Selected Solubility-Product Constants at 298 K

Formula	K_{sp}
$Al(OH)_3$	4.6×10^{-33}
$AlPO_4$	9.84×10^{-21}
Sb_2S_3	1.6×10^{-93}
As_2S_3	1×10^{-16}
$Ba(BrO_3)_2$	2.43×10^{-4}
$BaCO_3$	2.58×10^{-9}
$BaCrO_4$	1.17×10^{-10}
BaF_2	1.84×10^{-7}
$Ba(OH)_2\cdot8H_2O$	2.55×10^{-4}
$Ba(IO_3)_2$	4.01×10^{-9}
$Ba(IO_3)_2\cdot H_2O$	1.67×10^{-9}
$BaMoO_4$	3.54×10^{-8}
$Ba(NO_3)_2$	4.64×10^{-3}
$Ba_3(PO_4)_2$	3.40×10^{-23}
$BaSeO_4$	3.40×10^{-8}
$BaSO_4$	1.08×10^{-10}
$BaSO_3$	5.0×10^{-10}
$CaCO_3$	3.36×10^{-9}
$CaCO_3$	6.0×10^{-9}
CaF_2	3.45×10^{-11}
$Ca(OH)_2$	5.02×10^{-6}
$Ca(IO_3)_2$	6.47×10^{-6}
$Ca(IO_3)_2\cdot6H_2O$	7.10×10^{-7}
$CaMoO$	1.46×10^{-8}
$CaC_2O_4\times H_2O$	2.32×10^{-9}
$Ca_3(PO_4)_2$	2.07×10^{-33}
$CaSO_4$	4.93×10^{-5}
$CaSO_4\cdot2H_2O$	3.14×10^{-5}
$CaSO_4\cdot0.5H_2O$	3.1×10^{-7}
$Cr(OH)_3$	3×10^{-29}
$CuBr$	6.27×10^{-9}
$CuCO_3$	1.4×10^{-10}
$Cu(IO_3)_2\cdot H_2O$	6.94×10^{-8}
CuC_2O_4	4.43×10^{-10}
$Cu_3(PO_4)_2$	1.40×10^{-37}
CuS	6.3×10^{-26}
Cu_2S	2.5×10^{-48}
Formula	K_{sp}
$PbBr_2$	6.60×10^{-6}
$PbCO_3$	7.40×10^{-14}
$PbCl_2$	1.70×10^{-5}
$PbCrO_4$	3×10^{-13}
PbF_2	3.3×10^{-8}
$Pb(OH)_2$	1.43×10^{-20}
$FeCO_3$	3.13×10^{-11}
FeF_2	2.36×10^{-6}
$Fe(OH)_2$	4.87×10^{-17}
FeS	1.6×10^{-19}

$Fe(OH)_3$	2.79×10^{-39}
$FePO_4\cdot2H_2O$	9.91×10^{-16}
$La(IO_3)_3$	7.50×10^{-12}
$PbBr_2$	6.60×10^{-6}
$PbCO_3$	7.40×10^{-14}
$PbCl_2$	1.70×10^{-5}
$PbCrO_4$	3×10^{-13}
PbF_2	3.3×10^{-8}
$PbSO_4$	2.53×10^{-8}
PbS	8.9×10^{-29}
Li_2CO_3	8.15×10^{-4}
LiF	1.84×10^{-3}
Li_3PO_4	2.37×10^{-4}
$MgNH_4PO_4$	3×10^{-13}
$MgCO_3$	6.82×10^{-6}
$MgCO_3\cdot3H_2O$	2.38×10^{-6}
$MgCO_3\cdot5H_2O$	3.79×10^{-6}
MgF_2	5.16×10^{-11}
$Mg(OH)_2$	5.61×10^{-12}
$AgCN$	5.97×10^{-17}
$AgIO_3$	3.17×10^{-8}
$AgSCN$	1.03×10^{-12}
ZnF	3.04×10^{-2}
$Zn(OH)_2$	3×10^{-17}
$Zn(IO_3)_2\cdot2H_2O$	4.1×10^{-6}
$ZnC_2O_4\cdot2H_2O$	1.38×10^{-9}
$ZnSe$	3.6×10^{-26}

5 pts. 1. An Alka-Seltzer tablet contains 1.9 g of sodium bicarbonate ($NaHCO_3$, MW 84.0). What is the potential volume of CO_2 in mL produced by this pill at 35 ^oC (body temperature) and atmospheric pressure if all of its bicarbonate is converted to CO_2?

5 pts. 2. A 0.5-L sample of air at 20 ^oC and 1.5 atm of pressure is heated to 100 ^oC while keeping the volume unchanged. What is its overall pressure after this heating?

5 pts. 3. Explain in terms of the Kinetic Molecular Theory why it doesn't matter what the gas is – we can still use the ideal gas law. The key question here is why a gas like argon (MW 40) behaves essentially the same as helium (MW 4.0) in terms of the relationship between number of molecules and pressure at a given concentration and temperature. What is going on there?

