(#8-5) Can I determine the pH of a weak acid?

Ka Table

HF = 6.6E-4; $HClO_2$ = 1.1E-2; HCN = 6.2E-10; $HC_2H_3O_2$ = 9.1E-5; HNO_2 = 7.2E-5

Strong Acids

1. Determine the pH of the following strong acids
   a. 0.5M HBr. $-log(.5) = 0.3$
   b. .01M HCl $-log(.01) = 2$
   c. .005M HI $-log(.005) = 2.3$

2. In the previous question the actual type of acid was not needed to calculate the pH of the acid. Why?
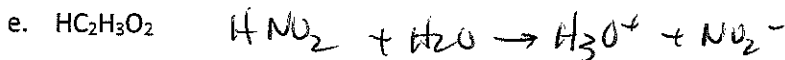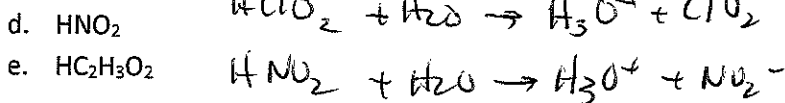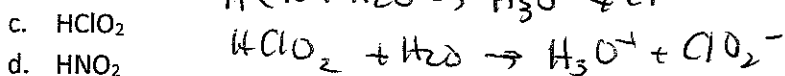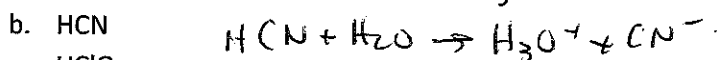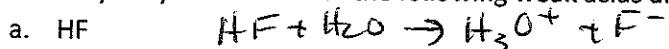
   all strong 100% → product

3. For a weak acid two factors affect the number of hydronium ions that get produced. What are they?
   a. __Concentration__
   b. __K value__

4. Weak acids and bases undergo __Hydrolysis__ in order to produce hydronium and hydroxide ions.

5. Write the hydrolysis reaction for the following weak acids and bases.
   a. HF $HF + H_2O \rightarrow H_3O^+ + F^-$
   b. HCN $HCN + H_2O \rightarrow H_3O^+ + CN^-$
   c. $HClO_2$ $HClO_2 + H_2O \rightarrow H_3O^+ + ClO_2^-$
   d. HNO_2
   e. $HC_2H_3O_2$ $HNO_2 + H_2O \rightarrow H_3O^+ + NO_2^-$

   $HC_2H_3O_2 + H_2O \rightarrow H_3O^+ + C_2H_3O_2^-$

6. Write the Equilibrium expression for each of the previous reactions.
   a.
   b.
   c.
   d.
   e.

$H_2O_{(l)}$
Not included

$K_a = \dfrac{[H_3O^+][F^-]}{[HF]}$

$K_a = \dfrac{[H_3O^+][CN^-]}{[HCN]}$

$K_a = \dfrac{[H_3O^+][ClO_2^-]}{[HClO_2]}$
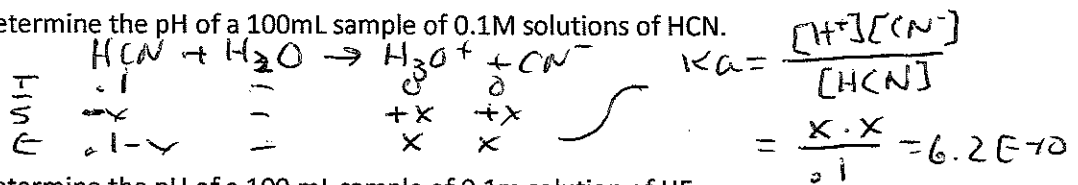
$K_a = \dfrac{[H^+][NO_2^-]}{[HNO_2]}$
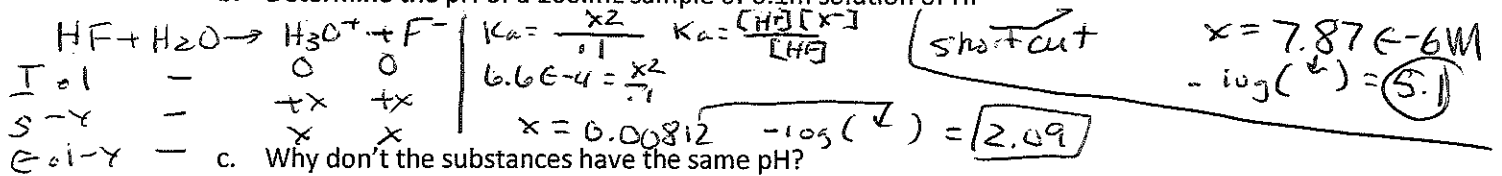
$K_a = \dfrac{[H^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$

88

7. Answer the following questions relative to HCN and HF. (HF = 6.6E-4; HCN = 6.2E-10)

a. Determine the pH of a 100mL sample of 0.1M solutions of HCN.

$$HCN + H_2O \rightarrow H_3O^+ + CN^-$$

I	.1		0	0
S	-x		+x	+x
E	.1-x		x	x

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

$$= \frac{x \cdot x}{.1} = 6.2E-10$$

b. Determine the pH of a 100.mL sample of 0.1m solution of HF

$$HF + H_2O \rightarrow H_3O^+ + F^-$$

I	.1		0	0
S	-x		+x	+x
E	.1-x		x	x

$$K_a = \frac{x^2}{.1} \quad K_a = \frac{[H_3O][x^-]}{[HF]}$$

$$6.6E-4 = \frac{x^2}{.1}$$

$$x = 0.00812 \quad -\log(x) = \boxed{2.09}$$

(shortcut) $x = 7.87E-6M$
$-\log(x) = \boxed{5.1}$

c. Why don't the substances have the same pH?

