

# Balancing Chemical Equations

Simulation: [edtechsims.com/balancing-equations](https://edtechsims.com/balancing-equations)

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_



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## Part A: Key Concepts

**On the sim:** Open the Key Concepts tab and read through all four sections.

**A1** Complete the sentences.

[5]

In a chemical equation, the substances we start with are the \_\_\_\_\_ and the substances formed are the \_\_\_\_\_.

The Law of Conservation of \_\_\_\_\_ states that atoms cannot be created or destroyed in a chemical reaction.

To balance an equation, we may change only the \_\_\_\_\_ (numbers in front of formulae), never the \_\_\_\_\_.

**A2** Complete Table 1 by counting the atoms of each element.

[4]

| Formula                                           | Element 1 | Element 2 | Element 3 |
|---------------------------------------------------|-----------|-----------|-----------|
| 2 H <sub>2</sub> O                                | H:        | O:        | —         |
| 3 CO <sub>2</sub>                                 | C:        | O:        | —         |
| Ca(OH) <sub>2</sub>                               | Ca:       | O:        | H:        |
| 2 Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> | Al:       | S:        | O:        |

Table 1

**A3** A student balances  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$  by writing  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}_2$ . Explain why this is wrong. [2]

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## Part B: Pancake Builder

**On the sim:** Open the Pancake Builder tab. The recipe is: 2 eggs + 1 bag of flour → 1 stack of pancakes. Set the numbers of eggs and flour, then click Make Pancakes!

**B1** Complete Table 2.

[6]

| Ingredients used | Pancakes made | Eggs left | Flour left | Limiting | Excess |
|------------------|---------------|-----------|------------|----------|--------|
| 3 eggs + 1 flour |               |           |            |          |        |
| 2 eggs + 2 flour |               |           |            |          |        |
| 4 eggs + 2 flour |               |           |            |          |        |

Table 2

**B2** Define limiting reagent and excess reagent.

[2]

Limiting reagent: .....

Excess reagent: .....

**B3** You have 9 eggs and 3 bags of flour. How many stacks of pancakes can you make? What is left over?

[2]

.....  
.....

## Part C: Molecular Builder

**On the sim:** Open the Molecular Builder tab. For each reaction, set the number of each reactant molecule and click React!

### C1 Make Water: $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$

| Reactants used                      | Product(s) formed | H <sub>2</sub> left | O <sub>2</sub> left | Limiting | Excess |
|-------------------------------------|-------------------|---------------------|---------------------|----------|--------|
| 3 H <sub>2</sub> + 1 O <sub>2</sub> |                   |                     |                     |          |        |
| 2 H <sub>2</sub> + 2 O <sub>2</sub> |                   |                     |                     |          |        |
| 4 H <sub>2</sub> + 2 O <sub>2</sub> |                   |                     |                     |          |        |

### C2 Make Ammonia: $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$

| Reactants used                      | Product(s) formed | N <sub>2</sub> left | H <sub>2</sub> left | Limiting | Excess |
|-------------------------------------|-------------------|---------------------|---------------------|----------|--------|
| 1 N <sub>2</sub> + 4 H <sub>2</sub> |                   |                     |                     |          |        |
| 2 N <sub>2</sub> + 3 H <sub>2</sub> |                   |                     |                     |          |        |
| 2 N <sub>2</sub> + 6 H <sub>2</sub> |                   |                     |                     |          |        |

### C3 Combust Methane: $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$

| Reactants used                       | Product(s) formed | CH <sub>4</sub> left | O <sub>2</sub> left | Limiting | Excess |
|--------------------------------------|-------------------|----------------------|---------------------|----------|--------|
| 1 CH <sub>4</sub> + 3 O <sub>2</sub> |                   |                      |                     |          |        |
| 2 CH <sub>4</sub> + 2 O <sub>2</sub> |                   |                      |                     |          |        |
| 2 CH <sub>4</sub> + 4 O <sub>2</sub> |                   |                      |                     |          |        |

**C4** Check that  $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$  is balanced by counting the atoms on each side. [2]

| Element | Reactant side | Product side |
|---------|---------------|--------------|
| H       |               |              |
| O       |               |              |

**C5** What is the link between the coefficients in a balanced equation and the numbers of molecules that react? [1]

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## Part D: Quiz Time and Equation Balancer

**On the sim:** Complete the tiered quiz in the Quiz Time tab. Then use the Equation Balancer tab to check your answers to Part E.

