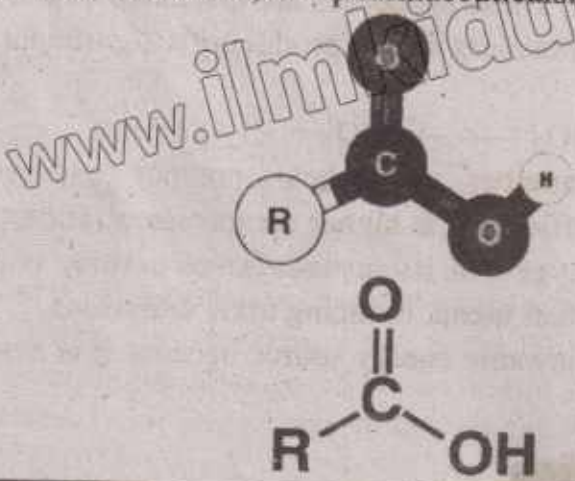
CHAPTER 24

Carboxylic Acids

Student Learning Outcomes

After studying this chapter, students will be able to:

- Describe the reactions of carboxylic acids with metals, bases and carbonates including names and formulae of the salts produced.
- Describe the formation of ethanoic acid by the oxidation of ethanol; with acidified aqueous potassium manganate (VII) & by bacterial oxidation during vinegar production
- Describe the reaction of a carboxylic acid with an alcohol using an acid catalyst to form an ester
- Describe the industrial applications of carboxylic acids and esters, including their use as solvents, flavours, fragrances, and plastics.
- Explain the role of carboxylic acids and esters in daily life, including their use in food preservation, cosmetics, and pharmaceuticals.



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Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

24.1 Preparation of Acetic Acid or Ethanoic Acid

24.2 Reactions of Carboxylic Acids as Acids

24.3 Reaction of Carboxylic Acids with Alcohols (Esterification)

Q.1: What are carboxylic acid?

Ans. Organic acids or carboxylic acids are the class of organic compounds containing a

carboxyl group (-COOH) attached to an alkyl group or hydrogen. They are generally weak acids as compared to the mineral acids because they do not give proton easily. They occur naturally in living organisms and they can also be synthesized.

Q.2: Describe oxidation of ethanol to form ethanoic acid.

Ans. Oxidation of Ethanol: Ethanol is oxidized by the acidified potassium manganate (VII) to first ethanal which then further undergoes oxidation under the reaction conditions to give ethanoic acid.

Hot acidified potassium manganate (VII) acts as a very efficient oxidizing agent and oxidizes ethanol to ethanoic acid and during this reaction the purple colour of the reagent changes to colourless.

$$\underset{\text{Ethanol}}{CH_3-CH_2-OH} + [O] \xrightarrow{KMnO_4/H^+} \underset{\text{Ethanal}}{CH_3-\overset{\overset{O}{\|}}{C}-H} + H_2O$$

$$CH_3-\overset{\overset{O}{\|}}{C}-H + [O] \xrightarrow{KMnO_4/H^+} \underset{\text{Ethanoic acid}}{CH_3-\overset{\overset{O}{\|}}{C}-OH} + H_2O$$

Q.3: Explain fermentation reaction which is used to prepare acetic acid on commercial scale?

Ans. Preparation of Ethanoic acid by Oxidative Fermentation:

Alcoholic foodstuffs like grain, malt, rice or potato mesh are converted to vinegar when they undergo fermentation reaction in the presence of bacteria. These bacteria can produce vinegar from alcoholic foodstuffs if sufficient oxygen is provided. The overall chemical reaction in this fermentation process is:

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + O_2 \longrightarrow \underset{\text{Ethanoic acid}}{CH_3COOH} + H_2O$$

In this process, alcohol is fermented to vinegar in a tank provided with a continuous supply of oxygen. The liquid present in the tank is stirred continuously when the oxygen is bubbled through it. In this method, vinegar containing 15% ethanoic acid can be prepared in only 24 hours.