16 pts. 4. Write the net ionic equations and associated equilibrium expressions for the following reactions:

a. $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O$

b. the reaction between Mg metal and aqueous HCl.

c. the reaction between iron(III) nitrate and potassium thiocyanate.

d. the dissolving of sodium phosphate.

24 pts. 5. Indicate in each case whether the compound is a strong-, weak-, or non-electrolyte, circling the correct answer in each case. In the case of strong electrolytes, indicate the ions formed in water.

				cation?	anion?
NH_4Cl	strong	weak	non		
morphine	strong	weak	non		
KSCN	strong	weak	non		
HNO_3	strong	weak	non		
NH_2CH_3	strong	weak	non		
H_2SO_4	strong	weak	non		
$Ca(OH)_2$	strong	weak	non		
HF	strong	weak	non		
HI	strong	weak	non		
methamphetamine	strong	weak	non		
O_2	strong	weak	non		
citric acid	strong	weak	non		

10 pts. 6. Calculate the solubility in g/L of lead(II) chloride (MW 278.1) at 25 °C.

9 pts. 7. In each case, assume the system is at equilibrium, and then is perturbed in the specified way. Show the chemical equation for the reaction that will occur in order to bring the system back to equilibrium.

a. A mixture contains N_2O_4 and NO_2; the volume is decreased.

b. Sulfuric acid is added to a saturated solution of calcium sulfate

c. In a saturated solution of MgF_2, sodium fluoride is added.

15 pts. 8. Calculate the equilibrium pressures of NO, Cl_2, and NOCl produced by the reaction of a starting mixture with 3.0 atm NO and 1.0 atm Cl_2.

$$2\ NO(g) + Cl_2(g) \rightleftharpoons 2\ NOCl(g) \qquad K_P = 2.5\times10^3$$

15 pts. 9. This question is about the lab experiment you carried out involving the following equilibrium:

$$Fe^{3+} + SCN^- \rightleftharpoons FeSCN^{2+}$$

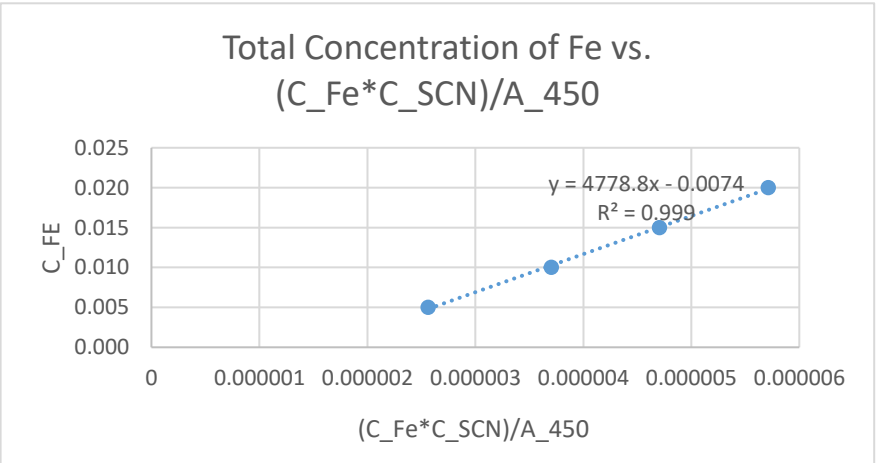
[PRACTICE EXAM NOTE: THIS PROBLEM RELATES TO THE OLD WAY THE LAB WAS DONE, NOT THE WAY YOU DID IT THIS YEAR. LOOK OVER YOUR LAB AND IMAGINE WHAT A 15-PT PROBLEM RELATED TO THAT MIGHT LOOK LIKE.]

In this experiment, there was a trial that was recorded as shown below, with its associated data analysis.

nitric acid /mL	water /mL	0.0100 M $Fe(NO_3)_3$ solution /mL	0.00020 M KSCN solution /mL	C_{Fe} /M	C_{SCN} /M	Absorption	$[FeSCN^{2+}]_{eq}$ /M
20.00	9.00	20.00	1.00	**(a)**	**(a)**	0.150	**(c)**

Results are shown on the right, plotted based on the following equation:

$$C_{Fe} = \varepsilon_{450}\left(\frac{C_{Fe}C_{SCN}}{A_{450}}\right) - \frac{1}{K_{eq}}$$



(b) ε = _____ $cm^{-1}M^{-1}$

K_{eq} = _____

(a) calculate the initial (or "total") concentrations of Fe^{3+} and SCN^- in the solution,
(b) calculate the values of the molar absorptivity and K_{eq} from these data, and
(c) calculate the equilibrium concentration of SCN^- based on the Beer-Lambert law.

Show your calculations below, and place your answers in the spaces provided above.