

# CHEMISTRY



## WORKSHEET-5



**STP**

A PROJECT BY PUNJAB GROUP

## Worksheet-05

## (C. Organic Chemistry)

## Carboxylic Acid and Amino Acids

- Q.1** Which of the following is the weakest acid?  
 A)  $\text{CH}_3\text{COOH}$                       C)  $\text{Cl}_2\text{CHCOOH}$   
 B)  $\text{ClCH}_2\text{COOH}$                     D)  $\text{Cl}_3\text{COOH}$
- Q.2** Which of the following acids cannot be prepared directly from carboxylic acid?  
 A) Acid halide                      C) Ester  
 B) Acid amide                      D) Acid anhydride
- Q.3** All of the following methods are used to prepare carboxylic acids EXCEPT:  
 A) By the oxidation of alcohol  
 B) By acid hydrolysis of alkane nitrile  
 C) By the reaction  $\text{R-Mg-Br}$  with  $\text{CO}_2$  followed by acid hydrolysis  
 D) By the reduction of aldehydes
- Q.4** Which one of the following methods is used to prepare acid anhydride?  
 A) Dehydration of carboxylic acid with  $\text{P}_2\text{O}_5$   
 B) Reaction of carboxylic acid with  $\text{SOCl}_2$   
 C) Reaction of carboxylic acid with  $\text{NH}_3$   
 D) Reaction of carboxylic acid with alcohol in the presence of conc.  $\text{H}_2\text{SO}_4$
- Q.5** Which one of the following organic acids is the most reactive and the strongest acid?  
 A)  $\text{HCOOH}$                       C)  $\text{CH}_3\text{CH}_2\text{COOH}$   
 B)  $\text{CH}_3\text{COOH}$                     D)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- Q.6** Which of the following halosubstituted carboxylic acids is the strongest acid?  
 A)  $\text{FCH}_2\text{COOH}$                     C)  $\text{BrCH}_2\text{COOH}$   
 B)  $\text{ClCH}_2\text{COOH}$                     D)  $\text{ICH}_2\text{COOH}$
- Q.7** Organic compounds X and Y react together to form organic compound (Z). What type of compounds X, Y and Z be?

Options	X	Y	Z
A)	Acid	Ester	Alcohol
B)	Alcohol	Ester	Acid
C)	Ester	Alcohol	Acid
D)	Alcohol	Acid	Ester

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**Q.13** Which of the followings has comparatively less acidic character?

- A) Ethanoic acid                      C) Phenol  
B) Ethanol                                D) Water

**Q.14** Which reaction does not produce benzoic acid?

- A) By hydrolysis of  $C_6H_5CO_2C_2H_5$   
B) By hydrolysis of  $C_6H_5CN$   
C) By oxidation of toluene  
D) By oxidation of phenol

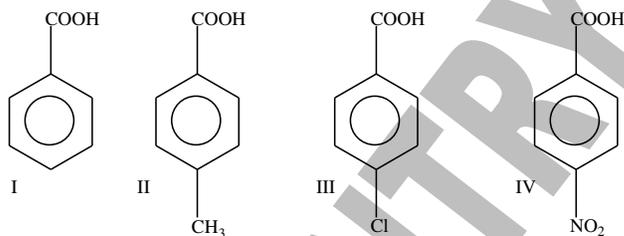
**Q.15** Which class of organic compounds is used for artificial flavorings in jams?

- A) Ester                                    C) Ketone  
B) Carboxylic acid                      D) Aldehydes

**Q.16** Which of the following compounds would react readily with NaOH?

- A)  $R - NH_2$                               C)  $RCOOH$   
B)  $R - COCl$                               D)  $RCH_2 - OH$

**Q.17** In the following carboxylic acids:



The decreasing order of acidic character is:

- A) III > IV > I > II                      C) I > IV > III > II  
B) II > I > III > IV                      D) IV > III > I > II

**Q.18** Amino acids have all of the following properties EXCEPT:

- A) They are colourless, crystalline solids  
B) They have low melting points  
C) They are soluble in water  
D) They behave like salts rather than simple amides and carboxylic acid

