Carboxylic Acid Formula Questions with Solutions

Q1: Write the General Formula of the open-chain Carboxylic Acids.

Answer: The General Formula of open Carboxylic Acids is $C_nH_{2n+1}COOH$.
Where n = number of carbon atoms present in the molecule - 1.

Q2. Which acid is present in the red ants?

Answer: Red ants contain Formic Acid, which is why the bite of a red ant causes itching and irritation.

Q3. Write the name of the following acid: HOOC-COOH.

Answer: The given acid has a molecular formula, $C_2H_2O_4$. This is Oxalic Acid, also known as Ethanedioic Acid. This acid is commonly found in many plants and vegetables. It is the simplest dicarboxylic acid.

Q4. Explain the reason for the acidity of Carboxylic Acids.

Answer: Carboxylic Acids are acidic because the hydrogen atom in the carboxylic acid group is directly attached to the highly electronegative oxygen atom. Due to this reason, the hydrogen atom can easily be lost in the solution leading to the formation of a hydrogen ion (H^+) and a carboxylate anion ($RCOO^-$). The number of Hydrogen ions released in the solution leads to the acidity of the solution.

Q5. List the first 5 Carboxylic Acids.

Answer: The first 5 Carboxylic acids contain one, two, three, four, and five carbon atoms in their structure. The general formula of all Carboxylic Acids is $C_nH_{2n+1}COOH$.
Where n = number of carbon atoms present in the molecule -1.
The first five Carboxylic Acids are Methanoic Acid (HCOOH), Ethanoic Acid (CH_3COOH), Propanoic Acid (CH_3CH_2COOH), Butanoic Acid ($CH_3CH_2CH_2COOH$), and Pentanoic Acid ($CH_3CH_2CH_2CH_2COOH$).

Q6. The Carboxylic Acid that has the highest boiling point is

a. Heptanoic Acid ($C_6H_{13}COOH$)
b. Octanoic Acid ($C_7H_{15}COOH$)
c. Nonanoic Acid ($C_8H_{17}COOH$)
d. Decanoic Acid ($C_9H_{19}COOH$)

Answer: (d)

Explanation: The intermolecular forces of attraction increase with an increase in the molecular weight of the molecule. From the above-given options, Decanoic Acid has the highest molecular weight and thus has the strongest intermolecular forces. This is why it will require the highest energy to break apart its bonds.

Q7. The compound that is most soluble in Water (H_2O) is _____.

a. Pentane
b. Pentanone
c. Ethanoic Acid
d. Pentanoic Acid

Answer: (c)

Explanation: Water is a polar compound. Thus, it can dissolve only polar molecules in itself. Both Pentane and Pentanone are non-polar compounds. Even though both Ethanoic Acid and Pentanoic Acid are polar in nature, Ethanoic Acid is more soluble in water than Pentanoic Acid. Pentanoic Acid has a larger non-polar carbon chain than Ethanoic Acid. This difference in the size of the non-polar carbon chain makes Ethanoic Acid more soluble in water than Pentanoic Acid.

Q8. List five important uses of Carboxylic Acids.

Answer: Carboxylic Acids are used in various applications, such as in the formation of:

1. Coatings
2. Polymer Formation
3. Adhesives
4. Drugs
5. Biopolymers

Carboxylic Acids can also be used as solvents, food additives, anti-microbial substances and food flavouring substances.

Q9. Are Carboxylic acids weak or strong?

Answer: Carboxylic Acids are weak acids. This is because they do not ionise completely in water, i.e. the hydrogen ion (H^+) concentration in the solution of carboxylic acids is less compared to that in the mineral acids.

Q10. Which Carboxylic Acid is present in human blood?

Answer: Carbonic Acid is present in the human blood and helps in the process of respiration. Even though this acid is present naturally in the human bloodstream, it is advised not to come in contact directly with the concentrated form of this acid, as it may cause irritation to the respiratory tract and the eyes.

Q11. The strongest Carboxylic Acid among the following is:

a. Ethanoic Acid
b. Propanoic Acid
c. Benzoic Acid
d. None of the above

Answer: (c)

Explanation: Benzoic acid is the strongest. This is due to the delocalisation of electrons within the benzene ring. The delocalisation of electrons within the ring gives different resonating structures. Due to this reason, the benzoate ion is very stable, and the benzoic acid is very strongly acidic.

