Marks 4

- If 50 mL of a 0.10 M solution of $AgNO_3$ is mixed with 50 mL of a 0.40 M solution of Na_2CO_3, what mass of Ag_2CO_3 will precipitate from the reaction?

The ionic equation for the precipitation reaction is:

$$\mathbf{2Ag^+(aq) + CO_3^{2-}(aq) \rightarrow Ag_2CO_3(s)}$$

Thus, two moles of $Ag^+(aq)$ are required for every one mole of $CO_3^{2-}(aq)$.

The number of moles of $Ag^+(aq)$ and $CO_3^{2-}(aq)$ are given by:

$$\mathbf{n(Ag^+(aq)) = concentration \times volume = 0.10 \times \frac{50}{1000} = 0.0050\ mol}$$

$$\mathbf{n(CO_3^{2-}(aq)) = 0.40 \times \frac{50}{1000} = 0.020\ mol}$$

There is insufficient $Ag^+(aq)$ to react with all of the $CO_3^{2-}(aq)$ and so it is $Ag^+(aq)$ is the limiting reagent. From the chemical equation, 1 mole of $Ag_2CO_3(s)$ is produced from every two moles of $Ag^+(aq)$ ions. The amount of $Ag_2CO_3(s)$ produced is therefore:

$$\mathbf{n(Ag_2CO_3(s)) = ½ \times n(Ag^+(aq)) = ½ \times 0.0050 = 0.0025\ mol}$$

The formula mass of Ag_2CO_3 is (2 × 107.87 (Ag)) + 12.01 (C) + (3 × 16.00 (O)) = 275.75. This number of moles thus corresponds to a mass of:

$$\mathbf{mass\ of\ Ag_2CO_3 = number\ of\ moles \times formula\ mass = 0.0025 \times 275.75 = 0.69\ g}$$

Answer: **0.69 g**

What is the final concentration of CO_3^{2-} ions in the solution after the above reaction?

From the chemical equation, one mole of $Ag_2CO_3(s)$ is produced from every mole of CO_3^{2-} which reacts. Therefore 0.0025 mol of CO_3^{2-} reacts. This leaves:

$$\mathbf{number\ of\ moles\ of\ unreacted\ CO_3^{2-} = 0.020 - 0.0025 = 0.018\ mol}$$

The total volume of the solution after mixing is (50 + 50) = 100 mL. The final concentration is therefore:

$$\mathbf{concentration = \frac{number\ of\ moles}{volume} = \frac{0.018}{100/1000} = 0.18\ M}$$

Answer: **0.18 M**

ANSWER CONTINUES ON THE NEXT PAGE

- Give balanced ionic equations for the reactions that occur in each of the following cases. **3**

Sodium metal is added to excess water.

$2Na(s) + 2H_2O(l) \rightarrow 2Na^+(aq) + 2OH^-(aq) + H_2(g)$

Solutions of cobalt(II) nitrate and sodium phosphate are mixed.

$3Co^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Co_3(PO_4)_2(s)$

Solid calcium carbonate is dissolved in dilute nitric acid.

$CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + H_2O(l)$