EQUILIBRIA

Chapter 17

Buffers

Solutions that resist pH change when small amounts of acid and base added

Two types

weak acid + its salt

weak base + its salt

Common ion effect

BUFFERS

Solutions that resist pH change when small amounts of acid and base added

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + A^-_{(aq)}$$

Add base → right shift

BUFFERS

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + A^-_{(aq)}$$

Add acid → left shift

BUFFERS

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + A^-_{(aq)}$$

$$HC_2H_3O_2 + H_2O \rightleftharpoons H_3O^+ + C_2H_3O_2^-$$

Buffer pH depends on ratio of conjugate acid-base pair

ADDING ACID/BASE TO BUFFERS

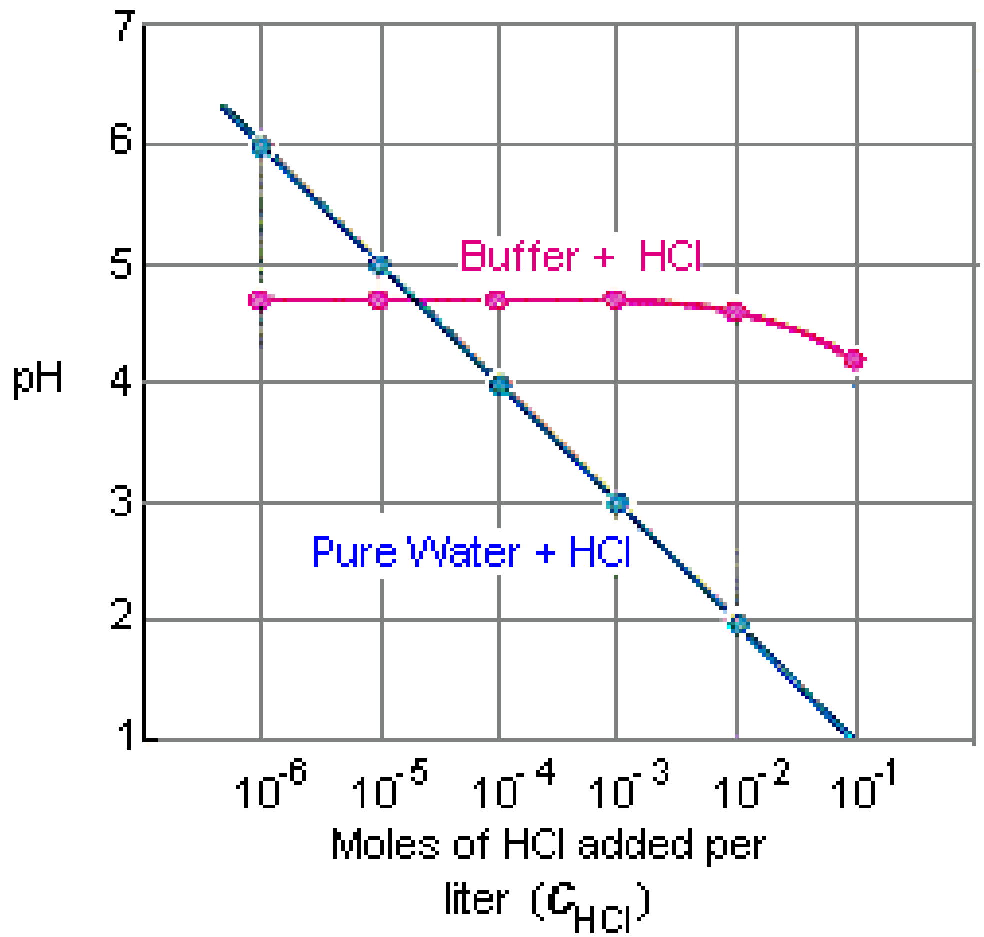
PURE WATER

Add 1 M HCl in 10 mL increments to 100 mL water

1 M HA BUFFER

Add 1 M HCl in 10 mL increments to 100 mL buffer

ADDING ACID/BASE TO BUFFERS



Buffers and Blood

Oxygen transported by hemoglobin

CO_2 transported in plasma and red blood cells

HCO_3^- is buffer for controlling blood pH

Henderson-Hasselbalch Equation

$$pK = -\log K$$

$$pH = pK + \log\left(\frac{[A^-]}{[HA]}\right)$$

$$pH = pK_a + \log\frac{[base]}{[acid]}$$

Solubility Product

K_{sp}

equilbrium constant for low solubility ionic compounds

$$AgCl_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$$

$$K_{sp}=[Ag^{+}][Cl^{-}]$$

SOLUBILITY PRODUCT

$$AgCl_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$$

At equilibrium the system is a saturated solution of Ag^{+} & Cl^{-}

Low K_{sp} means low solubility

SOLUBILITY PRODUCT

Write K_{sp} for $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

$$K_{sp}=[Ca^{2+}][F^-]^2$$

SOLUBILITY PRODUCT

Solubility AgCl: 0.00188 g/L

Molar Solubility Ag_2SO_4: 0.015 mol/L

Given solubility or K_{sp}, find other

PROBLEM 1

Find K_{sp} for Ag_2CrO_4

Given solubility is 7.8×10^{-6} mol/L

$$Ag_2CrO_4 \rightleftharpoons 2\,Ag^+ + CrO_4^{2-}$$

$$1\text{ mol} \rightsquigarrow 2\text{ mol} + 1\text{ mol}$$

$$7.8 \times 10^{-6}\text{ mol} \rightarrow 2 \times 7.8 \times 10^{-6}\text{ mol} + 7.8 \times 10^{-6}\text{ mol}$$

$$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$$

$$K_{sp} = [2 \times 7.8 \times 10^{-6}]^2[7.8 \times 10^{-6}]$$

$$= 1.9 \times 10^{-12}$$

PROBLEM 2

Find solubility of CaF_2 from K_{sp}

Given $K_{sp} = 3.9 \times 10^{-11}$

$K_{sp} = [Ca^{2+}][F^-]^2$

$CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

x mol $\rightarrow$ x mol + 2x mol

$K_{sp} = [x][2x]^2 = 3.9 \times 10^{-11}$

$x = 2.1 \times 10^{-4}$ mol/L (molar sol)

Problem 2

Convert from mol/L to g/L

$$2.1 \times 10^{-4} \times 78 = 1.6 \times 10^{-3} \text{ g/L}$$