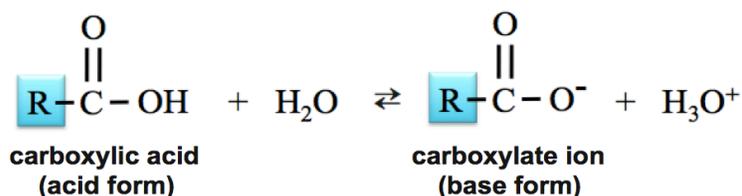


Summary of the Reactions of Chapter 9:

1) Reactions of Carboxylic Acids

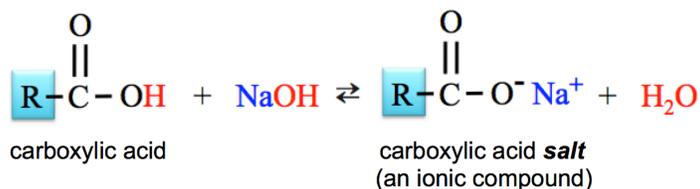
a) Reaction of a Carboxylic acid and water.

- When placed in water, a carboxylic acid molecule acts as an acid and water acts as a base. An H^+ from the hydroxyl group (OH) of the carboxylic acid is donated to H_2O .



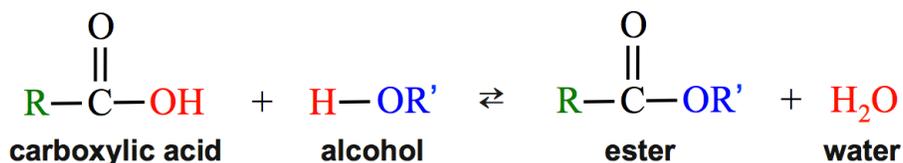
b) Neutralization: Reaction of a Carboxylic Acid and a Hydroxide Ion

- In a **neutralization reaction**, a carboxylic acid will react with a *hydroxide-containing base* compound to produce H_2O and a *carboxylic acid salt*.



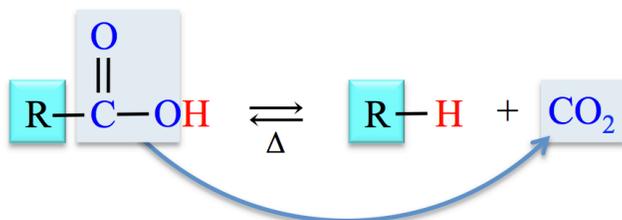
c) Esterification: The Reaction of a Carboxylic Acid and an Alcohol

- In an **esterification reaction**, a carboxylic acid reacts with an alcohol to produce an *ester* and water.



d) Decarboxylation of Carboxylic Acids

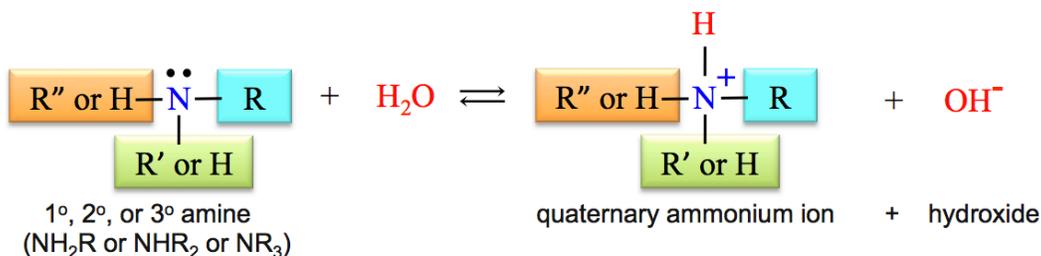
- In decarboxylation reactions, *carboxyl group* (COOH) is removed and *replaced by a hydrogen atom*.



2) Chemical Reactions of Amines

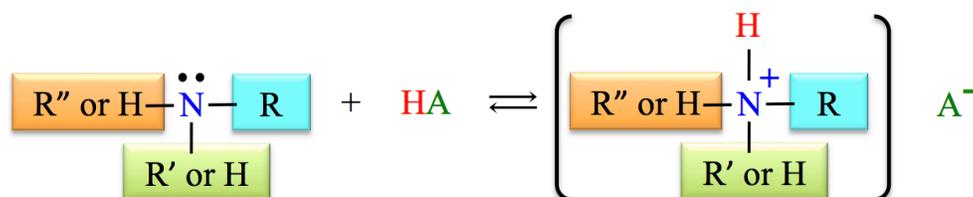
a) Reactions of Amines with Water

- An amine acts as a **base** when it reacts with **water** to produce a **quaternary ammonium ion** and a **hydroxide ion**.



