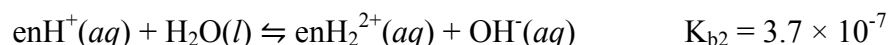


Worksheet 6

1. A 7.0 mass % solution of H_3PO_4 in water has a density of 1.0353 g / mL. Calculate the pH and the concentrations of all species present (H_3PO_4 , H_2PO_4^- , HPO_4^{2-} , PO_4^{3-} , H_3O^+ , and OH^-) in the solution. You will need to look up the equilibrium constants.
2. Neutralization reactions involving either a strong acid or a strong base go essentially to completion, and therefore we must take such neutralizations into account before calculating concentrations in mixtures of acids and bases. Consider a mixture of 3.28 g of Na_3PO_4 and 300.0 mL of 0.180 M HCl. Write balanced net ionic equations for the neutralization reactions, and calculate the pH of the solution.
3. A 1.000 L sample of HF gas at 20.0°C and 0.601 atm pressure was dissolved in enough water to make 50.0 mL of hydrofluoric acid. What is the pH of the solution?
4. Ethylenediamine ($\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$, abbreviated en) is an organic base that can accept protons:



Consider the titration of 30.0 mL of 0.100 M ethylenediamine with 0.100 M HCl. Calculate the pH after additions of the following volumes of acid, and construct a qualitative plot of pH versus milliliters of HCl added.

- (a) 0.0 mL (b) 15.0 mL (c) 30.0 mL (d) 45.0 mL (e) 60.0 mL (f) 75.0 mL

5. A 40.0 mL sample of a mixture of HCl and H_3PO_4 was titrated with 0.100 M NaOH. The first equivalence point was reached after 88.0 mL of base, and the second equivalence point was reached after 126.4 mL of base.

- (a) What is the concentration of H_3O^+ at the first equivalence point?
- (b) What are the initial concentrations of HCl and H_3PO_4 in the mixture?
- (c) What percent of the HCl is neutralized at the first equivalence point?
- (d) What is the pH of the mixture before addition of any base?
- (e) Sketch the pH titration curve, and label the buffer regions and equivalence points.
- (f) What indicators would you select to signal the equivalence points?

Worksheet 6

6. In qualitative analysis, Ca^{2+} and Ba^{2+} are separated from Na^+ , K^+ , and Mg^{2+} by adding aqueous $(\text{NH}_4)_2\text{CO}_3$ to a solution that also contains aqueous NH_3 . Assume that the concentrations after mixing are 0.080 M $(\text{NH}_4)_2\text{CO}_3$ and 0.16 M NH_3 .

(a) List all the Bronsted-Lowry acids and bases present initially, and identify the principal reaction.

(b) Calculate the pH and the concentrations of all species present in the solution.