**D1** Record your quiz score.

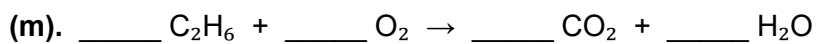
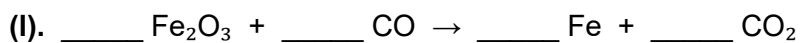
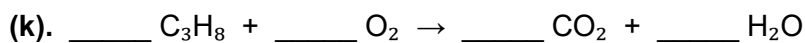
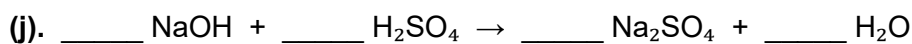
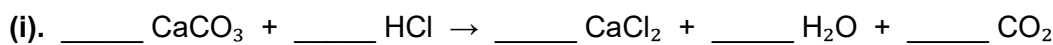
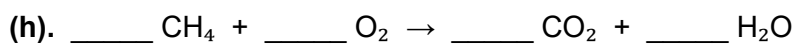
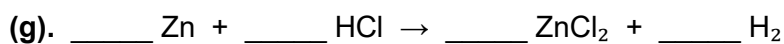
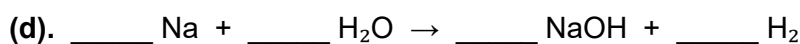
My score: \_\_\_\_\_ / \_\_\_\_\_

**D2** Which equation in the quiz was the hardest to balance? What strategy helped you? [2]

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## Part E: Practice Questions

**E1** Balance the following equations. Write 1 where a coefficient of 1 is needed. [14]



**E2** Write a balanced chemical equation, with state symbols, for each word equation. [8]

(a) *magnesium + hydrochloric acid → magnesium chloride + hydrogen*

.....

(b) *calcium carbonate → calcium oxide + carbon dioxide (on heating)*

.....

(c) *sodium hydroxide + hydrochloric acid → sodium chloride + water*

.....

(d) *iron + oxygen → iron(III) oxide*

.....

**E3** 5 molecules of  $\text{H}_2$  react with 2 molecules of  $\text{O}_2$  according to  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ . How many molecules of water are formed? Which reactant is in excess, and by how much? [3]

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For students who are really fast or want more practice, try the following game:

[edtechsims.com/balancing-equations-challenge](https://edtechsims.com/balancing-equations-challenge)



# Answer Key: Balancing Chemical Equations

## Part A: Key Concepts

**On the sim:** Open the Key Concepts tab and read through all four sections.

**A1** Complete the sentences. [5]

In a chemical equation, the substances we start with are the **reactants** and the substances formed are the **products**.

The Law of Conservation of **Mass** states that atoms cannot be created or destroyed in a chemical reaction.

To balance an equation, we may change only the **coefficients** (numbers in front of formulae), never the **subscripts**.

**A2** Complete Table 1 by counting the atoms of each element. [4]

| Formula                                           | Element 1 | Element 2 | Element 3 |
|---------------------------------------------------|-----------|-----------|-----------|
| 2 H <sub>2</sub> O                                | H: 4      | O: 2      | —         |
| 3 CO <sub>2</sub>                                 | C: 3      | O: 6      | —         |
| Ca(OH) <sub>2</sub>                               | Ca: 1     | O: 2      | H: 2      |
| 2 Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> | Al: 4     | S: 6      | O: 24     |

Table 1

**A3** A student balances  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$  by writing  $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}_2$ . Explain why this is wrong. [2]

Changing the subscript changes the substance:  $\text{H}_2\text{O}_2$  is hydrogen peroxide, not water. The correct way is to change coefficients:  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ .

## Part B: Pancake Builder

**On the sim:** Open the Pancake Builder tab. The recipe is: 2 eggs + 1 bag of flour → 1 stack of pancakes. Set the numbers of eggs and flour, then click Make Pancakes!

**B1** Complete Table 2. [6]

| Ingredients used | Pancakes made | Eggs left | Flour left | Limiting | Excess |
|------------------|---------------|-----------|------------|----------|--------|
| 3 eggs + 1 flour | 1             | 1         | 0          | Flour    | Egg    |
| 2 eggs + 2 flour | 1             | 0         | 1          | Egg      | Flour  |
| 4 eggs + 2 flour | 2             | 0         | 0          | none     | none   |

Table 2

**B2** Define limiting reagent and excess reagent. [2]

Limiting reagent: the reactant that is used up first and limits the amount of product formed.

Excess reagent: the reactant that is left over after the reaction stops.

**B3** You have 9 eggs and 3 bags of flour. How many stacks of pancakes can you make? What is left over? [2]

3 stacks (3 bags of flour need only 6 eggs). Flour is limiting; 3 eggs are left over.

## Part C: Molecular Builder

**On the sim:** Open the Molecular Builder tab. For each reaction, set the number of each reactant molecule and click React!

