31) Since these are all buffer solutions, you can use the Henderson-Hasselbalch equation

a) $pH = pKa + \log \frac{[Base]}{[Acid]}$

$pH = (-\log 1.8 \times 10^{-5}) + \log \frac{0.25}{0.10}$

$pH = 4.74 + 0.40 = 5.14$

b) $pH = pKa + \log \frac{[Base]}{[Acid]}$

$pH = 4.74 + \log \frac{0.10}{0.25}$

$pH = 4.34$

c) $pH = pKa + \log \frac{[Base]}{[acid]}$

$pH = 4.74 + \log \frac{0.20}{0.080}$

$pH = 5.14$

d) $pH = pKa + \log \frac{[Base]}{[Acid]}$

$pH = 4.74 + \log \frac{0.080}{0.20}$

$pH = 4.34$

33) $[HC_7H_5O_2] = \dfrac{21.5\,g\ HC_7H_5O_2 \ \dfrac{1\,mol}{122.12\,g}}{0.2000\,L} = 0.880\,M$

$[C_7H_5O_2^-] = \dfrac{37.7\,g\ NaC_7H_5O_2 \ \dfrac{1\,mole\ NaC_7H_5O_2}{144.10\,g\ NaC_7H_5O_2} \Big| \dfrac{1\,mole\ C_7H_5O_2^-}{1\,mole\ NaC_7H_5O_2}}{0.2000\,L}$

$= 1.31\,M$

* since its a buffer, use Henderson-Hasselbalch

$pH = pKa + \log \dfrac{[C_7H_5O_2^-]}{[HC_7H_5O_2]}$

$pH = -\log(6.4 \times 10^{-5}) + \log \dfrac{1.31}{0.880}$

$pH = 4.19 + 0.173 = 4.36$

35 a) $[H^+] = \dfrac{0.010\,mol}{0.2500\,L} = 0.040\,M$

H^+
NH_3
NH_4^+

	H^+	+	NH_3	$\longrightarrow$	NH_4^+
I	0.040		0.050		0.15
C	-0.040		-0.040		+0.040
E	0		0.010		0.19

$pH = pKa + \log \dfrac{[Base]}{[Acid]}$

$= -\log 5.6 \times 10^{-10} + \log \dfrac{0.010}{0.19}$

$= 9.25 - 1.29 = 7.97$

b) H^+ NH_3 NH_4^+

	H^+	+ NH_3	$\rightarrow$ NH_4^+
I	0.040	0.50	1.50
C	-0.040	-0.040	+0.04
E	0	0.46	1.54

$$pH = pKa + \log \frac{[Base]}{[Acid]}$$

$$= 9.25 + \log \frac{0.46}{1.54} = 8.73$$

both buffers have the same initial pH however their buffer capacities are different. (B) has a larger buffer capacity since it has larger buffer components. Buffers with larger buffer capacities can absorb more added H^+ or OH^-

37) $pH = pKa + \log \frac{[Base]}{[Acid]}$

* since buffer components are in same volume, $\frac{[Base]}{[Acid]} = \frac{mol\ Base}{mol\ Acid}$

$5.00 = \sout{-\log(1.8 \times 10^{-5})}$ 4.76 $+ \log \frac{mol\ Base}{mol\ Acid}$

mole $HC_2H_3O_2 = (0.5000L)(0.200M) = 0.100$ mol

$0.26 = \log \frac{x}{0.100}$ $\quad 10^{0.26} = \frac{x}{0.100}$

$x = 0.18$ mole $NaC_2H_3O_2$ $\frac{82.03g}{1\ mol} = 15g\ NaC_2H_3O_2$

3a) $C_5H_5NH^+ \rightleftharpoons H^+ + C_5H_5N$

$$K_a = \frac{1.0\times10^{-14}}{1.7\times10^{-9}} = 5.9\times10^{-6}$$

$$pK_a = -\log(5.9\times10^{-6}) = 5.23$$

$$pH = pK_a + \log\frac{[C_5H_5N]}{[C_5H_5NH^+]}$$

a) $$4.5 = 5.23 + \log\frac{[Base]}{[Acid]}$$

$$10^{-0.73} = \frac{[Base]}{[Acid]} = 0.19$$

b) $$5.00 = 5.23 + \log\frac{[Base]}{[Acid]}$$

$$10^{-0.23} = \frac{[Base]}{[Acid]} = 0.59$$

c) $$5.23 = 5.23 + \log\frac{[Base]}{[Acid]}$$

$$10^{-0.00} = \frac{[Base]}{[Acid]} = 1.0$$

d) $$5.50 = 5.23 + \log\frac{[Base]}{[Acid]}$$

$$10^{0.27} = \frac{[Base]}{[Acid]} = 1.9$$

41. A best buffer has large and equal quantities of weak acid and conjugate base. Since [Acid] = [Base] for the best buffer…

pH = pKa + log [Base]/[Acid] = pKa + 0

*** for the best buffer solution, pH is equal to pKa (or close to it)

If we want a buffer with a pH = 7.00, we want a pKa as close to 7 as possible (Ka around 1.0×10^{-7})

HOCl has a Ka = 3.5×10^{-8} and pKa = 7.46

7.00 = 7.46 + log [Base]/[Acid] = $10^{-0.46}$ = 0.35

So any [OCl^-]/[HOCl] value with a ratio of 0.35 to 1 will work