

Question 7.73

The concentration of sulphide ion in 0.1M HCl solution saturated with hydrogen sulphide is 1.0×10^{-19} M. If 10 mL of this is added to 5 mL of 0.04M solution of the following: FeSO_4 , MnCl_2 , ZnCl_2 and CdCl_2 . In which of these solutions precipitation will take place?

Given K_{sp} for $\text{FeS} = 6.3 \times 10^{-18}$, $\text{MnS} = 2.5 \times 10^{-13}$,
 $\text{ZnS} = 1.6 \times 10^{-24}$, $\text{CdS} = 8.0 \times 10^{-27}$.

Answer

For precipitation to take place, it is required that the calculated ionic product exceeds the K_{sp} value.

Before mixing:

$$[\text{S}^{2-}] = 1.0 \times 10^{-19} \text{ M}, \quad [\text{M}^{2+}] = 0.04 \text{ M}$$

$$\text{Volume} = 10 \text{ mL}$$

$$\text{Volume} = 5 \text{ mL}$$

After mixing:

$$[\text{S}^{2-}] = ?, \quad [\text{M}^{2+}] = ?$$

$$\text{Volume} = 10 + 5 = 15 \text{ mL}$$

$$\text{Volume} = 15 \text{ mL}$$

$$[\text{S}^{2-}] = \frac{1.0 \times 10^{-19} \times 10}{15} = 6.67 \times 10^{-20} \text{ M}$$

$$[\text{M}^{2+}] = \frac{0.04 \times 5}{15} = 1.33 \times 10^{-2} \text{ M}$$

$$\begin{aligned} \text{Ionic product} &= [\text{M}^{2+}][\text{S}^{2-}] \\ &= (1.33 \times 10^{-2})(6.67 \times 10^{-20}) \\ &= \boxed{8.87 \times 10^{-22}} \end{aligned}$$

\therefore The ionic product exceeds the K_{sp} of ZnS and CdS .

Therefore, precipitation will occur in

$CdCl_2$ and $ZnCl_2$ solutions.