

Ionization Constant Calculations

Assigned questions - 18B



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{HS}^-]}{[\text{H}_2\text{S}]}$$

Percent Ionization

Definition - % = out of 100

$$\% \text{ ionization} = \frac{[\text{H}_3\text{O}^+]_{\text{equilibr.}}}{[\text{Acid}]_{\text{initial}}} \times 100\%$$

Example - What is % ionization if an acid's initial conc. is 1.5 mol/L and $[\text{H}_3\text{O}^+] = 0.075 \text{ mol/L}$

$$\% \text{ ioniz.} = \frac{[\text{H}_3\text{O}^+]}{[\text{HA}]} \times 100\%$$

$$\begin{aligned} \% \text{ ioniz.} &= \frac{0.075}{1.5} \times 100\% \\ &= 5.0\% \end{aligned}$$

Ex. 2 A 1.2 mol/L solution of base ionizes 13%. Calculate K_b

	$\text{B} + \text{H}_2\text{O} \rightleftharpoons \text{BH}^+ + \text{OH}^-$			
I	1.2	}	0	0
C	0.156	}	0.156	0.156
E	1.044	}	0.156	0.156

$$\% \text{ ioniz.} = \frac{[\text{OH}^-]}{[\text{B}]} \times 100\%$$

$$13 = \frac{[\text{OH}^-]}{1.2} \times 100$$

$$\begin{aligned} \frac{1.2 \times 13}{100} &= [\text{OH}^-] \\ 0.156 &= [\text{OH}^-] \end{aligned}$$

$$K_b = \frac{[\text{BH}^+][\text{OH}^-]}{[\text{B}]}$$

at equil. →

$$K_b = \frac{0.156 \times 0.156}{1.044} = 0.0233$$

Ex. 3 A 0.50 mol/L solution of HCOOH has a K_a of 1.8×10^{-4} . Calculate % ionization.

	HCOOH + H ₂ O	\rightleftharpoons	[H ₃ O ⁺]	[HCOO ⁻]
I	0.50	}	0	0
C	-x		x	x
E	0.50-x		x	x

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]}$$

at equil.

$$1.8 \times 10^{-4} = \frac{x \cdot x}{0.50 - x}$$

$$\sqrt{1.8 \times 10^{-4} \times 0.50} = \sqrt{x^2}$$

$$9.5 \times 10^{-3} \text{ mol/L} = x$$

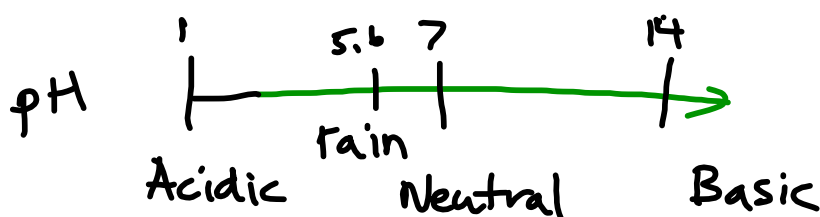
$$\% \text{ Ioniz.} = \frac{[\text{H}_3\text{O}^+]}{[\text{HCOOH}]} \times 100\%$$

$$= \frac{9.5 \times 10^{-3}}{0.50} \times 100\%$$

$$= 1.9\%$$

Worksheet
1, 3, 4, 8

pH-Definition and $[H_3O^+]$



Definition - "p" means

$$-\log [H_3O^+]$$

Examples -

$$\log 100 = 2 \qquad 10^2 = 100$$

$$\log 10 = 1 \qquad 10^1 = 10$$

$$\log 1 = 0 \qquad 10^0 = 1$$

$$\log 0.1 = -1 \qquad \vdots$$

2. $[H_3O^+] \rightarrow pH$

a) $1.0 \times 10^{-7} \rightarrow 7$

b) $3.3 \times 10^{-2} \rightarrow -(-1.5) = 1.5$

3. $pH \rightarrow [H_3O^+]$

$$8.1 = -\log [H_3O^+]$$

$$-8.1 = -(-\log H_3O^+)$$

$$-8.1 = \log [H_3O^+]$$

10^x key on calculator

$$7.9 \times 10^{-9} \text{ mol/L} = [H_3O^+]$$

p. 567 text

pH Calculations

Example- Find pH of a 0.45 mol/L solution of HF
($K_a = 6.6 \times 10^{-4}$)

$$\text{HF} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{F}^-$$

I	0.45		0	0
C	-x		x	x
E	0.45-x		x	x

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{F}^-]}{[\text{HF}]}$$

$$6.6 \times 10^{-4} = \frac{x \cdot x}{0.45 - x}$$

$$0.45 - 6.6 \times 10^{-4} = x^2$$

$$1.7 \times 10^{-2} = x$$

$$\text{pH} = -\log(1.7 \times 10^{-2})$$

$$= 1.8$$

Worksheet
#2, 7, 5

Text p. 511
#5, 7