Due on Tuesday, February 02, 2016

3.6 Phosphate ion reacts in water to form monohydrogen phosphate according to the following reaction:

$PO_4^{3-} + H_2O = HPO_4^{2-} + OH^-$

The equilibrium constant for this reaction is $10^{-1.97}$. a) Given that this is a dilute system (so you can assume ideal conditions), temperature is 298°K and the total combined phosphate/monohydrogen phosphate is 10^{-4} M, what percentage of the total concentration is in the phosphate ion form at pH= 11? b) Will the reaction proceed as written at pH=9 when $[PO_4^{3-}]=10^{-6.8}$ and $[HPO_4^{2-}]=10^{-4}$ M? And if not, which direction will the reaction proceed?

3.10 The log Henry constant (units of L-atm/mole and measured at 25°C) for trichloroethylene (TCE) is 1.03; for tetrachloroethylene (PCE) it is 1.44; for 1,2-dimethylbenzene it is 0.71; and for parathion it is -3.42. (a) What are the dimensionless Henry's law constants for each of these chemicals? (b) Rank the chemicals in order of ease of stripping from water to air.

3.14 What would be the pH if 10^{-2} moles of hydrofluoric acid (HF) were added to 1 L pure water? The pK_a of HF is 3.2.

3.27 Peridisulfate ($S_2O_8^{2-}$) reacts with thiosulfate ($S_2O_3^{2-}$) according to the following reaction:

$S_2O_8^{2-} + 2\ S_2O_3^{2-} \rightarrow 2SO_4^{2-} + S_4O_6^{2-}$

a) Show how the change in perdisulfate concentration with time is related to the change in concentration with time of the other three species. b) If the reaction is elementary and irreversible, what is the overall order of the reaction?

3.34 Nitrogen dioxide (NO_2) concentrations are measured in an air-quality study and decrease from 5 ppm_v to 2 ppm_v in 4 min with a particular light intensity. (a) What is the first-order rate constant for this reaction? (b) What is the half-life of NO_2 during this study? (c) What would the rate constant need to be changed to in order to decrease the time required to lower the NO_2 concentration from 5 ppm_v to 2 ppm_v in 1.5 min?

3.35 Assume that municipal solid waste is 30% organic carbon by wet weight. The organic carbon in the solid waste decays by first order kinetics after placed in a landfill with reported rate constants for a dry climate (0.02/yr), moderate climate (0.038/yr), and wet climate (0.057/yr). Dry climate is defined as precipitation plus recirculated leachate being less than 20 inches/year; moderate climate as precipitation plus recirculated leachate ranges from 20 to 40 inches/year; and, a wet climate having precipitation plus recirculated leachate greater than 40 inches/year. Estimate the time it takes for 20 and 90 percent of the organic carbon contained in a municipal solid waste landfill to decay in the three different climates. In practice, this will be the period when greenhouse gases should be captured from the landfill).