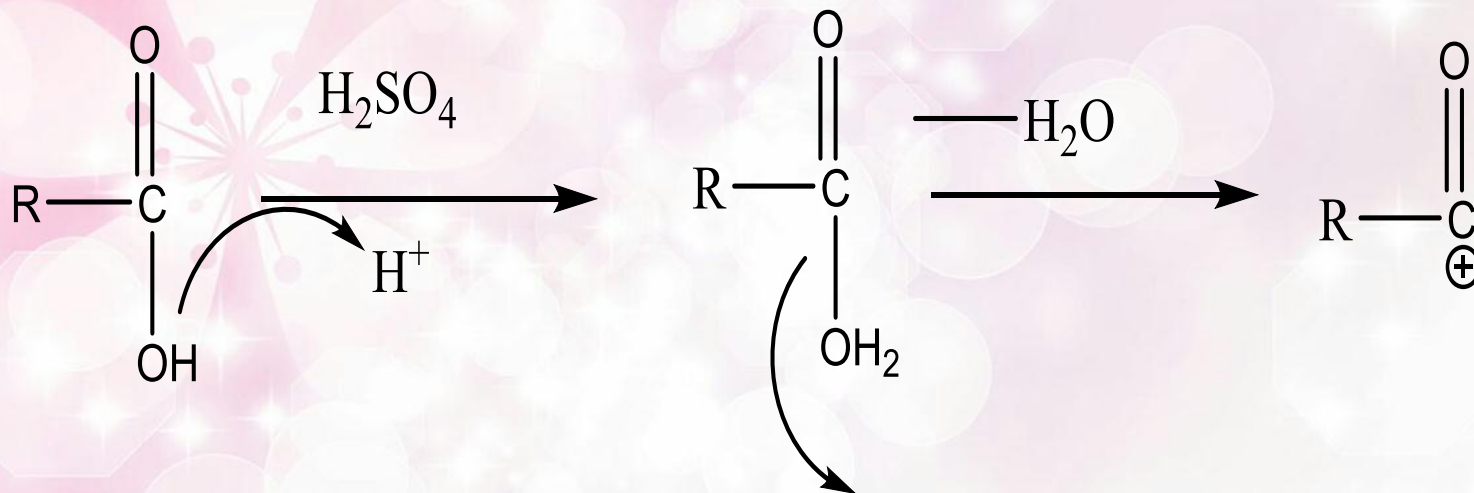
- Mechanism involves following steps:
- 1.elimination of nitrogen.
- 2.formation of intermediate.
- 3.intermediate undergo rearrangement to form isocyanate.
- 4.hydrolysis of isocyanate to form amine &  $\text{CO}_2$

Transformation occurs more rapidly without heating with sterically hindered acids(mesitoic acid)