Q.4: Discuss reactions of carboxylic acids as acids.

Ans. Reactions of carboxylic Acids as Acids

Reaction with Metals: Generally carboxylic acids are much weaker acids than the mineral acids. However, some carboxylic acids react with more reactive metals rather slowly to give a salt evolving hydrogen gas. For example, dilute ethanoic acid reacts with magnesium metal to give magnesium ethanoate and hydrogen gas.

$$\underset{\text{Ethanoic acid}}{2CH_3COOH} + Mg \longrightarrow \underset{\substack{\text{Magnesium}\\\text{Ethanoate}}}{(CH_3COO)_2Mg} + H_2$$

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Reaction with bases: Reactions of carboxylic acids with bases like metal hydroxides are simple neutralization reactions. Ethanoic acid reacts with sodium hydroxide to give sodium ethanoate and water.

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\substack{\text{Sodium}\\\text{Hydroxide}}}{NaOH} \longrightarrow \underset{\text{Sodium ethanoate}}{CH_3COONa} + H_2O$$

Reaction of Carboxylic Acids with Carbonates: When solid sodium carbonate is mixed with an aqueous solution of ethanoic acid, effervescence takes place due to evolution of CO_2 gas and sodium ethanoate is formed in the solution.

$$\underset{\text{Ethanoic acid}}{2CH_3COOH} + \underset{\substack{\text{Sodium}\\\text{Carbonate}}}{Na_2CO_3} \longrightarrow \underset{\text{Sodium ethanoate}}{2CH_3COONa} + CO_2 + H_2O$$

Reaction proceeds slowly with marble chips ($CaCO_3$).

$$\underset{\text{Ethanoic acid}}{2CH_3COOH} + \underset{\substack{\text{Calcium}\\\text{carbonate}}}{CaCO_3} \longrightarrow \underset{\text{Calcium ethanoate}}{(CH_3COO)_2Ca} + CO_2 + H_2O$$

Q.5: Describe reaction of carboxylic acids with alcohols.

(OR) What is esterification reaction? Explain.

Ans. Reaction of Carboxylic Acids with Alcohols (Esterification)

Carboxylic acids form esters when they are heated with excess of alcohols in the presence of concentrated H_2SO_4, as a catalyst. Reaction is called esterification reaction.

$$\underset{\text{Ethanoic acid}}{2CH_3COOH} + \underset{\substack{\text{Calcium}\\\text{carbonate}}}{CaCO_3} \longrightarrow \underset{\text{Calcium ethanoate}}{(CH_3COO)_2Ca} + CO_2 + H_2O$$

24.4 Industrial Applications of Carboxylic Acids and Esters

24.5 Carboxylic Acids and Esters in Daily Life

Q.6: Describe the industrial applications of carboxylic acids and esters.

Ans. Carboxylic acids and Esters as Solvents: Acetic acid dissolves many compounds such as oils, sulphur, iodine and water. In industry, acetic acid is used as a solvent for resins, paints and lacquers.

Esters are also commonly used as solvents. Ethyl acetate is used to extract caffeine from coffee. It is also used as nail polish and paint remover. Some volatile esters are used as solvents for coatings, paints, varnishes, plastics, resins and lacquers.

Carboxylic acids and Esters as Flavouring agents: Flavouring agents are substances added to give an additional taste or flavour to a substance. They also help in masking unpleasant tastes of drugs especially used by children. Organic acids like tartaric acid, citric acid and malic acid are very commonly used as flavour enhancers in food industry.

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The sour taste of foods is largely due to these acids. They are also responsible to improve the taste of some food and beverage products especially soft drinks.

Esters have pleasant odours and flavours. They are added to food products to improve their smell or taste.

Carboxylic Acid and Esters as Synthetic Fibers: Esters have also an important role to play in the production of synthetic polymers. A very important polymer, polyester is made by reacting diols and dicarboxylic acids. Esters are also important in the manufacture of soaps and detergents.

