

What is the pH of
 0.020 M HCl. Note that
 HCl is a strong acid.



	$[\text{HCl}]$	$[\text{H}_3\text{O}^+]$	$[\text{Cl}^-]$
<u>I</u>	0.020	~0	0
<u>C</u>	-0.020	+0.020	+0.020
<u>E</u>	0	0.020	0.020

$$[\text{H}_3\text{O}^+] = 0.020 \text{ M}$$

$$\begin{aligned} \text{pH} &= -\log [\text{H}_3\text{O}^+] \\ &= -\log(0.020) = 1.70 \end{aligned}$$

$$[\text{H}_3\text{O}^+][\text{OH}^-] = K_w$$

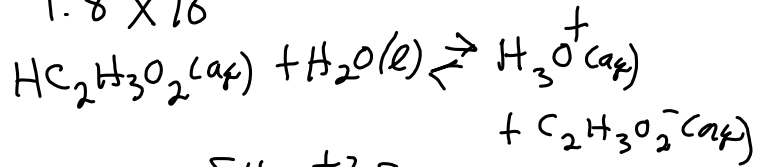
$$\begin{aligned} [\text{OH}^-] &= \frac{K_w}{[\text{H}_3\text{O}^+]} = \frac{1.0 \times 10^{-14}}{0.020} \\ &= 5.0 \times 10^{-13} \text{ M} \end{aligned}$$

$$\text{pH} + \text{pOH} = 14.00$$

$$\begin{aligned} \text{pOH} &= 14.00 - 1.70 \\ &= 12.30 \end{aligned}$$

$$\begin{aligned} \text{pOH} &= -\log[\text{OH}^-] = -\log(5.0 \times 10^{-13}) \\ &= 12.30 \end{aligned}$$

What is the pOH of a
 1.25 M $\text{HC}_2\text{H}_3\text{O}_2$ solution?
 Note that K_a for $\text{HC}_2\text{H}_3\text{O}_2$ is
 1.8×10^{-5}



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

	$[\text{HC}_2\text{H}_3\text{O}_2]$	$[\text{H}_3\text{O}^+]$	$[\text{C}_2\text{H}_3\text{O}_2^-]$
I	1.25	≈ 0	0
C	-X	+X	+X
E	$1.25 - X$	X	X

$$K_a = \frac{(X)(X)}{1.25 - X} = \frac{X^2}{1.25 - X} = 1.8 \times 10^{-5}$$

$$X \ll 1.25$$

$$1.25 - X \approx 1.25$$

$$\frac{X^2}{1.25} = 1.8 \times 10^{-5}$$

$$X^2 = 2.25 \times 10^{-5}$$

$$X = 4.7 \times 10^{-3}$$

$$1.25 - 0.0047$$

$$= 1.24525$$

$$\approx 1.25$$

$$X = [\text{H}_3\text{O}^+] = 4.7 \times 10^{-3} \text{ M}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] = -\log(4.7 \times 10^{-3})$$

$$= 2.33$$

$$\text{pOH} = 14.00 - 2.33$$

$$= 11.67$$

$$\begin{aligned}[\text{OH}^-] &= \frac{K_w}{[\text{H}_3\text{O}^+]} \\ &= \frac{1.0 \times 10^{-14}}{4.7 \times 10^{-3}} \\ &= 2.1 \times 10^{-12} \text{ M}\end{aligned}$$

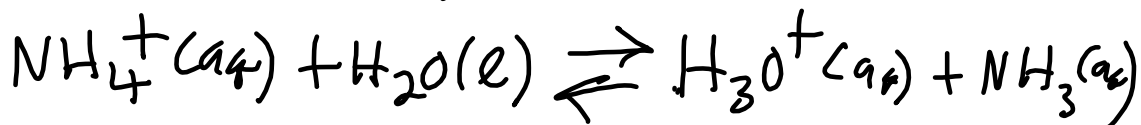
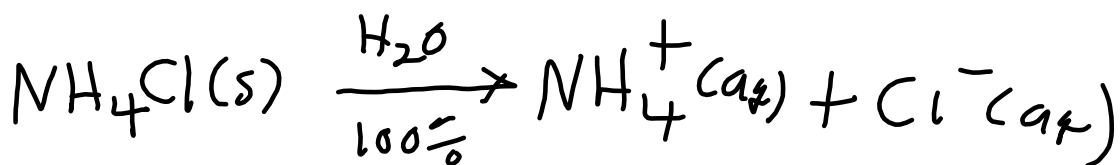
$$\begin{aligned}\text{pOH} &= -\log[\text{OH}^-] = -\log(2.1 \times 10^{-12}) \\ &= 11.67\end{aligned}$$

For conjugates

$$K_a \cdot K_b = K_w$$

What is the $[OH^-]$ in
a 2.55 M NH_4Cl solution?

K_b for NH_3 is 1.8×10^{-5}



$$K_a = \frac{[H_3O^+][NH_3]}{[NH_4^+]}$$

	$[NH_4^+]$	$[H_3O^+]$	$[NH_3]$
I	2.55	~ 0	0
C	-x	+x	+x
E	2.55-x	x	x

$$K_a = \frac{(x)(x)}{2.55-x} = \frac{x^2}{2.55-x} = ?$$

$$K_a \cdot K_b = K_w$$

$$K_a = \frac{K_w}{K_b} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$

$$\frac{x^2}{2.55 - x} = 5.6 \times 10^{-10}$$

$$x \ll 2.55$$

$$2.55 - x \approx 2.55$$

$$\frac{x^2}{2.55} = 5.6 \times 10^{-10}$$

$$x^2 = 1.428 \times 10^{-9}$$

$$x = 3.8 \times 10^{-5}$$

$$[H_3O^+] = 3.8 \times 10^{-5} M$$

$$[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{1.0 \times 10^{-14}}{3.8 \times 10^{-5}} = 2.6 \times 10^{-10}$$