Acid #6

Answer key.

1. $H_3Cit \longleftrightarrow H^+ + H_2Cit^-$

$$K_a = \frac{[H^+][H_2Cit^-]}{[H_3Cit]} = 8.4 \times 10^{-4}$$

$[H^+] = \text{antilog}(-2.10) = 7.94 \times 10^{-3}\ M$

$[H_2Cit^-] = [H^+] = 7.94 \times 10^{-3}\ M$

$[H_3Cit] = [H_3Cit]_{initial} - [H^+]$

$$K_a = \frac{(7.94 \times 10^{-3})^2}{[H_3Cit]_{initial} - 7.94 \times 10^{-3}} = 8.4 \times 10^{-4}$$

$[H_3Cit]_{initial} = \underline{8.3 \times 10^{-2}\ M}$

2. NaF: Na^+ does not hydrolyze

$F^- + H_2O \longleftrightarrow HF + OH^-$

$$K_b = \frac{[HF][OH^-]}{[F^-]} = \frac{K_w}{K_{a(HF)}} = \frac{1.0 \times 10^{-14}}{3.5 \times 10^{-4}} = 2.86 \times 10^{-11}$$

let $x = [OH^-]$

then $[HF] = x$

and $[F^-] = 1.0M - x$

$\approx 1.0M$ if x is small

$$2.86 \times 10^{-11} = \frac{x^2}{1.0}$$

$[OH^-] = x = 5.35 \times 10^{-6}\ M$

$pOH = 5.272$

$\underline{pH = 8.73}$

Acid 6 cont'd.

Answer key.

3. $Mg(OH)_{2(s)} \longleftrightarrow Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$

$K_{sp} = [Mg^{2+}][OH^-]^2 = 1.8 \times 10^{-11}$

let $[Mg^{2+}] = x$

then $[OH^-] = 2x$

$K_{sp} = 4x^3 = 1.8 \times 10^{-11}$

$x = 1.65 \times 10^{-4} M$

$[OH^-] = 2x = 3.30 \times 10^{-4} M$

$pOH = 3.481$

$\underline{pH = 10.52}$

11 a) $HF + H_2O \longleftrightarrow H_3O^+ + F^-$

$K_a = \frac{[H_3O^+][F^-]}{[HF]} = 3.5 \times 10^{-4}$

$[H_3O^+] = \text{antilog}(-2.21) = 6.17 \times 10^{-3} M$

$[F^-] = [H_3O^+] = 6.17 \times 10^{-3} M$

$[HF] = (2.09 g/L \div 20 g/mol) - 6.17 \times 10^{-3} M = 9.38 \times 10^{-2} M$

$K_a = \frac{(6.17 \times 10^{-3})^2}{9.38 \times 10^{-2}} = \underline{4.1 \times 10^{-4}}$

b) $\%$ dissociation $= \frac{6.17 \times 10^{-3}}{(2.09 g/L \div 20 g/mol)} \times 100 = \underline{6.2\%}$

5. pH range 8.2 – 10.0

pOH range 5.8 – 4.0

$[OH^-]$ range $1.5 \times 10^{-6} M$ to $1.0 \times 10^{-4} M$ a difference of $9.35 \times 10^{-5} M$

$\underline{\text{or } 1 \times 10^{-4} M}$

Acid #6 cont'd

Answer key

6. $\underline{H_3O^+} + F^- \longleftrightarrow HF + H_2O$ products favored

$\underline{HF} + NH_3 \longleftrightarrow NH_4^+ + F^-$ products favored

Stronger acid underlined

7. $CH_3COOH + H_2O \longleftrightarrow CH_3COO^- + H_3O^+$

$$K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} = 1.8 \times 10^{-5}$$

$[H_3O^+] = \text{anti.log}(-3.2) = 6.3 \times 10^{-4}\ M$

$[CH_3COO^-] = [H_3O^+] = 6.3 \times 10^{-4}\ M$

$[CH_3COOH] = [CH_3COOH]_{initial} - 6.3 \times 10^{-4}\ M$

$$1.8 \times 10^{-5} = \frac{(6.3 \times 10^{-4})^2}{[CH_3COOH]_{in.} - 6.3 \times 10^{-4}}$$

$[CH_3COOH]_{initial} = 2.3 \times 10^{-2}\ M$

mass $= 2.3 \times 10^{-2}\ mol/L \times 60.0\ g/mol = \underline{1.4\ g\ per\ litre} = \underline{1\ g/L}$

8. Na_2S : Na^+ does not hydrolyse

$S^{2-} + H_2O \longleftrightarrow HS^- + OH^-$

$HS^- + H_2O \longleftrightarrow \underline{H_2S} + OH^-$

as H_2S gas escapes the reactions proceed in the forward direction to produce more OH^- (strongly basic) and H_2S gas (odour.)