# MECHANISM:

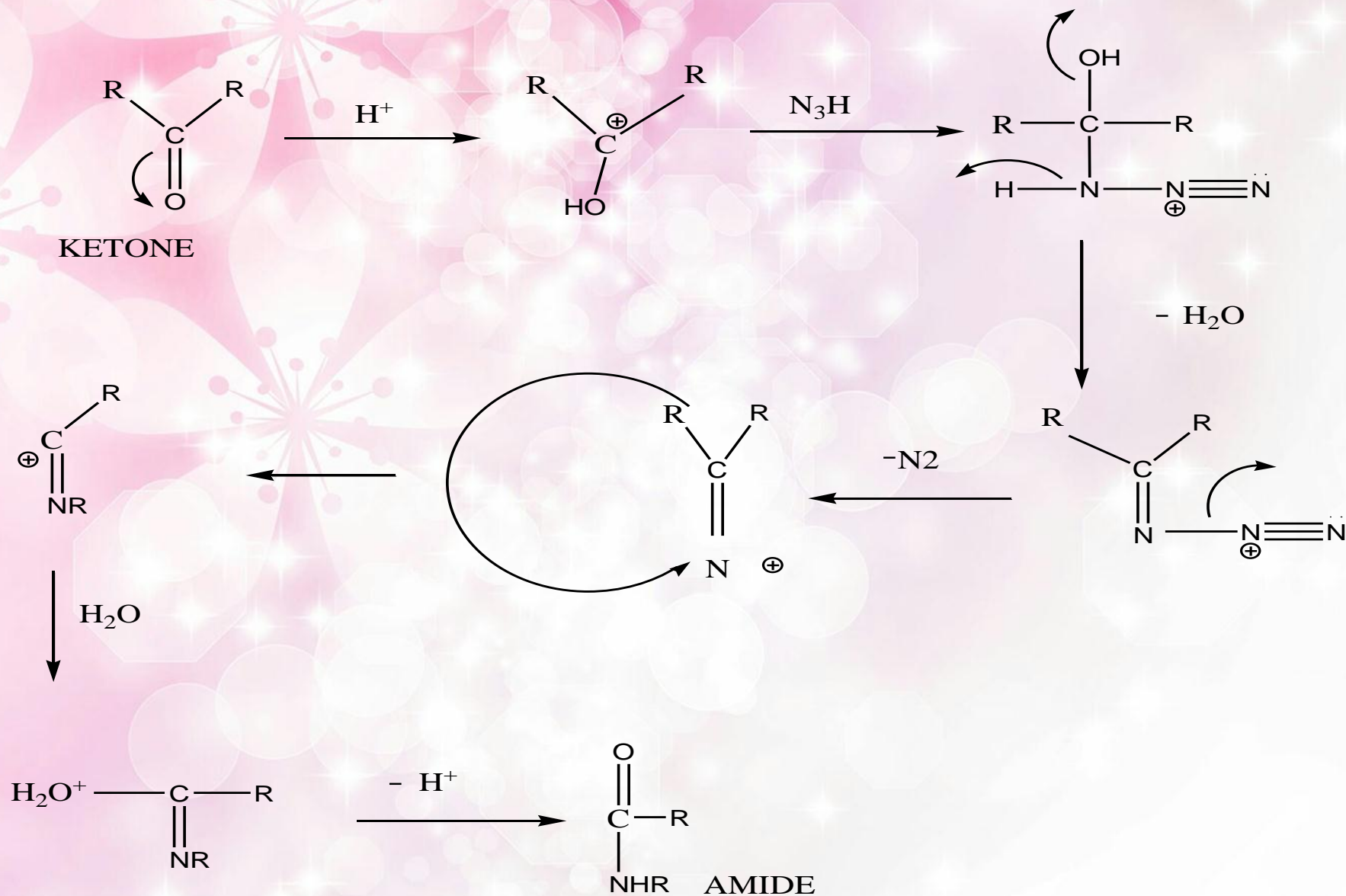


The reaction with acids i.e. benzoic acid, which require heating for the removal of nitrogen from acid azide proceed as below