Carboxylic acids and their derivatives are very commonly used to give different types of plastics. For example, acetic acid is used in the production of cellulose acetate plastic. Palmitic and stearic acids are extensively used in the production of soaps, cosmetics, pharmaceuticals, candles and protective coatings. Oleic acid is used in the manufacture of soaps and detergents. Acrylic acid is a starting reagent to prepare many long-chain polymers called acrylates.



Uses of carboxylic acids in daily life

Q.7: Describe applications of carboxylic acids in daily life.

Ans. Applications of carboxylic Acids in Daily Life:

Food preservatives : Food preservatives are chemical compounds which are added in food stuff to prevent or retard the growth of microorganisms,

Examples: Benzoic acid, acetic acid, propionic acid and methyl and ethyl esters of 4-hydroxy benzoic acid. The presence of these preservatives helps to maintain the quality of food and extend shelf-life. The foods which are preserved include jams, juices, fruit juices, milk and many other drinks. Acetic acid is very widely used as preservative in pickles.



Jam, juices and pickles

Carboxylic acids and their compounds used in Medicines:

Carboxylic acids and the compounds obtained from them are very commonly used as medicines such as aspirin and ibuprofen.

Addition of some carboxylic acids during preparation of medicines help to improve

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drug delivery, absorption, and overall performance.

Plasticizers:

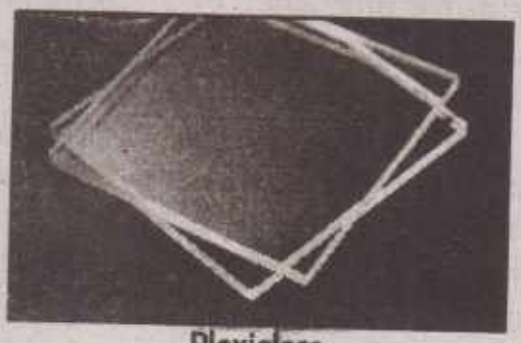
Citric acid esters are primarily plasticizers which are used in many industries.

Plexiglass:

Polymethyl methacrylate is used as a substitute of glass and it is named as Plexiglass.



Polyester



Plexiglass

Household Fragrant Items: Carboxylic acids occur in many common household fragrant items. A list of such items is given in the Table.

Carboxylic Acids in House hold items

Item	Carboxylic Acid
Vitamin C	Ascorbic acid
Lemons	Citric acid
Vinegar	Acetic acid
Apple, grapes, carrots	Malic acid

Q.8: Describe applications of esters in daily life:

Ans. Applications of Esters in Daily Life: Esters are an important component of many fruits and are responsible to enhance their flavours. They generally have a pleasant smell and they are commonly used as fragrances in many food products used in daily life.

Esters and their Flavours

Esters	Flavour
Methyl butyrate	Apple
Ethyl butyrate	Pine apple
n-Amyl acetate	Pears, Bananas
n-Octyl acetate	Orange
Methyl salicylate	Apricot

24.1 Quick Check!

1. Can you oxidize methanol with $KMnO_4$ Just like ethanol?

Ans. Yes. It would oxidize and convert into methanoic acid (HCOOH).

2. Explain the difference between a fermentation reaction and a chemical reaction.

Ans. Fermentation Reaction:

It is a biochemical process carried out by living organism (like bacteria or yeast) to convert substances.

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Chemical Reaction:

A standard Chemical reaction (like oxidation in a lab) uses chemical reagents and catalysts without living cells.

24.2 Quick Check!

1. Is Ethanoic acid is a weak acid?

Ans. Yes. Ethanoic acid is a weak acid because it does not give protons easily as compared to mineral acids.

2. How will calcium carbonate react with ethanoic acid?

Ans. Calcium carbonate will react slowly with ethanoic acid to produce calcium ethanoate salt, water, and carbon dioxide gas, which causes fizzing.

