Weak Acids

① $[H^+] = 10^{-pH}$

$= 10^{-2.78}$

$= 0.00166 \text{ mol/L}$

$p = \frac{[H^+]}{[HC_3H_5O_2]} \times 100\%$

$= \frac{0.00166}{0.05} \times 100\%$

$p = \boxed{3.32\%}$

② $[H^+] = 10^{-2.54}$

$= 0.00288 \text{ mol/L}$

$p = \frac{[H^+]}{[CH_3COOH]} \times 100\%$

$= \frac{0.00288}{0.46} \times 100\%$

$p = \boxed{0.63\%}$

③ $[H^+] = 10^{-2}$

$= 0.01 \text{ mol/L}$

$p = \frac{[H^+]}{[HF]} \times 100\%$

$= \frac{0.01}{0.15} \times 100\%$

$p = \boxed{6.67\%}$

④

	$HF_{(aq)} \rightleftharpoons$	$H^+_{(aq)}$ +	$F^-_{(aq)}$
I	0.1	0	0
C	$-x$	$+x$	$+x$
E	$0.1-x$	x	x

$x = 7.8\%$ of $[HF]$

$= (0.1)(0.078)$

$x = 0.0078$

$[HF]_{eq} = 0.1 - x$

$= 0.1 - 0.0078$

$= 0.0922$ mol/L

$[H^+] = [F^-] = x$

$= 0.0078$ mol/L

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

$$= \frac{(0.0078)(0.0078)}{(0.0922)}$$

$$K_a = \boxed{6.6 \times 10^{-4}}$$

⑤ $HNO_2(aq) \rightleftharpoons H^+(aq) + NO_2^-(aq)$

	HNO_2	H^+	NO_2^-
I	0.2	0	0
C	$-x$	$+x$	$+x$
E	$0.2-x$	x	x

$x =$ 5.8% of $[HNO_2]$

$= (0.058)(0.2)$

$x = 0.0116$

$[HNO_2] = 0.2 - x$

$= 0.2 - 0.0116$

$= 0.1884$ mol/L

$[H^+] = [NO_2^-] = x$

$= 0.0116$ mol/L

$$K_a = \frac{[H^+][NO_2^-]}{[HNO_2]}$$

$$= \frac{(0.0116)(0.0116)}{(0.1884)}$$

$K_a = \boxed{7.1 \times 10^{-4}}$

⑥ a) $HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$

	$HF(aq)$	$H^+(aq)$	$F^-(aq)$
I	0.1	0	0
C	$-x$	$+x$	$+x$
E	$0.1-x$	x	x

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

$$6.7\times10^{-4} = \frac{(x)(x)}{(0.1-x)}$$

Since K_a is small, x will be small. Thus

$$0.1 - x \approx 0.1$$

$$6.7\times10^{-4} = \frac{x^2}{0.1}$$

$$x = \sqrt{(0.1)(6.7\times10^{-4})}$$

$$x = 0.00818$$

$$[H^+] = \boxed{0.00818 \text{ mol/L}}$$

⑥ b) $HCN_{(aq)} \rightleftharpoons H^+_{(aq)} + CN^-_{(aq)}$

I	0.1	0	0
C	$-x$	$+x$	$+x$
E	$0.1-x$	x	x

$$K_a = \frac{[H^+][CN^-]}{[HCN]}$$

$$4.9\times10^{-10} = \frac{(x)(x)}{(0.1-x)}$$

Since K_a is small, x will be small. Thus

$$0.1 - x \approx 0.1$$

$$4.9\times10^{-10} = \frac{x^2}{0.1}$$

$$x = \sqrt{(0.1)(4.9\times10^{-10})}$$

$$x = 7\times10^{-6}$$

$$[H^+] = \boxed{7\times10^{-6}\ \text{mol/L}}$$

c) HF is more acidic

⑦ $p = \frac{[H^+]}{[CH_3CH_2COOH]} \times 100\%$

$= \frac{1.16 \times 10^{-3}}{0.1} \times 100\%$

