"Fiction writing is great. You can make up almost anything."
— Ivana Trump, upon finishing her first novel

1. (6 points) At 50°C the $K_w$ for water is exactly $5.47 \times 10^{-14}$. What is the hydrogen ion concentration and also the pH of a neutral solution at this temperature?

2. (6 points) Write the autoprotolysis reaction for CH$_3$CH$_2$OH.

3. (6 points) Calculate the pH of a mixture of 0.0023 M HCl and 0.0056 M HNO$_3$.

4. (12 points) A 0.024 M solution of an unknown base has a pH of 8.33. Determine the $K_a$ of the conjugate acid of this base.
5. (12 points) How many mL of 0.20 M sodium acetate must be added to 500 mL of 0.10 M acetic acid ($K_a = 1.8 \times 10^{-5}$) to make a buffer solution with a pH of 4.50?

6. (12 points) What is the pH of a solution that is formed by mixing 100 mL of 0.020 M HF with 100 mL of 0.040 M NaF? $K_a$ of HF = $6.8 \times 10^{-4}$
7. (12 points) Consider malonic acid, a diprotic acid with ionization constants $K_1 = 1.4 \times 10^{-3}$ and $K_2 = 2.0 \times 10^{-6}$. For a solution with an analytical concentration of 0.10 M, calculate the equilibrium concentration of every malonate species at pH = 5.00.

8. (5 points) For the titration of a monoprotic weak acid with NaOH, is the pH at the equivalence point greater than, less than, or equal to 7.00? Why?

10. (12 points) If we mix 50.0 mL of 0.20 M NaOH with 50.0 mL of 0.10 M citric acid, what is the resulting pH? For citric acid: \( K_1 = 7.4 \times 10^{-4}, K_2 = 1.7 \times 10^{-5}, K_3 = 4.0 \times 10^{-7} \)

11. (12 points) Suppose the above solution mixture were adjusted to an ionic strength of 1.0 M by the addition of NaCl. At this ionic strength, \( f_1 = 0.79 \), \( f_2 = 0.38 \), and \( f_3 = 0.11 \). What is the new pH?