CHM 1046
Professor Fowler
Chapter 16 Homework

Malonic acid (H_2Mal) is diprotic and has $pK_{a1} = 2.83$ and $pK_{a2} = 5.70$.

$H_2Mal_{(aq)} + H_2O_{(L)} \rightleftharpoons HMal^{-1}_{(aq)} + H_3O^{+1}_{(aq)}$

$HMal^{-1}_{(aq)} + H_2O_{(L)} \rightleftharpoons Mal^{-2}_{(aq)} + H_3O^{+1}$

1. Determine the expression (with H_2Mal and $HMal^{-1}$) and the numerical value for K_{a1}. (1 pt)

2. Determine the expression (with $HMal^{-1}$ and Mal^{-2}) and the numerical value for K_{a2}. (1 pt)

3. Set up an equilibrium table for the first reaction when $[H_2Mal]_0 = 0.300$ M. Determine both $[H_3O^{+1}]$ and $[HMal^{-1}]$. Then find the pH.
   Finally, find the % dissociation using: $\left(\frac{[HMal^{-1}]}{[H_2Mal]_o}\right) \times 100\%$
   (2 pts)

4. Review Polyprotic Acids and Example 16.04 in chapter 16 notes.
Set up a similar equilibrium table for the second malonic acid reaction.
Use "y" as the variable to determine $[Mal^{-2}]$. Show all three steps in the derivation for y from K_{a2}. Also, show with an equation that "y" does not affect pH. Finally, determine the % of the original H_2Mal concentration (0.3 M) that becomes Mal^{-2}:
$\left(\frac{[Mal^{-2}]}{[H_2Mal]_o}\right) \times 100\%$ (2 pts)

5. Review Triprotic Acids in chapter 16 notes. Suppose we have a triprotic acid (H_3A).
If we solve the first and second equilibrium tables, we get:
$[H_3O^{+1}] = [H_2A^{-1}] = x = \sqrt{(K_{a1}[H_3A]_0)}$ and $[HA^{-2}] = y = K_{a2}$.
Finish the third table below and find z in terms of x, y, and $K_{a3} = \frac{[A^{-3}][H_3O^{+1}]}{[HA^{-2}]}$
Then, substitute the expressions for x and y above into your equation for z.
Actual number values are not necessary. (2 pts)

HA^{-2} + H_2O	⇌ A^{-3} +	H_3O^{+1}
y	0	x
− z	+ z	+ z

6. Review Buffers in the chapter 16 notes. Describe the two characteristics of a buffer solution. Then, describe the two components of a buffer solution. Next, use the Henderson-Hasselbalch equation to determine the pH of an HF and F^{-1} buffer solution where [HF] = 1.00 M and $[F^{-1}]$ = 2.00 M. Use $K_a = 6.8 \times 10^{-4}$ to find the pKa. (2 pts)