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AP Chemistry – Aqueous Equilibria – 57

Name _____Per ___

1. The elementary steps of a chemical process are proposed to be:
$HBr_{(g)} + O_{2(g)} \rightarrow HOOBr_{(g)}$
$HOOBr_{(g)} + HBr_{(g)} \rightarrow 2HOBr_{(g)}$
$HOBr_{(g)} + HBr_{(g)} \rightarrow H_2O_{(g)} + Br_{2(g)}$. (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 Rate = $k[HBr][O_2]$. 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 $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$ is second order in NO and first order in O_2. When [NO] = 0.040 M and $[O_2]$ = 0.035 M, the observed rate of disappearance of NO is 9.3×10^{-5} M/s. (a) What is the rate of disappearance of 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 $(CH_3)_3N_{(aq)} + H_2O_{(l)} \leftrightarrow (CH_3)_3NH^+_{(aq)} + OH^-_{(aq)}$ has a $K_b = 6.4 \times 10^{-5}$. If we start with 0.075 M trimethylamine, $(CH_3)_3N$ and 0.10 M trimethylammonium ion, $(CH_3)_3NH^+$, what is the pH of the resulting solution?

4. What is the pH of 25°C water saturated with CO_2 at a partial pressure of 1.10 atm? The Henry's Law constant for CO_2 at 25°C is 3.1×10^{-2} mole/L·atm. Carbon dioxide in water forms carbonic acid. The carbonic acid has a $K_{a1} = 4.3 \times 10^{-7}$ and $K_{a2} = 5.6 \times 10^{-11}$.

5. Calculate the pH of a solution made by combining 125 mL of 0.050 M hydrofluoric acid, $K_a = 6.8 \times 10^{-4}$, 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^- to Ag^+ to produce Ag and Br and thereby darken the film. (a) If a minimum energy of 2.00×10^5 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:
$NH_{3(aq)} + H_2O_{(l)} \leftrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$. (a) If the hydroxide ion concentration is 4.80×10^{-4} M in 0.0170 M $NH_{3(aq)}$ what is the pH?

(b) What is the K_b for $NH_{3(aq)}$?

(c) What is the percent ionization in 0.0170 M $NH_{3(aq)}$?

(d) If 25.0 mL of the 0.0170 M $NH_{3(aq)}$ is placed in an Erlenmeyer flask and titrated to a neutral endpoint with 0.0115 M $HCl_{(aq)}$ what amount of the acid was added?

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