They have the same conc. But HF has a larger K, so it is stronger.

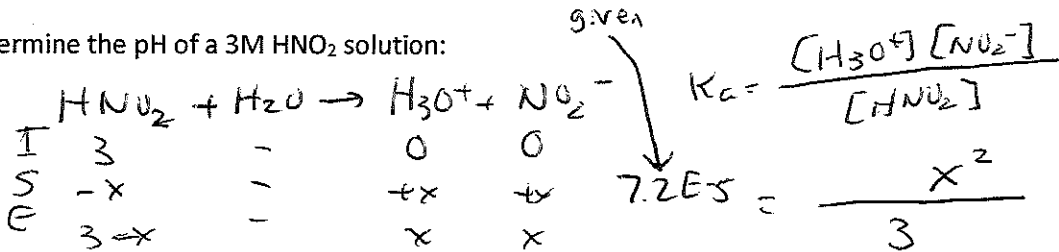d. Which substance would be considered the strongest acid?

HF, K_a = strength

e. Which of these two acids can neutralize more base?

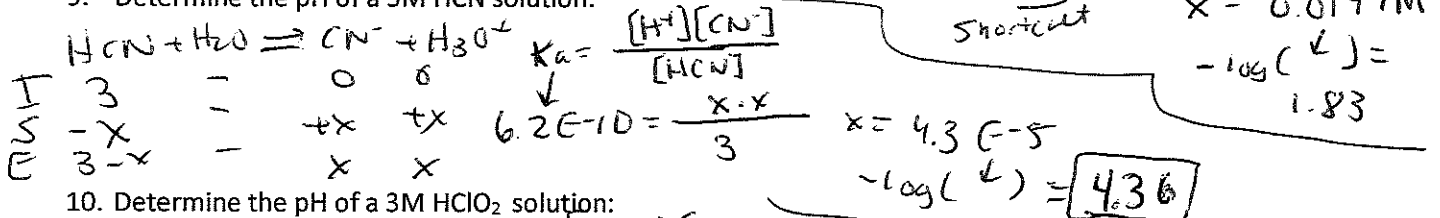Same, same moles of acid $M = \frac{mol}{L}$ Same

f. Student hypothesis: It is impossible to have a solution of HCN that is more acidic then HF. Justify or nullify.

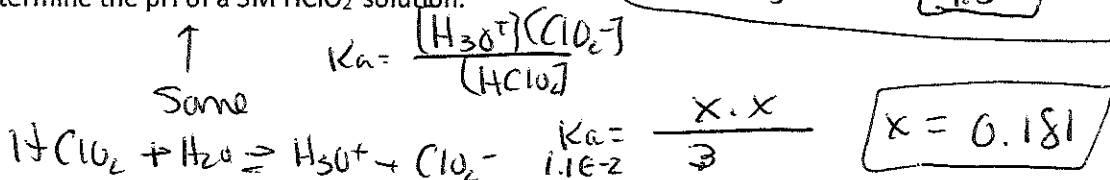It can, if it has a much higher concentration

8. Determine the pH of a 3M HNO_2 solution:

$$HNO_2 + H_2O \rightarrow H_3O^+ + NO_2^-$$

given

I	3		0	0
S	-x		+x	+x
E	3-x		x	x

$$K_a = \frac{[H_3O^+][NO_2^-]}{[HNO_2]}$$

$$7.2E-5 = \frac{x^2}{3}$$

shortcut $x = 0.0147M$
$-\log(x) = 1.83$

9. Determine the pH of a 3M HCN solution:

$$HCN + H_2O \rightleftharpoons CN^- + H_3O^+$$

I	3		0	0
S	-x		+x	+x
E	3-x		x	x

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

$$6.2E-10 = \frac{x \cdot x}{3} \quad x = 4.3E-5$$

$$-\log(x) = \boxed{4.36}$$

10. Determine the pH of a 3M $HClO_2$ solution:

Same

$$K_a = \frac{[H_3O^+][ClO_2^-]}{[HClO_2]}$$

$$HClO_2 + H_2O \rightleftharpoons H_3O^+ + ClO_2^- \quad K_a = 1.1E-2 \quad \frac{x \cdot x}{3} \quad \boxed{x = 0.181}$$

11. Give an scenario where a weaker acid could produce a pH that is lower (more acidic)

Notice above the only difference is K value (strength)

So, if K↓ (low) [HX]↑ (High), a weak could be more acidic

89