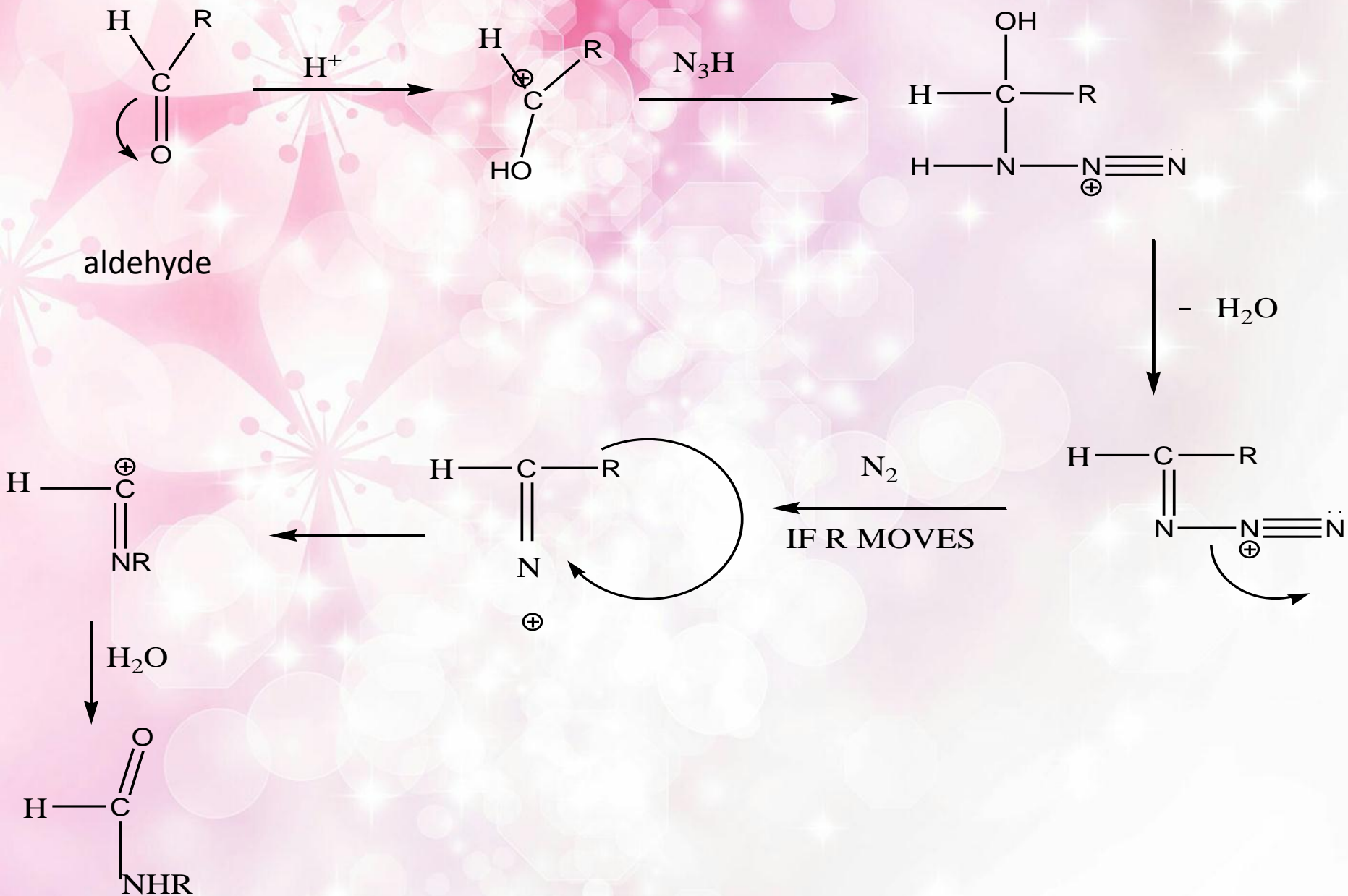




# REACTION WITH KETONES:



# MECHANISM FOR ALDEHYDES:



- IF 'H' MOVES:

