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CLASS X - SCIENCE

CARBON AND ITS COMPOUNDS - II

PRASHANT KIRAD

PK HITS🔥

- IUPAC Naming
- Electron Dot Structure (Ethanol, Amine)
- Homologous Series (MCQs)
- Important Reactions:
- Esterification
- Saponification
- Dehydration of Ethanol
- Working of Soap (diagram)

TOPICS TO BE COVERED

- Chemical properties of carbon compounds
  Combustion, Oxidation, Addition, Substitution
- Ethanol and its reactions
- Ethanoic acid and its reactions
- Soap v/s detergents
- Cleansing action of soap
  Structure of soap
  Micelle formation

$$\# \quad 2^{n-4} + 1 =$$

$(n = \text{no. of carbon})$

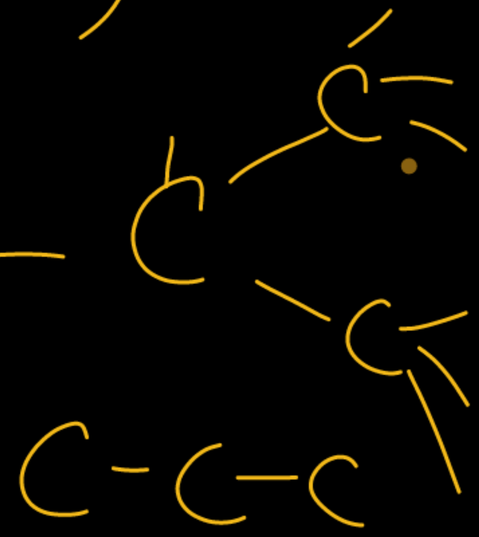
Butane $\rightarrow$?

(4)

C_4H_{10}

$2^{4-4} + 1$

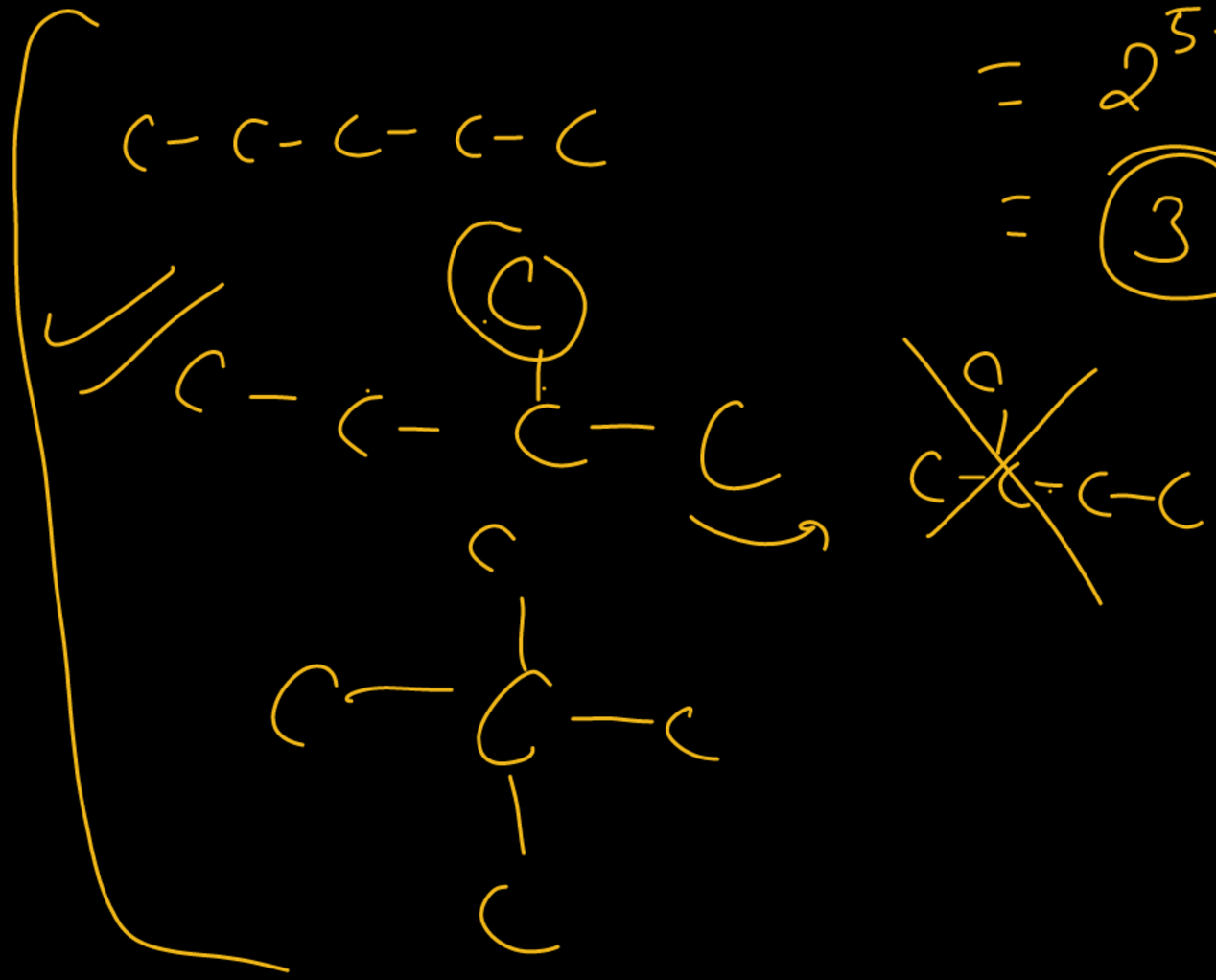
$1 + 1 = 2$



5 carbon $= 2^{n-4} + 1$

$= 2^{5-4} + 1$

$= 3$ //



C_nH_{2n+2}, C_nH_{2n} C_nH_{2n-2}

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

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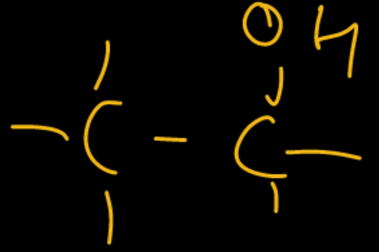
Combustion

Carbon burns in oxygen to give carbon dioxide along with the release of heat and light.

