

### Question #61416 – Chemistry – Organic Chemistry

Question:

1. What is the concentration of NO gas at equilibrium if you mix 0.20 mol of N<sub>2</sub> and 0.15 mol of O<sub>2</sub> in a 1.0 L container at 2000 °C? The K<sub>c</sub> for the reaction at 2000 °C is  $4.10 \times 10^{-4}$ .

Solution

$$K_c = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}$$

If x mol of N<sub>2</sub> react with O<sub>2</sub>

$$K_c = \frac{[2x]^2}{[0.2-x][0.15-x]}$$

$$(K_c - 4) \cdot x^2 - 0.35K_c x + K_c \cdot 0.03 = 0$$

$x = \frac{(4 - K_c + (0.35^2 - 4(K_c - 4) \cdot K_c \cdot 0.03)^{0.5})}{2(K_c - 4)}$  – typical solution of quadratic equation

$$[\text{NO}] = 2x = 2 \cdot \frac{(4 - K_c + (0.35^2 - 4(K_c - 4) \cdot K_c \cdot 0.03)^{0.5})}{2(K_c - 4)}$$

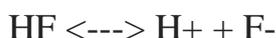
From this equation  $[\text{NO}] = 3,47 \cdot 10^{-3}$

Answer:  $[\text{NO}] = 3,47 \cdot 10^{-3}$

Question:

2. What would be the equilibrium pH if 200 milligrams of Hydrofluoric acid (HF) were dissolved in 1 liter of solution? The pK<sub>a</sub> for the acid is equal to 3.2. (Hint: Convert pK<sub>a</sub> to K<sub>a</sub>)

Solution:



$$[\text{H}^+] = [\text{F}^-] + [\text{OH}^-]$$

$$C_{\text{HF}} = [\text{HF}] + [\text{F}^-]$$

$$K_a = \frac{[\text{H}^+][\text{F}^-]}{[\text{HF}]}$$

$$[\text{H}^+] = \frac{K_a C_{\text{HF}}}{[\text{H}^+] + K_a} + \frac{K_w}{[\text{H}^+]}$$

$$C_{\text{HF}} = 0.2 / (20 \cdot 1) = 0.01 \text{ mol/l}$$

$$K_a = 10^{-3.2} = 6.3 \cdot 10^{-4}$$

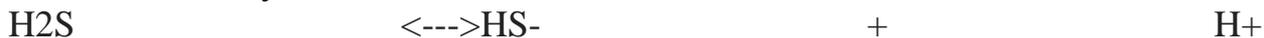
$$[\text{H}^+] = 0.00222 \text{ mol/l}$$

$$\text{pH} = 2.65$$

Answer: pH = 2.65

Question:

3. The Henry's law constant for H<sub>2</sub>S is 0.1 mole/L.atm and



Where K<sub>a</sub> = 10<sup>-7</sup>. The equilibrium pH of the solution is 4.5 if pure H<sub>2</sub>S gas is dissolved in water. Find the partial pressure of the H<sub>2</sub>S gas above the solution.

Solution:

$$[\text{H}^+] = 10^{-4.5} = 3 \cdot 10^{-5}$$

$$[\text{H}^+] = [\text{HS}^-] + [\text{OH}^-]$$

$$[\text{HS}^-] = 3 \cdot 10^{-5}$$

$$C(\text{H}_2\text{S}) = [\text{HS}^-] \cdot (1 + [\text{H}^+] / K_a) = 0,01$$

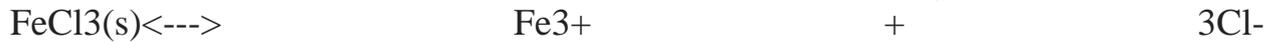
$$C=KP$$

$$P(\text{H}_2\text{S})=0.01/0.1=0.1 \text{ atm}$$

$$\text{Answer: } P(\text{H}_2\text{S})= 0.1 \text{ atm}$$

Question:

4. At a wastewater treatment plant,  $\text{FeCl}_3(\text{s})$  is added to remove excess phosphate ( $\text{PO}_4^{3-}$ ) from the effluent. Assume the following reactions occur:



The  $K_{\text{sp}}$  for the second reaction is  $1.3 \times 10^{-22}$ . What concentration of  $\text{Fe}^{3+}$  (in mg/L) is needed to maintain the phosphate concentration below the limit of 1 mg/L P?

Solution:

$$K_{\text{sp}} = [\text{Fe}^{3+}][\text{PO}_4^{3-}]$$

$$[\text{PO}_4^{3-}] = 0.001 \text{ g/l} / 95 \text{ g/mol} = 1.05 \times 10^{-5} \text{ mol/l}$$

$$[\text{Fe}^{3+}] = 1.235 \times 10^{-17} \text{ mol/l} = 7 \times 10^{-16} \text{ g/l}$$

$$\text{Answer: } [\text{Fe}^{3+}] = 7 \times 10^{-16} \text{ g/l}$$