

Answer on Question #44016 - Chemistry - Organic Chemistry

Question:

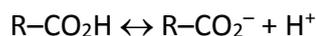
Arrange the following acids in the increasing order of reactivity: formic acid, benzoic acid, acetic acid.

Solution:

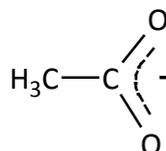
To compare the reactivity of carboxylic acids is convenient to use their acidity. The acidity of an acid refers to its ability or tendency to lose a proton (H^+) and measured on the pK_a scale. The smaller the number on this scale, the stronger the acid is. Three of the compounds together with their pK_a values are:

Acid	Formula	pK_a
Acetic	CH_3CO_2H	4.8
Benzoic	$C_6H_5CO_2H$	4.2
Formic	HCO_2H	3.75

Carboxylic acids can dissociate in aqueous solution into carboxylate anions ($R-CO_2^-$) and protons:



The most important factor in determining the relative acid strengths of these molecules is the nature of the $R-CO_2^-$ anion formed. In the case of acetic acid the structure of anion is:



The negative charge has been spread around over the whole of the $-CO_2^-$ group, but with the greatest chance of finding it in the region of the two oxygen atoms. Acidity depends on the stability of the anions formed – on how much it is possible to delocalize the negative charge. The less the charge is delocalized, the less stable the ion, and the weaker the acid.

CH_3- group of the acetate anion ($CH_3CO_2^-$) have a tendency to "push" electrons away from themselves. That means that there will be a small amount of extra negative charge built up on the $-CO_2^-$ group. Any build up of charge will make the ion less stable. Phenyl group of benzoate anion ($C_6H_5CO_2^-$) and hydrogen atom of formate anion (HCO_2^-), as compared with the CH_3- group of the acetate anion ($CH_3CO_2^-$), have a tendency to "withdraw" electrons from carboxylic group, enhancing the acidity.

However, be aware that if we compare chemical properties of these acids other than acidity, the order of increasing of reactivity may be different.

Answer: acetic acid, benzoic acid, formic acid.