Another Type of K_a Problem - Percent Dissociation

Example: Propanoic acid, CH_3CH_2COOH is a weak monoprotic acid that is used to keep mould from forming in bread. A student prepared a 0.10 mol/L solution of propanoic acid and found the pH was 2.96 What is the acid dissociation constant for propanoic acid and what was the percent dissociation?

First, of course, write your dissociation equation:

$CH_3CH_2COOH\ (aq) + H_2O\ (l) \rightleftharpoons H_3O^+\ (aq) + CH_3CH_2COO^-\ (aq)$

Calculate the $[H_3O^+]$ from the given pH

$[H_3O^+] = 10^{-pH}$

$= 10^{-2.96}$

$= 1.10 \times 10^{-3}$

Set up your ice table and calculate your numbers.

$[CH_3CH_2COOH]$	$[H_3O^+]$	$[CH_3CH_2COO^-]$
I 0.10	0	0
C $-(1.10 \times 10^{-3})$	$+(1.10 \times 10^{-3})$	$+(1.10 \times 10^{-3})$
E 0.0989	1.10×10^{-3}	1.10×10^{-3}

Now we have all the information necessary to calculate K_a :

$$K_a = \frac{[H_3O^+][CH_3CH_2COO^-]}{[CH_3CH_2COOH]} = \frac{(1.10 \times 10^{-3})(1.10 \times 10^{-3})}{0.0989} = 1.2 \times 10^{-5}$$

Now calculate the percent dissociation by expressing the fraction that dissociates out of the initial concentration and change it to a percent:

$$\% \text{ dissociation} = \frac{1.10 \times 10^{-3}}{0.10} \times 100 = 1.1\ \%$$