**Q.19** Which of the following carboxylic acids is prepared by acid hydrolysis of ethane nitrile?

- A) Methanoic acid                      C) Propanoic acid  
B) Ethanoic acid                         D) Butanoic acid

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**Q.20 Mark the incorrect statement about  $\alpha$ -amino acids:**

- A) They all have chiral carbon except glycine
- B) They are all L-amino acids
- C) 10 amino acids are called non-essential or dispensable amino acids
- D) Polypeptides act as acid only

**Q.21 Which of the following methods is used to prepare amines (mixture of amines) on the commercial scale?**

- A) Williamson's synthesis
- B) Strecker synthesis
- C) Wolf Kishner reduction reaction
- D) Hofmann's method

**Q.22 Dehydration of an acid amide gives:**

- A) Cyanide
- B) Isocyanide
- C) Amine
- D) Fatty acid

**Q.23 Hoffmann's bromamide reaction is used to prepare \_\_\_\_\_ amine from amides.**

- A) 1°
- B) 3°
- C) 2°
- D) 1° and 2°

**Q.24 Consider the following structure of primary amine:**



**The correct name of the above structure according to IUPAC is:**

- A) 4-Methyl pentan-2-amine
- B) 3-Methyl butan-2-amine
- C) 2-Methyl pentan-2-amine
- D) 4-Methyl pentan-3-amine

**Q.25 For which of the following type of amines carbylamine test gives positive reaction:**

- A) Prim. amine
- B) Sec. amine
- C) Tert. amines
- D) Both B and C

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**Q.26 The correct order of basic nature of the following:**

**$\text{CH}_3\text{NH}_2$ ,  $(\text{CH}_3)_2\text{NH}$ ,  $(\text{CH}_3)_3\text{N}$  and  $\text{NH}_3$  is:**

- A)  $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3$
- B)  $\text{CH}_3\text{NH}_2 > (\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N} > \text{NH}_3$
- C)  $(\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N} > \text{NH}_3 > \text{CH}_3\text{NH}_2$
- D)  $\text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3 > (\text{CH}_3)_2\text{NH}$

**Q.27 Reaction of ethanoic acid with ammonia gives:**

- A) Ethane amide
- B) Ethane nitrile
- C) Ethyl amine
- D) Nitro methane

**Q.28 Which of the following compounds is expected to be strongest base?**

- A) Hydroxylamine
- B) Methylamine
- C) Aniline
- D) Ethylamine

**Q.29 Which of the following types of isomerism is not shown by aliphatic amines?**

- A) Chain isomerism
- B) Position isomerism
- C) Metamerism
- D) Tautomerism

**Q.30 Electrophoresis is not used for the separation of:**

- A) Nucleic acids
- B) Amino acids
- C) Proteins
- D) Lipids

**Q.31 In gel electrophoresis, how do we make the DNA migrate through the gel?**

- A) We place a negative electrode away from the walls
- B) Large fragments drift to the end of the gel
- C) We place a positive electrode away from the walls
- D) Gravity

**Q.32 In electrophoresis, the electrophoretic mobility ( $\mu$ ) determines the characteristics of migration of different biomolecules. Which of the following is not having any influence in  $\mu$ :**

- A) Stereochemistry of molecule
- B) Molecular weight
- C) Size of molecule
- D) Net charge of molecule

**Q.33 Which of the following derivatives of carboxylic acid is the most reactive?**

- A) Acid amide
- B) Acid halide
- C) Ester
- D) Acid anhydride

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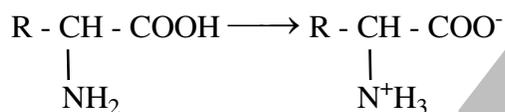
**Q.34** In which of the following reactions acid chloride produces aldehyde?

- A) Reaction with  $H_2$                       C) Hydrolysis  
 B) Reaction with  $NH_3$                   D) Reaction with Alcohol

**Q.35** Which of the following method is/are not used to prepare primary amines?

- A) By the reduction of acid amide  
 B) By reductive amination of aldehyde or ketones  
 C) By catalytic hydrogenation  $H_2/Pt$   
 D) By the reaction of Grignard reagent with  $NH_3$

**Q.36** Each molecule of  $\alpha$ -amino acid can interact within itself due to its basic  $-NH_2$  group and its acidic  $-COOH$  group. This is called zwitter ion:



Which of the following characteristics features is/are shown by zwitterion?