Q12. The product formed upon the reduction of CH_2=CH-COOH with $LiAlH_4$ is:

a. $CH_3CH_2CH_2OH$
b. CH_3CH_2COOH
c. CH_2=$CHCH_2OH$
d. None of the above

Answer: (c)

Explanation: Even though $LiAlH_4$ is a strong reducing agent, it cannot reduce the double bond. So, the product formed upon the reduction of CH_2=CH-COOH with $LiAlH_4$ is CH_2=$CHCH_2OH$.

$$CH_2\text{=}CH\text{-}COOH \xrightarrow{LiAlH_4} CH_2\text{=}CHCH_2OH$$

Q13. Of the following, the strongest acid is:

a. o-$NO_2C_6H_4COOH$
b. p-$NO_2C_6H_4COOH$
c. m-$NO_2C_6H_4COOH$
d. PhCOOH

Answer: (a)

Explanation: Due to the ortho-effect, o-$NO_2C_6H_4COOH$ is the strongest of the given acids.

Q14. The acid with the lowest pKa value is:

a. CH_3COOH
b. CH_3CH_2COOH
c. HCOOH
d. $(CH_3)_2COOH$

Answer: (c)

Explanation: pKa for a given acid is the opposite of its acidic strength, i.e. the stronger the acid, the smaller the value of pKa. The smaller the -R group attached to the carboxylic acid group (-COOH), the stronger the acid. Hence, out of the given acids, HCOOH is the strongest acid. Therefore, HCOOH has the lowest pKa value.

Q15. The General Formula $C_nH_{2n}O_2$ is for the open-chain:

a. Ketones
b. Aldehydes
c. Alcohols
d. Carboxylic Acids

Answer: (d)

Explanation: The General formula for carboxylic acids is $C_nH_{2n+1}COOH$.
Where n = number of carbon atoms present in the molecule -1.
On putting n = n-1 in this general formula, the formula becomes:
$C_{(n-1)}H_{2(n-1)+1}COOH = C_{(n-1)}H_{2n-2+1}C_1O_1O_1H_1 = C_nH_{2n}O_2$
Thus, the given General Formula is for the open-chain Carboxylic Acids. Thus, option (d) is correct.

Practice Questions on Carboxylic Acid Formula

Q1. The strongest acid among the following is:

a. HCOOH
b. $CH_3CH_2CH(Cl)COOH$
c. CH_3COOH
d. $CH_2(Cl)CH_2CH_2COOH$

Answer: (b)

Explanation: $CH_3CH_2CH(Cl)COOH$ is the strongest acid due to the -I effect of the chlorine atom attached right next to the carboxylic acid group. The highly electronegative chlorine atom is attached to the carboxylic group directly.

Q2. Arrange the following acids in the increasing order of their acid strengths.
$(CH_3)_2CHCOOH$, $CH_3CH(Br)CH_2COOH$, $CH_3CH_2CH(Br)COOH$

Answer: From the given acids, $CH_3CH(Br)CH_2COOH$ and $CH_3CH_2CH(Br)COOH$ are more acidic than $(CH_3)_2CHCOOH$ due to the presence of the highly electronegative element Bromine present in both of these compounds. However, $CH_3CH_2CH(Br)COOH$ is most acidic because the highly electronegative Bromine atom is attached to a carbon, which is just next to the carboxylic carbon. So, the increasing order of their acid strengths is:

$$(CH_3)_2CHCOOH < CH_3CH(Br)CH_2COOH < CH_3CH_2CH(Br)COOH$$

Q3. Write a balanced chemical equation for the reaction between CH_3COOH and PCl_5.

Answer: The Acetic Acid (CH_3COOH) and Phosphorus Pentachloride (PCl_5) react to form Acetyl Chloride (CH_3COCl), Phosphorus Oxychloride ($POCl_3$) and Hydrochloric Acid (HCl). The balanced chemical equation for the same is given below.

$$CH_3COOH + PCl_5 \rightarrow CH_3COCl + POCl_3 + HCl$$

Q4. Write the IUPAC name of the following compound: HOOC - CH = CH - COOH

Answer: The given compound is a dicarboxylic acid. The IUPAC naming of the given compound is done as follows:

1. The longest carbon chain is selected in the given compound.
2. The carbon chain is numbered starting from the end that is close to the functional group carbon. This is done to give the smallest numbering to the functional group carbon. As the given compound is symmetrical, the numbering can be started from any end.
3. After numbering, the name is given as per the IUPAC rule.

Hence, the IUPAC name of the given compound is But-2-ene-1,4-dioic acid.

Q5. Write an equation for the following conversion:

Butanol → Butanoic Acid

Answer: The alcohols are the reduction products of carboxylic acids. That's why, to prepare carboxylic acid, the alcohol must be oxidised. The reaction equation for the above conversion will be:

$$CH_3CH_2CH_2CH_2OH \xrightarrow[Jones Reagent]{CrO_3 + H_2SO_4} CH_3CH_2CH_2COOH$$

Butanol is oxidised by using the acidified Chromium Trioxide to form Butanoic Acid.