

Acid-base Eq ① pH of Polyprotic Acid ②

What is the pH of 0.125 M maleic acid soln.
 $K_{a1} = 1.2 \times 10^{-2}$, $K_{a2} = 4.7 \times 10^{-7}$.

	$H_2M + H_2O \rightleftharpoons H_3O^{\oplus} + HM^{\ominus}$	
I	0.125	0 0
C	-x	+x +x
E	(0.125-x)	x x

Quick check
 for x
 $\frac{0.125}{1.2 \times 10^{-2}} = 10.4 < 100$
 cannot ignore x

$$K_{a1} = 1.2 \times 10^{-2} = \frac{(x)(x)}{(0.125-x)} = \frac{x^2}{(0.125-x)}$$

open up eqn -

$$x^2 + 1.2 \times 10^{-2}x - 1.5 \times 10^{-3} = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-(1.2 \times 10^{-2}) \pm \sqrt{(1.2 \times 10^{-2})^2 - (4)(1)(-1.5 \times 10^{-3})}}{2(1)}$$

$$x = -1.2 \times 10^{-2} \pm 7.8 \times 10^{-2}$$

$$x = 3.3 \times 10^{-2} \quad \{H_3O^{\oplus}\}$$

$K_{a1} = 1.2 \times 10^{-2}$ $K_{a2} = 4.7 \times 10^{-7}$ step 2nd ionization
 10^{-5}

$$pH = -\log 3.3 \times 10^{-2} = \boxed{1.48}$$