- $C + O_2 \rightarrow CO_2$ + Heat and Light
- $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Heat and Light
- $CH_3CH_2OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ + Heat and Light



CH_3CH_2OH

1. Complete Combustion

Occurs in an unlimited supply of air, oxygen in particular.
Here the hydrocarbon will burn out completely with the oxygen and leave only two byproducts, water, and carbon dioxide.
E.g., burning of a candle.

2. Incomplete Combustion

Takes place when the air is inlimited supply.
Due to lack of oxygen, the fuel will not react completely. This, in turn, produces carbon monoxide and soot instead of carbon dioxide.
E.g., burning of paper.

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Combustion and Flame:

- **Flame Formation:** A flame is produced only when gaseous substances burn.
- **Coal and Charcoal**: Burn without a flame, emitting red glow and heat, as they lack volatile substances.
- **Yellow Candle Flame:** Caused by incomplete combustion, leading to carbon (soot) particles glowing.

Formation of Coal and Petroleum:

- **Coal:** Formed from plants (e.g., trees, ferns) buried under earth and rock millions of years ago.
- **Petroleum and Natural Gas:** Formed from sea organisms buried under silt, decomposed by bacteria, and subjected to high pressure.
- Both are termed fossil fuels as they originate from ancient biomass.

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

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Oxidation

Carbon compounds can be easily oxidised on combustion.

$$CH_3 - CH_2OH \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

Alkaline potassium permanganate or acidified potassium dichromate are oxidising alcohols to acids.

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

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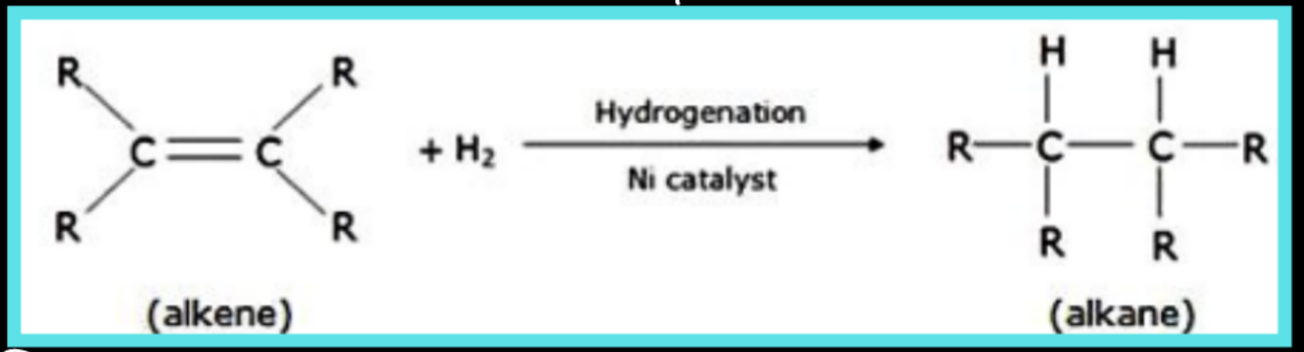
Addition Reaction

The *addition of hydrogen* to an unsaturated hydrocarbon to get a saturated hydrocarbon in *presence of nickel or palladium as catalyst* is called ***hydrogenation.***

Ni / Pd



Vegetable oil → Vegetable Ghee

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

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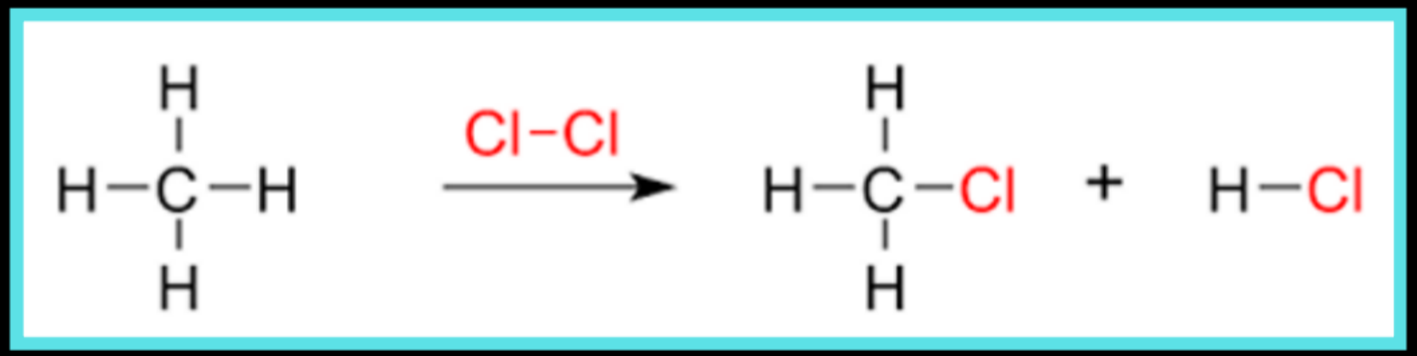
Substitution Reaction

In the presence of sunlight, chlorine is added to hydrocarbons in a very fast reaction. *Chlorine can replace the hydrogen atoms one by one.*

$$CH_4 \xrightarrow{Cl_2} CH_3Cl + HCl$$



ETHANOL

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Group	Alcohol family
Molecular formula	C_2H_5OH
Nature	Neutral

Properties of Ethanol

- Colorless, pleasant smell and burning taste.
- Soluble in water and Neutral compound.
- Volatile liquid with low boiling point of 351K.

CH_3OH

Ethanol + Methanol

BPL → Denatured Alchal

Uses of Ethanol

- Used to make rectified spirit (95% ethanol and 5% water).
- Used to manufacture paint, medicine, dye, perfume, varnish etc.
- Used to make blended petrol.
- An active ingredient of all alcoholic drinks like beer, whiskey etc.

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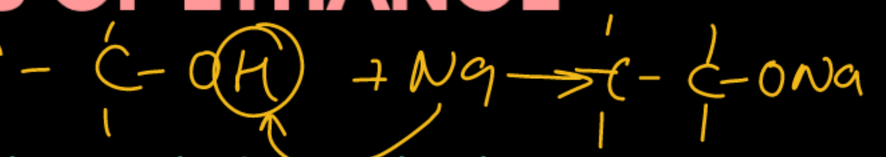
REACTIONS OF ETHANOL

Reaction of Ethanol with sodium



Alcohols react with sodium leading to the evolution of hydrogen.
With ethanol, the other product is sodium ethoxide.

$$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5O^-Na^+ + H_2$$

Ethanol (Ethyl alcohol) | Sodium | Sodium ethoxide | Hydrogen

Reaction to give unsaturated hydrocarbon

Heating ethanol at 443 K with excess concentrated sulphuric acid results in the dehydration of ethanol to give ethene.

