





Balancing Equations

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Chemical Reactions / Equations
 Reactants → Products

Color change
Solid forms (Cloudiness ... precipitation)
Bubbles form (gas generated)
Heat, light, or flame produced
Heat is absorbed (cooling)





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Chemical Reactions/Equations


Reactants → Products

$2 \text{Na} + 2 \text{H}_2\text{O} \rightarrow \text{H}_2 + 2 \text{NaOH}$



Reactants (Left Side of Reaction Arrow)
 Substances present at the beginning
 Starting materials
 Initial materials that enter into the reaction; things consumed

Products (Right Side of Reaction Arrow)
 Substances present at the end of the reaction
 New materials formed
 Ending materials; things produced



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Chemical Equations

Reactants (A + B) \longrightarrow Products (C + D)

+ is read as
“plus”
“and”
 \longrightarrow is read as
“yields”
“produces”
“forms”



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State Symbols

Reactants (A + B) \longrightarrow Products (C + D)

May use “state symbols” (often as subscript):

- (aq) = aqueous, dissolved in water
- (s) = solid, precipitate; also \downarrow or ppt
- (l) = liquid
- (g) = gas; also \uparrow

Clue to classifying reaction types
Used primarily in introductory classes



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Chemical Equations

Reactants (A + B) \longrightarrow Products (C + D)

Must be “balanced”

follow the Law of Conservation of Mass

Total mass reactants = Total mass products

No mass is lost during chemical reaction

No atoms destroyed during ordinary reactions

Atoms recombined into new materials (products)

Total # atoms reactants = Total # atoms products




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Chemical Equations


Reactants (A + B) → Products (C + D)

# of each element BEFORE a reaction REACTANTS	=	# of same elements AFTER the reaction PRODUCTS	
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Start with correct chemical formulas
WORK WITH COEFFICIENTS
(Trial and error until atoms on both sides are equal)

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Chemical Equations

 **For Hydrogen + Oxygen yields water**

Write Starting Materials and Products

Pay attention to diatomic

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$

Count atoms => must be same on both sides

$2 H \quad 2 O \rightarrow 2 H \quad 1 O$

There is a tendency (wrong) to balance with subscripts:

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{2(l)}$

$2 H \quad 2 O \rightarrow 2 H \quad 2 O$

But, H_2O is not the same as H_2O_2

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Chemical Equations

For Hydrogen + Oxygen yields water

Write Starting Materials and Products

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(l)}$

Count atoms => must be same on both sides

$2 H \quad 2 O \rightarrow 2 H \quad 1 O$

Oxygen unbalanced; Try

$H_{2(g)} + O_{2(g)} \rightarrow 2 H_2O_{(l)}$

Count atoms => must be same on both sides

$2 H \quad 2 O \rightarrow 4 H \quad 2 O$

Oxygen now balanced, try

$2 H_{2(g)} + O_{2(g)} \rightarrow 2 H_2O_{(l)}$

Count atoms => must be same on both sides

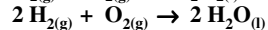
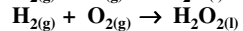
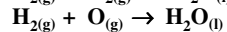
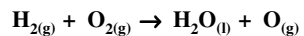
$4 H \quad 2 O \rightarrow 4 H \quad 2 O$

Success!

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Chemical Equations

Which is correct for the formation of water?



Pay attention To:
Correct Formulas
Diatomics
Atom Count

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Hints for Balancing

Work with whole numbers ...
fractional coefficients tend to confuse



Bottom line:

No fixed rule ... every reaction is different
Requires practice to develop balancing skills



My two guidelines:

Start with a metal or most complex reaction material
Save water (or diatomic gasses) last step

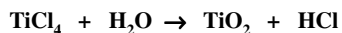


Genius is 10% inspiration and 90% perspiration.
Thomas Alva Edison

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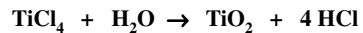
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Balance This Chemical Equation

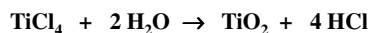


Safety Tip: HCl is a corrosive acid; lab precautions needed

Start with Chlorine:



Atom Count: 1 Ti; 4 Cl; 2 H; 1 O \rightarrow 1 Ti; 4 Cl; 4 H; 2 O
Ti & Cl balanced; H and O are not
4 H suggests 2 waters, so try 2 H₂O



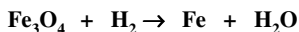
Atom Count: 1 Ti; 4 Cl; 4 H; 2 O \rightarrow 1 Ti; 4 Cl; 4 H; 2 O

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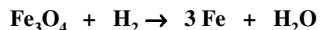
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Balance This Chemical Equation



