

(66)



based on overall rxn $K_{eq} = \frac{[\text{Mn}^{2+}][\text{H}_2\text{S}]}{[\text{H}^+]^2}$

The following rxns make up the overall rxn though:



$$K_{sp} = [\text{Mn}^{2+}][\text{S}^{2-}] = 5 \times 10^{-15}$$

$$K_a = \frac{[\text{H}^+]^2[\text{S}^{2-}]}{[\text{H}_2\text{S}]} = K_1 \times K_2 = 1 \times 10^{-20}$$

To get K_{eq} expression we look to see how we can combine K_{sp} and K_a

$$\frac{K_a}{K_{sp}} = \frac{\frac{[\text{H}^+]^2[\text{S}^{2-}]}{[\text{H}_2\text{S}]}}{[\text{Mn}^{2+}][\text{S}^{2-}]} \Rightarrow \text{S}^{2-} \text{ cancels leaving } \frac{[\text{H}^+]^2[\text{Mn}^{2+}]}{[\text{H}_2\text{S}]}$$

but that isn't what our K_{eq} is.

$$\frac{K_{sp}}{K_a} = \frac{\frac{[\text{Mn}^{2+}][\text{S}^{2-}]}{[\text{H}_2\text{S}]}}{\frac{[\text{H}^+]^2[\text{S}^{2-}]}{[\text{H}_2\text{S}]}} \Rightarrow \text{S}^{2-} \text{ cancels leaving } \frac{[\text{Mn}^{2+}][\text{H}_2\text{S}]}{[\text{H}^+]^2}$$

which is what we should get.

$$\text{So } \frac{K_{sp}}{K_a} = K_{eq} = \frac{5 \times 10^{-15}}{1 \times 10^{-20}}$$