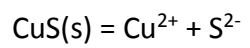


Supplementary Example

Calculate the molar solubility of the CuS at pH 8.00

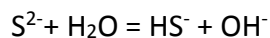


$$K_{sp} = [\text{Cu}^{2+}][\text{S}^{2-}] = 8\text{e-}37$$

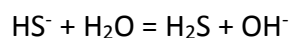
See answer on next page.

Solve for $[\text{Cu}^{2+}]$.

Hydrolysis of S^{2-} :



$$K_{b1} = \frac{[\text{HS}^-][\text{OH}^-]}{[\text{S}^{2-}]} = K_w/K_{a2} = K_w/1.00\text{e-}14 = 1$$



$$K_{b2} = \frac{[\text{H}_2\text{S}][\text{OH}^-]}{[\text{HS}^-]} = K_w/K_{a1} = K_w/9.5\text{e-}8 = 1.1\text{e-}7$$

$$[\text{H}^+] = 1.00\text{e-}8 \quad [\text{OH}^-] = 1.00\text{e-}6$$

Recognize that solving for $[\text{Cu}^{2+}]$ will give us CuS solubility

Write MBE

$$[\text{Cu}^{2+}] = [\text{S}^{2-}] + [\text{HS}^-] + [\text{H}_2\text{S}]$$

From K_{b1} solve for $[\text{HS}^-]$

$$K_{b1} = \frac{[\text{HS}^-][\text{OH}^-]}{[\text{S}^{2-}]}$$

$$[\text{HS}^-] = K_{b1}[\text{S}^{2-}]/[\text{OH}^-] = 1[\text{S}^{2-}]/1.00\text{e-}6 = 1.0\text{e}6[\text{S}^{2-}]$$

Sub into MBE

$$[\text{Cu}^{2+}] = [\text{S}^{2-}] + 1.0\text{e}6[\text{S}^{2-}] + [\text{H}_2\text{S}] \quad \#1$$

Now for $[\text{H}_2\text{S}]$

$$K_{b2} = \frac{[\text{H}_2\text{S}][\text{OH}^-]}{[\text{HS}^-]} = \frac{[\text{H}_2\text{S}][\text{OH}^-]}{1.0\text{e}6[\text{S}^{2-}]}$$

Solve for $[\text{H}_2\text{S}]$

$$\begin{aligned} [\text{H}_2\text{S}] &= K_{b2}1.0\text{e}6[\text{S}^{2-}]/[\text{OH}^-] = 1.1\text{e-}7*1.0\text{e}6[\text{S}^{2-}]/1.00\text{e-}6 \\ &= 1.1\text{e}5[\text{S}^{2-}] \end{aligned}$$

Sub into #1

$$[\text{Cu}^{2+}] = [\text{S}^{2-}] + 1.0\text{e}6[\text{S}^{2-}] + 1.1\text{e}5[\text{S}^{2-}] = 1.1\text{e}6[\text{S}^{2-}] \quad \#3$$

Now use K_{sp}

$$K_{sp} = [\text{Cu}^{2+}][\text{S}^{2-}] = 8\text{e-}37$$

Solve for $[\text{S}^{2-}]$

$$[\text{S}^{2-}] = 8\text{e-}37/[\text{Cu}^{2+}] \quad \text{sub into \#3}$$

$$[\text{Cu}^{2+}] = 1.1\text{e}6[\text{S}^{2-}] = 8\text{e-}37/[\text{Cu}^{2+}]$$

$$[\text{Cu}^{2+}] = 9\text{e-}19 \text{ M}$$