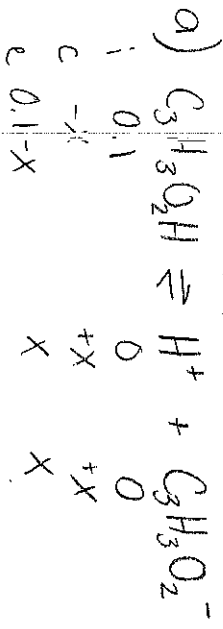Acid Base Equilibrium In-Class Free Response Quiz

1.) Acrylic acid ($C_3H_3O_2H$) is a precursor for many important plastics. The K_a for acrylic acid is 5.6×10^{-5}.

   a. Calculate the pH of a 0.10M solution of acrylic acid.

   b. Calculate the percent dissociation of a 0.10M solution of acrylic acid.

   c. Calculate the pH of the solution that is formed when 250mL of 0.10M acrylic acid is added to 250mL of 0.050M sodium acrylate. $NaC_3H_3O_2$

a)
$$C_3H_3O_2H \rightleftharpoons H^+ + C_3H_3O_2^-$$

i	0.1	0	0
c	-x	+x	+x
e	0.1-x	x	x

$$\frac{x^2}{0.1-x} = 5.6 \times 10^{-5} \qquad x = 0.00237$$

5% rule

$$pH = -\log(0.00237)$$

$$\boxed{pH = 2.6}$$

b)
$$\frac{0.00237}{0.1} \times 100 = \boxed{2.37\%}$$

c)
$$pH = pK_a + \log\left(\frac{[base]}{[acid]}\right)$$

$$pH = -\log(5.6 \times 10^{-5}) + \log\left(\frac{0.025M}{0.05M}\right) \Rightarrow 3.95 \rightarrow \boxed{4.0}$$

$$[acid] = \frac{.1M \times .25L}{(.25 + .25)L} = \frac{0.025 \text{ mol}}{0.05L} = 0.05M$$

$$[base] = \frac{.05M \times .25L}{(.25 + .15)L} = \frac{0.0125 \text{ mol}}{0.025L} = 0.025M$$

2.) A buffer system is created with 0.15M propanoic acid ($HC_3H_5O_2$, $K_a = 1.7 \times 10^{-4}$) and 0.10M $KC_3H_5O_2$.

   (a) Calculate the initial pH of this buffer system.

   (b) What would the pH of the system be if 0.025 mol of HCl is added to 1.0L of the initial buffer system? Assume no volume change.

   (c) What would the pH of the system be if 0.20 mol of NaOH is added to 1.0L of the initial buffer system? Assume no volume change.

a)
$$pH = pK_a + \log\left(\frac{[base]}{[acid]}\right)$$

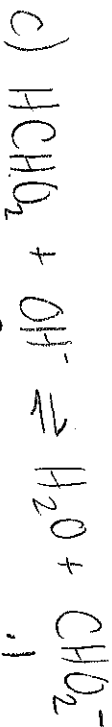$$pH = -\log(1.7 \times 10^{-4}) + \log\left(\frac{.1}{.15}\right)$$

$$\boxed{pH = 3.6}$$

b)
$$CHO_2^- + H^+ \rightleftharpoons HCHO_2$$

i	.1 mol	0.025 mol	.15 mol
c	-.025	-0.025	+0.025
e	$\frac{0.075 \text{ mol}}{1L}$	0	$\frac{0.175 \text{ mol}}{1L}$

$$pH = -\log(1.7 \times 10^{-4}) + \log\left(\frac{0.075}{0.175}\right)$$

$$\boxed{pH = 3.4}$$

c)
$$HCHO_2 + OH^- \rightleftharpoons H_2O + CHO_2^-$$

i	.15	.2	.1
c	-.15	-.15	+.15
e	0	0.05	.25

$$pOH = -\log(0.05) = 1.3$$

$$pH = 12.7 \Rightarrow \boxed{13}$$