- A) In zwitterion the German zwei means two  
 B) It is amphoteric in nature  
 C) It is crystalline solid and soluble in water  
 D) All of these

**Q.37**  $\alpha$ -amino acid molecules can react with each other, the acid  $-COOH$  group in one molecule reacts with the basic  $-NH_2$  group in another molecule, when two  $\alpha$ -amino acids react together, the resulting molecule is called:

- A) Peptide                                      C) Polypeptide  
 B) Dipeptide                                    D) Tripeptide

**Q.38** On the acid hydrolysis of acid amide, which of the following product is obtained:

- A) Alkane nitrile  
 B) Sod. salt of carboxylic acid  
 C) Primary amine  
 D) Carboxylic acid

**Q.39** Which of the following derivatives of carboxylic acid is least reactive?

- A) Acid halide                                  C) Ester  
 B) Acid amide                                  D) Acid anhydride

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## ANSWER KEY (Worksheet-05)

1	A	11	C	21	D	31	B
2	B	12	D	22	A	32	A
3	D	13	B	23	A	33	B
4	A	14	D	24	A	34	A
5	A	15	A	25	A	35	D
6	A	16	C	26	A	36	D
7	D	17	D	27	A	37	B
8	A	18	B	28	D	38	D
9	B	19	B	29	D	39	B
10	C	20	D	30	D	40	

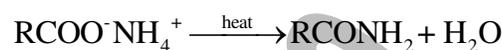
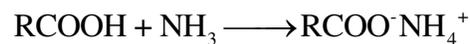
## ANSWERS EXPLAINED

- Q.1 (A) Acid strength increases by increasing a number of electron-withdrawing substituents (e.g. Cl- group) on the carbon next to the **-COOH group**. Order of decreasing acidic strength is as follow  $\text{Cl}_3\text{CCOOH} > \text{Cl}_2\text{CHCOOH} > \text{ClCH}_2\text{COOH} > \text{CH}_3\text{COOH}$

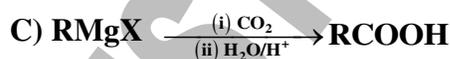
- Greater is  $K_a$  value (or less  $pK_a$  value) stronger is the acid

Carboxylic acid/Substituted carboxylic acid	$K_a$ value	$pK_a$ value
$\text{Cl}_3\text{CCOOH}$	$23200 \times 10^{-5}$	0.60
$\text{Cl}_2\text{CHCOOH}$	$5530 \times 10^{-5}$	1.26
$\text{ClCH}_2\text{COOH}$	$136 \times 10^{-5}$	2.87
$\text{CH}_3\text{COOH}$	$1.7 \times 10^{-5}$	4.76

- Q.2 (B) Because when **carboxylic acid** is treated with **ammonia**, first of all ammonium salt of carboxylic acid is formed which on heating produces acid amide as **shown in the reaction**



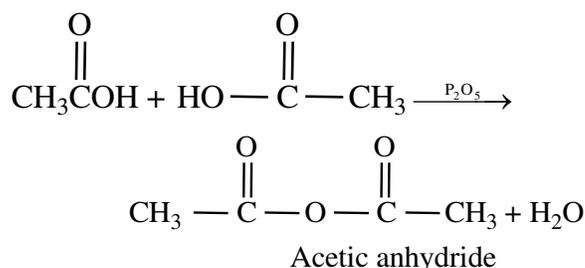
- Q.3 (D) In fact, by the reduction of **aldehydes, alcohols** are obtained instead of **carboxylic acids**. Detail of all preparatory methods of **carboxylic acids** are given below:



(Carbonation reaction)



- Q.4 (A) Acid anhydride is prepared when carboxylic acids are dehydrated on heating strongly in the presence of phosphorus pentoxide as shown below in the reaction e.g.



**Q.5 (A)** Methanoic acid is very reactive and stronger acid because with the increase of alkyl group polarity of carboxyl group decreases and strength of the acid also decreases.