Saturated

$$CH_3 - CH_2OH \xrightarrow[H_2SO_4]{\text{Hot Conc.}} CH_2 = CH_2 + H_2O$$

The concentrated sulphuric acid can be regarded as a dehydrating agent which removes water from ethanol.

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AFFECT OF ALCOHOL ON LIVING BEINGS

- Large amounts of ethanol slow metabolism and depress the central nervous system, leading to poor coordination, confusion, drowsiness, and impaired judgment.
- Methanol, even in small quantities, can be deadly, causing blindness and coagulating cell protoplasm.
- Ethanol is used as an industrial solvent, and to prevent misuse, it is denatured by adding poisonous substances like methanol and blue dye to make it undrinkable.

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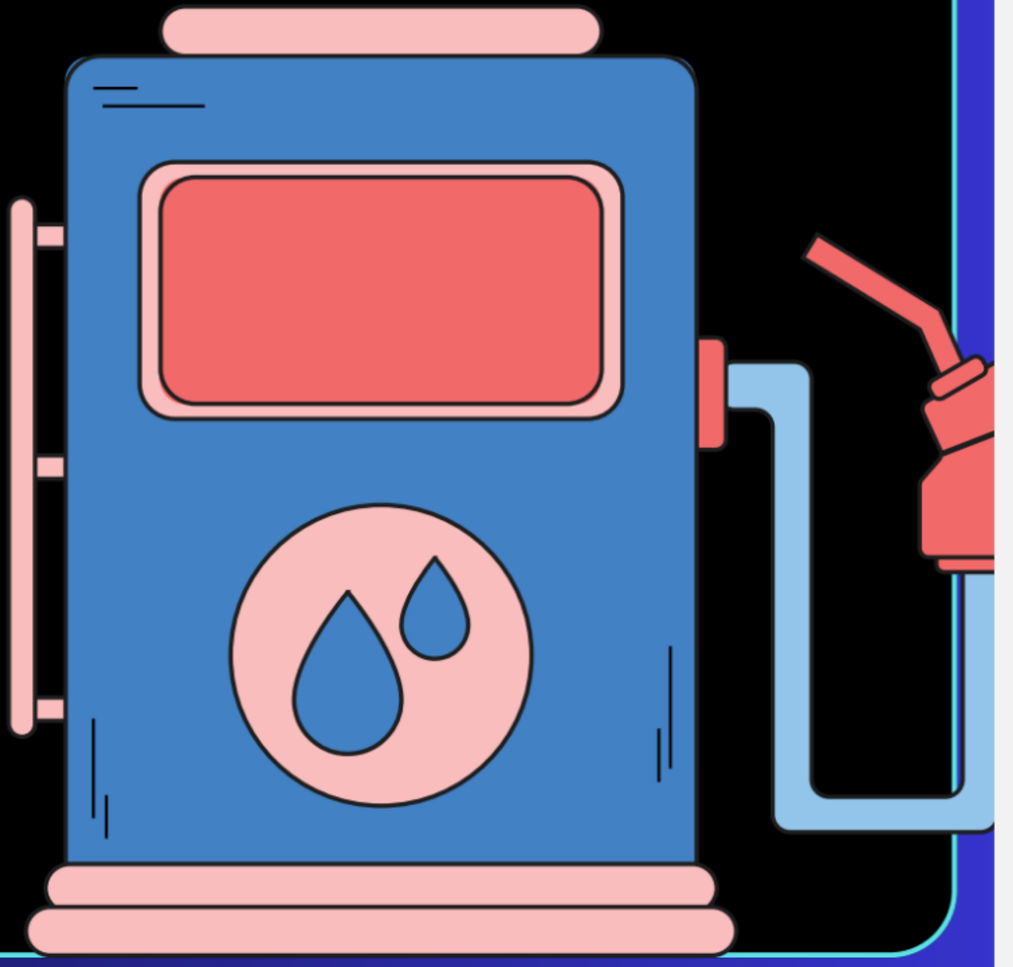
ALCOHOL AS FUEL

- Sugarcane plants efficiently convert sunlight into chemical energy.
- Sugarcane juice can be fermented into molasses to produce ethanol.
- Some countries use ethanol as an additive in petrol because it is a cleaner fuel, producing only carbon dioxide and waterwhen burned with sufficient oxygen.



ETHANOIC ACID

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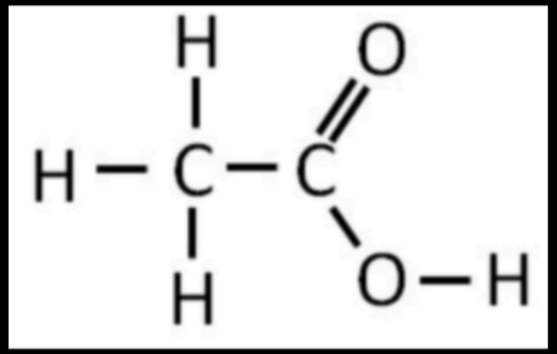
Group	Carboxylic acid faily
Molecular formula	CH_3OOH
Nature	Acidic