24.3 Quick Check!

1. Explain the function of a preservative.

Ans. Food Preservatives are chemical compound which are added in food stuff to prevent or retard the growth of microorganisms. The presence of preservatives help to maintain the quality of food and extend shelf-life. For example, acetic acid is very widely used as preservative in pickles.

2. Give examples of some citrus fruits.

Ans. Citrus fruits are known for their high vitamin C content and acidic (citric acid) nature. Common examples include:

- Lemons
- Oranges
- Grapefruits
- Tangerines (Kinnow)
- Pomelos

INTERESTING INFORMATION

Pure acetic acid is also called glacial acetic acid. It is a corrosive and colourless solid, completely miscible with water.



Objective Type Questions

Additional MCQ's

Multiple Choice Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

24.1 Preparation of Acetic Acid or Ethanoic Acid

24.2 Reactions of Carboxylic Acids as Acids

24.3 Reaction of Carboxylic Acids with Alcohols (Esterification)

1. Carboxylic acids are defined by the presence of which functional group?

(a) –OH (Hydroxyl) (b) –CHO (Aldehyde)

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(c) –COOH (Carboxyl) (d) –CO–(carbonyl)

2. **compared to mineral acids, organic acids are generally:**
   (a) stronger (b) Weaker (c) Highly volatile (d) Non-reactive
3. **In the oxidation of ethanol, what is the first product formed before it becomes ethanoic acid?**
   (a) Methane (b) Ethene (c) Ethanal (d) Methanol
4. **What colour change occurs in potassium maganate (VII) during the oxidation of ethanol?**
   (a) Purple to colourless (b) Colourless to purple
   (c) Orange to green (d) red to blue
5. **Which process is used to convert alcoholic foodstuffs like rice or malt into vinegar?**
   (a) Dehydration (b) Oxidative fermentation
   (c) Hydrolysis (d) Reduction
6. **The concentration of ethanoic acid prepared in 24 hours via the fermentation method is:**
   (a) 5 % (b) 10 % (c) 15 % (d) 25 %
7. **When ethanoic acid reacts with magnesium metal, which gas is evolved?**
   (a) Carbon dioxide (b) Hydrogen (c) oxygen (d) Ethane
8. **The reaction between ethanoic acid and sodium hydroxide is classified as a:**
   (a) Redox reaction (b) Fermentation
   (c) Neutralization reaction (d) Addition reaction
9. **What observation indicates the reaction of ethanoic acid with carbonates?**
   (a) Colour change to blue (b) Formation of a solid precipitate
   (c) Effervescence (bubbling) (d) Evolution of heat only
10. **Which salt is formed when ethanoic acid reacts with marble chips ($CaCO_3$)?**
    (a) Sodium ethanoate (b) Calcium carbonate
    (c) Calcium ethanoate (d) Magnesium ethanoate
11. **What are the products when ethanoic acid reacts with sodium carbonate?**
    (a) Sodium ethanoate and hydrogen
    (b) Sodium ethanoate, water and carbon dioxide
    (c) Ethanal and water (d) Carbon dioxide and hydrogen
12. **The reaction between a carboxylic acid and an alcohol is called:**
    (a) Oxidation (b) Fermentation (c) Esterification (d) Sponification
13. **Which catalyst is essential for the formation of esters?**
    (a) Acidified $KMnO_4$ (b) Dilute HCl
    (c) Concentrated H_2SO_4 (d) Magnesium ribbon

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14. **What is the product of the reaction between ethanoic acid and methanol?**
(a) Ethyl ethanoate (b) Methyl ethanoate
(c) Methane (d) Ethyl methanoate

15. **In the reaction $CH_3COOH + CH_3CH_2OH$, what is the second product formed alongside the ester?**
(a) Hydrogen gas (b) Oxygen (c) Carbon dioxide (d) Water

16. **What is the role of bacteria in the production of vinegar?**
(a) They facilitate the fermentation reaction
(b) They act as a metal catalyst
(c) They stop the oxidation process (d) They change the colour of the liquid

