Acids, Bases, Buffers Practice Questions (Fri. 3/26)

1. $NaA \rightarrow Na^+ + A^-$
   .45   .45   .45

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

HA	H^+	A^-
.250	0	.45
$-x$	$+x$	$+x$
$.250-x$	x	$.45+x$

$\rightarrow$ $1.0 \times 10^{-6} = \dfrac{(x)(.45+x)}{(.250-x)}$ 5% Rule

$x = [H^+] = 5.6 \times 10^{-7}$ M

$\boxed{pH = 6.25}$

2. $HF \rightleftharpoons H^+ + F^-$
   WA   SCB

SCB from the Salt

The solution would contain significant amounts of both H^+ and F^- $\rightarrow$ a Buffer!! If HCl is added to the solution, it will be neutralized by the F^- (SCB).

3. $HF \rightleftharpoons H^+ + F^-$

HF	H^+	F^-
.20	0	.10 ← from the NaF
$-x$	$+x$	$+x$
$.20-x$	x	$.10+x$

Look this up! I forgot :)

K_a of $H_f = 3.2 \times 10^{-4}$

$3.2 \times 10^{-4} = \dfrac{(x)(.10)}{(.20)}$ 5% Rule

$x = [H^+] = 6.4 \times 10^{-4}$ M

$\boxed{pH = 3.19}$

4. $NaCN \rightarrow Na^+ + CN^-$
   $HCN \rightleftharpoons H^+ + CN^-$
   ← shift

The common ion will shift the acid equilibrium to the left, causing the $[H^+]$ to decrease and pH to increase. B is False

** CHOICE E. If strong base is added, it will be neutralized by the HCN → $HCN + OH^- \rightarrow CN^- + H_2O$

5. $\underset{}{HCl} + \overset{\text{Base}}{NH_3} \rightarrow \overset{\text{SCA}}{NH_4^+} + Cl^-$

HCl	NH_3	NH_4^+	Cl^-
.050	.297	0	0
−.050	−.050	+.050	+.050
0	.247	.050	.050

Buffer

HCl

$(100.0)(.100) = M_2(200.0)$

$M_2 = .050\text{ M}$

NH_3

$(100.0)(.594) = M_2(200.0)$

$M_2 = .247\text{ M}$

$$pH = pKa + \log \frac{B}{A}$$

$$pH = -\log \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} + \log \frac{.247}{.050}$$

$$\boxed{pH = 9.95}$$

OR work the neutralization and then find the new equilibrium

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

NH_3	H_2O	NH_4^+	OH^-
.247		.050	0
−x		+x	+x
.247−x		.050+x	x

$$K_b = 1.8 \times 10^{-5} = \frac{(.050)(x)}{(.247)}$$

$$x = [OH^-] = 8.9 \times 10^{-5}$$

$$pOH = 4.04$$

$$\boxed{pH = 9.95}$$

6. $\underset{2.0\text{M}}{HCN} \rightleftharpoons H^+ + \underset{1.0\text{M}}{CN^-}$

F A. The solution is a buffer because it contains a weak acid and its conjugate base.

F B. and C. When a buffer is made with a weak acid, its pH will be < 7 and $[OH^-] < [H^+]$

F D. This buffer contains more acid than base, so will be able to neutralize more strong base than strong acid.

* E. All are false!

7. $HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$ } Buffer!!

equil. $.2-x$ $\quad x \quad .2+x$

$$1.8\times10^{-5} = \frac{(x)(.2+x)}{(.2-x)}$$

$x = 1.8\times10^{-5}$ M

$\boxed{pH = 4.74}$

or

$$pH = pKa + \log\frac{B}{A}$$

$$= -\log 1.8\times10^{-5} + \log\frac{.2}{.2}$$

$$= \boxed{4.74}$$

$\log 1 = 0$

Handy Fact → * when you have a buffer with equimolar acid and base, pH = pKa

8. Salt
$NaC_2H_3O_2 \rightarrow Na^+ + C_2H_3O_2^-$

$.125M \qquad .125M$

SCB → $C_2H_3O_2^- + H_2O \rightleftharpoons HC_2H_3O_2 + OH^-$

$C_2H_3O_2^-$	$HC_2H_3O_2$	OH^-
$.125M$	0	0
$-x$	$+x$	$+x$
$.125-x$	x	x

Salts can produce ions that go into hydrolysis

need K_b

$$\frac{1\times10^{-14}}{1.8\times10^{-5}} = \frac{x^2}{.125}$$

$x = [OH^-] = 8.3\times10^{-6}$ M

$pOH = 5.08$

$\boxed{pH = 8.92}$

9. $HCl \rightarrow H^+ + Cl^-$

$.010 \quad .010 \quad .010$

$pH = -\log .010$

$\boxed{p = 2.00}$

$[H^+]$ produced by weak acid is negligible.

10. net ionic eq. $OH^- + HC_2H_3O_2 \rightarrow C_2H_3O_2^- + H_2O$

Just do this in calc

$.0500\,L \times \frac{.100\,moles}{1\,L} = .00500\,moles$

$.0250\,L \times \frac{.100\,moles}{1\,L} = .00250\,moles$

neutralization reaction:

OH^-	$+\ HC_2H_3O_2$	$\rightarrow C_2H_3O_2^-$	$+\ H_2O$
.00500 moles	.00250 moles	0	
− .00250	− .00250	+ .00250	
.00250 moles	0	.00250 moles	

At the end of the neutralization reaction, the solution contains strong base and weak base.

strong base → OH^-

weak base → $C_2H_3O_2^-$

pH is determined by strong base:

$$pOH = -\log \frac{.00250\,moles}{.0750\,L} = 1.477$$

$$\boxed{pH = 12.523}$$

11. To make a buffer with a pH of 9.26, should use a weak base and its conjugate. So C or D

D is BEST because it is the most concentrated and has a greater capacity to neutralize strong acid or strong base.

* [Buffer capacity] *

↓

depends on concentration