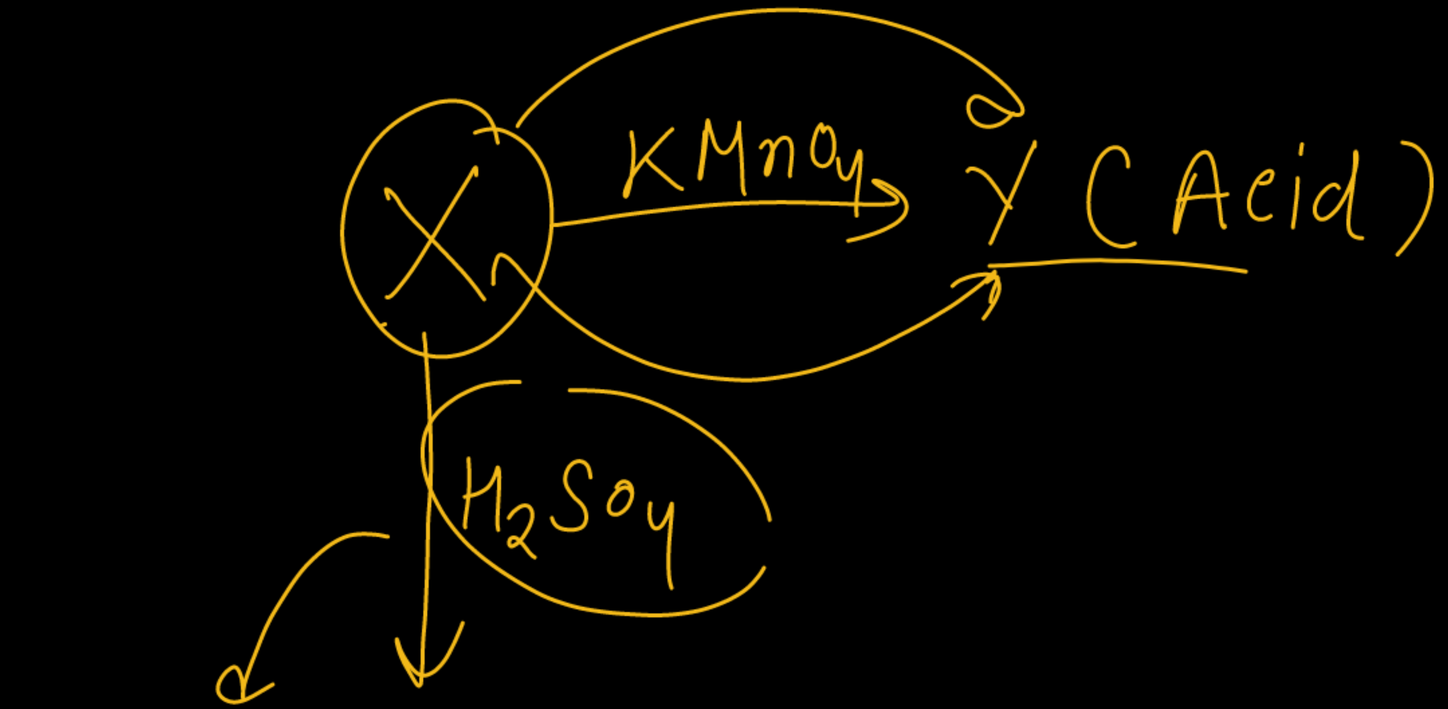
Properties of Ethanoic acid

Acetic Acid

- Colorless liquid having sour taste and have smell of vinegar.
- Boiling point is 391 K.
- When pure CH3COOH is freezed, it forms colorless ice like solid. So it is called glacial acetic acid.

Uses of Ethanoic acid

- Used to manufacture cellulose acetate, i.e. rayon.
- Used to manufacture acetone, dyes, perfume etc.
- Used to make vinegar (5-8% solution of acetic acid in water is called vinegar and is used widely as a preservative in pickles)



C=C ; Z (Unsaturated)

REACTIONS OF ETHANOIC ACID

Esterification reaction

- Esters are most commonly formed by reaction of an acid and an alcohol.
- Ethanoic acid reacts with absolute ethanol in the presence of an acid catalyst to give an ester.

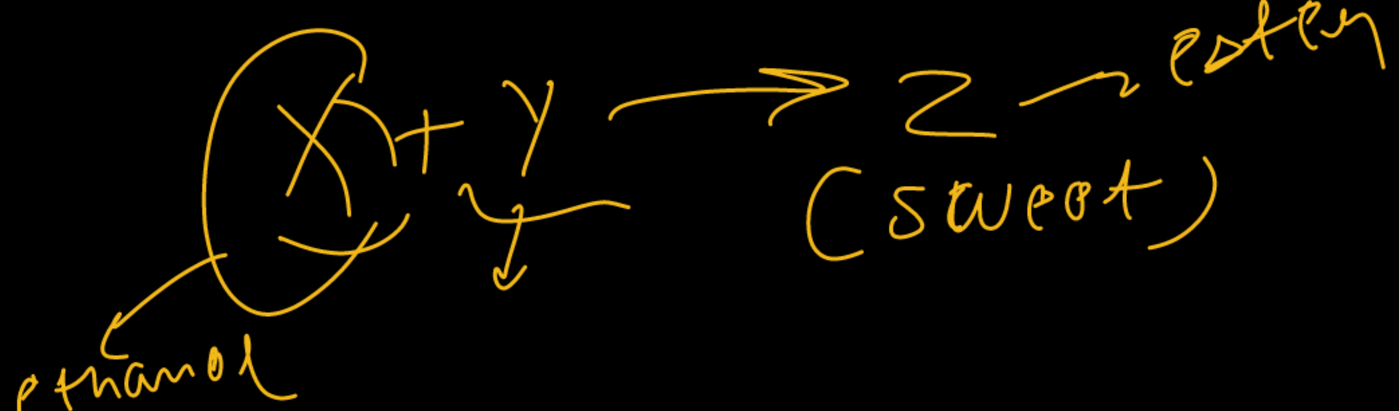
$$CH_3COOH + C_2H_5OH \xrightarrow[H_2SO_4]{H^+} CH_3COOC_2H_5 + H_2O$$

Esters are sweet-smelling substances. These are used in making perfumes and as flavouring agents.

Saponification reaction

Process of converting esters into salts of carboxylic acids and ethanol by treating them with a base.

$$\underset{\text{Ethyl ethanoate (Ethyl acetate)}}{CH_3COOC_2H_5} + \underset{\text{Sodium hydroxide}}{NaOH} \xrightarrow{\text{Heat}} \underset{\text{Sodium ethanoate (Sodium acetate)}}{CH_3COONa} + \underset{\text{Ethanol (Ethyl alcohol)}}{C_2H_5OH}$$



Z + Base (w) → Soap + X

(ester) NaOH

Ethanol

$A \xrightarrow{H_2SO_4} B$ Ethene

C (Unsaturated)

(A) + E → C → Ester

Ethanol — Ethanoic (Sweet)

$E + Na \longrightarrow (D)\ CH_3COONa$

$(C) + NaOH \longrightarrow (D) + (A)$

REACTIONS OF ETHANOIC ACID

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Reaction with a base

Ethanoic acid reacts with a base to give salt and water.

CH_3COOH	+	$NaOH$	⟶	CH_3COONa	+	H_2O
Ethanoic Acid		Sodium hydroxide		Sodium ethanoate		Water

Reaction with carbonates and hydrogencarbonates

Ethanoic acid reacts with carbonates and hydrogen carbonates to give rise to salt, carbon dioxide, and water.

