Today 2/23 Sections 16.1 - 16.4

This weekend:

- look over exam
- do worksheet 4 homework problems
- download Prelab for experiment 7
- Ali's problem club

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weak bases (A^-)

$A^- + H_2O \rightleftharpoons OH^- + HA \quad K_b^{A^-} = \frac{[OH^-][HA]}{[A^-]}$

weak acid

$HA + H_2O \rightleftharpoons H_3O^+ + A^- \quad K_a^{HA} = \frac{[H_3O^+][A^-]}{[HA]}$

water dissociation

$H_2O \rightleftharpoons H_3O^+ + OH^- \quad K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$

Titrations (neutralization reactions)

$\underset{SA}{H_3O^+} + \underset{SB}{OH^-} \longrightarrow 2H_2O \quad \boxed{K_n = 1 \times 10^{+14}}$ (neutralization)

$\underset{wa}{HA} + \underset{SB}{OH^-} \longleftarrow H_2O + \underset{wb}{A^-} \quad K_n = \frac{1}{K_b^{A^-}} = \boxed{\frac{K_a^{HA}}{K_w}} = K_n$

$K_b^{A^-} = \frac{K_w}{K_a^{HA}}$

$\underset{wb}{A^-} + \underset{sa}{H_3O^+} \longleftarrow H_2O + \underset{wa}{HA} \quad \boxed{K_n = \frac{1}{K_a^{HA}} = \frac{K_b^{A^-}}{K_w}}$

* big arrow goes away from the strong acid or base

HF $K_a = 3.5 \times 10^{-4}$ $\quad HF + H_2O \rightleftharpoons H_3O^+ + F^-$

HOCl $K_a = 3.5 \times 10^{-8}$ $\quad HOCl + H_2O \rightleftharpoons H_3O^+ + OCl^-$

mix weak acids

$H_3O^+ + F^- \rightleftharpoons H_2O + HF \quad \frac{1}{K_a^{HF}}$

$HOCl + H_2O \rightleftharpoons H_3O^+ + OCl^- \quad K_a$

$HOCl + F^- \rightleftharpoons OCl^- + HF \quad K_c = (3.5 \times 10^{-8})\left(\frac{1}{3.5 \times 10^{-4}}\right) = 1.0 \times 10^{-4}$

if you had flipped the HOCl equation instead...

$OCl^- + HF \rightleftharpoons F^- + HOCl \quad K_c = 1.0 \times 10^4$

*you can use these to determine which is stronger, in this case HF was stronger

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M	HA	+ H_2O ⇌	H_3O^+	+	A^-	$K_a^{HA} = 6.2 \times 10^{-8} = \frac{[H_3O^+][A^-]}{[HA]}$
I	0.010		0		0.025	
C	−x		+x		+x	
E	0.010 − x		x		0.025 + x	

$K_a = \frac{(x)(0.025+x)}{(0.010-x)}$

400 rule: $\frac{0.010}{6.2 \times 10^{-8}} > 400$ ✓

$6.2 \times 10^{-8} = \frac{x\,(0.025)}{0.010}$

$x = 2.48 \times 10^{-8} = [H_3O^+]$

$pH = -\log(2.48 \times 10^{-8})$

$\boxed{pH = 7.61}$

M	A^-	+ H_2O ⇌	OH^-	+	HA	$K_b^{A^-} = \frac{K_w}{K_a^{HA}} = 1.6 \times 10^{-7}$
I	0.025		0		~~.025~~ .014	
C	−x		+x		+x	
E	0.025 − x		x		.014 + x	

400 rule: $\frac{.025}{1.6 \times 10^{-7}}$ ✓

$K_b = 1.6 \times 10^{-7} = \frac{[OH^-][HA]}{[A^-]}$

$1.6 \times 10^{-7} = \frac{(x)(.014+x)}{(0.025-x)}$

$1.6 \times 10^{-7} = \frac{x\,(.014)}{(.025)}$

$x = 2.9 \times 10^{-7} = [OH^-]$

$pOH = -\log(2.9 \times 10^{-7})$

$pOH = 6.54$

$\boxed{pH = 7.46}$

Pretty close to one another (would have been exact if the same concentrations were used)

Buffer: Mixture of wa and wb

$$K_a = \frac{[H_3O^+][A^-]}{HA}$$

$$pK_a = pH - \log\frac{[A^-]}{[HA]}$$

$$\boxed{pH = pK_a + \log\frac{[A^-]}{[HA]}}$$

Henderson - Hasselbalch Buffer equation

$$\boxed{pH = pK_a + \log\frac{n_{A^-}}{n_{HA}}}$$ (volumes canceled)

$$pH = 7.208 + \log\left(\frac{0.025}{0.010}\right)$$

$$\boxed{pH = 7.61}$$

$$pK_a = \log(6.2\times10^{-8}) = 7.208$$

Suppose we add 0.003 mol H_3O^+ to our buffer. What is new pH?

$$pH = 7.208 + \log\left(\frac{n_{A^-} - n_{H_3O^+}}{n_{HA} + n_{H_3O^+}}\right)$$

$$pH = 7.208 + \log\left(\frac{0.025 - .003}{0.010 + 0.003}\right)$$

$$pH = 7.44$$ (became slightly more acidic)

*if you add strong base (OH^-) the moles of weak base would increase, and decrease moles of weak acid