1) (20 points)

   a) Write the complete charge balance equation for a solution of MgCl$_2$.

   b) Write the mass balance expression for a 0.1 M solution of the weak acid HNO$_2$.

2) Define, explain, or otherwise describe the term activity coefficient.

3) (20 points) Consider the titration curves for 25.00 mL of 0.1000 M malonic acid with 0.1000 M NaOH. For malonic acid, $K_{a1} = 1.42 \times 10^{-3}$ and $K_{a2} = 2.01 \times 10^{-6}$

   c) Calculate the pH before any base is added

   d) Find the pH when 37.50 mL of base is added.
4) (20 points) Consider the titration curves for 25.00 mL of 0.1000 M malonic acid with 0.1000 M NaOH. For malonic acid, $K_{a1} = 1.42 \times 10^{-3}$ and $K_{a2} = 2.01 \times 10^{-6}$

e) Calculate the pH before any base is added.

f) Find the pH when 37.50 mL of base is added.