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 CH_3CO_2H.**

- **Remember for $CH_3CO_2H_{(aq)} = CH_3CO_2^-{}_{(aq)} + H^+{}_{(aq)}$**
  $K_A = \frac{[CH_3\,CO_2^-][H^+]}{[CH_3\,CO_2H]}$

- **So we need to get the equilibrium $[H^+]$, $[CH_3CO_2^-]$ and $[CH_3CO_2H]$**
- **We can get the first two from the pH.**
- **Think of the ICE chart and you'll realize why $[H^+]$ & $[CH_3CO_2^-]$ are equal**
- **To get $[CH_3CO_2H]$, we could do a titration with NaOH and see how much of NaOH is needed to neutralize the CH_3CO_2H:**

  $NaOH + CH_3CO_2H \rightarrow NaCH_3CO_2 + H_2O$

  We let

  n_1 = moles of NaOH = C_1V_1
  n_2 = moles of CH_3CO_2H = 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 CH_3CO_2H, the only unknown in the formula will be C2, 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 Fe^{+3} and 0.010 L of 1.0 mole/L SCN^- :

Fe^{+3}	+	SCN^-	=	$FeSCN^{+2}$
Yellow-orange		colorless		DEEP RED

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

Answer

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

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

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

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

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

Adding 0.40 grams of SCN^- is adding:

m/M = n = 0.40 grams of SCN^- / (32 +12 + 14 g/mole) = 0.00690 moles

new $[SCN^-] = \frac{n_{total}}{V_{total}} = \frac{new\ n + CV}{V_{total}} = \frac{0.00690\ moles + 1.0 moles/L(0.010\ L)}{0.010 + 0.010\ L}$ = 0.85 moles/L

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)