24.4 Industrial Applications of Carboxylic Acids and Esters

24.5 Carboxylic Acids and Esters in Daily Life

17. **Which term is used to describe pure acetic acid that exists as a corrosive, colourless solid?**
(a) Glacial acetic acid (b) Aqueous acetate
(c) Crystalline ester (d) Liquid vinegar

18. **Which ester is commonly used to extract caffeine from coffee and as a nail polish remover?**
(a) Methyl salicylate (b) n-octyl acetate
(c) Polyester (d) Ethyl acetate

19. **Organic acids like tartaric and citric acid are used in the food industry primarily as:**
(a) Solvents for oils (b) Flavour enhancers
(c) Synthetic fibers (d) Colouring agents

20. **Which pair of compounds reacts to form the synthetic polymer known as polyester?**
(a) Esters and water (b) Diols and dicarboxylic acids
(c) Methanol and acetic acid (d) Water and diols

21. **Which carboxylic acid is commonly used as a preservative in pickles?**
(a) Acetic acid (b) Malic acid (c) Ascorbic acid (d) Oleic acid

22. **Which acid is extensively used in the production of soaps and detergents?**
(a) Citric acid (b) Benzonic acid
(c) Hydrochloric acid (d) Oleic acid

23. **Which ester provides the flavour of "pineapple"?**
(a) Ethyl butyrate (b) Methyl salicylate
(c) Methyl butyrate (d) n-Amyl acetate

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24. **What material is produced using polymethyl methacrylate and serves as a substitute for glass?**
(a) Nail polish (b) Polyester (c) Bakelite (d) Plexiglass

25. **Which of the following acid is naturally found in apples, grapes and carrots?**
(a) Malic acid (b) Ascorbic acid (c) Tartaric acid (d) Acetic acid

26. **It is an ester found in pears and bananas.**
(a) Methyl salicylate (b) Methyl butyrate
(c) n-octyl acetate (d) n-Amyl acetate

Answers

1.	(c)	2.	(b)	3.	(c)	4.	(a)	5.	(b)	6.	(c)	7.	(b)
8.	(c)	9.	(c)	10.	(c)	11.	(b)	12.	(c)	13.	(c)	14.	(b)
15.	(d)	16.	(a)	17.	(a)	18.	(d)	19.	(b)	20.	(b)	21.	(a)
22.	(d)	23.	(a)	24.	(d)	25.	(a)	26.	(d)				

Additional Short Questions

Short Answer Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

24.2 Reactions of carboxylic Acids as Acids

24.3 Reaction of Carboxylic Acids with Alcohols (Esterification)

1. **What are carboxylic acids?**

Ans. Carboxylic Acids:

Organic acids or carboxylic acids are the class of organic compounds containing a carboxylic group (-COOH) attached to an alkyl group or hydrogen.

2. **Compare carboxylic acid to the mineral acids:**

Ans. Carboxylic acids are weak acids as compared to the mineral acids because they do not give proton easily.

3. **Define esterification.**

Ans. Esterification:

Carboxylic acids form esters when they are heated with excess of alcohols in the presence of concentrated HS_2O_4 as a catalyst. This reaction is called esterification reaction.

4. **What is oxidative fermentation?**

Ans. Oxidative Fermentation:

It is a process where alcoholic foodstuffs like grain, malt, rice or potato mesh are converted to vinegar when they undergo fermentation reaction in the presence of

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bacteria.

5. In how many hours vinegar containing 15% ethanoic acid can be prepared by oxidative fermentation?

Ans. By oxidative fermentation, vinegar containing 15% ethanoic acid can be prepared in only 24 hours.

6. What is the functional group of carboxylic acids?

Ans. The functional group of carboxylic acids is the carboxyl group (–COOH), which consists of a carbonyl group (C=O) and a hydroxyl group (–OH) attached to the same carbon atom.