### C1 Make Water: $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$

| Reactants used                      | Product(s) formed  | H <sub>2</sub> left | O <sub>2</sub> left | Limiting       | Excess         |
|-------------------------------------|--------------------|---------------------|---------------------|----------------|----------------|
| 3 H <sub>2</sub> + 1 O <sub>2</sub> | 2 H <sub>2</sub> O | 1                   | 0                   | O <sub>2</sub> | H <sub>2</sub> |
| 2 H <sub>2</sub> + 2 O <sub>2</sub> | 2 H <sub>2</sub> O | 0                   | 1                   | H <sub>2</sub> | O <sub>2</sub> |
| 4 H <sub>2</sub> + 2 O <sub>2</sub> | 4 H <sub>2</sub> O | 0                   | 0                   | none           | none           |

### C2 Make Ammonia: $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$

| Reactants used                      | Product(s) formed | N <sub>2</sub> left | H <sub>2</sub> left | Limiting       | Excess         |
|-------------------------------------|-------------------|---------------------|---------------------|----------------|----------------|
| 1 N <sub>2</sub> + 4 H <sub>2</sub> | 2 NH <sub>3</sub> | 0                   | 1                   | N <sub>2</sub> | H <sub>2</sub> |
| 2 N <sub>2</sub> + 3 H <sub>2</sub> | 2 NH <sub>3</sub> | 1                   | 0                   | H <sub>2</sub> | N <sub>2</sub> |
| 2 N <sub>2</sub> + 6 H <sub>2</sub> | 4 NH <sub>3</sub> | 0                   | 0                   | none           | none           |

### C3 Combust Methane: $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$

| Reactants used                       | Product(s) formed                      | CH <sub>4</sub> left | O <sub>2</sub> left | Limiting        | Excess          |
|--------------------------------------|----------------------------------------|----------------------|---------------------|-----------------|-----------------|
| 1 CH <sub>4</sub> + 3 O <sub>2</sub> | 1 CO <sub>2</sub> , 2 H <sub>2</sub> O | 0                    | 1                   | CH <sub>4</sub> | O <sub>2</sub>  |
| 2 CH <sub>4</sub> + 2 O <sub>2</sub> | 1 CO <sub>2</sub> , 2 H <sub>2</sub> O | 1                    | 0                   | O <sub>2</sub>  | CH <sub>4</sub> |
| 2 CH <sub>4</sub> + 4 O <sub>2</sub> | 2 CO <sub>2</sub> , 4 H <sub>2</sub> O | 0                    | 0                   | none            | none            |

**C4** Check that  $2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$  is balanced by counting the atoms on each side. [2]

| Element | Reactant side | Product side |
|---------|---------------|--------------|
| H       | 4             | 4            |
| O       | 2             | 2            |

**C5** What is the link between the coefficients in a balanced equation and the numbers of molecules that react? [1]

The coefficients give the ratio in which molecules react and form. If the reactants are not in this ratio, one reactant is limiting and the other is in excess.

## Part D: Quiz Time and Equation Balancer

**On the sim:** Complete the tiered quiz in the Quiz Time tab. Then use the Equation Balancer tab to check your answers to Part E.

**D1** Record your quiz score.

Score from the sim.

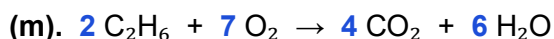
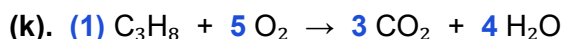
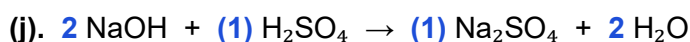
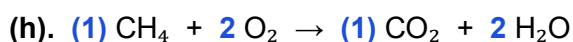
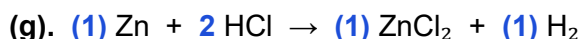
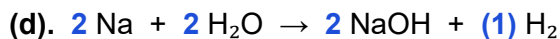
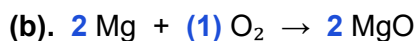
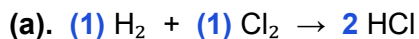
**D2** Which equation in the quiz was the hardest to balance? What strategy helped you? [2]

Open response, e.g. balance the element that appears in only one reactant and one product first; leave elements such as O<sub>2</sub> or H<sub>2</sub> until last; use brackets for polyatomic ions as one unit.

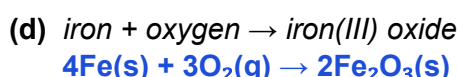
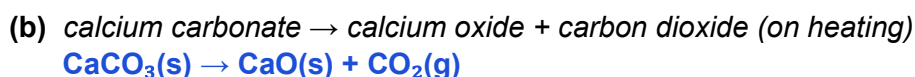
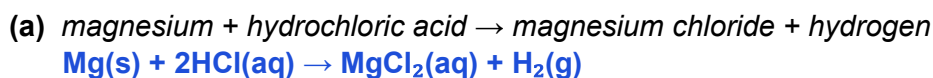
## Part E: Practice Questions

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**E1** Balance the following equations. Write 1 where a coefficient of 1 is needed. [14]



**E2** Write a balanced chemical equation, with state symbols, for each word equation. [8]



**E3** 5 molecules of H<sub>2</sub> react with 2 molecules of O<sub>2</sub> according to 2 H<sub>2</sub> + O<sub>2</sub> → 2 H<sub>2</sub>O. How many molecules of water are formed? Which reactant is in excess, and by how much? [3]

2 O<sub>2</sub> react with 4 H<sub>2</sub> to form 4 H<sub>2</sub>O. O<sub>2</sub> is limiting; H<sub>2</sub> is in excess by 1 molecule.