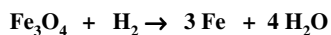
Start with Iron



Atom Count: 3 Fe; 2 H; 4 O \rightarrow 3 Fe; 2 H; 1 O

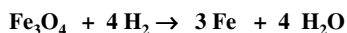
Fe & H balanced; O is not ... suggests water is key

4 O on the start side suggests 4 waters on product side; try 4 H₂O



Atom Count: 3 Fe; 2 H; 4 O \rightarrow 3 Fe; 8 H; 4 O

Fe & O balanced; H is not ... finish by balancing H



Atom Count: 3 Fe; 8 H; 4 O \rightarrow 3 Fe; 8 H; 4 O

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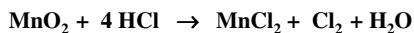


Balance This Chemical Equation



Safety Tip: Cl₂ is toxic; lab precautions needed

Mn Balanced: Start with 4 Chlorine on product side



Atom Count: 1 Mn; 4 Cl; 4 H; 2 O \rightarrow 1 Mn; 4 Cl; 2 H; 1 O

O is odd on product side, try making it even



Atom Count: 1 Mn; 4 Cl; 4 H; 2 O \rightarrow 1 Mn; 4 Cl; 4 H; 2 O

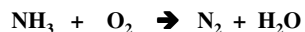
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Balance This Chemical Equation



Reaction has odd/even combination of diatomic molecules

Start with Nitrogen ... try



Atom Count: 2 N; 6 H; 2 O \rightarrow 2 N; 2 H; 1 O

Oxygen unbalanced ... try



Atom Count: 2 N; 6 H; 2 O \rightarrow 2 N; 4 H; 2 O

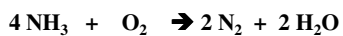
Hydrogen unbalanced ... try changing N in product

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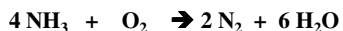
Continuing With: $4 \text{NH}_3 + \text{O}_2 \rightarrow 2 \text{N}_2 + 2 \text{H}_2\text{O}$



Atom Count: 4 N; 12 H; 2 O \rightarrow 4 N; 4 H; 2 O



H & O unbalanced ... try balancing H with water



Atom Count: 4 N; 12 H; 2 O \rightarrow 4 N; 12 H; 6 O

Only O unbalanced ... finish with O on starting side



Atom Count: 4 N; 12 H; 6 O \rightarrow 4 N; 12 H; 6 O

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Balance This Chemical Equation



Safety Tip: SO_2 is a corrosive acid; lab precautions needed

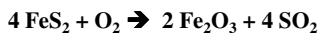
Atom Count: 1 Fe; 2 S; 2 O \rightarrow 2 Fe; 1 S; 5 O

Everything unbalanced ... start with iron ... try



Atom Count: 2 Fe; 4 S; 2 O \rightarrow 2 Fe; 4 S; 11 O

Oxygen odd & unbalanced ... try another Fe on product side



Atom Count: 4 Fe; 8 S; 2 O \rightarrow 4 Fe; 4 S; 14 O

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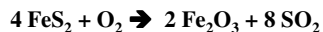
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Continuing With: $\text{FeS}_2 + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3 + \text{SO}_2$



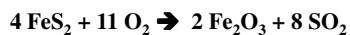
Atom Count: 4 Fe; 8 S; 2 O \rightarrow 4 Fe; 4 S; 14 O

Sulfur unbalanced ... try to balance Sulfur



Atom Count: 4 Fe; 8 S; 2 O \rightarrow 4 Fe; 8 S; 22 O

Only Oxygen unbalanced ... finish by balancing Oxygen



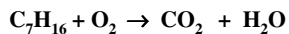
Atom Count: 4 Fe; 8 S; 22 O \rightarrow 4 Fe; 8 S; 22 O

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Balance This Chemical Equation



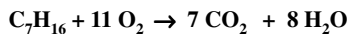
Atom Count: 7 C; 16 H; 2 O → 1 C; 2 H; 3 O

Start with the most complex: carbon and hydrogen



Atom Count: 7 C; 16 H; 2 O → 7 C; 16 H; 22 O

Finish with the only stand alone element, oxygen



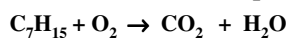
Atom Count: 7 C; 16 H; 22 O → 7 C; 16 H; 22 O

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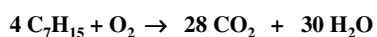
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Balance This Chemical Equation



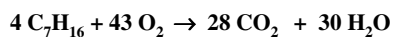
Atom Count: 7 C; 15 H; 2 O → 1 C; 2 H; 3 O

Start with carbon and hydrogen; H odd/even issue



Atom Count: 28 C; 60 H; 2 O → 28 C; 60 H; 86 O

Finish with the only stand alone element, oxygen



Atom Count: 28 C; 60 H; 86 O → 28 C; 60 H; 86 O

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Practice Improves Performance



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