7. Why are organic acids classified as "weak acids"?

Ans. Organic acids are considered weak acids because they do not give up protons (H^+ ions) easily compared to mineral acids like HCl or HS_2O_4.

8. What is the observation when ethanol is oxidized by acidified $KMnO_4$?

Ans. The purple colour of the potassium manganate (VII) reagent changes to colourless as the reaction proceeds.

9. Name the intermediate product formed during the oxidation of ethanol to ethanoic acid.

Ans. The intermediate product formed during the oxidation of ethanol to ethanoic acid is ethanol (an aldehyde).

10. What are the requirements for the oxidative fermentation of alcohol into vinegar?

Ans. It requires alcoholic foodstuffs (like grain or rice), the presence of specific bacteria, and a continuous supply of oxygen.

11. Compare the reaction of carboxylic acid with mineral acids when reacting with metals.

Ans. Carboxylic acids react much more slowly with reactive metals than mineral acids do.

12. Write the word equation for the reaction between ethanoic acid and magnesium.

Ans. Ethanoic acid + Magnesium ⟶ Magnesium Ethanoate + Hydrogen

13. How can you chemically test for the presence of a carboxylic acid using carbonates?

Ans. Add a carbonate (like sodium carbonate) to the solution. If a carboxylic acid is present, effervescence (bubbling) will occur due to the release of carbon dioxide gas.

14. What salt is formed when ethanoic acid reacts with marble Chips?

Ans. When ethanoic acid reacts with marble chips calcium ethanoate $(CHC_3COO)_2$ Ca is

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formed.

15. What is the role of concentrated H_2SO_4 in esterification?

Ans. Concentrated H_2SO_4 acts as a catalyst to speed up the reaction between the acid and the alcohol.

24.4 Industrial Applications of Carboxylic Acids and Esters

24.5 Carboxylic Acids and Esters in Daily-Life

16. What is glacial acetic acid?

Ans. Glacial Acetic Acid:

Pure acetic acid is also called glacial acetic acid. It is a corrosive and colourless solid, completely miscible with water.

17. Enlist some uses of ethyl acetate.

Ans. Uses of Ethyl acetate:

- Ethyl acetate is used to extract caffeine from coffee.
- It is also used as nail polish and paint remover.

18. Mention uses of some volatile esters.

Ans. Some volatile esters are used as solvents for coatings, paints, varnishes, plastics, resins and lacquers.

19. What are flavouring agents?

Ans. Flavouring Agents:

Flavouring agents are substances added to give an additional taste or flavour to a substance.

They also help in making unpleasant tastes of drugs especially used by children.

20. What is importance of esters in food products?

Ans. Esters have pleasant odours and flaw ours. They are added to food products to improve their smell or taste.

21. Why is acetic acid used as a solvent in industry?

Ans. Acetic acid is an effective solvent because it can dissolve many compounds such as oils, sulphur, iodine and water. In industry, acetic acid is used as a solvent for resins, points and lacquers.

22. Which organic acids are used as flavour enhancers?

Ans. Organic acids like tartaric acid, citric acid and malic acid are very commonly used as flavour enhancers. The sour taste of foods is largely due to these acids. They are also responsible to improve the taste of some food and beverage products especially soft drinks.

23. How is polyester made?

Ans. Polyester is a very important polymer. It is made by reacting diols and dicarboxylic acids.

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24. In which fields palmitic and Stearic acids are used?

Ans. Palmitic and stearic acid are extensively used in the production of soaps, cosmetics, pharmaceuticals, candles and protective coatings.

25. Which acid is used in the manufacture of soaps and detergents?

Ans. Oleic acid is used in the manufacture of soaps and detergents.

26. What are food preservatives?

Ans. Food preservatives are chemical compounds which are added in food stuff to prevent or retard the growth of microorganisms.

Examples:

Benzoic acid, acetic acid, propionic acid and methyl and ethyl esters of 4-Hydroxy benzoic acid.