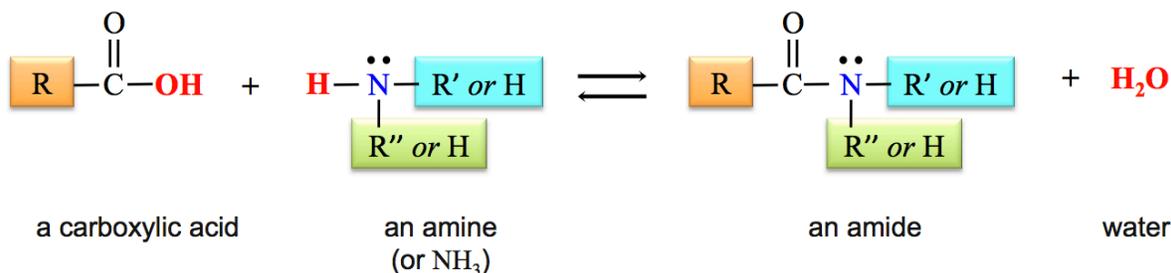
b) Reaction of Amines with Acids

- An amine will react with an **acid** to produce a **quaternary ammonium compound** in a **neutralization reaction**.



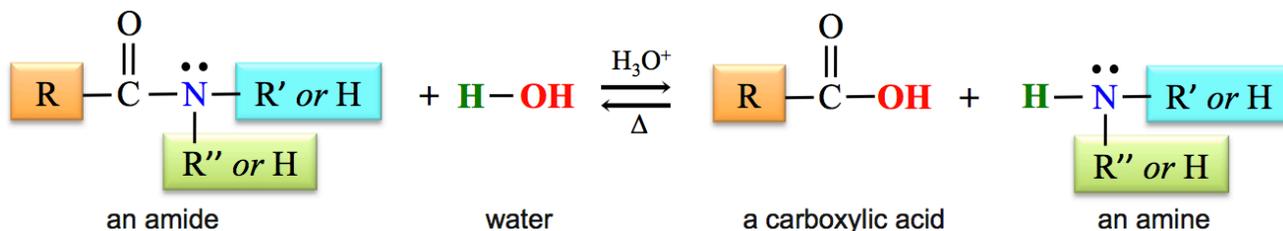
3) Formation of Amides: The Reaction of Carboxylic Acids with Amines

- An **amide** is produced when a **carboxylic acid** reacts with an **amine** or **ammonia** (NH₃).



4) Hydrolysis of Amides

- The reverse of the **amide formation** reaction is the **hydrolysis of amides**.
- With heat and an acid catalyst, an amide can be hydrolyzed to produce a **carboxylic acid** and an **amine** (or ammonia).

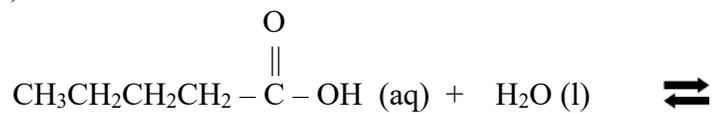


- 1) Write the chemical equation for the reaction of propanoic acid with 1-butanol (an alcohol).
The formula of 1-butanol is $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-OH}$.
- 2) Write the chemical equation for the reaction of ethanoic acid with N-methylethanamine.
- 3) Write the chemical equation for a pentanoate ion *acting as base* when it reacts with hydrochloric acid (HCl).
- 4) Write the chemical equation for the *decarboxylation* of 2-methyl-propanoic acid.
- 5) Write the chemical equation for the reaction of propanoic acid with water.

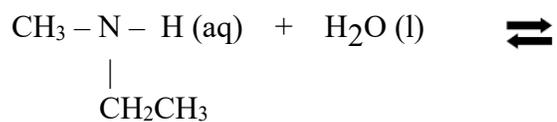
- 6) Write the chemical equation for the reaction of *N,N*-diethyl-1-propanamine with water.
(Hint: the amine is a base):

7) Complete the following reactions:

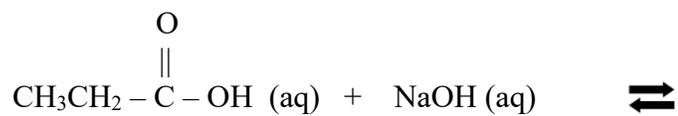
a)



