NI · Net ionic equations

Completed notes | Notes 1/2

Write a dissolved ionic compound as its ions. Write a net ionic equation, name the spectator ions, and check atoms and charge.

1. Which substances are written as ions

A dissolved ionic compound is separate ions

An ionic compound that is dissolved in water breaks into its ions. This is called **dissociation**.

$Na_2SO_4(aq)$ is really $2Na^+(aq)$ and $SO_4^{2-}(aq)$. The subscript 2 on Na becomes the **coefficient** 2.

An ion with several atoms, like SO_4^{2-} or NO_3^-, stays **together**. Every ion keeps its charge and the state (aq).

Check the charges: $2(+1) + (-2) = 0$. The ions of a compound always add to **zero**.

Read the state before you split

Split only an ionic compound or a strong acid marked **(aq)**.

A solid, a liquid or a gas stays **whole**: Cu(s), $H_2O(l)$, $Cl_2(g)$.

A solid ionic compound stays whole too. AgCl(s) is **not** split.

A strong acid in water is written as ions. HCl(aq) is $\mathbf{H^+(aq)}$ and $Cl^-(aq)$.

On the diploma: read the state of every substance first. A common wrong choice splits a solid product into ions.

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Completed notes | Notes 2/2

2. From a full equation to a net ionic equation

Split, cancel, write what is left

Start with the balanced equation, with states: $Mg(s) + 2AgNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + 2Ag(s)$.

Split every dissolved ionic compound: $Mg(s) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow Mg^{2+}(aq) + 2NO_3^-(aq) + 2Ag(s)$. This is the **total ionic equation**.

$2NO_3^-(aq)$ is the same on both sides, so it did not change. An ion that does not change is a **spectator ion**.

Cancel the spectator ions. What is left is the **net ionic equation**: $Mg(s) + 2Ag^+(aq) \rightarrow Mg^{2+}(aq) + 2Ag(s)$.

To count an ion, multiply the coefficient by the subscript. $3CuCl_2(aq)$ gives $3Cu^{2+}(aq)$ and $\mathbf{6}Cl^-(aq)$.

On the diploma: a question may ask for the net ionic equation or for the spectator ion. Read which one it wants.

Check it, then ask if it is redox

Check atoms: 1 Mg and 2 Ag on each side. Check **charge**: 2(+1) = +2 on the left and +2 on the right.

Now the electron transfer is easy to see. Mg goes 0 → +2, so it is **oxidized**. Ag^+ goes +1 → 0, so it is **reduced**.

Not every net ionic equation is redox. In $Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$, lead stays +2 and iodine stays −1.

No **oxidation number** changes there, so no electrons move. The ions only join to make a solid.

On the diploma: do not call a reaction redox only because it has ions. Check the oxidation numbers.

NI · Worked practice

Net ionic equations | Questions 1-2 of 12

State symbols: (s) solid, (aq) dissolved in water, (l) liquid, (g) gas. Use the supplied reaction and conditions. B4 values name the Alberta Chemistry 30 Data Booklet table where used.

NI-P01 · Easy · Given: $MgCl_2(aq)$. Write the ions it forms in water, with the number of each ion.

1. $MgCl_2(aq)$ is a dissolved ionic compound, so it is written as separate ions.

2. $MgCl_2(aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$. The subscript 2 on Cl becomes the coefficient 2.

NI-P02 · Easy · Given: $(NH_4)_2SO_4(aq)$. Write the ions it forms in water, with the number of each ion.

1. NH_4^+ and SO_4^{2-} are ions with several atoms. Each one stays together.

2. $(NH_4)_2SO_4(aq) \rightarrow 2NH_4^+(aq) + SO_4^{2-}(aq)$. Check the charge: $2(+1) + (-2) = 0$.

NI · Worked practice

Net ionic equations | Questions 3-4 of 12

NI-P03 · Easy · Which of these is written as ions in a total ionic equation: Fe(s), NaOH(aq), $Br_2(l)$, $BaSO_4(s)$? Explain.

1. Only NaOH(aq) is split. It is an ionic compound dissolved in water, so it is $Na^+(aq)$ and $OH^-(aq)$.

2. Fe(s) and $BaSO_4(s)$ are solids and $Br_2(l)$ is a liquid, so those three stay whole.

NI-P04 · Easy · Given the total ionic equation $Zn(s) + Fe^{2+}(aq) + SO_4^{2-}(aq) \rightarrow Zn^{2+}(aq) + SO_4^{2-}(aq) + Fe(s)$. Name the spectator ion and write the net ionic equation.

1. $SO_4^{2-}(aq)$ is the same on both sides, so it is the spectator ion. Cancel it.

2. Net ionic: $Zn(s) + Fe^{2+}(aq) \rightarrow Zn^{2+}(aq) + Fe(s)$. The charge is +2 on each side.

NI · Worked practice

Net ionic equations | Questions 5-6 of 12

NI-P05 · Medium · Given: $Mg(s) + ZnCl_2(aq) \rightarrow MgCl_2(aq) + Zn(s)$. Write the total ionic equation and the net ionic equation. Name the spectator ion.

