1. If you were to mix the following solutions, which one would result in a buffer?
    - a. 5 mL of .1 M hydrochloric acid and 10 ml of .04 M formic acid
    - b. 5 mL of .01 M sodium hydroxide and 10 ml of .01 M sodium formate
    - c. 10 mL of .01 M hydrochloric acid and 20 ml of .005 M sodium formate
    - d. 10 mL of .01 M sodium hydroxide and 10 ml of .1 M formic acid.

Mixing a weak acid and a strong acid will not give you a buffer, so A is out. B is a mixture of strong and weak bases, so it's out too. In option C, the strong acid completely neutralizes the weak base to give a weak acid solution. In D, the strong base will only neutralize some of the weak acid, leaving a buffer solution.

2. If 10 mL of .1 M oxalic acid is added to 200 mL of .5 M sodium oxalate, the final pH of a solution of the solution is 6. What is the pKa of oxalic acid?
    - a. 10^{-4}
    - b. 10^{-5}
    - c. 4
    - d. 5

$[H^{+}] = 10^{-pH} = 10^{-6}$

$[H^{+}] = Ka\ (C_a/C_b)$

$Ka = [H^{+}](C_b/C_a) = 10^{-6}\ ([.2 * .5]/[.01 * .1]) = 10^{-4}$

Note: you do not have to account for the liters of solution because they cancel out.

$pKa = -\log K_a = -\log 10^{-4} = 4$

3. If 10 mL of .05 M sodium hydroxide is added to 50 mL of .02 M acetic acid, what is the final pH of the solution? The K_a of acetic acid is is 10^{-5}.
    - a. 4
    - b. 6
    - c. 7
    - d. 5

mols of OH^{-} = .01 L (.05 mol/L) = .0005

mols of HA = .05 L (.02 mol/L) = .001

R	HA	+	OH-	-->	A-	+	H2O
I	.001		.0005		0		~
C	-.0005		-.0005		+.0005		~
E	.0005		0		.0005		~

After neutralization, the concentrations of HA and A- are equal, so the pH is equal to the pKa of the acid, 5. Which means, that no more calculations are necessary. But just in case you didn't know that:

$[H^{+}] = K_a(C_a/C_b) = 10^{-5}\ (.0005/.0005) = 10^{-5}$

$pH = -\log[H^{+}] = -\log(10^{-5}) = 5$

4. In a titration of diethylamine with hydrochloric acid, 50 mL of .01 M hydrochloric acid was required to reach the equivalence point of the titration. If you started with 10 ml of the diethyl amine solution, what was the solution's original molarity?
    - a. .05 M
    - b. .01 M
    - c. .005 M
    - d. .001

The equivalence point is reached when the number of mols of hydrochloric acid used equals the number of mols of the weak base that were in the original solution.

mols of B = mols of H+ = .05 L (.01 mol/L) = .005 mol

molarity of solution of B = .005 mol / .01 L = .05 M

5. Find the pH when 625 mL of 0.2 M HBr is mixed with 500 mL of 0.5 M charged base that has a K_b of 5.0 x 10^{-10}

a. 5.6
b. 7.0
c. 6.4
d. 3.3

1. Eliminate spectator ions
   $HBr \rightarrow H^+$ + ~~Br^-~~
   Br^- is the conjugate base of the strong acid
   weak base + H+ $\rightleftarrows$ base+
2. Identify SA/SB: H^+ = HBr
3. Identify WA/WB: A^- = Base (is weak because it has a very small Kb)
4. If possible, neutralize
   H^+ and A^- can neutralize
5. Neutralize
   (0.625 L)(0.2 M H^+) + (0.5L)(0.5M A^-) = 0.125 mol H^+ + 0.25 mol A^-
   0.125 mol H^+ + 0.25 mol A^- $\rightarrow$ 0.125 mol HA + 0.125 mol A^-
6. Pick calculation, strong acid with weak base. Buffer calculation
   $[H+] = K_aC_a/C_b = 1.3 \times 10^{-3} * 0.2M/0.5M = 5.2 \times 10^{-4}$
   pH = -log [H+] = -log (5.2 x 10-4) = 3.3

6. Determine the pH at the equivalence point when 0.1 M LiOH is titrated with 100 mL of 0.5 M CH_3COOH (K_a = 1.8 x 10^{-5})

a. 7.3
b. 7
c. 8.8
d. 5.2

Find Veq: (0.1 M)(Veq) = (0.5M)(.1L)
Veq = 500 mL
$OH^- + CH_3COOH \rightarrow CH_3COO^- + H_2O$
$[CH_3COO^-]$ = moles of CH_3COOH initial/total vol
$[CH_3COO^-] = M_{HA}V_{HA}/(V_{HA} + V_{OH,eq})$
$[CH_3COO^-]$ = (0.5 M)(0.1L)/(.1L + .5 L) = 0.83M

R	CH3COO-	CH3COOH	OH-
I	0.083	0	~0
C	-x	+x	+x
E	0.083-x	x	x

$K_b = 5.6 \times 10^{-10} = x^2 / (0.083 - x)$
$x = [OH^-] = 6.8 \times 10^{-6}$ M
pOH = 5.17
pH = 8.8

7. For which of the following following equations must we assume that that autoprotolysis is negligible during the its derivation?

a. $[OH^-] = (K_b{*}C_b)^{0.5}$
b. $[OH^-] = K_b(C_b/C_a)$

c. $[OH^-] = C_b$
d. All of these.

All of the simplified equations we use in acid base chemistry assume that autoprotlysis is negligible.

8. How many equations do you need to set up in order to find the pH of a 0.2 M weak diprotic acid with a $K_{a1} = 10^{-5}$ and $K_{a2} = 10^{-9}$?

a. 1
b. 4
c. 5
d. 2
e. 3

five unknowns

$H_2A \rightleftharpoons H^+ + HA^-$

$HA^- \rightleftharpoons H^+ + A^{2-}$

H^+ OH^- H_2A HA^- A^{2-}