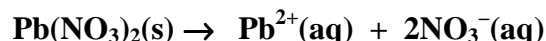
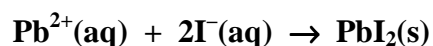


- A solution is prepared by dissolving lead(II) nitrate (33.12 g) in 1.00 L of water. Write the balanced ionic equation for this dissolution reaction.

Marks
5



When a 100.0 mL portion of this solution is mixed with a solution of potassium iodide (0.300 M, 150.0 mL), a bright yellow precipitate of lead(II) iodide forms. Write the balanced ionic equation for this precipitation reaction.



What mass of lead(II) iodide is formed?

The formula mass of $\text{Pb}(\text{NO}_3)_2$ is:

$$\begin{aligned} \text{formula mass} &= (207.2 \text{ (Pb)} + 2 \times 14.01 \text{ (N)} + 6 \times 16.00 \text{ (O)}) \text{ g mol}^{-1} \\ &= 331.22 \text{ g mol}^{-1} \end{aligned}$$

The number of moles in 33.12 g is therefore:

$$\text{number of moles} = \frac{\text{mass}}{\text{formula mass}} = \frac{33.12 \text{ g}}{331.22 \text{ g mol}^{-1}} = 0.1000 \text{ mol}$$

If this dissolved in 1.00 L and a 100.0 mL portion is taken, this will contain 0.01000 mol of $\text{Pb}^{2+}(\text{aq})$.

150.0 mL of a 0.300 M solution of KI contains:

$$\begin{aligned} \text{number of moles} &= \text{concentration} \times \text{volume} \\ &= 0.300 \text{ mol L}^{-1} \times 0.1500 \text{ L} = 0.0450 \text{ mol} \end{aligned}$$

The precipitation reaction requires 2 mol of $\text{I}^{-}(\text{aq})$ for every 1 mol of $\text{Pb}^{2+}(\text{aq})$. The 0.01000 mol of $\text{Pb}^{2+}(\text{aq})$ that is present requires 0.02000 mol of $\text{I}^{-}(\text{aq})$. As there is more $\text{I}^{-}(\text{aq})$ than this present, $\text{I}^{-}(\text{aq})$ is in excess and $\text{Pb}^{2+}(\text{aq})$ is the limiting reagent.

From the precipitation reaction, 1 mol of $\text{Pb}^{2+}(\text{aq})$ will produce 1 mol of $\text{PbI}_2(\text{s})$. Therefore 0.01000 mol of $\text{Pb}^{2+}(\text{aq})$ will produce 0.01000 mol of $\text{PbI}_2(\text{s})$.

The formula mass of PbI_2 is:

$$\begin{aligned} \text{formula mass} &= (207.2 \text{ (Pb)} + 2 \times 126.9 \text{ (I)}) \text{ g mol}^{-1} \\ &= 461.0 \text{ g mol}^{-1} \end{aligned}$$

The mass of 0.01000 mol is therefore:

$$\begin{aligned} \text{mass} &= \text{formula mass} \times \text{number of moles} = 461.0 \text{ g mol}^{-1} \times 0.01000 \text{ mol} \\ &= 4.61 \text{ g} \end{aligned}$$

Answer: **4.61 g**

ANSWER CONTINUES ON THE NEXT PAGE

What is the final concentration of $\Gamma(\text{aq})$ ions remaining in solution after the reaction is complete?

As described above reaction of 0.01000 mol of $\text{Pb}^{2+}(\text{aq})$ requires 0.02000 mol of $\Gamma(\text{aq})$. As 0.0450 mol are initially present, there are $(0.0450 - 0.02000)$ mol = 0.0250 mol of $\Gamma(\text{aq})$ after the precipitation reaction.

After mixing the two solutions, the total volume becomes $(100.0 + 150.0)$ mL = 250.0 mL. The final concentration of $\Gamma(\text{aq})$ is therefore:

$$\text{concentration} = \frac{\text{number of moles}}{\text{volume}} = \frac{0.0250 \text{ mol}}{0.2500 \text{ L}} = 0.100 \text{ mol L}^{-1} = 0.100 \text{ M}$$

Answer: **0.100 M**