17.23a)

	CH_3COOH	$\rightleftharpoons$	CH_3COO^-	+	H^+
I	0.150M		0.488		0 M
C	-x		+x		+x
E	0.150 - x		0.488 +x		x

$$\frac{20.0\text{ g } NaCH_3COO \mid 1\text{ mol } NaCH_3COO \mid 1000\text{ ml}}{500\text{ ml} \mid 82.04\text{ g } NaCH_3COO \mid 1\text{ L}} = 0.488M\ NaCH_3COO$$

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} \quad 1.8 \times 10^{-5} = \frac{(0.488+x)x}{0.150 - x} \approx \frac{0.488x}{0.150}$$

$x = 5.53 \times 10^{-6}$

$pH = -\log[H^+]$ $pH = -\log[5.53 \times 10^{-6}]$ $pH = 5.26$

17.23b) $Na^+ + CH_3COO^- + H^+ + Cl^- \Rightarrow Na^+ + Cl^- + CH_3COOH$

17.23c) $Na^+ + OH^- + CH_3COOH \Rightarrow Na^+ + CH_3COO^- + H_2O$

17.24a)

	NH_3	+	H_2O	$\rightleftharpoons$	NH_4^+	+	OH^-
I	1.00M		———		0.748 M		0 M
C	-x		———		+x		+x
E	1.00 - x		———		0.748 + x		x

$$\frac{10.0\text{ g } NH_4Cl \mid 1\text{ mol } NH_4Cl \mid 1000\text{ ml}}{250\text{ ml} \mid 53.50\text{ g } NH_4Cl \mid 1\text{ L}} = 0.748\text{ M } NH_4Cl$$

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} \qquad 1.8 \times 10^{-5} = \frac{(0.748 + x)x}{1.00 - x} \approx \frac{0.748x}{1.00}$$

$x = 2.41 \times 10^{-5}$

$pOH = -\log[OH^-]$ $\quad pOH = -\log[2.41 \times 10^{-5}]$ $\quad pOH = 4.62$

$pH + pOH = 14$ $\quad pH = 14 - pOH$ $\quad pH = 14 - 4.62 = 9.38$

17.24b) $NH_3 + H^+ + NO_3^- \Rightarrow NH_4^+ + NO_3^-$

17.24c) $Cl^- + K^+ + OH^- + NH_4^+ \Rightarrow K^+ + NH_3 + H_2O + Cl^-$

17.25a)

	HF	$\rightleftharpoons$	F^-	+	H^+
I	1.00M		0 M		0 M
C	-x		+x		+x
E	1.00 - x		x		x

$$K_a = \frac{[F^-][H^+]}{[HF]} \qquad 6.8 \times 10^{-4} = \frac{x^2}{1.00 - x} \approx \frac{x^2}{1.00}$$

$x = 0.0261$

$pH = -\log[H^+]$ $pH = -\log[0.0261]$ $pH = 1.58$

17.25b) $pH = -\log[H^+]$ $\quad 3.00 = -\log[H^+]$ $\quad [H^+] = 10^{-3} = 0.001$

	HF	$\rightleftharpoons$	F^-	+	H^+
I	1.00M		x		0 M
C	1.00 - 0.001		+ 0.001		+0.001
E	0.999		x + 0.001		0.001

$$K_a = \frac{[F^-][H^+]}{[HF]} \quad 6.8 \times 10^{-4} = \frac{(x + 0.001)0.001}{0.999} \quad x = 0.67M$$

$$1.25\ L \left| \frac{0.67\ mol\ NaF}{1\ L} \right| \frac{42.00\ g\ NaF}{1\ mol\ NaF} = 35.7\ g\ NaF$$

17.27a)

	CH_3COOH	$\rightleftharpoons$	CH_3COO^-	+	H^+
I	.10M		0.13M		0 M
C	-x		+x		+x
E	0.10 - x		0.13+x		x

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} \quad 1.8 \times 10^{-5} = \frac{(0.13+x)x}{0.10 - x} \approx \frac{0.13x}{0.10}$$

$x = 1.4 \times 10^{-5}$ $pH = -\log[H^+]$ $pH = -\log[1.4 \times 10^{-5}]$ $pH = 4.86$

17.27b)

	CH_3COOH	$\rightleftharpoons$	CH_3COO^-	+	H^+
I	.10 mol		0.13 mol		0 mol
R	-0.02		+0.02		0 mol
	0.08/1.0L		0.15/1.0L		0 mol
A	0.08M		0.15M		0M
C	-x		+x		+x
E	0.08 - x		0.15 + x		x

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} \quad 1.8 \times 10^{-5} = \frac{(0.15+x)x}{0.08 - x} \approx \frac{0.15x}{0.08}$$

$x = 1.0 \times 10^{-5}$ $\quad pH = -\log[H^+]$ $\quad pH = -\log[1.0 \times 10^{-5}]$ $\quad pH = 5.01$

17.27c)

	CH_3COOH	$\rightleftharpoons$	CH_3COO^-	+	H^+
I	.10 mol		0.13 mol		0 mol
R	+0.02		-0.02		0 mol
	0.12/1.0L		0.11/1.0L		0 mol
A	0.12M		0.12M		0M
C	-x		+x		+x
E	0.12 - x		0.11 + x		x

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} \quad 1.8 \times 10^{-5} = \frac{(0.11+x)x}{0.12 - x} \approx \frac{0.11x}{0.12}$$

$x = 2.0 \times 10^{-5}$ $\quad pH = -\log[H^+]$ $\quad pH = -\log[2.0 \times 10^{-5}]$ $\quad pH = 4.71$

