

What is the pH of vinegar?

(5.0 wt %  $\text{CH}_3\text{COOH} \Rightarrow [\text{CH}_3\text{COOH}]_0 = 0.83\text{M}$ )



I(M)	0.83	—	0	$10^{-7} \approx 0$
C(M)	-x		+x	+x
E(M)	0.83-x		x	x

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]} = \frac{x^2}{0.83-x} = 1.8 \times 10^{-5}$$

Solve (a) using quadratic formula, or

(b) realize that  $0.83 \geq 10^4 K_a$ , so  $x \ll 0.83$

$$\begin{aligned} \therefore \frac{x^2}{0.83} &= 1.8 \times 10^{-5} \Rightarrow x = \sqrt{(0.83)(1.8 \times 10^{-5})} \\ &= 0.00387\text{M} = [\text{H}_3\text{O}^+] \end{aligned}$$

$$\text{so pH} = -\log [\text{H}_3\text{O}^+] = \boxed{2.41}$$

$$\begin{aligned} \% \text{ dissociation} &= \frac{x}{[\text{CH}_3\text{COOH}]_0} \times 100\% = \frac{0.00387\text{M}}{0.83\text{M}} \times 100\% \\ &= 0.47\% \end{aligned}$$