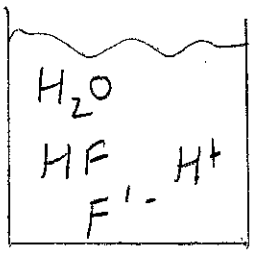
pH Calculation of Weak Acid Solution

What is the pH of a 1.0M HF solution?

step 1:



HF, F^{1-}, H^+, H_2O

step 2

$HF \rightleftharpoons H^+ + F^{1-}$ $\quad K_{a_{HF}} = 7.2 \times 10^{-4}$

$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^{1-}$ $\quad K_w = 1.0 \times 10^{-14}$

step 3

Since $K_{a_{HF}} >> K_w$, assume only H^+ from $K_{a_{HF}}$

step 4

$$K_{a_{HF}} = \frac{[H^+]_E^1 [F^{1-}]_E^1}{[HF]_E^1}$$

$[HF]_I = 1.0M$

$[H^+]_I = [F^{1-}]_I = 0M$

step 5

	HF	F^{1-}	H^+
I	1.0M	0M	0M
C	$-x$	$+x$	$+x$
E	$1.0M - x$	x	x

Assume 5% Rule

$1.0M - x \approx 1.0M$

✓ check $\frac{2.683 \times 10^{-2} M}{1.0M} \cdot 100\% < 5\%$

$$7.2 \times 10^{-4} M = \frac{(x)(x)}{1.0M - x}$$

$$7.2 \times 10^{-4} M = \frac{x^2}{1.0M}$$

$$[F^{1-}]_E = [H^+]_E = x = \sqrt{(1.0M)(7.2 \times 10^{-4} M)} = 2.683 \times 10^{-2} M$$

$$pH = -\log[H^+] = -\log(2.683 \times 10^{-2} M) = -(-1.571) = 1.571$$

step 6

$$\boxed{pH = 1.57}$$