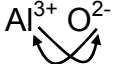
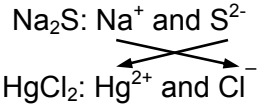


Writing Balanced Chemical Equations

Writing Formulas for Ionic Compounds

1. Write the symbol for the metal cation and its charge	Al^{3+} column 3A
2. Write the symbol for the nonmetal anion and its charge	O^{2-} column 6A
3. Charge (without sign) becomes subscript for other ion	$\text{Al}^{3+} \text{O}^{2-}$ 
4. Reduce subscripts to smallest whole number ratio	Al_2O_3
5. Check that the sum of the charges of the cations cancels the sum of the anions	$\text{Al} = (2) \cdot (+3) = +6$ $\text{O} = (3) \cdot (-2) = -6$

Balancing Double Displacement Reactions ($\text{AB} + \text{CD} \longrightarrow \text{AD} + \text{CB}$)

1. Identify the cations and anions in each compound	$\text{Na}_2\text{S} + \text{HgCl}_2 \longrightarrow$ $\text{Na}_2\text{S}: \text{Na}^+ \text{ and } \text{S}^{2-}$ $\text{HgCl}_2: \text{Hg}^{2+} \text{ and } \text{Cl}^-$ 
2. Pair up each cation with the anion from the OTHER compound	Na^+ pairs with Cl^- Hg^{2+} pairs with S^{2-}
3. Write two new (CORRECT!!) formulas using the pairs from step two	NaCl $\text{Hg}_2\text{S}_2 \longrightarrow \text{HgS}$
4. Adjust coefficients to ensure mass conservation	$2 \leftarrow \text{Na} \Rightarrow 1 \times 2$ $\text{Na}_2\text{S} + \text{HgCl}_2 \longrightarrow 2 \text{NaCl} + \text{HgS}$
5. Check	$\text{Na}_2\text{S} + \text{HgCl}_2 \longrightarrow 2 \text{NaCl} + \text{HgS(s)}$

Balancing Combustion Reactions (organic compounds + $\text{O}_2 \longrightarrow \text{CO}_2 + \text{H}_2\text{O}$)

1. Write a skeletal equation	$\text{C}_4\text{H}_{10}(l) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g)$
2. Balance atoms in complex substances first	$4 \leftarrow \text{C} \Rightarrow 1 \times 4$ $\text{C}_4\text{H}_{10}(l) + \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + \text{H}_2\text{O}(g)$ $10 \leftarrow \text{H} \Rightarrow 2 \times 5$ $\text{C}_4\text{H}_{10}(l) + \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + 5 \text{H}_2\text{O}(g)$
3. Balance free elements by adjusting coefficient in front of free element	$13/2 \times 2 \leftarrow \text{O} \Rightarrow 13$ $\text{C}_4\text{H}_{10}(l) + 13/2 \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + 5 \text{H}_2\text{O}(g)$
4. If fractional coefficients, multiply thru by denominator	$\{\text{C}_4\text{H}_{10}(l) + 13/2 \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + 5 \text{H}_2\text{O}(g)\} \times 2$ $2 \text{C}_4\text{H}_{10}(l) + 13 \text{O}_2(g) \rightarrow 8 \text{CO}_2(g) + 10 \text{H}_2\text{O}(g)$
5. Check	$8 \leftarrow \text{C} \Rightarrow 8; 20 \leftarrow \text{H} \Rightarrow 20; 26 \leftarrow \text{O} \Rightarrow 26$

Practice Problems

1. Write the empirical formulas for the compounds formed by the following ions:

- Al^{3+} and O^{2-} ions
- Mg^{2+} and NO_3^- ions
- Na^+ and PO_4^{3-} ions
- Fe^{3+} and CO_3^{2-}

2. Balance each chemical equation:

- $\text{H}_2 (g) + \text{Cl}_2 (g) \longrightarrow \text{HCl} (g)$
- $\text{Cu}_2\text{O} (s) + \text{C} (s) \longrightarrow \text{Cu} (s) + \text{CO} (g)$
- $\text{C}_2\text{H}_4 (g) + \text{O}_2 (g) \longrightarrow \text{CO}_2 (g) + \text{H}_2\text{O} (l)$
- $\text{C}_8\text{H}_8 (l) + \text{O}_2 (g) \longrightarrow \text{CO}_2 (g) + \text{H}_2\text{O} (l)$
- $\text{CH}_3\text{OH} (l) + \text{O}_2 (g) \longrightarrow \text{CO}_2 (g) + \text{H}_2\text{O} (l)$
- $\text{K}_2\text{CO}_3 (aq) + \text{NiCl}_2 (aq) \longrightarrow \text{NiCO}_3 (s) + \text{KCl} (aq)$
- $\text{NaCl} (aq) + \text{AgNO}_3 (aq) \longrightarrow$
- $\text{Ca}(\text{NO}_3)_2 (aq) + \text{Na}_2\text{SO}_4 (aq) \longrightarrow$
- $\text{NaOH} (aq) + \text{FeCl}_3 (aq) \longrightarrow$

References:

Tro, *Chemistry: A Molecular Approach* 2nd ed., Pearson

Brown/LeMay/Bursten, *Chemistry: The Central Science*, 12th ed., Pearson

- $3 \text{NaOH} (aq) + \text{FeCl}_3 (aq) \longrightarrow \text{Fe}(\text{OH})_3 (s) + 3 \text{NaCl} (aq)$
 - $2 \text{NaNO}_3 (aq) + \text{CuSO}_4 (aq) \longrightarrow \text{CuSO}_4 (s) + 2 \text{NaNO}_3 (aq)$
 - $\text{NaCl} (aq) + \text{AgNO}_3 (aq) \longrightarrow \text{AgCl} (s) + \text{NaNO}_3 (aq)$
 - $\text{K}_2\text{CO}_3 (aq) + \text{NiCl}_2 (aq) \longrightarrow \text{NiCO}_3 (s) + 2 \text{KCl} (aq)$
 - $2 \text{CH}_3\text{OH} (l) + 3 \text{O}_2 (g) \longrightarrow 2 \text{CO}_2 (g) + 4 \text{H}_2\text{O} (l)$
 - $\text{C}_8\text{H}_8 (l) + 10 \text{O}_2 (g) \longrightarrow 8 \text{CO}_2 (g) + 4 \text{H}_2\text{O} (l)$
 - $\text{C}_2\text{H}_4 (g) + 3 \text{O}_2 (g) \longrightarrow 2 \text{CO}_2 (g) + 2 \text{H}_2\text{O} (l)$
 - $\text{Cu}_2\text{O} (s) + \text{C} (s) \longrightarrow 2 \text{Cu} (s) + \text{CO} (g)$
 - $\text{H}_2 (g) + \text{Cl}_2 (g) \longrightarrow 2 \text{HCl} (g)$
- Al_2O_3
 - $\text{Mg}(\text{NO}_3)_2$
 - Na_3PO_4
 - $\text{Fe}_2(\text{CO}_3)_3$

Answers