27. What is the importance of food preservatives?

Ans. The presence of food preservatives helps to maintain the quality of food and extend shelf-life.

28. Give examples of foods which are preserved?

Ans. The foods which are preserved include jams, juices, fruit juices, milk and many other drinks.

29. Name the acid which is used as preservative in pickles.

Ans. Acetic acid is very widely used as preservative in pickles.

30. Give examples of carboxylic acids used in medicines.

Ans. Aspirin and Ibuprofen are common medicines carboxylic acids are also added during drug preparation to improve drug delivery, absorption, and overall performance.

31. What is Plexiglass?

Ans. Plexiglass:

Polymethyl methacrylate is used as a substitute of glass and it is named as plexiglass.

Exercise Questions (Solved)

A. Multiple Choice Questions

☆ **Choose and tick the correct answer from the given choices.**

1. Identify the ester functional group:

(a) –COOR (b) –COOH (c) $\geq C = O$ (d) $-CH_2-OH$

2. During the oxidation of ethanol by acidified $KMnO_4$, which element is reduced?

(a) K (b) O (c) Mn (d) H

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3. **Fermentation of foodstuff in the presence of acetic acid bacteria needs a sufficient supply of oxygen. What is the role of oxygen in this process?**
(a) It enhances the reactivity of bacteria
(b) It oxidizes ethanol which is formed during the reaction
(c) It inhibits the destruction of bacteria (d) It inhibits the oxidation of acetic acid

4. **Which organic acid is used as a component of food?**
(a) Formic acid (b) Oxalic acid (c) Propanoic acid (d) Acetic acid

5. **Which of the following acids is present in apples?**
(a) Citric acid (b) Tartaric acid (c) Acetic acid (d) Malic acid

6. **Which substances will react to produce $CH_3 - CH_2 - CH_2 - COOC_2H_5$?**
(a) $CH_3CH_2CH_2COOH$ and CH_3OH (b) CH_3CH_2COOH and CH_3CH_2OH
(c) $CH_3CH_2CH_2COOH$ and CH_3CH_2OH (d) $CH_3CH_2CH_2COOH$ and CH_3OH

7. **What is the formula of ester formed by the reaction of methanol with propanoic acid?**
(a) $CH_3COOCH_2CH_3$ (b) $CH_3CH_2COCH_2$
(c) $CH_3CH_2COOCH_3$ (d) $CH_3CH_2OCOCH_3$

8. **Which polymer is made by reacting a diol and a dicarboxylic acid?**
(a) Polyethene (b) Polyester (c) Polystyrene (d) Polyamide

9. **Which compound is used as a synthetic fiber?**
(a) Methyl acetate (b) Polyester (c) Resin (d) n-Amyl

Answers

1. (a) 2. (c) 3. (b) 4. (d) 5. (d) 6. (c) 7. (c)
8. (b) 9. (b)

B. Short Answer Questions

24.1 What is an esterification reaction?

Ans. Reaction of Carboxylic Acids with Alcohols (Esterification) : Carboxylic acids form esters when they are heated with excess of alcohols in the presence of concentrated H_2SO_4, as a catalyst. Reaction is called esterification reaction.

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{CH_3CH_2OH} \underset{}{\overset{H_2SO_4}{\rightleftharpoons}} \underset{\text{Ethyl ethanoate (an ester)}}{CH_3COOC_2H_5} + H_2O$$

Reaction proceeds slowly with marble chips ($CaCO_3$).

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Methanol}}{CH_3OH} \overset{H_2SO_4}{\rightleftharpoons} \underset{\text{Methyl ethanoate}}{CH_3COOCH_3} + H_2O$$

24.2 Name an oxidizing agent used to oxidize alcohols.

Ans. Acidified potassium manganate (VII) ($KMnO_4/H^+$) is an oxidizing agent used to

oxidize alcohols.