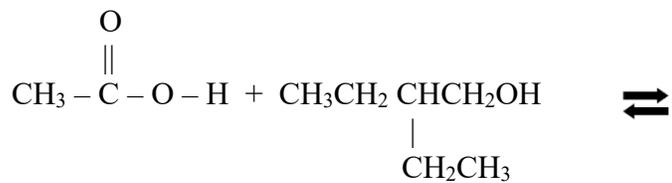
b)



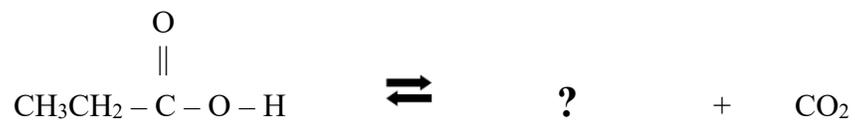
c)



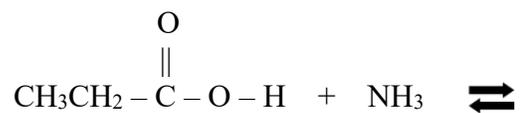
d)



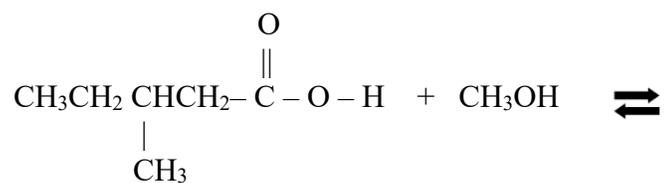
e) decarboxylation



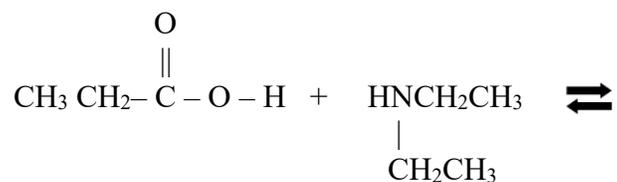
f)



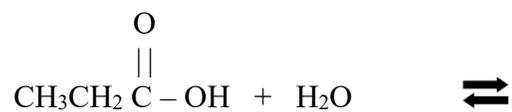
g)



h)



i)

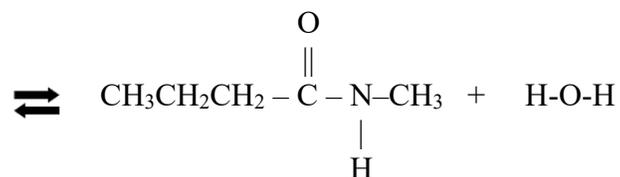


8) Fill in the missing reactant(s):

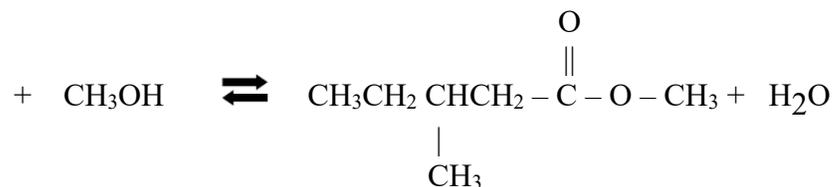
a)



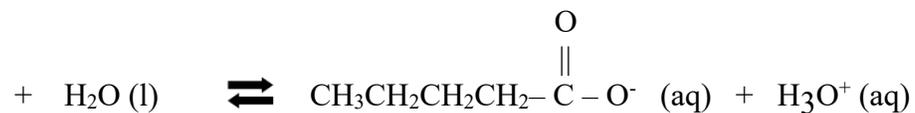
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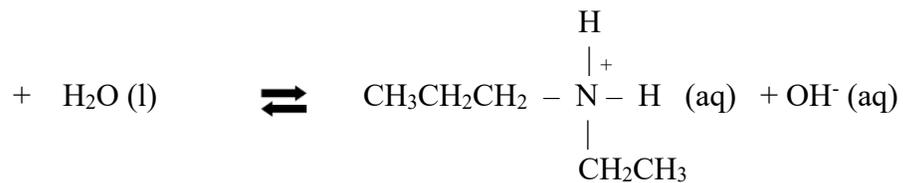
c)



