Marks 6

- Lead(II) iodide precipitates when 0.080 M lead(II) nitrate solution (150.0 mL) is added to 0.080 M potassium iodide solution (50.0 mL). Write a balanced ionic equation for the reaction that occurs.

$Pb^{2+}(aq) + 2I^{-}(aq) \rightarrow PbI_2(s)$

What amount (in mol) of lead(II) iodide precipitates?

Before precipitation, the number of moles of $Pb^{2+}(aq)$ and $I^{-}(aq)$ present are:

number of moles of Pb^{2+} = concentration × volume

$= cV = (0.080 \text{ mol L}^{-1}) \times (0.1500 \text{ L}) = 0.012 \text{ mol}$

number of moles of $I^{-} = (0.080 \text{ mol L}^{-1}) \times (0.0500 \text{ L}) = 0.0040 \text{ mol}$

The ionic equation shows that 2 moles of I^{-} are required for every one mole of Pb^{2+}. As there is less I^{-} present than Pb^{2+}, iodide is the limiting reagent and some of the lead(II) ions are left in solution after precipitation.

One mole of $PbI_2(s)$ is formed for every two moles of $I^{-}(aq)$ present and hence:

number of moles of $PbI_2(s)$ = ½ × 0.0040 mol = 0.0020 mol

Answer: **0.0020 mol**

What amount (in mol) of $Pb^{2+}(aq)$ ions remain in solution after the reaction?

From above, 0.012 mol of $Pb^{2+}(aq)$ is initially present. The ionic equation shows that one mole of $Pb^{2+}(aq)$ is lost for every one mole of $PbI_2(s)$ formed. As 0.0020 mol of $PbI_2(s)$ precipitates,

number of moles of $Pb^{2+}(aq)$ left = (0.012 – 0.0020) mol = 0.010 mol

Answer: **0.010 mol**

ANSWER CONTINUES ON THE NEXT PAGE

What is the final concentration of $NO_3^-(aq)$ ions remaining in solution after the reaction?

The nitrate is not involved in the reaction so the amount of it is unchanged.

$Pb(NO_3)_2$ contains two moles of NO_3^{2-} for every mole of Pb^{2+}. From above, 0.012 mol of Pb^{2+} is present so there must be (2 × 0.012) mol = 0.024 mol of $NO_3^{2-}(aq)$.

When the solutions are mixed, the total volume becomes (150.0 + 50.0) mL = 200.0 mL. Hence, the concentration of $NO_3^{2-}(aq)$ becomes:

$$\textbf{concentration} = \frac{\textbf{number of moles}}{\textbf{volume}} = \frac{n}{V} = \frac{0.024\ \text{mol}}{0.2000\ \text{L}} = 0.12\ \text{mol L}^{-1}$$

Answer: **0.12 mol L^{-1} = 0.12 M**