

SNC2D CHEMISTRY

CHEMICAL REACTIONS

Balancing Chemical Equations (P.178-182)

Skeleton Equations

A chemical equation that is complete except for coefficients is called an unbalanced equation or a **skeleton equation**. A skeleton equation is similar to a word equation except that the chemical names have been replaced with chemical formulas.

SKELETON EQUATION

- ✦ another name for a chemical equation

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Skeleton Equations

For example, when methane (often called natural gas) burns in a gas fireplace, it reacts with oxygen in the air. The products of the chemical reaction are water and carbon dioxide. We can describe this reaction in a word equation as follows:

word equation: methane + oxygen → water + carbon dioxide

We can then write a skeleton equation by replacing each chemical name with its formula.

skeleton equation: $CH_4 + O_2 \rightarrow H_2O + CO_2$

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Counting Atoms

However there is a problem. If we look at the reactants, the products and the numbers of atoms of each type there appears to be an imbalance. We have seemingly created one oxygen atom and destroyed two hydrogen atoms. But according to the law of conservation of mass this is impossible. So how do we solve this imbalance?

skeleton equation: $CH_4 + O_2 \rightarrow H_2O + CO_2$

	R	P
C	1	1
H	4	2
O	1	3

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Counting Atoms

Since we cannot change the types or formulas of the molecules – then they would not be the same chemical – we have to change the number of molecules of each. If we add an oxygen molecule to the reactants and a water molecule to the products, this balances the equation.

skeleton equation: $CH_4 + O_2 \rightarrow H_2O + CO_2$

	R	P
C	1	1
H	4	4
O	4	4

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Counting Atoms

PRACTICE

1. How many of each atom are there in the following compounds?

(a) Na_2CO_3 2 Na 1 C 3 O

(b) $Ca_3(PO_4)_2$ 3 Ca 2 P 8 O

(c) K_2CrO_4 2 K 1 Cr 4 O

(d) $3BaCl_2$ 3 Ba 6 Cl

(e) $4Al_2(CO_3)_3$ 8 Al 12 C 36 O

(f) $Pb(NO_3)_2$ 1 Pb 2 N 6 O

(g) $NH_4C_2H_3O_2$ 1 N 7 H 2 C 2 O

(h) $2(NH_4)_2Cr_2O_7$ 4 N 16 H 4 Cr 14 O

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Counting Atoms

PRACTICE

2. Why must the subscripts in chemical formulas not change when balancing an equation?

because if the subscripts change the chemical formula changes and we no longer have the same chemical

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Balanced Equations

An equation in which the reactants and the products contain equal numbers of atoms of each type is a **balanced chemical equation**. The usual way to write a balanced equation is to use coefficients. A **coefficient** is a number written in front of a chemical symbol or formula. It indicates the number of atoms or molecules of that substance.

word eqⁿ: methane + oxygen → water + carbon dioxide

skeleton eqⁿ: CH₄ + O₂ → H₂O + CO₂

balanced eqⁿ: 1CH₄ + 2O₂ → 2H₂O + 1CO₂

NOTE!
When no number is written, 1 is understood. However, in your balanced equations you are asked to write the number 1.

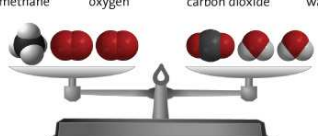
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Balanced Equations

BALANCED EQUATION

- balanced chemical (skeleton) equation
- # reactant atoms = # product atoms
- mass of reactants = mass of products

$$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$$
 methane oxygen carbon dioxide water



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Balancing Chemical Equations

NOTE!

Balancing a chemical equation requires patience, perseverance, and practice. One set of steps or rules will **not** apply to all the equations you are asked to write. Here are some tips:

- make sure you have the right formulas for all the compounds in the skeleton equation
- balance atoms of elements in any complicated-looking formulas first, and balance atoms of pure elements last
- never change a subscript in a formula to help make atoms balance – balance by placing coefficients in front of formulas only
- you may be able to treat polyatomic ions as a unit
- use guess-and-check to balance simple equations

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✓ Check Your Learning

1. For each of the following write the correct skeleton equation, and then balance it.

(a) iron + oxygen → iron (iii) oxide



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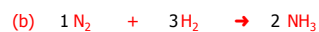
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✓ Check Your Learning

1. For each of the following write the correct skeleton equation, and then balance it.


(b) nitrogen + hydrogen → ammonia



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 **Check Your Learning**

1. For each of the following write the correct skeleton equation, and then balance it.

(c) barium chloride + magnesium sulphate
 \rightarrow barium sulphate + magnesium chloride

(c) $1 \text{BaCl}_2 + 1 \text{MgSO}_4 \rightarrow 1 \text{BaSO}_4 + 1 \text{MgCl}_2$


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 **Check Your Learning**

2. Balance the following skeleton equations.

(a) $4 \text{Na} + 1 \text{O}_2 \rightarrow 2 \text{Na}_2\text{O}$
 (b) $2 \text{K} + 1 \text{Cl}_2 \rightarrow 2 \text{KCl}$
 (c) $2 \text{Al} + 3 \text{Br}_2 \rightarrow 2 \text{AlBr}_3$
 (d) $2 \text{Li} + 1 \text{S} \rightarrow 1 \text{Li}_2\text{S}$
 (e) $3 \text{Mg} + 1 \text{N}_2 \rightarrow 1 \text{Mg}_3\text{N}_2$
 (f) $2 \text{Na} + 2 \text{H}_2\text{O} \rightarrow 2 \text{NaOH} + 1 \text{H}_2$
 (g) $2 \text{O}_3 \rightarrow 3 \text{O}_2$
 (h) $2 \text{Al}_2\text{O}_3 \rightarrow 4 \text{Al} + 3 \text{O}_2$
 (i) $1 \text{P}_4 + 5 \text{O}_2 \rightarrow 1 \text{P}_4\text{O}_{10}$
 (j) $4 \text{FeS} + 7 \text{O}_2 \rightarrow 2 \text{Fe}_2\text{O}_3 + 4 \text{SO}_2$

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 **Check Your Learning**

TEXTBOOK
 P.178 Q.1-3
 P.179 Q.1-3
 P.180 Q.1-3 \Rightarrow do not worry about showing "states"
 P.181 Q.1-3
 P.182 Q.1-3 \Rightarrow do not worry about showing "states"

NOTE!
 Check your work often – see P.552 of your text.

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