3.091 OCW Scholar

Self-Assessment
Aqueous Solutions

Supplemental Exam Problems for Study

Problem #1

(a) Identify the conjugate acid-base pairs in each equilibrium by drawing a line connecting each acid with its conjugate base, and identify the acid of each acid/base pair:

(i) $CH_3CO_2H(aq) + NH_3(aq) \rightleftharpoons CH_3CO_2^-(aq) + NH_4^+(aq)$

(ii) $SbF_5(aq) + 2\ HF(aq) \rightleftharpoons H_2F^+(aq) + SbF_6^-(aq)$

(b) A 1.11 M solution of fluoroacetic acid, FCH_2CO_2H, is 5% dissociated in water.

(i) Calculate the value of the pK_a of FCH_2CO_2H.

(ii) Calculate the value of the *pH* of the solution.

Problem #2

Chromium hydroxide ($Cr(OH)_3$) dissolves in water according to

$$Cr(OH)_3 = Cr^{3+}(aq) + 3\ OH^-(aq) \qquad K_{sp} = 6.31 \times 10^{-31} \text{ at } 25^\circ C$$

Calculate the solubility of chromium hydroxide in 3.091 nM (3.091×10^{-9} M) NaOH(*aq*). Express your answer in moles of $Cr(OH)_3$ per liter of solution.

Problem #3

Comment on the solubility of iodine (I_2) in each of these ***liquids***: (1) carbon tetrachloride (CCl_4); (2) hydrogen fluoride (HF). State whether at room temperature you expect I_2 to be ***highly soluble*** or ***almost insoluble***, and explain why.

(1) I_2 in $CCl_4(\ell)$

(2) I_2 in $HF(\ell)$

Problem #4

(a) The water dissociation equilibrium constant, K_w, expresses the relationship between hydronium (H_3O^+) and hydroxyl (OH^-) concentrations by the expression

$$K_w = [H_3O^+][OH^-]$$

Owing to the presence of dissolved salts the value of pK_w for seawater is 13.776 (not 14.00 as it is for pure water), where pK_w is defined as $-\log_{10}K_w$. Calculate the concentration of hydroxyl ions (OH^-) in seawater at a *pH* value of 7.00. Express your answer in moles OH^- per liter of solution (M).

(b) Would seawater at a *pH* value of 7.00 be classified acidic, basic, or neutral? Explain.

(c) Give an example of a dissolved salt that would cause the shift in the value of pK_w for seawater to 13.776 from the commonly accepted value of 14.00 which is valid for pure water. Justify your choice of salt.

3.091SC Introduction to Solid State Chemistry

Fall 2009