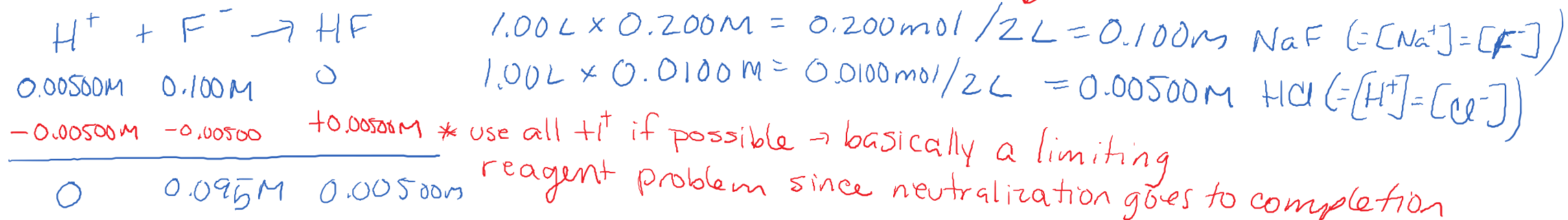
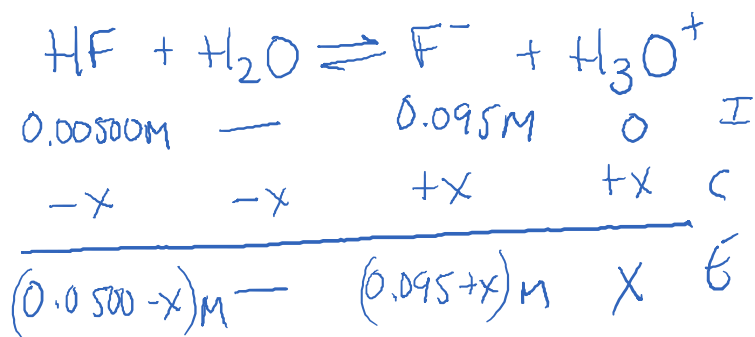


Example 2: What is the pH of a solution made by combining 1.00 L each of 0.200 M sodium fluoride  $\rightarrow \text{NaF} = \text{Na}^+ \text{F}^-$  ( $K_{a, \text{HF}} = 6.6 \times 10^{-4}$ ) and 0.0100 M hydrochloric acid?  $\rightarrow \text{HCl} = \text{H}^+ + \text{Cl}^-$

STEP ① NEUTRALIZE STRONG ACID



STEP ② Regain equilibrium



$\uparrow$  This should work with either  $K_a$  or  $K_b$  expression, as long as ICE table is set up & you use the right  $K$ .

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{F}^-]}{[\text{HF}]}$$

$$6.6 \times 10^{-4} = \frac{x(0.095+x)}{(0.00500-x)}$$

$$3.3 \times 10^{-6} - 6.6 \times 10^{-4}x = 0.095x + x^2$$

$$x^2 + 0.09566x - 3.3 \times 10^{-6} = 0$$

Solve with quadratic formula:

$$x = 3.45 \times 10^{-5}$$

$$= [\text{H}^+] \quad \text{pH} = 4.46$$

Question: How did we get an acidic pH when there's more  $\text{F}^-$ ? Is this OK?

$\rightarrow$  think of the H-H equation:

$$\text{pH} = \text{p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

As long as  $[\text{A}^-] > [\text{HA}]$  the log will be  $\oplus$  and  $\text{pH} > \text{p}K_a$  (but not necessarily  $> 7$ )

$\text{p}K_a$  for HF is 3.18  $\rightarrow$  so our pH is OK  $\smile$

show all these steps on a quiz or exam  $\smile$

# Scenario 2: Weak + Weak

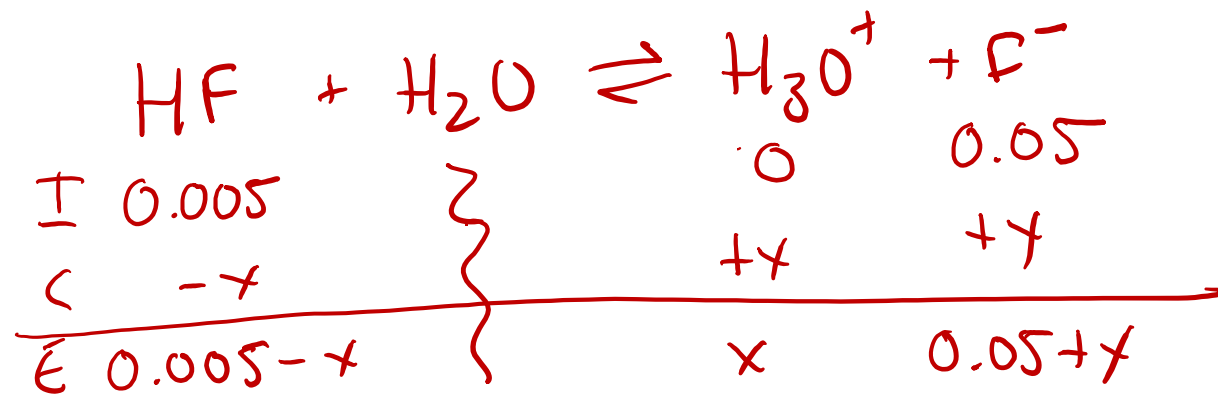
$$K_a = 6.6 \times 10^{-4}$$

A solution that contains both a weak acid (or base) and the salt of its' conjugate is dealt with by an equilibrium calculation:

e.g.: What is the pH of a solution made by combining 100 mL of a 0.1 M sodium fluoride solution with 100 mL of a 0.01 M hydrofluoric acid solution?

$$\text{After mixing: } F^- = 100 \text{ mL} \times 0.1 \text{ M} \div 200 \text{ mL} = 0.05 \text{ M}$$

$$HF = 100 \text{ mL} \times 0.01 \text{ M} \div 200 \text{ mL} = 0.005 \text{ M}$$



Can't use small-x "

$$pH = 4.18$$

$$6.6 \times 10^{-4} = \frac{[H_3O^+][F^-]}{[HF]}$$

$$6.6 \times 10^{-4} = \frac{(x)(.05+x)}{(0.005-x)}$$

$$3.3 \times 10^{-6} - 6.6 \times 10^{-4}x = .05x + x^2$$

$$x^2 + 0.05066x - 3.3 \times 10^{-6} = 0$$

$$\frac{-0.05066 \pm \sqrt{0.05066^2 - 4(1)(-3.3 \times 10^{-6})}}{2} = 6.5 \times 10^{-5} = [H_3O^+]$$

Revisit the last calculation: What is the pH of a solution made by combining 100 mL of a 0.1 M sodium fluoride solution with 100 mL of a 0.01 M hydrofluoric acid solution?



$$pH = pK_a + \log \frac{[F^-]}{[HF]}$$

$$= -\log(6.6 \times 10^{-4}) + \log \left( \frac{(0.05M)}{(0.005M)} \right)$$

= 4.18

← with the correct math  
on the other slide,  
now these agree ☺