24.3 Why sufficient oxygen is provided during fermentation to prepare acetic acid from ethanol?

Ans. Sufficient oxygen is provided during fermentation to prepare acetic acid from ethanol. It is because the process is oxidative fermentation, that takes place in the presence of bacteria. These bacteria require oxygen to chemically oxidize the ethanol into acetic acid.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + O_2 \longrightarrow \underset{\text{Ethanoic acid}}{CH_3COOH} + H_2O$$

24.4 What is the role of carboxylic acids in the preparation of beverages?

Ans. Carboxylic acids act as flavour enhancers and improve the taste of beverage products, especially soft drinks. Acids like citric acid provide a characteristic sour taste.

24.5 Give a practical example in which an acid or an ester is used as a flavouring agent.

Ans. Acid: Citric acid is used in soft drinks for a sour flavour.
Ester: Ethyl butyrate is used to provide a pineapple flavour in food products.

24.6 Which carboxylic acids are very oftenly used as flavour enhancers?

Ans. Carboxylic acids like tartaric acid, citric acid and malic acid are very commonly used as flowour enhancers in food industry.

24.7 Which property of acetic acid does make it suitable to act as preservative in pickle?

Ans. The ability of acetic acid to inhibit microbial growth which is responsible for food spoilage by lowering the pH is the basic property which make it sutiable to act as preservative in pickle.

C. Constructed Response Questions

24.1 How does ethanol react with propanoic acid?

Ans. Ethanol reacts with propanoic acid to form ethyl propanoate and water.

$$CH_3CH_2COOH + CH_3CH_2OH \xrightarrow{H_2SO_4} CH_3CH_2COOCH_2CH_3 + H_2O$$

24.2 How does acetic acid react with Mg and $MgCO_3$?

Ans. Acetic acid react with magnesium to form magnesium ethanoate

$$\underset{\text{Acetic Acid}}{2CH_3COOH} + \underset{\text{Magnesium}}{MgCO_3} \longrightarrow \underset{\text{Magnesium ethanoate}}{(CH_3COO)_2Mg} + \underset{\text{Magnesium gas}}{H_2}$$

Reaction of Acetic Acid with Magnesium Carbonate

$$\underset{\text{Acetic Acid}}{2CH_3COOH} + \underset{\text{Magnesium}}{Mg} \longrightarrow \underset{\text{Magnesium ethanoate}}{(CH_3COO)_2Mg} + H_2O + \underset{\text{Hydrogen gas}}{CO_2}$$

24.3 How carboxylic acids are used as solvents?

Ans. Acetic acid is used as a solvent for dissolving oils, sulphur, iodine and water. In industry, acetic acid is used as a solvent for resins, paints and lacquers.

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24.4 How carboxylic acid are used in daily life?

Ans. For Answer See Question No.7

D. Descriptive Questions

24.1 Explain fermentation reaction which is used to prepare acetic acid on commercial scale.

Ans. For answer see Q3

24.2 Describe the industrial applications of carboxylic acids and esters.

Ans. For answer see Q6

24.3 What are flavouring agents? Which carboxylic acids are used as flavouring agents?

Ans. Flavouring Agents: Flavouring agents are substances added to give an additional taste or flavour to a substance.

They also help in masking unpleasant tastes of drugs especially used by children.

Flavour Enhancers: Organic acids like tartaric acid, citric acid and malic acid are very commonly used as slowour enhancers in food industry.

- The sourtaste of foods in largely due to these acids.
- They are also responsible to improve the taste of some food and beverage products especially soft drinks.

Carboxylic Acids as Flavouring Agents: Carboxylic acids occur in many common household fragrant items. A list of such items is given in the table below:

Item	Carboxylic Acid
Vitamin C	Ascorbic acid
Lemons	Citric acid
Vinegar	Acetic acid
Apple, grapes, carrots	Malic acid

24.4 Explain the reactions of carboxylic acids with metals and carbonates.

Ans. For answer see Q4

24.5 Describe applications of esters in daily life.

Ans. For answer see Q8

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