$p = \boxed{1.16\%}$

⑧ $HC_4H_3N_2O_3(aq) \rightleftharpoons H^+(aq) + C_4H_3N_2O_3^-(aq)$

I	0.25	0	0
C	$-x$	$+x$	$+x$
E	$0.25 - x$	x	x

$K_a = \frac{[H^+][C_4H_3N_2O_3^-]}{[HC_4H_3N_2O_3]}$

$9.8 \times 10^{-5} = \frac{(x)(x)}{(0.25 - x)}$

Since K_a is small, x will be small. Thus,

$0.25 - x \approx 0.25$

$9.8 \times 10^{-5} = \frac{x^2}{0.25}$

$x = \sqrt{(0.25)(9.8 \times 10^{-5})}$

$x = 0.00495$

$[H^+] = \boxed{0.00495 \text{ mol/L}}$

$pH = -\log(0.00495)$

$pH = \boxed{2.31}$

⑨ $HC_3H_5O_3(aq) \rightleftharpoons H^+(aq) + C_3H_5O_3^-(aq)$

I	0.025	0	0
C	$-x$	$+x$	$+x$
E	$0.025 - x$	x	x

$$K_a = \frac{[H^+][C_3H_5O_3^-]}{[HC_3H_5O_3]}$$

$$1.4 \times 10^{-4} = \frac{(x)(x)}{(0.025 - x)}$$

Since K_a is small, x will be small. Thus $0.025 - x \approx 0.025$

$$1.4 \times 10^{-4} = \frac{x^2}{0.025}$$

$$x = \sqrt{(0.025)(1.4 \times 10^{-4})}$$

$$x = 0.00187$$

$$[H^+] = 0.00187 \text{ mol/L}$$

$$pH = -\log(0.00187)$$

$$pH = \boxed{2.73}$$

(10) $HCOOH(aq) \rightleftharpoons H^+(aq) + COOH^-(aq)$

I	0.15	0	0
C	$-x$	$+x$	$+x$
E	$0.15-x$	x	x

$$K_a = \frac{[H^+][COOH^-]}{[HCOOH]}$$

$$1.8\times10^{-4} = \frac{(x)(x)}{(0.15-x)}$$

$$1.8\times10^{-4} = \frac{x^2}{0.15}$$

$$x = \sqrt{(0.15)(1.8\times10^{-4})}$$

$$x = 0.0052$$

$$[H^+] = 0.0052 \text{ mol/L}$$

$$pH = -\log(0.0052)$$

$$pH = \boxed{2.28}$$

(11) $[H^+] = 10^{-pH}$

$= 10^{-3.08}$

$= 8.31 \times 10^{-4}$ mol/L

$HC_2H_6NO_2 (aq) \rightleftharpoons H^+ (aq) + C_2H_6NO_2^- (aq)$

$K_a = \dfrac{[H^+][C_2H_6NO_2^-]}{[HC_2H_6NO_2]}$ $\qquad [H^+] = [C_2H_6NO_2^-]$

$= \dfrac{(8.31 \times 10^{-4})(8.31 \times 10^{-4})}{(0.05)}$

$K_a = \boxed{1.38 \times 10^{-5}}$

(12) $pH = 2.40$

$[H^+] = 10^{-2.40} = 0.00398 \text{ mol/L}$

$HC_7H_5O_2(aq) \Leftrightarrow H^+(aq) + C_7H_5O_2^-(aq)$

$K_a = \dfrac{[H^+][C_7H_5O_2^-]}{[HC_7H_5O_2]}$ $\qquad [H^+] = [C_7H_5O_2^-]$

$= \dfrac{(0.00398)(0.00398)}{(0.25)}$

$K_a = \boxed{6.34 \times 10^{-5}}$

(13) $[H^+] = 10^{-2.40} = 0.00398 \text{ mol/L}$

$HC_6H_7O_6(aq) \Leftrightarrow H^+(aq) + C_6H_7O_6^-(aq)$

$K_a = \dfrac{[H^+][C_6H_7O_6^-]}{[HC_6H_7O_6]}$ $\qquad [H^+] = [C_6H_7O_6^-]$

$= \dfrac{(0.00398)(0.00398)}{(0.2)}$

$K_a = \boxed{7.92 \times 10^{-5}}$