

Exercise 3: A weak acid

Given the reaction of an acid $\text{HB} \rightleftharpoons \text{H}^+ + \text{B}^-$, you want to determine the equilibrium constant (actually, the dissociation constant of an acid, K_a). You will do this by observing the concentration of various species in a test tube.

1. Write the equilibrium constant expression for HB. Use K_a as the equilibrium constant. Use all or some of the following: $[\text{H}^+]_{\text{equilibrium}}$, $[\text{H}^+]_{\text{initial}}$, $[\text{B}^-]_{\text{equilibrium}}$, $[\text{B}^-]_{\text{initial}}$, $[\text{HB}]_{\text{equilibrium}}$, $[\text{HB}]_{\text{initial}}$.

2. The HB flask has a concentration of 2.5×10^{-4} M written on the side. You pipet 10 mL into a test tube, then add 40 mL of 0.010 M sodium chloride. What is the concentration of the diluted HB? Hint: Is the concentration of the sodium chloride relevant?

3. Call this $[\text{HB}]_{\text{initial}}$. How come the original 2.5×10^{-4} M isn't called the "initial concentration"?

4. Suppose you measure the pH of the diluted solution (using a pH meter) as 7.66. What is the concentration of the hydrogen ion in the diluted solution? Is this the initial or the equilibrium concentration?

5. What must be the concentration of the B^- ion? Is this the initial or the equilibrium concentration? Why *must* it be this concentration?

6. What is the equilibrium concentration of HB? How do you calculate it from the answer to question 3?

7. Calculate K_a .

8. Suppose, instead of 0.010 M NaCl, to the original 10 mL of HB, 40 mL of 0.010 M HA (where HA is some generic weak acid) is added. Will the measured pH reflect only the protons dissociated from HB? Why or why not?

9. Given the scenario above, a pH of 6.67 is measured. If you did not know K_a from question 7, could K_a be calculated from the information given? If so, calculate it. If not, what other piece of information is needed?

10. Given the two scenarios (questions 7 and 9), should the K_a 's be different, since one scenario has HA and the other one doesn't? Explain your answer.