- $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa$ (sodium acetate) $+ H_2O + CO_2$
- $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa$ (sodium acetate) $+ H_2O + CO_2$

SOAPS AND DETERGENTS

Soap	Detergents
Molecules of soap are ***sodium or potassium salts of long-chain carboxylic acids.***	Detergents are ***sodium salts of sulphonic acids or ammonium salts with chloride or bromide ions.***
Not so effective in hard water.	It is effective even in hard water.
Relatively weak cleansing action.	They have strong cleansing action.
Soaps are biodegradable.	Most of them are non-biodegradable.

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HARD V/S SOFT WATER

Hard water → Soap	~~Detergents~~ Soft water
It has high mineral content.	It has less mineral content.
Contains magnesium and calcium ions.	Contains sodium ions.
Soaps are not so effective.	Soaps are easily effective.
Often has a characteristic taste.	Tastes salty.
Example - Groundwater like deep wells	Example - Rainwater

STRUCTURE OF SOAP

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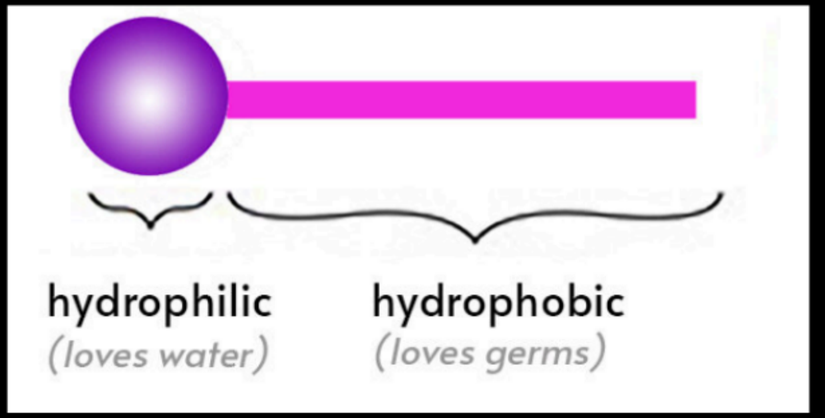
Soap has two parts, one is the ionic part and the other is a long carbon chain. These two parts are known as:

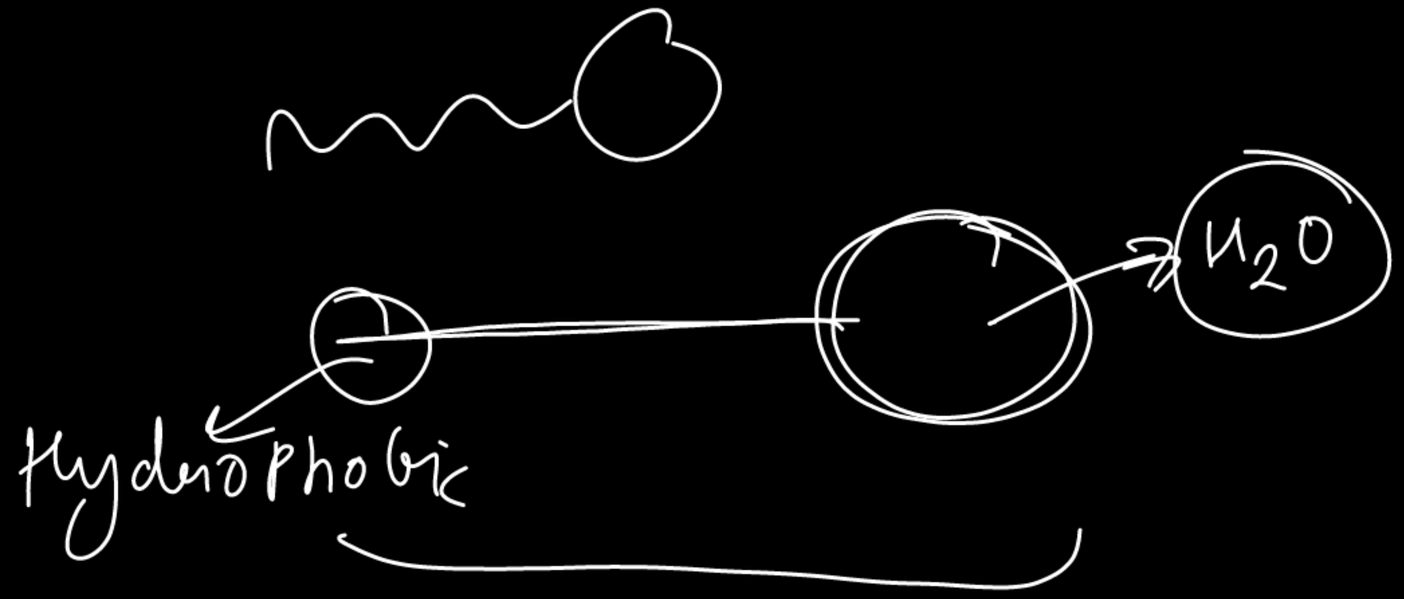
Hydrophobic tail:

- It is water repellent in nature and dissolves in oils. It is ionic in nature.

