### **Describing reactions in solution**

An ionic reaction can be described in three ways:

#### Formula equation

The reaction is written using the "molecular formula" of compounds with the state of matter. Ionic compounds are written in solution like "molecules":

$$AgNO_3(aq) + KCI(aq) \rightarrow AgCI(s) + KNO_3(aq)$$

### **Complete ionic equation**

The ions of soluble ionic compounds are dissociated in solution. For all non-soluble compounds, the ions remain "attached" together:

$$Ag^{+}(aq) + NO_{3}^{-}(aq) + K^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s) + K^{+}(aq) + NO_{3}^{-}(aq)$$

# **Net ionic equation**

It is the complete ionic reaction written without the spectator ions:

$$Ag^{+}(aq) + Cl^{-}(aq) \rightarrow AgCl(s)$$

## **Spectator ions**

They are easily recognized in a reaction because they have the same state of matter on the reactant side as on the product side.

They are necessary to balance the charges of any reaction involving ions.

However, they can be replaced by another ion because they are not "chemically" involved in the reaction. They are absent from the net ionic equation.

Complete and balance each reactions and write the corresponding molecular equation, complete ionic equation and net ionic equation. Identify any spectator ion(s).

- a. HCIO4(aq) + Mg(OH)2(s)
- b. Solid lead(II) hydroxide and aqueous hydrobromic acid (*Hint: precipitation of PbBr*<sub>2</sub>).

#### Answers

a. Molecular equation

$$2HClO4(aq) + Mg(OH)2(s) \rightarrow 2H2O(\ell) + Mg(ClO4)2(aq)$$

Complete ionic:

$$2H^{+}(aq) + 2CIO4^{-}(aq) + Mg(OH)_{2}(s) \rightarrow 2H_{2}O(\ell) + Mg^{2+}(aq) + 2CIO4^{-}(aq)$$

Net ionic:

$$2H^{+}(aq) + Mg(OH)_{2}(s) \rightarrow 2H_{2}O(\ell) + Mg^{2+}(aq)$$

Spectator ion: CIO4<sup>-</sup>(aq)

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b. Molecular equation:

$$Pb(OH)_2(s) + 2HBr(aq) \rightarrow 2H_2O(\ell) + PbBr_2(s)$$

Complete ionic equation:

$$Pb(OH)_2(s) + 2H^+(aq) + 2Br^-(aq) \rightarrow 2H_2O(\ell) + PbBr_2(s)$$

Net ionic equation:

$$Pb(OH)_2(s) + 2H^+(aq) + 2Br^-(aq) \rightarrow 2H_2O(l) + PbBr_2(s)$$
 Same as ionic eq.

No spectator ions.