1. Total ionic: $Mg(s) + Zn^{2+}(aq) + 2Cl^-(aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq) + Zn(s)$. Cancel $2Cl^-(aq)$, so Cl^- is the spectator ion.

2. Net ionic: $Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$. Check: Mg 1, Zn 1 and a charge of +2 on each side.

NI-P06 · Medium · Given: $Pb(s) + 2AgNO_3(aq) \rightarrow Pb(NO_3)_2(aq) + 2Ag(s)$. Write the net ionic equation and check its charge.

1. Total ionic: $Pb(s) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow Pb^{2+}(aq) + 2NO_3^-(aq) + 2Ag(s)$. Cancel $2NO_3^-(aq)$.

2. Net ionic: $Pb(s) + 2Ag^+(aq) \rightarrow Pb^{2+}(aq) + 2Ag(s)$. Charge: $2(+1) = +2$ on the left and +2 on the right.

NI · Worked practice

Net ionic equations | Questions 7-8 of 12

NI-P07 · Medium · Given: $Mg(s) + 2HBr(aq) \rightarrow MgBr_2(aq) + H_2(g)$. HBr(aq) is a strong acid. Write the net ionic equation and name the spectator ion.

1. Total ionic: $Mg(s) + 2H^+(aq) + 2Br^-(aq) \rightarrow Mg^{2+}(aq) + 2Br^-(aq) + H_2(g)$. Cancel $2Br^-(aq)$, so Br^- is the spectator ion.

2. Net ionic: $Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$. Check: Mg 1, H 2 and a charge of +2 on each side.

NI-P08 · Medium · Given: $Br_2(l) + 2NaI(aq) \rightarrow 2NaBr(aq) + I_2(s)$. Write the net ionic equation. Then say what is oxidized and what is reduced.

1. Total ionic: $Br_2(l) + 2Na^+(aq) + 2I^-(aq) \rightarrow 2Na^+(aq) + 2Br^-(aq) + I_2(s)$. Cancel $2Na^+(aq)$. Net ionic: $Br_2(l) + 2I^-(aq) \rightarrow 2Br^-(aq) + I_2(s)$.

2. I^- goes $-1 \rightarrow 0$, so it is oxidized. Br goes $0 \rightarrow -1$, so Br_2 is reduced. The charge is -2 on each side.

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Net ionic equations | Questions 9-10 of 12

NI-P09 · Challenging · Given: $2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$. HCl(aq) is a strong acid. Write the total ionic equation and the net ionic equation. Check the charge.

1. Total ionic: $2Al(s) + 6H^+(aq) + 6Cl^-(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^-(aq) + 3H_2(g)$. Two $AlCl_3$ give $2 \times 3 = 6$ Cl^-. Cancel $6Cl^-(aq)$.

2. Net ionic: $2Al(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2(g)$. Charge: $6(+1) = +6$ on the left and $2(+3) = +6$ on the right.

NI-P10 · Challenging · Given: $3CaCl_2(aq) + 2Na_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(s) + 6NaCl(aq)$. Write the net ionic equation. Is it a redox reaction? Explain.

1. Split the three dissolved compounds. $Ca_3(PO_4)_2(s)$ is a solid and stays whole. $6Na^+(aq)$ and $6Cl^-(aq)$ are on both sides, so cancel them. Net ionic: $3Ca^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Ca_3(PO_4)_2(s)$.

2. It is not a redox reaction. Calcium stays +2, phosphorus stays +5 and oxygen stays −2, so no oxidation number changes. The charge is $3(+2) + 2(-3) = 0$ on the left and 0 on the right.

NI · Worked practice

Net ionic equations | Questions 11-12 of 12

NI-P11 · Challenging · For $Zn(s) + 2AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2Ag(s)$, a student writes the net ionic equation $Zn(s) + Ag^+(aq) \rightarrow Zn^{2+}(aq) + Ag(s)$. Which check finds the mistake? Write the correct net ionic equation.

1. The charge check finds it. The left side is +1 and the right side is +2, so the equation is not balanced for charge.

2. The student dropped the coefficient 2. Correct net ionic: $Zn(s) + 2Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$. Now the charge is +2 on each side.

NI-P12 · Challenging · Given: $Cu(s) + 2Fe(NO_3)_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Fe(NO_3)_2(aq)$. Write the total ionic equation and the net ionic equation. How many nitrate ions cancel from each side?

1. Total ionic: $Cu(s) + 2Fe^{3+}(aq) + 6NO_3^-(aq) \rightarrow Cu^{2+}(aq) + 2NO_3^-(aq) + 2Fe^{2+}(aq) + 4NO_3^-(aq)$. The right side has 2 + 4 = 6 nitrate ions, so $6NO_3^-(aq)$ cancel from each side.

2. Net ionic: $Cu(s) + 2Fe^{3+}(aq) \rightarrow Cu^{2+}(aq) + 2Fe^{2+}(aq)$. Charge: 2(+3) = +6 on the left and +2 + 2(+2) = +6 on the right.