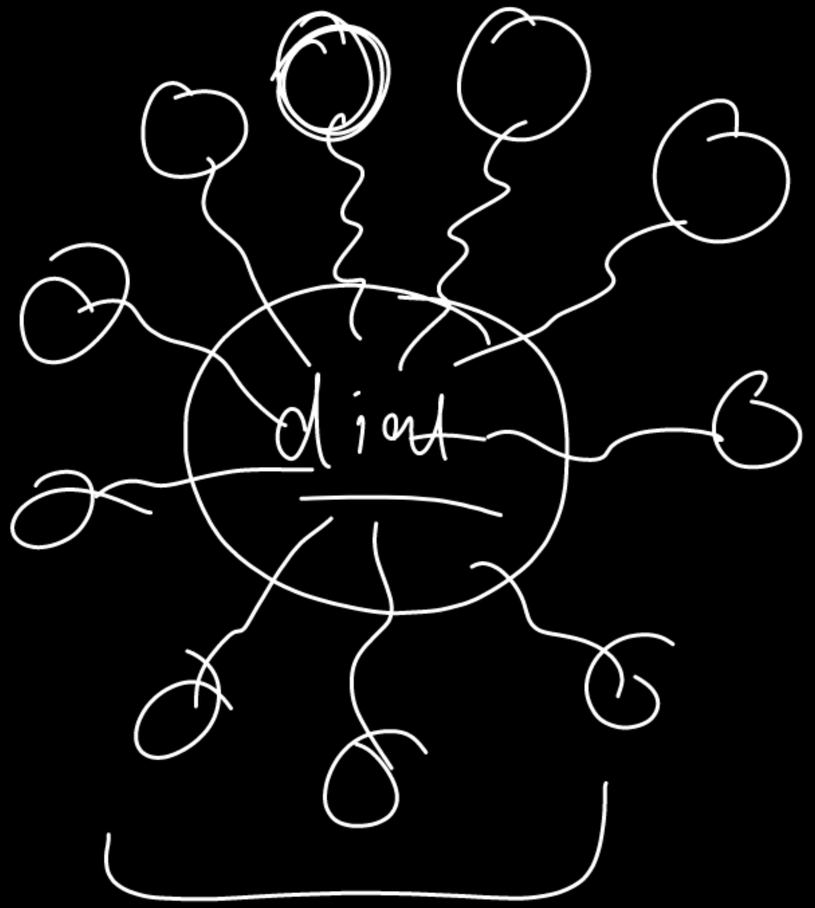


Hydrophilic head:

- It is water attractive or water-loving and dissolves in water. It is made up of a long chain of hydrocarbons.



Soap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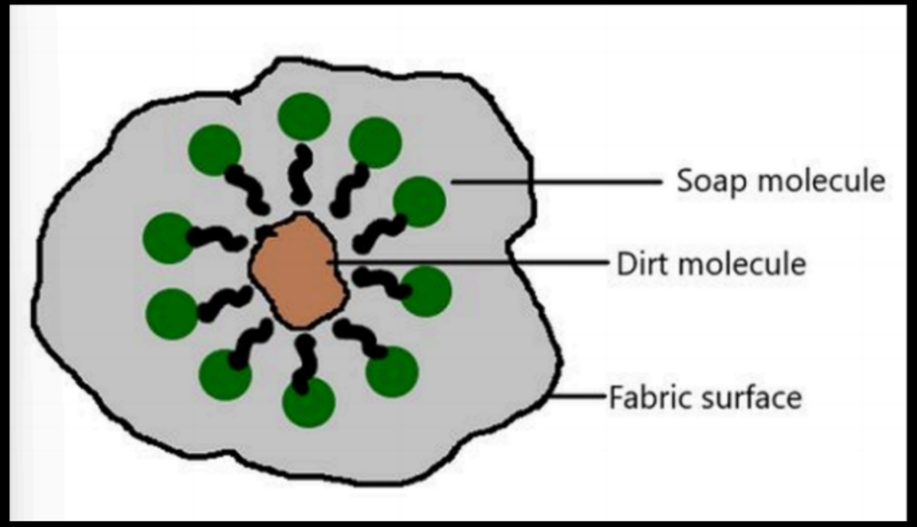
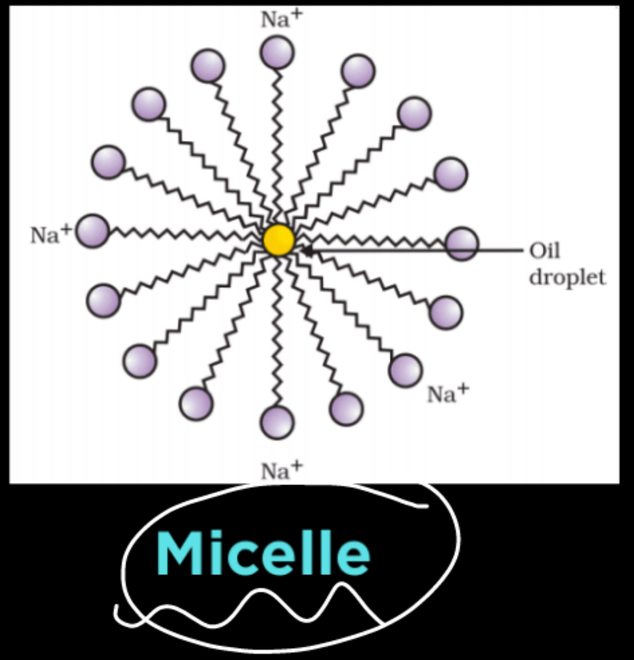
MICELLE FORMATION

A micelle is formed by the cluster of molecules where the molecules arrange themselves in a spherical shape with the hydrophobic end facing inwards and the hydrophilic end facing outwards.



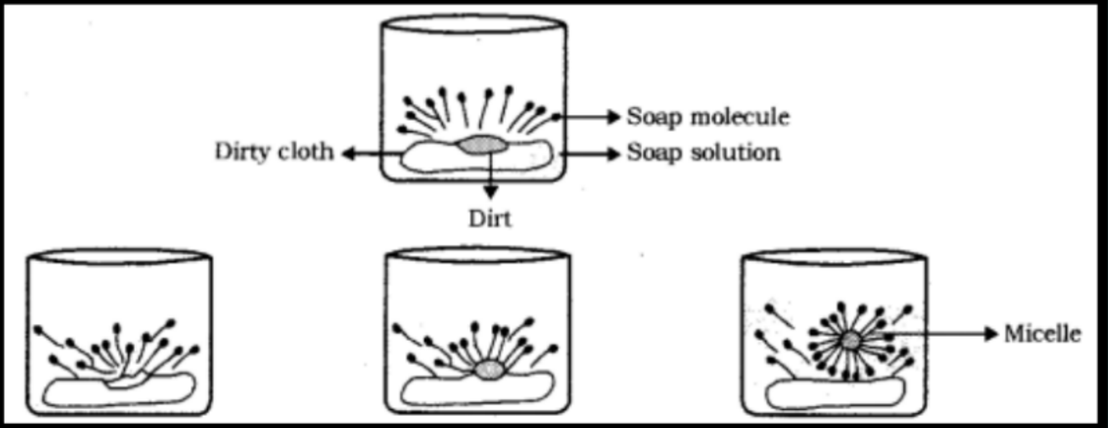


CLEANSING ACTION OF SOAP

The dirt is generally oily in nature and insoluble in water.