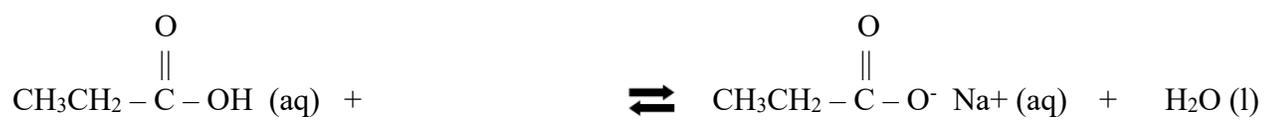
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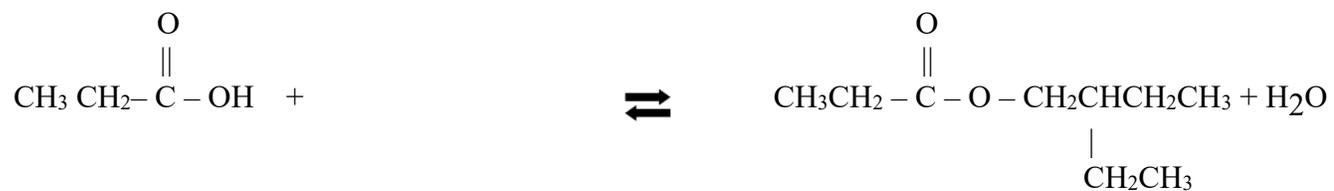
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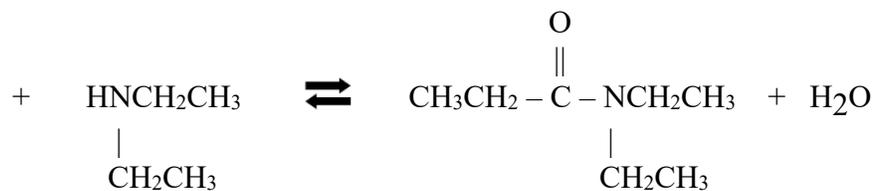
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g)

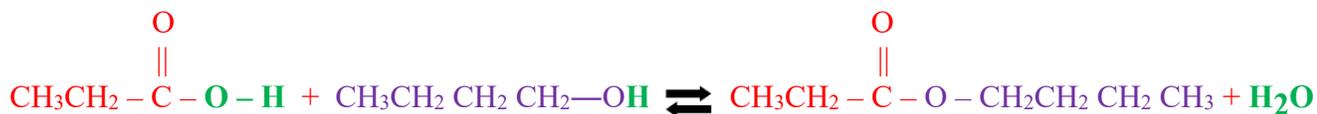


h)

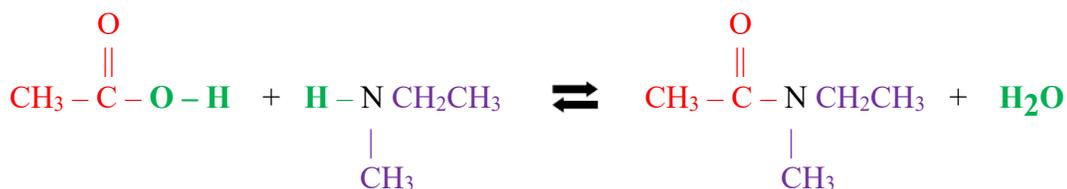


Key

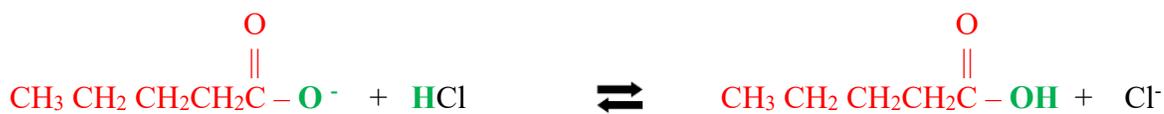
- 1) Write the chemical equation for the reaction of propanoic acid with 1-butanol (an alcohol).
The formula of 1-butanol is CH₃-CH₂-CH₂-CH₂-OH.



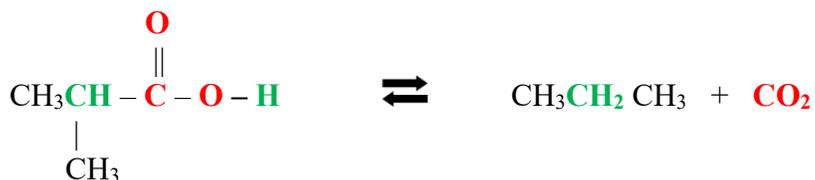
- 2) Write the chemical equation for the reaction of ethanoic acid with *N*-methylethanamine.



