

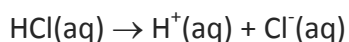
Answer on Question #79395 Chemistry/ General Chemistry

Calculate the concentrations of all species present (H_3O^+ , F^- , HF , Cl^- , and OH^-) in a solution that contains 0.17 M HF ($K_a=3.5 \times 10^{-4}$) and 0.17 M HCl .

My answers are: 0.17, 0.17, 0.17, 0.17, 5.89×10^{-14} but it says they're wrong but I don't understand how.

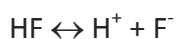
Solution

HCl is a strong acid. It dissociates completely:



As mole ratio of $n(\text{HCl}):n(\text{H}^+):n(\text{Cl}^-) = 1:1:1$ then initial concentrations of Cl^- and H^+ are $c(\text{Cl}^-)=0.17\text{M}$, $c(\text{H}^+) = 0.17\text{M}$

HF is a weak acid. It does not dissociate completely:



We should use ICE table to find equilibrium concentrations of all species:

	HF	H^+	F^-
Initial	0.17 M	0	0
Add	0	0.17 M	0
Change	-x	+x	+x
Equilibrium	$0.17 - x$	$0.17 + x$	x

$$K_a = \frac{(0.17 + x)x}{(0.17 - x)}$$

We make an assumption that x is very small (we'll check this assumption in the end of calculations- 5% rule), then

$$0.17 + x \cong 0.17$$

$$0.17 - x \cong 0.17$$

$$K_a = \frac{0.17x}{0.17}$$

$$K_a = x$$

$$x = 3.5 \times 10^{-4}$$

Select the smallest concentration for the 5% rule.

$$\frac{3.5 \times 10^{-4}}{0.17} \times 100\% = 0.2\%$$

This value is much less than 5%, so the assumptions are valid.

The concentrations at equilibrium are:

$$[\text{HF}] = 0.17 - x = 0.17 - 3.5 \times 10^{-4} = 0.1697 \text{ M}$$

$$[\text{H}^+] = 0.17 + x = 0.17 + 3.5 \times 10^{-4} = 0.1704 \text{ M}$$

$$[\text{F}^-] = x = 3.5 \times 10^{-4} \text{ M}$$

As Cl^- do not take part at any reaction its equilibrium concentration is the same as its initial concentration:

$$[\text{Cl}^-] = 0.17 \text{ M}$$

Find equilibrium concentration of OH^- :

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pH} = -\log(0.1704)$$

$$\text{pH} = 0.7687$$

$$\text{pOH} = 14 - \text{pH}$$

$$\text{pOH} = 14 - 0.7687$$

$$\text{pOH} = 13.23$$

$$\text{pOH} = -\log[\text{OH}^-]$$

$$13.23 = -\log[\text{OH}^-]$$

$$[\text{OH}^-] = 10^{-13.23}$$

$$[\text{OH}^-] = 5.87 \times 10^{-14} \text{ M}$$

Answer:

$[\text{H}_3\text{O}^+]$	$[\text{F}^-]$	$[\text{HF}]$	$[\text{Cl}^-]$	$[\text{OH}^-]$
0.1704 M	$3.5 \times 10^{-4} \text{ M}$	0.1697 M	0.17	$5.87 \times 10^{-14} \text{ M}$