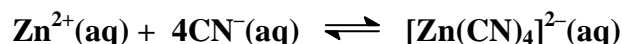


- Zinc sulfate (8.07 g) is dissolved in 1.00 L of a 1.00 M solution of KCN. Write the chemical equation for the formation of the aqueous ion  $[\text{Zn}(\text{CN})_4]^{2-}$ .

**Marks**  
**4**



Calculate the concentration of  $\text{Zn}^{2+}(\text{aq})$  in solution at equilibrium. Ignore any change in volume upon addition of the salt.  $K_{\text{stab}}$  of  $[\text{Zn}(\text{CN})_4]^{2-} = 4.2 \times 10^{19} \text{ M}^{-4}$ .

**The formula mass of zinc sulfate ( $\text{ZnSO}_4$ ) is:**

$$\text{formula mass} = 65.39 (\text{Zn}) + 32.07 (\text{S}) + 4 \times 16.00 (\text{O}) = 161.46 \text{ g mol}^{-1}$$

**The number of moles in 8.07 g is therefore:**

$$\text{number of moles} = n = \frac{m}{M} = \frac{8.07 \text{ g}}{161.46 \text{ g mol}^{-1}} = 0.0500 \text{ mol}$$

As  $c = \frac{n}{V}$ ,  $[\text{Zn}^{2+}(\text{aq})]_{\text{initial}} = 0.0500 \text{ M}$  when this is dissolved in a 1.00 L solution.

**The reaction table is:**

	$\text{Zn}^{2+}(\text{aq})$	$4\text{CN}^{-}(\text{aq})$	$\rightleftharpoons$	$[\text{Zn}(\text{CN})_4]^{2-}(\text{aq})$
<b>initial</b>	<b>0.0500</b>	<b>1.00</b>		<b>0</b>
<b>change</b>	<b>-x</b>	<b>-4x</b>		<b>+x</b>
<b>equilibrium</b>	<b>0.0500 - x</b>	<b>1.00 - 4x</b>		<b>x</b>

As  $K_{\text{stab}}$  is *very* large, virtually all of the  $\text{Zn}^{2+}(\text{aq})$  will have reacted. It is a good approximation, therefore, to take:

$$[\text{CN}^{-}(\text{aq})]_{\text{equilibrium}} = 1.00 - 4x \sim 1.00 - 4 \times [\text{Zn}^{2+}(\text{aq})]_{\text{initial}} \\ = (1.00 - 4 \times 0.0500) \text{ M} = 0.80 \text{ M}$$

$$[[\text{Zn}(\text{CN})_4]^{2-}(\text{aq})]_{\text{equilibrium}} = x \sim [\text{Zn}^{2+}(\text{aq})]_{\text{initial}} \\ = 0.0500 \text{ M}$$

**At equilibrium,**

$$K_{\text{stab}} = \frac{[[\text{Zn}(\text{CN})_4]^{2-}(\text{aq})]}{[\text{Zn}^{2+}(\text{aq})][\text{CN}^{-}(\text{aq})]^4} = \frac{0.0500}{(0.0500 - x)(0.80)^4} = 4.2 \times 10^{19}$$

**Hence,  $[\text{Zn}^{2+}(\text{aq})]_{\text{equilibrium}} = (0.0500 - x) \text{ M} = 2.9 \times 10^{-21} \text{ M}$**

Answer:  $2.9 \times 10^{-21} \text{ M}$

Name the complex ion.

**tetracyanozincate(II) ion**