**CH108 – Conference Course – Intensive Chemistry Seminar**
Spring 2016, Unique 49810

**23 March 2016**

1. Polyprotic acids are acids with more than one titratable proton (i.e. more than one proton that can be titrated off by adding $OH^-$.

a) Write out all acid/base equilibrium reactions, including $K_a$, for the acid $H_3A$.

b) Rank the ease with which each of these protons can be removed from the acid. Describe how you are doing this ranking and justify your answer.

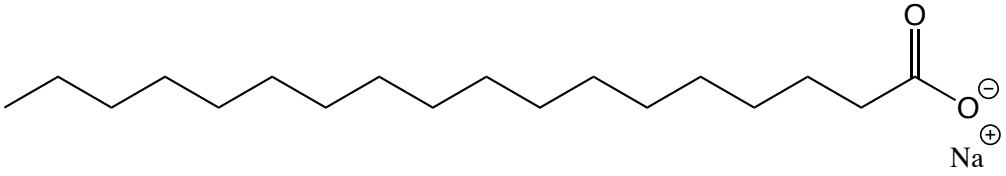
c) What is the strongest base in your equilibrium reactions? What is its $K_b$?

d) The $K_a$ values for a certain triprotic acid are $10^{-2}$, $10^{-6}$, and $10^{-9}$. Draw a figure of the triation of $H_3A$ with a strong base.

2. Rank the following molecules in order of increasing $pK_a$: $CH_3SH$, $CH_3OH$, HCOOH. Justify your ranking.

3. a) Rank the following molecules in order of pH (good structures would probably help here): $CH_3OH$, $CH_3CH(OH)CH_3$, $C(CH_3)_3OH$. Justify your ranking.

b) Steric acid, shown below, is a common ingredient in commercial soaps such as laundry detergent and shampoo. Explain why this molecule acts as an effective soap.



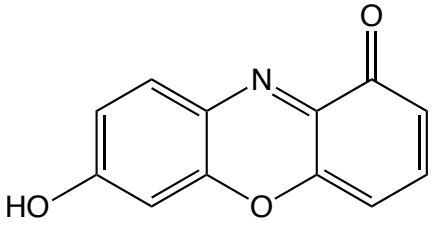

c) How do you justify the statement in part b) with your ranked molecules in part a)?

4. Determine the pH of a buffer solution formed from equal amounts of phosphoric acid ($H_3PO_4$) and sodium phosphate ($NaH_2PO_4$). As long as they are added in equal amounts, does it matter how much of the salts you actually use?

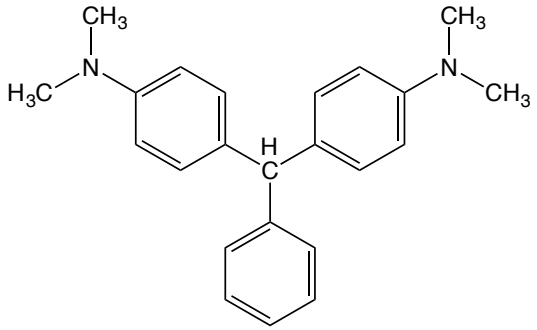
5. A number of organic molecules change color upon losing their most acidic proton. These molecules can be used to visualize the pH of a solution, and thus are called indicators, HIn.

$$HIn + H_2O \rightarrow H_3O^+ + In^-$$

a) One common indicator is litmus, which is red when protonated and blue when deprotonated. Identify the most acidic hydrogen of litmus.




b) Another common indicator is malachite green, which is yellow when protonated and green when deprotonated. Identify the most acidic hydrogen of malachite green.




c) Provide a physical explanation for the color change in both of these molecules upon deprotonation.