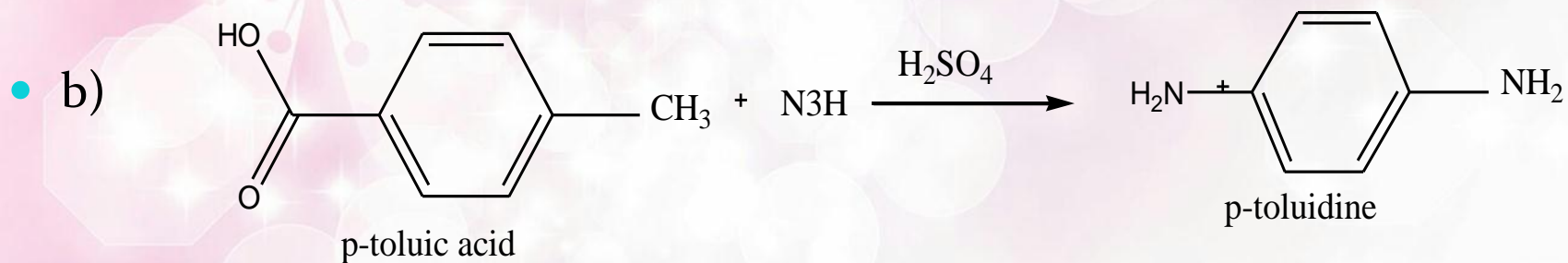
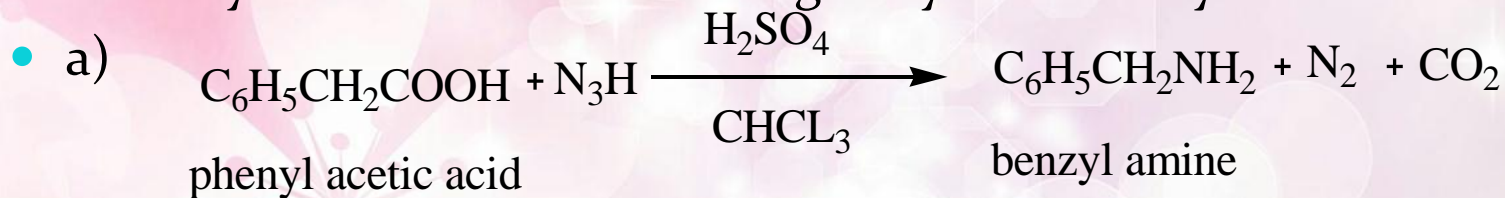




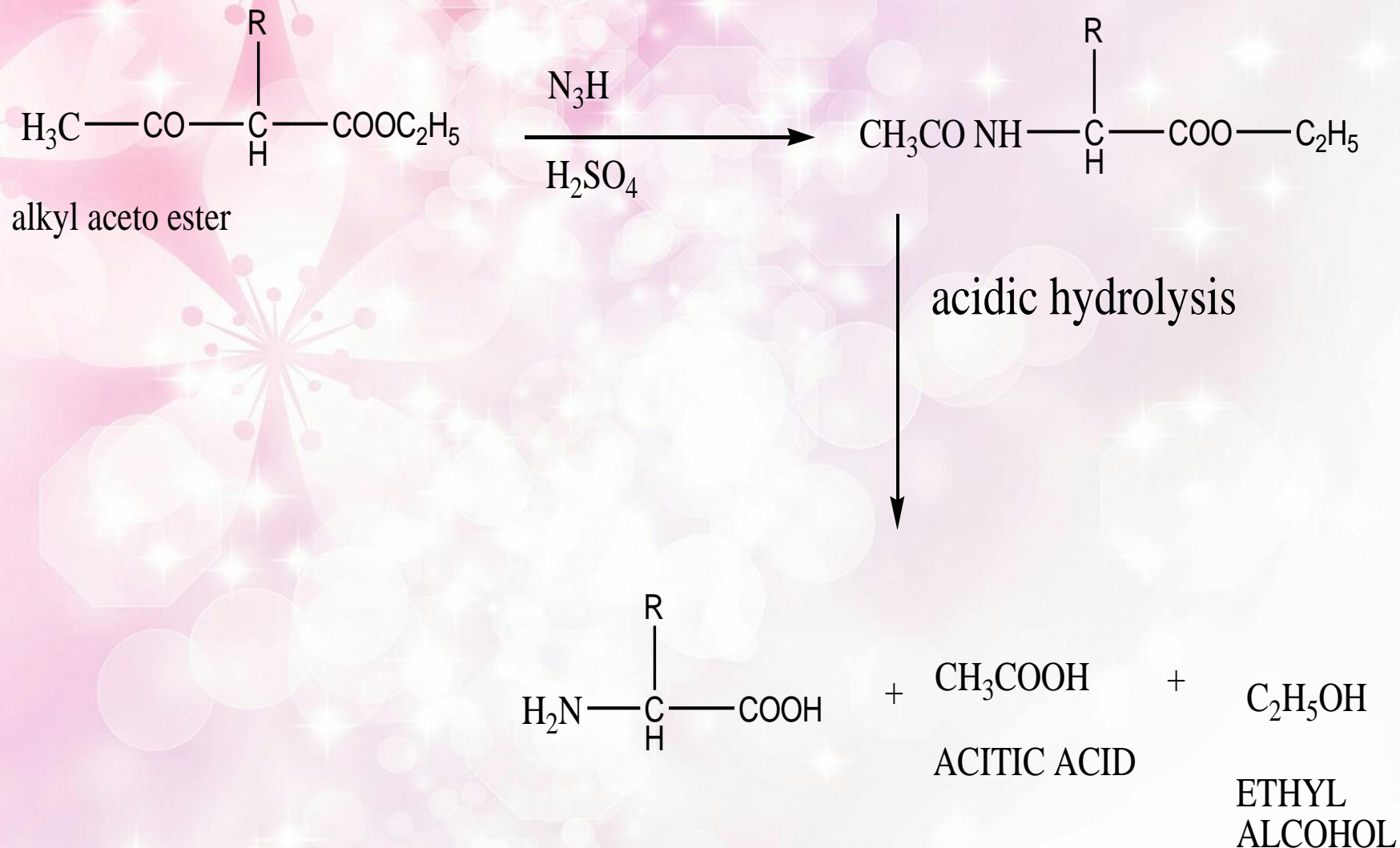
# APPLICATIONS:

- **PREPARATION OF AMINES:**

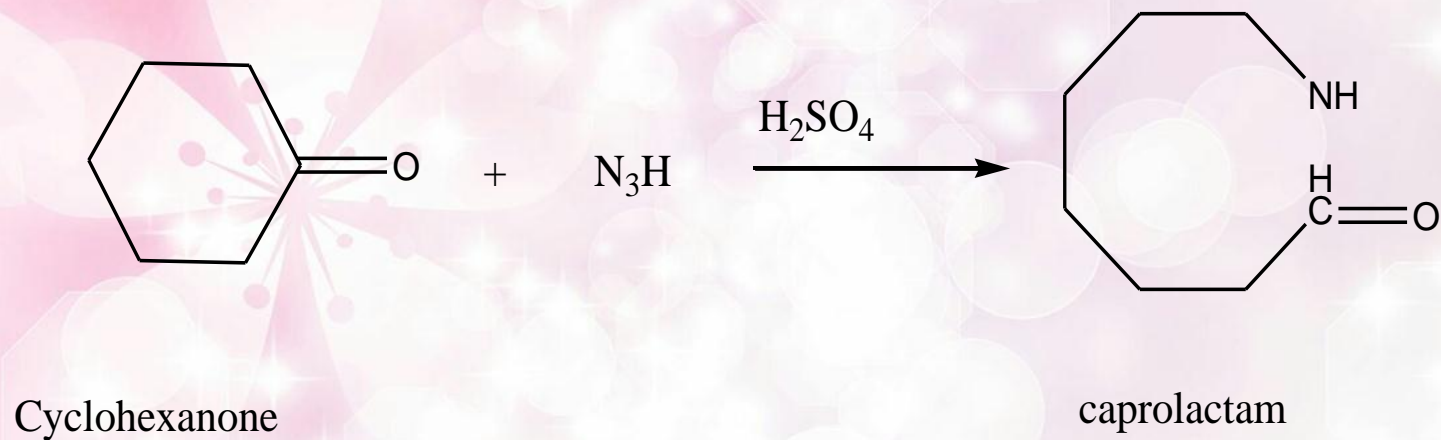
- Primary amines are obtained in good yield directly from acids.



## PREPARATION OF a AMINOACIDS:



- **PREPARATION OF LACTONES:**
- Cyclic ketones react to give lactones





## ***REFERENCES***

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