- If 20.0 mL of a 0.100 M solution of sodium phosphate is mixed with 25.0 mL of a 0.200 M solution of zinc chloride, what mass of zinc phosphate will precipitate from the reaction?

Marks 6

25.0 mL of a 0.200 M solution of $ZnCl_2$ contains:

$$\mathbf{n(Zn^{2+}(aq)) = concentration \times volume = 0.200 \times \frac{25}{1000} = 0.00500\ mol}$$

20.0 mL of a 0.100 solution of Na_3PO_4 contains:

$$\mathbf{n(PO_4^{3-}) = 0.100 \times \frac{20}{1000} = 0.00200\ mol}$$

The ionic equation for the precipitation reaction is:

$$\mathbf{3Zn^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Zn_3(PO_4)_2(s)}$$

As $n(Zn^{2+}(aq) > \frac{3}{2} \times n(PO_4^{3-}(aq))$, PO_4^{3-} which is the limiting reagent. The maximum amount of product depends on $n(PO_4^{3-})$. The amount of zinc phosphate formed is:

$$\mathbf{n(Zn_3(PO_4)_2(s) = ½ \times n(PO_4^{3-}(aq)) = ½ \times 0.00200 = 0.00100\ mol}$$

The formula mass of zinc phosphate is:

$$\mathbf{(3 \times 65.39\ (Zn)) + 2 \times (30.97\ (P) + 4 \times 16.00\ (O)) = 386.11}$$

The mass of this amount of zinc phosphate is therefore:

$$\mathbf{mass = number\ of\ moles \times formula\ mass = 0.00100 \times 386.11 = 0.386\ g}$$

Answer: **0.386 g**

ANSWER CONTINUES ON THE NEXT PAGE

What is the final concentration of zinc ions in solution after the above reaction?

The number of moles of $Zn^{2+}(aq)$ removed by precipitation = 3 × 0.00100 = 0.00300 mol. The amount remaining is therefore:

$n(Zn^{2+}(aq)) = 0.00500 - 0.00300 = 0.00200$ mol

The total volume of the solution after mixing is (20.0 + 25.0) = 45.0 mL so the concentration is:

$$[Zn^{2+}(aq)] = \frac{\text{number of moles}}{\text{volume}} = \frac{0.00200}{(45/1000)} = 0.0444\,M$$

Answer: **0.0444 M**

What is the final concentration of sodium ions in solution after the above reaction?

20.0 mL of a 0.100 solution of Na_3PO_4 contains:

$$n(Na^+) = 3 \times 0.100 \times \frac{20}{1000} = 0.00600 \text{ mol}$$

After mixing, this amount is contained in a volume of 45.0 mL so the concentration is:

$$[Na^+(aq)] = \frac{\text{number of moles}}{\text{volume}} = \frac{0.00600}{(45/1000)} = 0.133\,M$$

Answer: **0.133 M**