- Because alkyl group is electron-donating group and it decreases polarity and thus deprotonation of carboxylic acid decreases with the increase of alkyl group.
- Order of reactivity and strength of acid is given below.



- Their  $K_a$  are given as respectively.



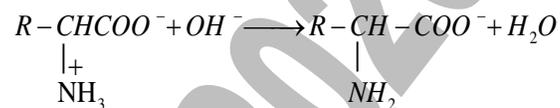
**Q.6 (A)** The electron-withdrawing tendency of a substituent depends upon its electronegativity. More electronegative substituent will have **greater electron-withdrawing** tendency.



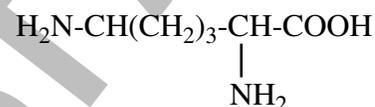
**Q.7 (D)** Compounds **X, Y and Z** stand for **Alcohol, carboxylic acid** and ester respectively. **X and Y** react with each other in the presence of **conc.  $\text{H}_2\text{SO}_4$**  to form **ester**. It is known as esterification or condensation reaction.

**Q.8 (A)** **Glycine** is not optically active compound because it **does not** contain asymmetric carbon atom (**Chiral carbon**).

**Q.9 (B)** When an **alkali** is added to an  **$\alpha$ -amino acid**, (in the form of **zwitter ion**)  **$-\text{NH}_3^+$**  group releases the proton and therefore, the acidic character is due to this group.



**Q.10 (C)** The correct structure formula of **lysine** is

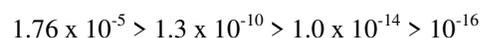


**Q.11 (C)** It is **incorrect** statement. The correct statement is as follow:

- **20  $\alpha$ -amino acids** can be sub-classified according to how the properties of other functional groups in the 'R' group influence the system.
- **Non—polar side chains** (e.g. alkyl groups)
- **Polar** (e.g. amides alcohols)
- **Acidic** (carboxylic acids, phenols)
- **Basic** (e.g. amines)

**Q.12 (D)** In fact it is used as local irritant but not as an antiseptic in nasal infection.

**Q.13 (B)** **Order of strength of acidic character** is given as follow:



**Q.14 (D)** Benzoic acid **cannot** be prepared by oxidation of **phenol**. Others **A, B, C methods** are used to **prepare Benzoic acid**.

**Q.15 (A)** **Ester (a class of organic compounds)** is used for artificial flavorings in **jams**.

**Q.16 (C)** **Carboxylic acid (RCOOH)** would react readily with **NaOH** as shown in the reaction:



**Q.17 (D)** Their **decreasing order** of acidic character is as follow **IV > III > I > II**

- **The electron releasing group –OH, –NH<sub>2</sub>, –CH<sub>3</sub> etc. tend to decrease strength of benzoic acid.**
- **The electron withdrawing groups such as –NO<sub>2</sub>, –Cl etc. tend to increase the strength of benzoic acid.**

**Q.18 (B)** In fact, **amino acid** have **high melting points**.

**Q.19 (B)** By acid hydrolysis of ethane nitrile ethanoic acid is obtained as shown in the reaction:



**Q.20 (D)** **Polypeptides** are amphoteric because of the presence of **free –NH<sub>2</sub> and –COOH** groups. Therefore they can be treated as **acids** and **bases**.

**Q.21 (D)** **Hofmann's method:**

Haloalkanes when heated with an ethanolic solution of ammonia in a sealed tube at 100°C, a mixture of the three amines and some quaternary

ammonium salt are obtained. This reaction is called ammonylsis.

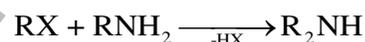
- This method is used for the industrial preparation of amines.
- The three amines so obtained can be separated from the quaternary ammonia salt by boiling with KOH, when the quaternary salt is left behind, and the three amines distil over.
- These can be separated from each other by fractional distillation:

#### Preparations of amines

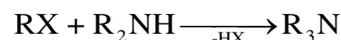
- **Primary amine:**



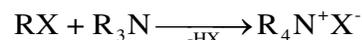
- **Secondary amine:**



- **Tertiary amine:**

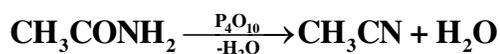


- **Quaternary salt:**



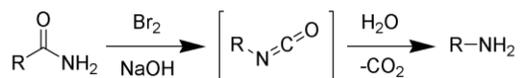
**Q.22 (A)** Amides are dehydrated by heating a solid mixture of the amide and phosphorus (V) oxide P<sub>4</sub>O<sub>10</sub>.