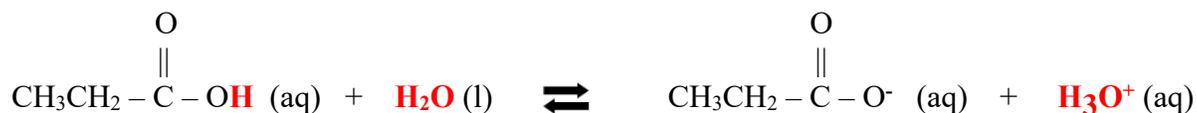
- 3) Write the chemical equation for a pentanoate ion *acting as base* when it reacts with hydrochloric acid (HCl).



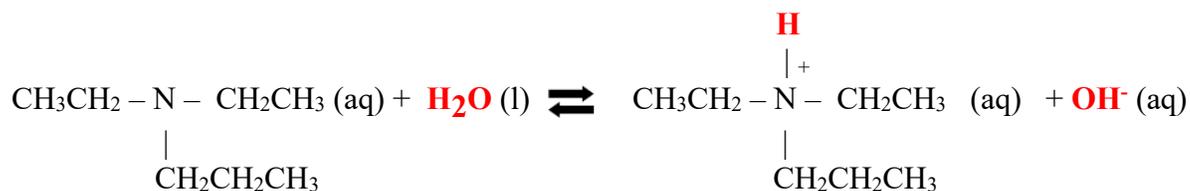
- 4) Write the chemical equation for the *decarboxylation* of 2-methyl-propanoic acid.



- 5) Write the chemical equation for the reaction of propanoic acid with water.



- 6) Write the chemical equation for the reaction of *N,N*-diethyl-1-propanamine with water.
 (Hint: the amine is a base):

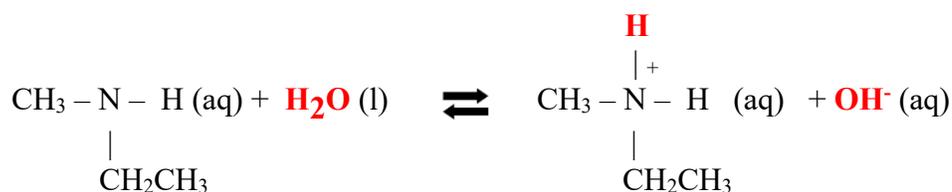


- 7) Complete the following reactions:

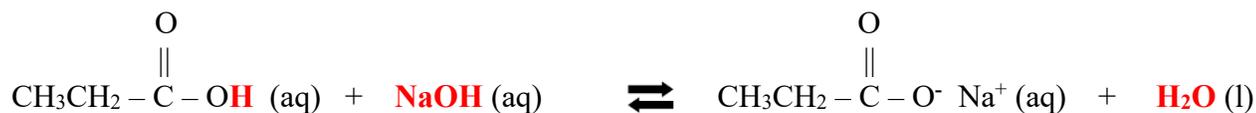
a)



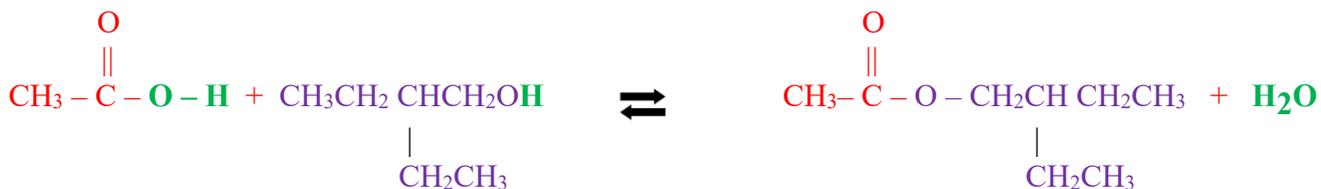
b)



c)



d)



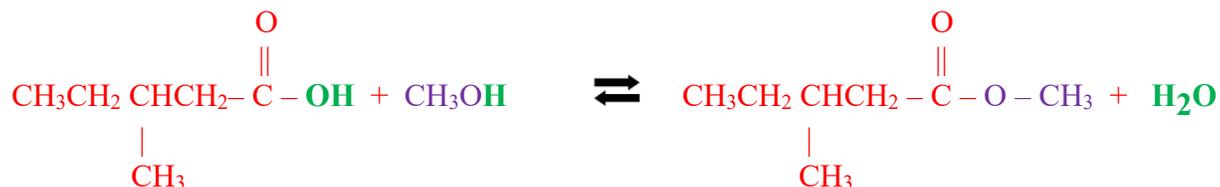
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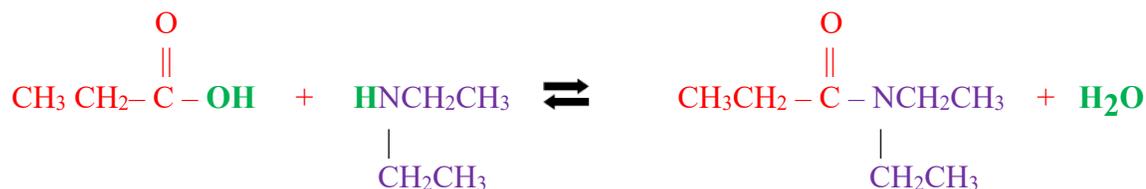
f)



