

- 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?

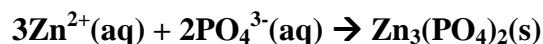
25.0 mL of a 0.200 M solution of ZnCl_2 contains:

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

20.0 mL of a 0.100 solution of Na_3PO_4 contains:

$$n(\text{PO}_4^{3-}) = 0.100 \times \frac{20}{1000} = 0.00200 \text{ mol}$$

The ionic equation for the precipitation reaction is:



As $n(\text{Zn}^{2+}(\text{aq})) > \frac{3}{2} \times n(\text{PO}_4^{3-}(\text{aq}))$, PO_4^{3-} which is the limiting reagent. The maximum amount of product depends on $n(\text{PO}_4^{3-})$. The amount of zinc phosphate formed is:

$$n(\text{Zn}_3(\text{PO}_4)_2(\text{s})) = \frac{1}{2} \times n(\text{PO}_4^{3-}(\text{aq})) = \frac{1}{2} \times 0.00200 = 0.00100 \text{ mol}$$

The formula mass of zinc phosphate is:

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

The mass of this amount of zinc phosphate is therefore:

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

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 $\text{Zn}^{2+}(\text{aq})$ removed by precipitation = $3 \times 0.00100 = 0.00300$ mol. The amount remaining is therefore:

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

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

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

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:

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

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

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

Answer: **0.133 M**