- **Water is removed from the amide group to leave a nitrile group, –CN. The liquid nitrile is collected by simple distillation.**
- **e.g. on the dehydration of ethanamide, in the presence of P<sub>2</sub>O<sub>5</sub> ethane nitrile is obtained as shown in the reaction.**



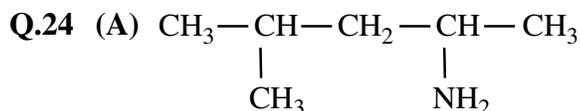
**Q.23 (A)** **Hoffmann's-bromide (or hypobromide) reaction:**

This reaction is also known as Hoffmann's rearrangement of amides. Treatment of acid amides with bromide and caustic potash gives primary amines having one carbon less than the amide.



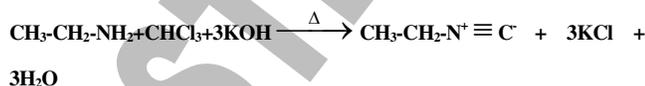
### Isocyanate

The reaction is named after its discoverer - August Wilhelm von Hofmann. This reaction is also sometimes called the Hofmann degradation or the Harmon Process.



The correct name of the above structure according to IUPAC is 4-Methyl pentan-2-amine.

Q.25 (A) The carbylamine reaction, also known as Hoffmann's isocyanide test is a chemical test for detection of primary amines. In this reaction, the analyte is heated with alcoholic potassium hydroxide and chloroform. If a primary amine is present, the isocyanide (carbylamine) is formed which are foul smelling substances.



The carbylamine test does not give a positive reaction with secondary and tertiary amines.

Q.26 (A) The basicity of amines is often discussed indirectly in terms of the acidity of their respective conjugate acids.

- Recall that the conjugate acid of a weak base (e.g. like water) is a strong acid (like hydronium ion), while the conjugate acid of a strong base (like hydroxide ion) is a weak acid (like water).

- The concept of pKa has already been developed as a measure of the acidity of Bronsted acids, and we will also see that a corresponding concept, pKb can be used as a measure of the basicity of bases and that these two quantities are very closely related.

- Consider the acid dissociation, in dilute aqueous solution, of ammonia and a representative primary, secondary, and tertiary amine.

- The correct order of basic nature of the following  $\text{CH}_3\text{NH}_2$ ,  $(\text{CH}_3)_2\text{NH}$ ,  $(\text{CH}_3)_3\text{N}$  and  $\text{NH}_3$  is  $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3$ .

- The relative decreasing order of basic character can be justified on the basis of  $K_b$  and  $pK_b$  value as shown in the tabular form.

Type of amines and ammonia	$K_b$	$pK_b$
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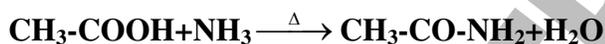
I. $(\text{CH}_3)_2\text{NH}$	$5.4 \times 10^{-4}$	3.27
II. $\text{CH}_3\text{NH}_2$	$4.5 \times 10^{-4}$	3.35
III. $(\text{CH}_3)_3\text{N}$	$0.6 \times 10^{-4}$	4.22
IV. $\text{NH}_3$	$1.8 \times 10^{-5}$	4.74

The observed order of basic strength of amines and ammonia is as follow:



- Thus the basic strength of aliphatic amines is governed by the following three factors:
- Electron-releasing tendency of the alkyl groups
- Solvation tendency of the protonated amine
- Steric effects of the alkyl groups

**Q.27 (A)** By the reaction of ethanoic acid with ammonia, ethane amide is obtained as shown in the reaction:



**Q.28 (D)** The strongest base among the following is ethylamine.

**Q.29 (D)** Tautomerism is not shown by aliphatic amines while chain isomerism, position isomerism and metamerism are shown by aliphatic amines.

