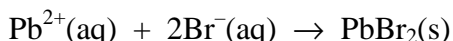


- Lead ions react with bromide ions according to the following equation.



If 0.040 M lead(II) nitrate solution (100.0 mL) is added to 0.020 M potassium bromide solution (300.0 mL), what amount (in mol) of lead(II) bromide precipitates?

**Marks**  
**4**

**The number of moles of  $\text{Pb}^{2+}$  ions in 100.0 mL of a 0.040 M solution of  $\text{Pb}(\text{NO}_3)_2$  is:**

$$\begin{aligned}\text{number of moles} &= \text{concentration} \times \text{volume} \\ &= (0.040 \text{ mol L}^{-1}) \times (0.1000 \text{ L}) = 0.0040 \text{ mol}\end{aligned}$$

**The number of moles of  $\text{Br}^{-}$  ions in 300.0 mL of a 0.020 M solution of KBr is:**

$$\text{number of moles} = (0.020 \text{ mol L}^{-1}) \times (0.3000 \text{ L}) = 0.0060 \text{ mol}$$

**The precipitation reaction requires 2  $\text{Br}^{-}$  ions for every  $\text{Pb}^{2+}$  ion. As there is *less* than twice as much  $\text{Br}^{-}$  than  $\text{Pb}^{2+}$ , it is the  $\text{Br}^{-}$  that is the limiting reagent.**

**From the chemical equation, 2 mol of  $\text{Br}^{-}$  leads to 1 mol of  $\text{PbBr}_2(\text{s})$  and so:**

$$\text{number of moles of } \text{PbBr}_2(\text{s}) \text{ formed} = \frac{1}{2} \times 0.0060 \text{ mol} = 0.0030 \text{ mol}$$

Answer: **0.0030 mol**

What is the final concentration of  $\text{NO}_3^{-}(\text{aq})$  ions remaining in solution after the reaction?

**$\text{NO}_3^{-}$  is not involved in the reaction: it is a spectator ion. The amount present are the reaction is the same as at the beginning. When 1 mol of  $\text{Pb}(\text{NO}_3)_2$  dissolves, it forms 1 mol of  $\text{Pb}^{2+}(\text{aq})$  and 2 mol of  $\text{NO}_3^{-}(\text{aq})$ . Hence, the number of moles of  $\text{NO}_3^{-}(\text{aq})$  present is:**

$$\text{number of moles} = 2 \times (0.040 \text{ mol L}^{-1}) \times (0.1000 \text{ L}) = 0.0080 \text{ mol}$$

**After the solutions are mixed, the total volume is (100.0 + 300.0) mL = 400.0 mL.**

**This amount is now present in this volume and so has a concentration:**

$$\text{concentration} = \text{number of moles} / \text{volume} = 0.0080 \text{ mol} / 0.4000 \text{ L} = 0.020 \text{ M}$$

Answer: **0.020 M**