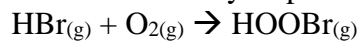


## AP Chemistry – Aqueous Equilibria – 57

Name \_\_\_\_\_ Per \_\_\_\_\_

1. The elementary steps of a chemical process are proposed to be:



$\text{HOBr}_{(g)} + \text{HBr}_{(g)} \rightarrow \text{H}_2\text{O}_{(g)} + \text{Br}_{2(g)}$ . (a) Add these elementary steps to obtain the overall reaction. (Hint: You will need to double one of the equations to properly add the steps together.)

(b) The rate law for this process is  $\text{Rate} = k[\text{HBr}][\text{O}_2]$ . Which step is rate-determining?

(c) What is the molecularity of this step?

(d) What are the intermediates in this process?

2. The reaction of  $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$  is second order in NO and first order in  $\text{O}_2$ . When  $[\text{NO}] = 0.040 \text{ M}$  and  $[\text{O}_2] = 0.035 \text{ M}$ , the observed rate of disappearance of NO is  $9.3 \times 10^{-5} \text{ M/s}$ . (a) What is the rate of disappearance of  $\text{O}_2$  at this moment?

(b) What is the value of the rate constant?

(c) What would happen to the rate if the concentration of NO were increased by a factor of 1.8?

3. The equilibrium  $(\text{CH}_3)_3\text{N}_{(aq)} + \text{H}_2\text{O}_{(l)} \leftrightarrow (\text{CH}_3)_3\text{NH}^+_{(aq)} + \text{OH}^-_{(aq)}$  has a  $K_b = 6.4 \times 10^{-5}$ . If we start with 0.075 M trimethylamine,  $(\text{CH}_3)_3\text{N}$  and 0.10 M trimethylammonium ion,  $(\text{CH}_3)_3\text{NH}^+$ , what is the pH of the resulting solution?

4. What is the pH of 25°C water saturated with CO<sub>2</sub> at a partial pressure of 1.10 atm? The Henry's Law constant for CO<sub>2</sub> at 25°C is 3.1 x 10<sup>-2</sup> mole/L·atm. Carbon dioxide in water forms carbonic acid. The carbonic acid has a K<sub>a1</sub> = 4.3 x 10<sup>-7</sup> and K<sub>a2</sub> = 5.6 x 10<sup>-11</sup>.

5. Calculate the pH of a solution made by combining 125 mL of 0.050 M hydrofluoric acid, K<sub>a</sub> = 6.8 x 10<sup>-4</sup>, with 50.0 mL of 0.10 M sodium fluoride.

6. The light sensitive substance in black-and-white film is AgBr. Photons provide the energy necessary to transfer an electron from Br<sup>-</sup> to Ag<sup>+</sup> to produce Ag and Br and thereby darken the film. (a) If a minimum energy of 2.00 x 10<sup>5</sup> J/mole is needed for this process, what is the minimum energy needed by each photon?

(b) Calculate the wavelength of the light necessary to provide photons of this energy.

7. Ammonia reacts in aqueous solution in the following equilibrium reaction:

$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \leftrightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$ . (a) If the hydroxide ion concentration is  $4.80 \times 10^{-4} \text{ M}$  in  $0.0170 \text{ M NH}_3(\text{aq})$  what is the pH?

(b) What is the  $K_b$  for  $\text{NH}_3(\text{aq})$ ?

(c) What is the percent ionization in  $0.0170 \text{ M NH}_3(\text{aq})$ ?

(d) If  $25.0 \text{ mL}$  of the  $0.0170 \text{ M NH}_3(\text{aq})$  is placed in an Erlenmeyer flask and titrated to a neutral endpoint with  $0.0115 \text{ M HCl}(\text{aq})$  what amount of the acid was added?

(e) What would be the pH of the solution from part (d) if only  $18.5 \text{ mL}$  of  $0.0115 \text{ M HCl}(\text{aq})$  was added?