g)



h)

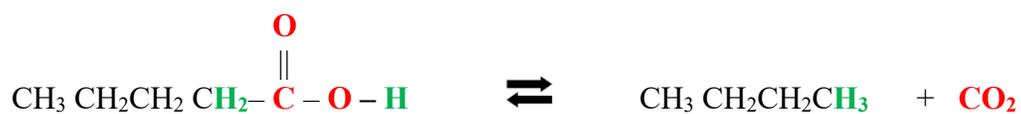


i)

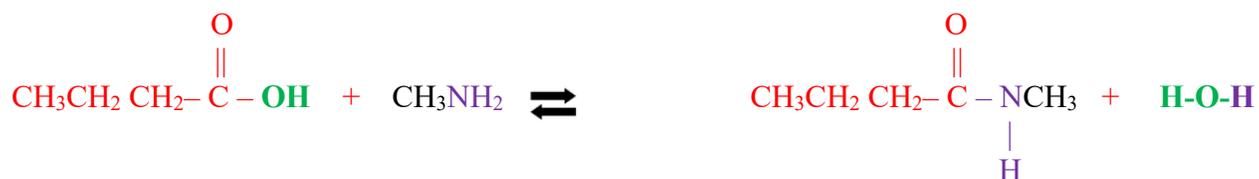


8. Fill in the missing reactant(s):

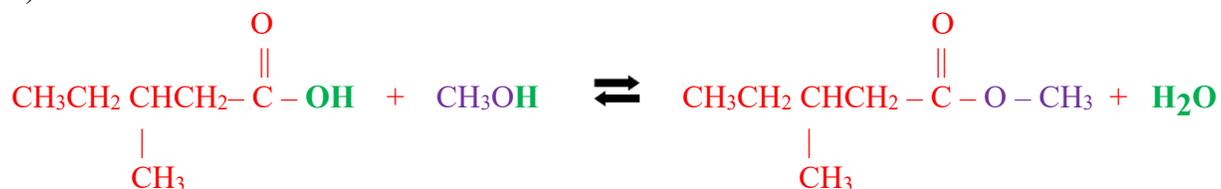
a)



b)



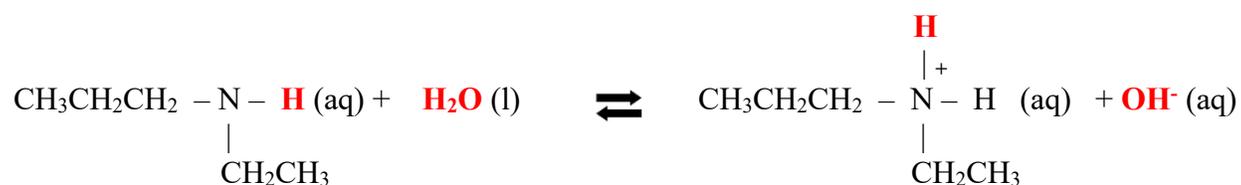
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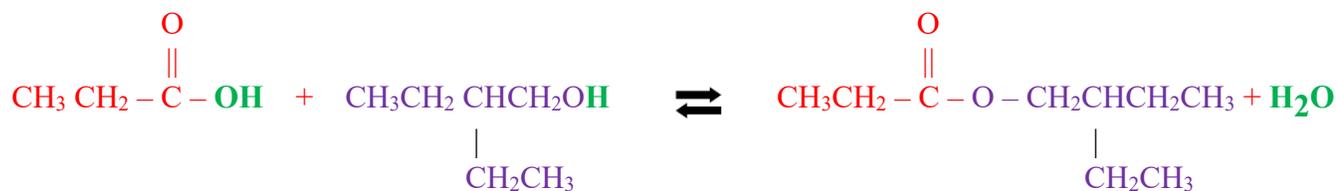
e)



f)



g)



h)