Process:

- The *ionic end of soap interacts with water*, while the *carbon chain interacts with oil.*
- Soap molecules form structures called ***micelles***, with *one end oriented towards the oil droplet and the ionic end facing outward.*
- This forms an *emulsion* in water.
- ***Soap micelles help pull out dirt in water***, allowing clothes to be washed clean.



Cleansing action of soap

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Q1.Addition reactions are undergone by (2019)

(a) saturated hydrocarbons (alkanes)

(b) only alkenes

(c) only alkynes

(d) both alkenes and alkynes

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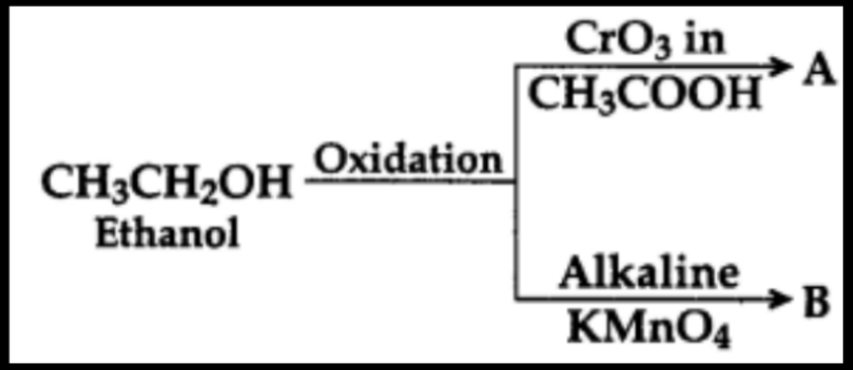
Q2.Identify A and B



(a) CH_3CHO, Ethanol, CH_3COOH, Ethanoic acid

(b) CH_3COOH, Ethanol, CH_3CHO, Ethanoic acid

(c) CH_3CHO, $CO_2 + H_2O$

(d) CH_3COOH, $CO_2 + H_2O$

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Q3. In the soap micelles (2021)

(a) the ionic end of soap is on the surface of the cluster while the carbon chain is in the interior of the cluster.

(b) ionic end of soap is in the interior of the cluster and the carbon chain is out of the cluster.

(c) both ionic end and carbon chain are in the interior of the cluster

(d) both ionic end and carbon chain are on the exterior of the cluster

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Q4.Which of the following represents saponification reaction?(2023)

(a) $CH_3COONa + NaOH \rightarrow CH_4 + Na_2CO_3$

(b) $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$

(c) $2CH_3COOH + 2Na \rightarrow 2CH_3COONa + H_2$

(d) $CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$

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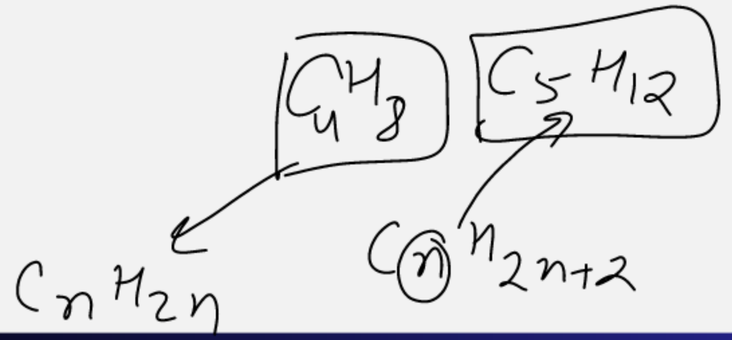
Q5.Ethanol on complete oxidation gives: (2024)

a) Ethanal

b) Acetone/ethanone

c) Acetic acid/ethanoic acid

d) CO_2 and water



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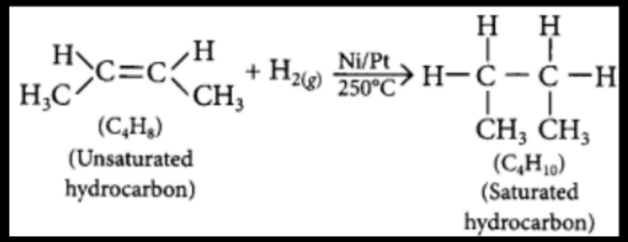
Q6.Two carbon compounds X and Y have the molecular formula C_4H_8 and C_5H_{12} respectively. Which one of these is most likely to show addition reaction? Justify your answer. Also give the chemical equation to explain the process of addition reaction in this case.

All unsaturated hydrocarbons (containing double or triple bonds) have a tendency to convert into saturated hydrocarbons (single bonds) by adding small molecules such as hydrogen (H_2), halogens (X_2), etc. These reactions are called addition reactions.

Compound X (C_4H_8) belongs to the alkene series (C_nH_{2n}), while compound Y (C_5H_{12}) belongs to the alkane series (C_nH_{2n+2}). Therefore, compound X will undergo an addition reaction.



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Q7.Write the chemical equations to show what happens when

(i) an ester reacts with a base?

(ii) ethanol reacts with ethanoic acid in the presence of sulphuric acid?

Answer:

(i) When an ester reacts with the base then it gives sodium salt of carboxylic acid and an alcohol. It is known as saponification reaction.

$$\underset{\text{Ethyl ethanoate (ester)}}{CH_3COOC_2H_5} \xrightarrow{NaOH} \underset{\text{Ethanol (alcohol)}}{C_2H_5OH} + \underset{\text{Sodium ethanoate}}{CH_3COONa}$$

(ii) Carboxylic acids react with alcohols in the presence of a little concentrated sulphuric acid to form pleasant smelling esters. This reaction is called esterification reaction.

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow[H_2SO_4]{\text{Conc.}} \underset{\text{Ethyl ethanoate}}{CH_3COOC_2H_5} + H_2O$$

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Q8. What happens when 5% alkaline $KMnO_4$ solution is added drop by drop to warm ethanol taken in a test tube? State the role of alkaline $KMnO_4$ solution in this reaction. (2024)

When 5% alkaline $KMnO_4$ solution is added drop by drop to warm ethanol then it gets oxidised to ethanoic acid.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[KMnO_4]{\text{alkaline}} \underset{\text{Ethanoic acid}}{CH_3COOH}$$

Here, alkaline $KMnO_4$ acts as an oxidising agent i.e., the substance which is capable of adding oxygen to others. Thus, alkaline $KMnO_4$ provides oxygen to ethanol to form ethanoic acid.

