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$_3$CO$_2$(aq) + NH$_3$(aq) $\rightleftharpoons$ CH$_3$CO$_2^-(aq)$ + NH$_4^+(aq)$

(ii) SbF$_5$(aq) + 2 HF(aq) $\rightleftharpoons$ H$_2$F$^+(aq)$ + SbF$_6^-(aq)$

(b) A 1.11 M solution of fluoroacetic acid, FCH$_2$CO$_2$H, is 5% dissociated in water.

(i) Calculate the value of the $pK_a$ of FCH$_2$CO$_2$H.

(ii) Calculate the value of the $pH$ of the solution.
Problem #2

Chromium hydroxide (Cr(OH)₃) dissolves in water according to

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

Calculate the solubility of chromium hydroxide in 3.091 nM (3.091 \times 10^{-9} \text{ M}) NaOH(aq). Express your answer in moles of Cr(OH)₃ per liter of solution.

Problem #3

Comment on the solubility of iodine (I₂) in each of these liquids: (1) carbon tetrachloride (CCl₄); (2) hydrogen fluoride (HF). State whether at room temperature you expect I₂ to be highly soluble or almost insoluble, and explain why.

(1) I₂ in CCl₄(ℓ)

(2) I₂ in HF(ℓ)
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.