# Law of Conservation of Matter

In a **chemical reaction** the number of atoms on both sides of a reaction must be the same (*balanced*). Atoms can neither be created or destroyed in a reaction process.

Balancing Chemical Reactions

The process of adding *coefficients*, a whole number that multiplies the number of atoms on the reactant, product, or both sides of a chemical reaction to make atoms numbers equal

Reaction Balancing Example
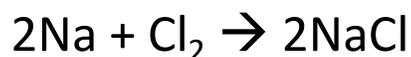
Unbalanced Reaction

$$Na + Cl_2 \rightarrow NaCl$$
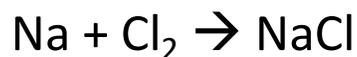
Na = 1   Na = 1
Cl = 2   Cl = 1

Balanced Reaction

$$2Na + Cl_2 \rightarrow 2NaCl$$

Na = 2x1 = 2   Na = 2x1 = 2
Cl = 2   Cl = 2x1 = 2

2

Reaction Balancing Ratios

Balancing chemical reactions relies on ratios of atoms, modified by *coefficients* in front of an atom, compound, or molecule.
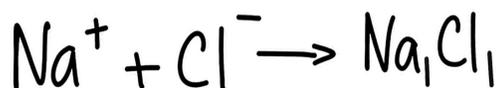
Balancing Ratio Coefficient Chart

Ratio	Coeff	Ratio	Coeff	Ratio	Coeff	Ratio	Coeff	Ratio	Coeff
1:1	1-1	1:2	2-1	2:4	2-1	4:3	3-4	3:6	2-1
2:2	1-1	2:1	1-2	4:2	1-2	3:4	4:3	6:3	1-2
3:3	1-1	1:3	3-1	2:3	3-2	2:6	3-1		
4:4	1-1	3:1	1-3	3:2	2-3	6:2	1-3		

3

Balanced vs. Unbalanced Reactions

Balanced Reaction   Unbalanced Reaction

$Na^+ + Cl^- \longrightarrow Na_1Cl_1$

Na : 1 | Na : 1

Cl : 1 | Cl : 1

Eqn. has same # of reactants and products

$Al^{3+} + Cl^{1-} \longrightarrow Al_1Cl_3$

Al : 1 | Al : 1

Cl : 1 | Cl : 3
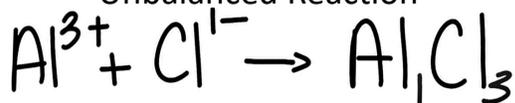
Product has more Cl than the reactants   1Cl vs. 3Cl

4

Binary Compound Balancing

$3\,Sn + \underline{\quad} N_2 \longrightarrow \underline{\quad} Sn_3N_2$
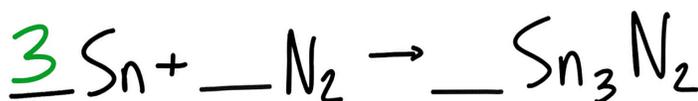
Sn	✗3 ← 3·1	Sn	3
N	2	N	2

Steps | $\dfrac{Sn}{1:3}$ 3-1

Steps

1. Write Rxn
2. Count atoms and/or ions
3. Add coefficents
4. Continue Balance.
5. Check Answer

5

Binary Compound Balancing

$$\underline{} Cu + \underline{3} ClO_3 \longrightarrow \underline{} Cu(ClO_3)_3$$
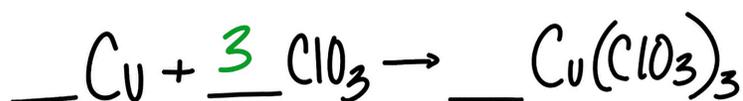
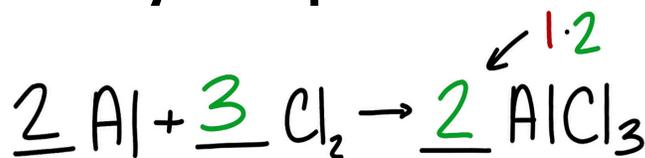| Cu	1	Cu	1
ClO_3	X 3	ClO_3	3

Steps | ClO_3
1:3 3-1

Steps
1. Write Rxn
2. Count atoms and/or ions
3. Add coefficents
4. Continue Balance.
5. Check Answer

6

Binary Compound Balancing

$$\underline{2} Al + \underline{3} Cl_2 \longrightarrow \underline{2} AlCl_3 \quad ^{1\cdot2}$$

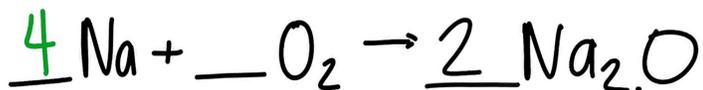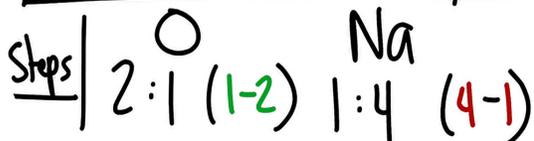| Al	X 2	Al	X 2
Cl	X 6	Cl	X 6

Steps | Cl   Al
2:3 3-2   1:2 2-1

Steps
1. Write Rxn
2. Count atoms and/or ions
3. Add coefficents
4. Continue Balance.
5. Check Answer

7

3

Binary Compound Balancing

$\underline{4} Na + \underline{} O_2 \rightarrow \underline{2} Na_2O$

Na	X̶ 4		Na	2̶ 4
O	2		O	X̶ 2

Steps | 2:1 (1-2)   1:4 (4-1)
         O   Na
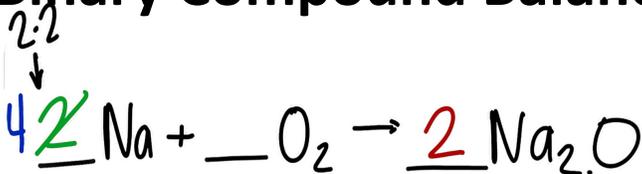
Steps
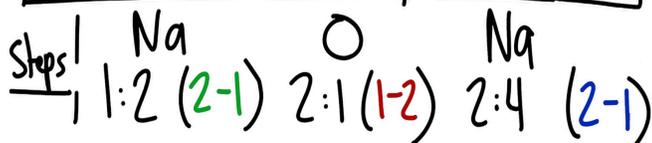1. Write Rxn
2. Count atoms and/or ions
3. Add coefficents
4. Continue Balance.
5. Check Answer

8

Binary Compound Balancing

2:2

$\underline{4\,2̶} Na + \underline{} O_2 \rightarrow \underline{2} Na_2O$

Na	X̶ 2̶ 4		Na	2̶ 4
O	2		O	X̶ 2

Steps | 1:2 (2-1) 2:1 (1-2) 2:4 (2-1)
         Na   O   Na

Steps
1. Write Rxn
2. Count atoms and/or ions
3. Add coefficents
4. Continue Balance.
5. Check Answer

9