17.28a)

$$M = \frac{\text{moles}}{\text{liters}} = \frac{0.15\ \text{mol}}{1.20\ \text{L}} = 0.125\text{M Prop Acid} \qquad M = \frac{\text{moles}}{\text{liters}} = \frac{0.10\ \text{mol}}{1.20\ \text{L}} = 0.083\text{M Prop Salt}$$

	C_2H_5COOH	$\rightleftharpoons$	$C_2H5_3COO^-$	+	H^+
I	0.125		0.083M		0 M
C	-x		+x		+x
E	0.125 - x		0.083 + x		x

$$K_a = \frac{[C_2H_5COO^-][H^+]}{[C_2H_5COOH]} \quad 1.3 \times 10^{-5} = \frac{(0.083+x)x}{0.125 - x} \approx \frac{0.083x}{0.125}$$

$x = 2.0 \times 10^{-5}$ $\quad pH = -\log[H^+]$ $\quad pH = -\log[2.0 \times 10^{-5}]$ $\quad pH = 4.71$

17.28b)

	C_2H_5COOH	$\rightleftharpoons$	$C_2H_5COO^-$	+	H^+
I	.15 mol		0.10 mol		0 mol
R	-0.01		+0.01		0 mol
	0.14/1.20L		0.11/1.20L		0 mol
A	0.117M		0.0917M		0M
C	-x		+x		+x
E	0.117 - x		0.0917 + x		x

$$K_a = \frac{[C_2H_5COO^-][H^+]}{[C_2H_5COOH]} \quad 1.3 \times 10^{-5} = \frac{(0.0917+x)x}{0.117 - x} \approx \frac{0.0917x}{0.117}$$

$x = 1.7 \times 10^{-5}$ $\quad pH = -\log[H^+]$ $\quad pH = -\log[1.7 \times 10^{-5}]$ $\quad pH = 4.78$

17.28c)

	C_2H_5COOH	$\rightleftharpoons$	$C_2H_5COO^-$	+	H^+
I	.15 mol		0.10 mol		0 mol
R	+0.01		-0.01		0 mol
	0.16/1.20L		0.09/1.20L		0 mol
A	0.133M		0.0750M		0M
C	-x		+x		+x
E	0.133 - x		0.075 + x		x

$$K_a = \frac{[C_2H_5COO^-][H^+]}{[C_2H_5COOH]} \quad 1.3 \times 10^{-5} = \frac{(0.0750+x)x}{0.133 - x} \approx \frac{0.0750x}{0.133}$$

$x = 2.3 \times 10^{-5}$ $\quad pH = -\log[H^+]$ $\quad pH = -\log[2.3 \times 10^{-5}]$ $\quad pH = 4.64$

17.29a) $pH = -\log[H^+]$ $\quad 7.4 = -\log[H^+]$ $\quad [H^+] = 10^{-7.4} = 3.98 \times 10^{-8} M$

$$\underline{H_2CO_3 \rightleftharpoons HCO_3^- + H^+}$$

$$K_a = \frac{[HCO_3^-][H^+]}{[H_2CO_3]} \qquad \frac{K_a}{[H^+]} = \frac{[HCO_3^-]}{[H_2CO_3]} = \frac{4.3 \times 10^{-7}}{3.98 \times 10^{-8}} = 10.8 : 1$$

17.29b) $pH = -\log[H^+]$ $\quad 7.1 = -\log[H^+]$ $\quad [H^+] = 10^{-7.1} = 7.94 \times 10^{-8} M$

$$H_2CO_3 \rightleftharpoons HCO_3^- + H^+$$

$$K_a = \frac{[HCO_3^-][H^+]}{[H_2CO_3]} \qquad \frac{K_a}{[H^+]} = \frac{[HCO_3^-]}{[H_2CO_3]} = \frac{4.3 \times 10^{-7}}{7.94 \times 10^{-8}} = 5.42 : 1$$

17.30

$$\frac{6.5\text{ g } NaH_2PO_4}{355\text{ ml}} \left| \frac{1\text{ mol } NaH_2PO_4}{120.0\text{ g } NaH_2PO_4} \right| \frac{1000\text{ ml}}{1\text{ L}} = 0.153M\ NaH_2PO_4$$

$$\frac{8.0\text{ g } Na_2HPO_4}{355\text{ ml}} \left| \frac{1\text{ mol } Na_2HPO_4}{142.0\text{ g } Na_2HPO_4} \right| \frac{1000\text{ ml}}{1\text{ L}} = 0.159M\ Na_2HPO_4$$

	$H_2PO_4^-$	$\rightleftharpoons$	HPO_4^{2-}	+	H^+
I	0.153		0.159M		0 M
C	-x		+x		+x
E	0.153 - x		0.159 + x		x

$$K_a = \frac{[HPO_4^{2-}][H^+]}{[H_2PO_4^-]} \quad 6.2 \times 10^{-8} = \frac{(0.159+x)x}{0.153 - x} \approx \frac{0.159x}{0.153}$$

$x = 5.96 \times 10^{-8}$ $pH = -\log[H^+]$ $pH = -\log[5.96 \times 10^{-8}]$ $pH = 7.22$

17.31 In order to create a buffer, you must have a conjugate acid/base pair. The best choice is a weak acid with a pKa value close to the pH of the buffer you hope to create; in this case 3.50. Given 0.10M solutions of:

HCOOH pKa = 3.75 CH_3COOH pKa = 4.74 H_3PO_4 pKa = 2.12

The HCOOH/NaHCOO acid/conjugate base pair is the best choice, given the desired pH of 3.50.