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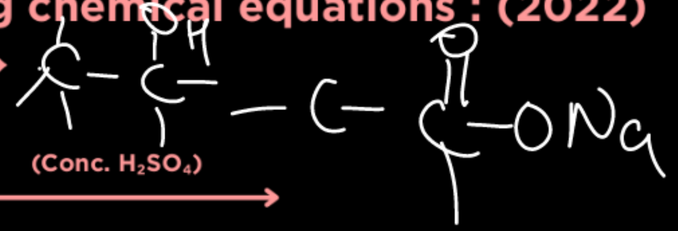
Q9.Complete the following chemical equations : (2022)

(i) $CH_3COOC_2H_5 + NaOH \rightarrow$

(ii) $CH_3COOH + NaOH \rightarrow$

(iii) $C_2H_5OH + CH_3COOH \xrightarrow{\text{(Conc. } H_2SO_4\text{)}}$



(i) $CH_3COONa + C_2H_5OH$

(ii) $CH_3COONa + H_2O$

(iii) $CH_3COOC_2H_5 + H_2O$

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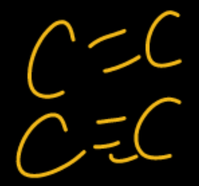
Q10.Why does micelle formation take place when soap is added to water? Why are micelles not formed when soap is added to ethanol?(2020)

A soap molecule has two ends with different properties, one end is polar i.e., water soluble or hydrophilic while other end is non-polar i.e., water insoluble or hydrophobic. When soap is added to water, the polar ends get dissolve in water and non-polar ends get dissolved in each other and directed towards the centre. As a result, a spherical ionic molecule known as micelles, formation takes place. Since, soaps are soluble in ethanol, therefore, micelles formation does not occur.



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Q11. Why do unsaturated hydrocarbons burn with a sooty flame? (2017, 2019)

Unsaturated hydrocarbons burn with a sooty flame because they have a higher percentage of carbon compared to saturated hydrocarbons. During combustion, due to incomplete oxidation of the excess carbon, tiny unburnt carbon particles are released, which glow in the flame and produce a yellow, sooty flame.
This incomplete combustion occurs especially in limited supply of oxygen.

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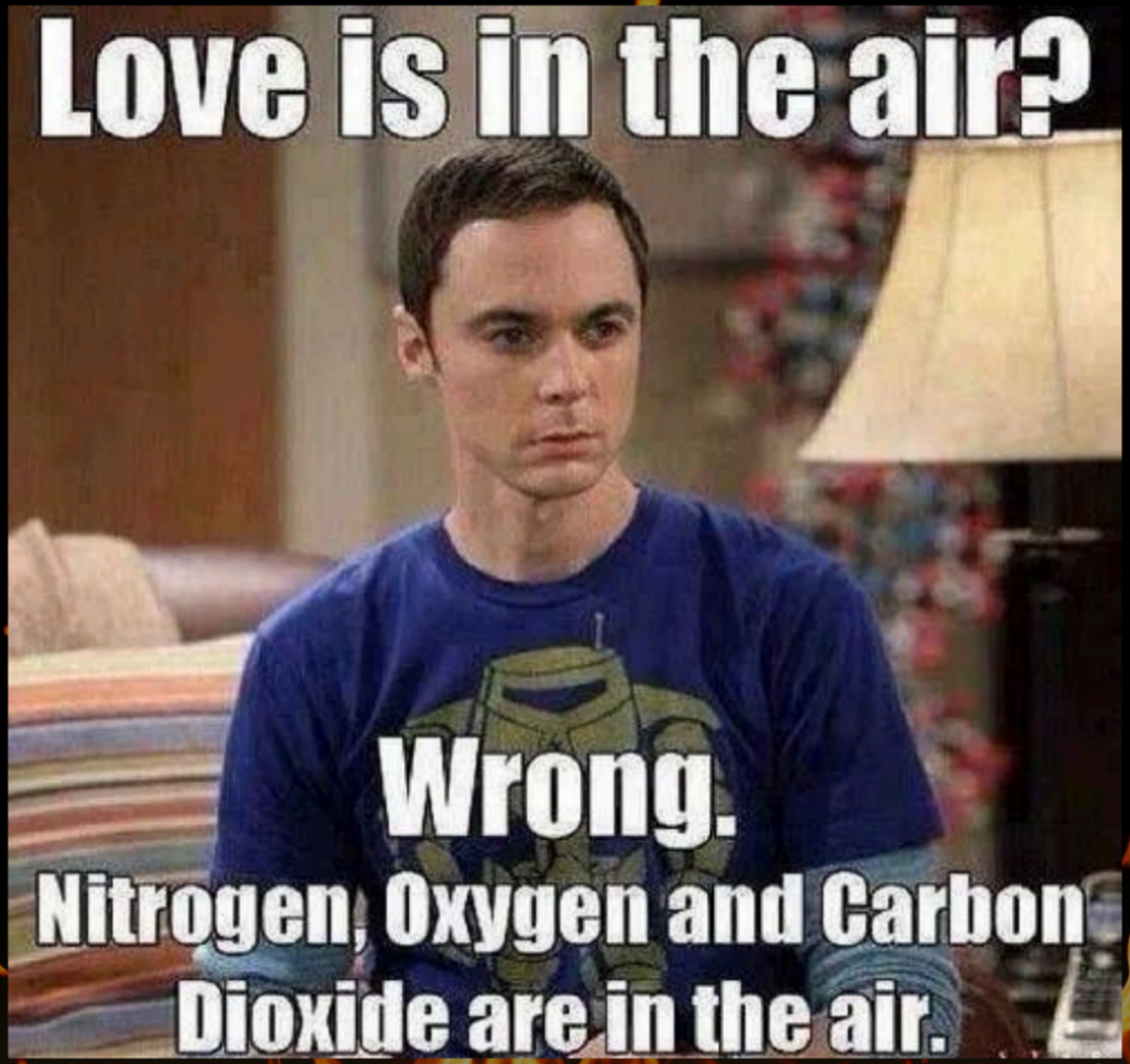
Q12. Why is hydrogenation of vegetable oils done? Name the catalyst used.

Hydrogenation of vegetable oils is done to convert liquid oils (unsaturated fats) into semi-solid or solid fats like margarine, which have a longer shelf life and are easier to transport.
Catalyst used: Nickel (Ni).


Love is in the air?
Wrong.
Nitrogen, Oxygen and Carbon Dioxide are in the air.