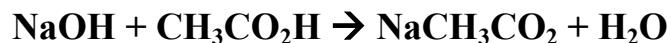


## Term 3 LAB EXAM STUDY GUIDE

### Understanding the Theory Behind the Ka Lab

- The purpose of the lab is to gather enough data so that we could calculate the  $K_A$  of the acid  $\text{CH}_3\text{CO}_2\text{H}$ .
- Remember for  $\text{CH}_3\text{CO}_2\text{H}_{(\text{aq})} = \text{CH}_3\text{CO}_2^-_{(\text{aq})} + \text{H}^+_{(\text{aq})}$   
$$K_A = \frac{[\text{CH}_3\text{CO}_2^-][\text{H}^+]}{[\text{CH}_3\text{CO}_2\text{H}]}$$
- So we need to get the equilibrium  $[\text{H}^+]$ ,  $[\text{CH}_3\text{CO}_2^-]$  and  $[\text{CH}_3\text{CO}_2\text{H}]$
- We can get the first two from the pH.
- Think of the ICE chart and you'll realize why  $[\text{H}^+]$  &  $[\text{CH}_3\text{CO}_2^-]$  are equal
- To get  $[\text{CH}_3\text{CO}_2\text{H}]$ , we could do a titration with NaOH and see how much of NaOH is needed to neutralize the  $\text{CH}_3\text{CO}_2\text{H}$ :



We let

$$n_1 = \text{moles of NaOH} = C_1V_1$$

$$n_2 = \text{moles of CH}_3\text{CO}_2\text{H} = C_2V_2$$

Since the base and weak acid react in a 1:1 ratio, then  $n_1 = n_2$ , so:

$$C_1V_1 = C_2V_2$$

If we measure the volume of a known concentration of NaOH needed to neutralize a known volume of  $\text{CH}_3\text{CO}_2\text{H}$ , the only unknown in the formula will be  $C_2$ , the last concentration we are looking for.

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Let's assume that an equilibrium was created by combining 0.010 L of 1.0 mole/L  $\text{Fe}^{+3}$  and 0.010 L of 1.0 mole/L  $\text{SCN}^-$  :



- Do the calculations to make sure that adding 0.0050 L of 1.0 mole/L  $\text{Fe}^{+3}$  to the above will indeed increase the concentration of  $\text{Fe}^{+3}$  and subsequently shift the equilibrium to the right.
- Will adding 0.40 grams of  $\text{SCN}^-$  be more effective in disturbing the original equilibrium? Show why or why not.

#### Answer

$$\text{a) Original } [\text{Fe}^{+3}] = \frac{n}{V_{\text{total}}} = \frac{CV}{V_{\text{total}}} = \frac{1.0 \text{ moles/L}(0.010 \text{ L})}{0.010 + 0.010 \text{ L}} = 0.50 \text{ moles Fe}^{+3} / \text{L}$$

Adding 0.005 L of 1.0 mole/L  $\text{Fe}^{+3}$  is adding:

$n = CV = 1.0 \text{ mole/L} (0.005 \text{ L}) = 0.005 \text{ moles of Fe}^{+3}$  while increasing the volume by 0.005 L:

$$\text{new } [\text{Fe}^{+3}] = \frac{n_{\text{total}}}{V_{\text{total}}} = \frac{\text{new } n + CV}{V_{\text{total}}} = \frac{0.005 \text{ moles} + 1.0 \text{ moles/L}(0.010 \text{ L})}{0.010 + 0.010 \text{ L} + 0.005 \text{ L}} = 0.60 \text{ moles Fe}^{+3} / \text{L}$$

So indeed, the concentration has gone up, and it will create more effective collisions with  $\text{SCN}^-$ , increasing the forward rate and driving the reaction towards more red  $\text{FeSCN}^{+2}$ .

$$\text{b) Original } [\text{SCN}^-] = \frac{n}{V_{\text{total}}} = \frac{CV}{V_{\text{total}}} = \frac{1.0 \text{ moles/L}(0.010 \text{ L})}{0.010 + 0.010 \text{ L}} = 0.50 \text{ moles SCN}^- / \text{L}$$

Adding 0.40 grams of  $\text{SCN}^-$  is adding:

$$\begin{aligned} m/M &= n = 0.40 \text{ grams of SCN}^- / (32 + 12 + 14 \text{ g/mole}) = 0.00690 \text{ moles} \\ \text{new } [\text{SCN}^-] &= \frac{n_{\text{total}}}{V_{\text{total}}} = \frac{\text{new } n + CV}{V_{\text{total}}} = \frac{0.00690 \text{ moles} + 1.0 \text{ moles/L}(0.010 \text{ L})}{0.010 + 0.010 \text{ L}} = 0.85 \text{ moles/L} \end{aligned}$$

So the concentration goes up more dramatically it will be more effective in disturbing the equilibrium, so it should go a deeper red.

(Notice that by adding a dissolving solid we don't change the volume appreciably, so we assume that it's still the same as the original created by adding the two solutions )