Answer on Question #54271 – Chemistry – Physical Chemistry

Question:
On dissolving 19.5 g of CH_2FCOOH in 500 g of water a depression of 1c in freezing point of water is observed calculate vant hoff factor and dissociation constant of fluro acetic acid given kf=1,86 Kkg mol-1

Answer:
The van't Hoff factor *i* is the ratio between the actual concentration of particles produced when the substance is dissolved, and the concentration of a substance as calculated from its mass.
If a fraction *a* of the solute dissociates into n ions, then $i=1+a(n-1)$.
$FCH_2COOH <-----> FCH_2COO^- + H^+$
The dissociation of fluoroacetic acid yields n=2 particles, so that $i=1+a$.

1) Calculation of van't Hoff factor:

Molar mass of fluoroacetic acid is
$M(FCH_2COOH)=78$ g/mol
Number of moles of fluoroacetic acid is
$n(FCH_2COOH) = m(FCH_2COOH) / M(FCH_2COOH) = 19.5\text{ g} / 78\text{ g/mol} = 0.25$ mol
Molality, m = (number of moles fluoroacetic acid) / (mass of water in kg) = 0.25 mol / 0.5 kg = 0.5 mol/kg
$\Delta T_f = i \times K_f \times m$
$i = \Delta T_f / (K_f \times m)$
Here, $\Delta T_f = 1.0$ K; $K_f = 1.86$ K×kg/mol; m = 0.5 mol/kg
$i = 1.0 / (1.86 \times 0.5) = 1.0753$

2) Calculation of dissociation constant, K_a

	$FCH_2COOH <-----> FCH_2COO^- + H^+$		
Initial conc.	0.5	0	0
At equilibrium	$0.5(1-a)$	$0.5a$	$0.5a$

$K_a = 0.5a^2 / (1-a) = 0.5 \times (0.0753)^2 / (1 - 0.0753) = 3.07 \times 10^{-3}$