**Q.30 (D)** Electrophoresis is the motion of dispersed particles relative to a fluid under the influence of a spatially uniform electric field. It is used for the separation of proteins, amino acids, nucleic acids but not for lipids.

**Q.31 (B)** Gel electrophoresis is a laboratory method used to separate mixtures of

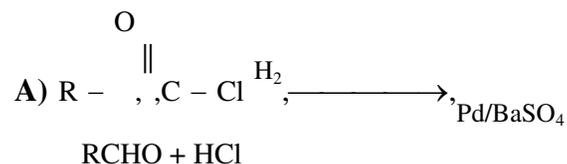
DNA, RNA, or proteins according to molecular size. In gel electrophoresis, the molecules to be separated are pushed by an electrical field through a gel that contains small pores.

**Q.32 (A)** In electrophoresis, the electrophoretic mobility ( $\mu$ ) determines the characteristics of migration of different biomolecules by the size of molecule, molecular weight and net charge on the molecule but stereochemistry of molecule is not involved in electrophoresis.

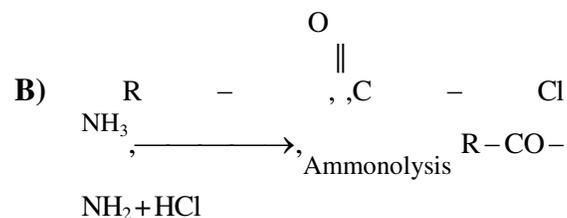
**Q.33 (B)** Among the derivative of carboxylic acid, acid halide is more reactive because halogen group is good leaving. Order of reactivity of derivative of carboxylic acid is given below:



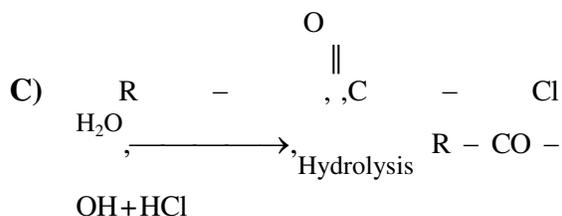
**Q.34 (A)** When acid chloride is treated with hydrogen, aldehyde is produced in the presence of Pd/BaSO<sub>4</sub>. Detail of all the reactions is given below:



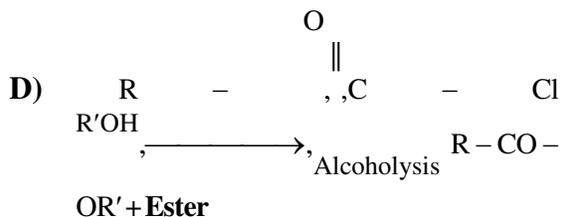
Aldehyde



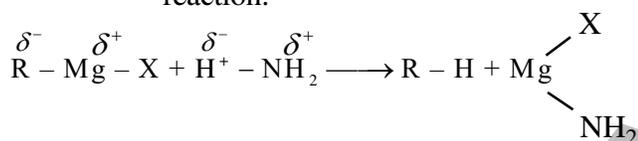
Acid amide



Carboxylic acid

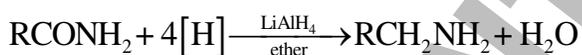


**Q.35 (D)** When Grignard reagent is treated with ammonia, alkane is produced along with side product as shown in the reaction:



**Methods which are used to prepare amine are as:**

A) By the reduction of acid amide



B) Reductive amination of aldehyde or ketones



C) By catalytic hydrogenation  $\text{H}_2/\text{Pt}$



**Q.36 (D)** All are the characteristics of zwitter ion.

**Q.37 (B)** Amino acid molecules can react with each other, the acid  $-\text{COOH}$  group in one molecule reacts with the basic  $-\text{NH}_2$  group in another molecule. When two amino acids react

together, the resulting molecule is called dipeptide.

**Q.38 (D)** On the acidic hydrolysis of acid amide **carboxylic acid** is **obtained** along with side product as **shown** in the **reaction**:



**Q.39 (B)** The order of reactivity of derivatives of carboxylic acid is as follow:



This order clearly shows that acid amide is the least reactive.

# STOP

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