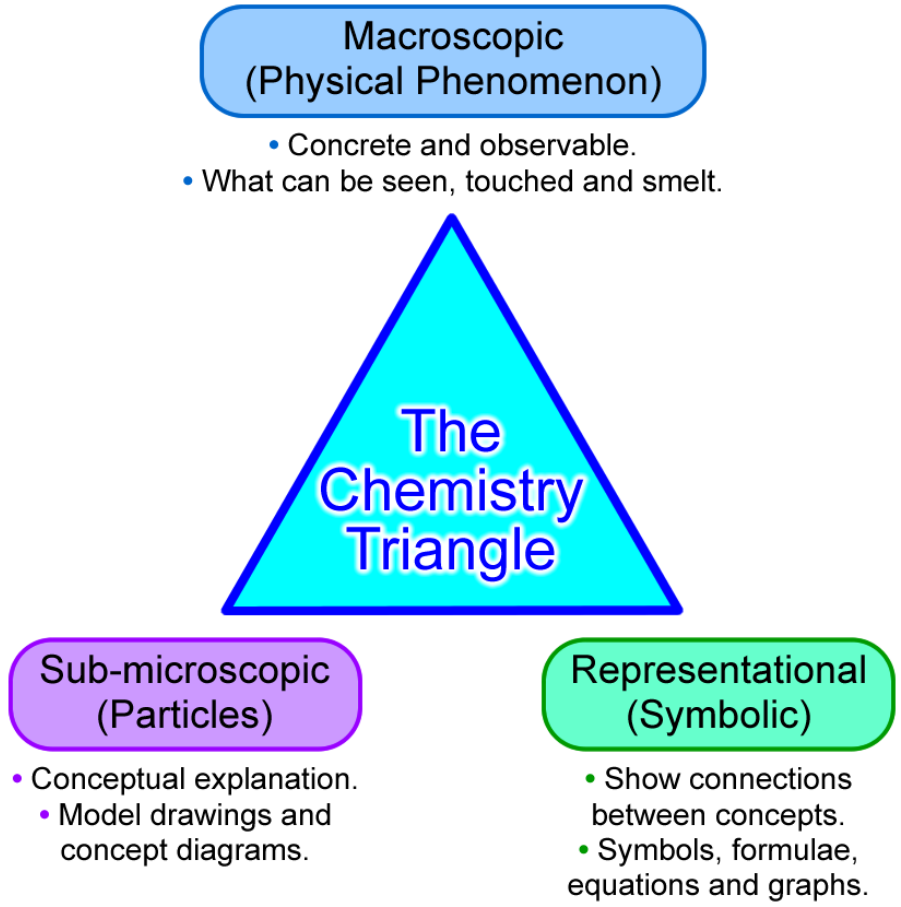
Balancing Chemical Equations

Making Chemistry Visible

Balancing Chemical Equations



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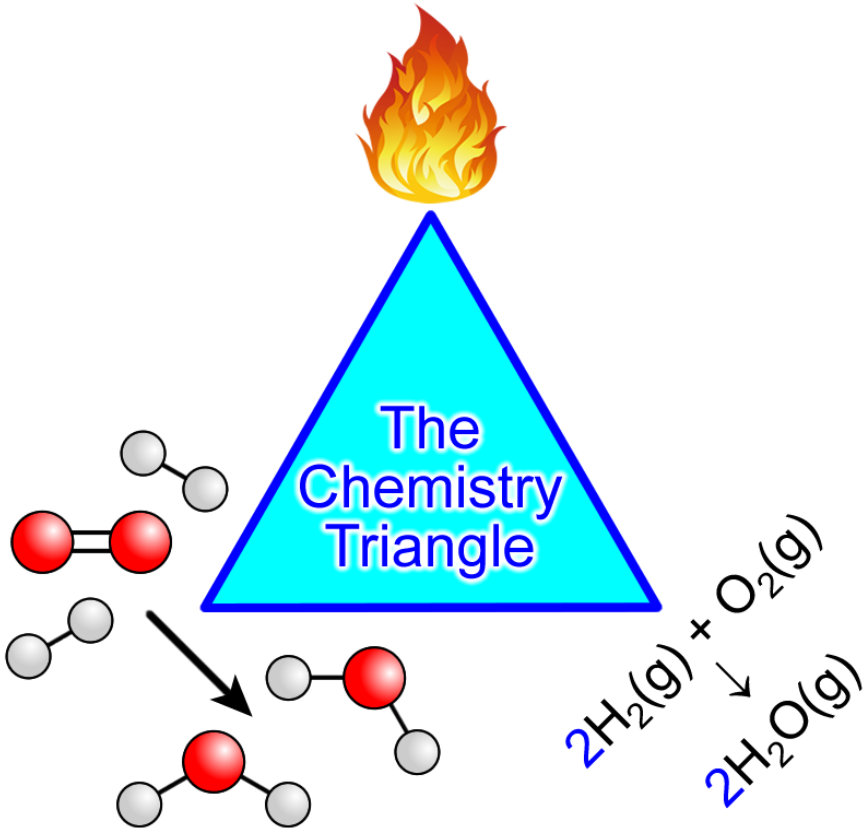
Balancing Chemical Equations



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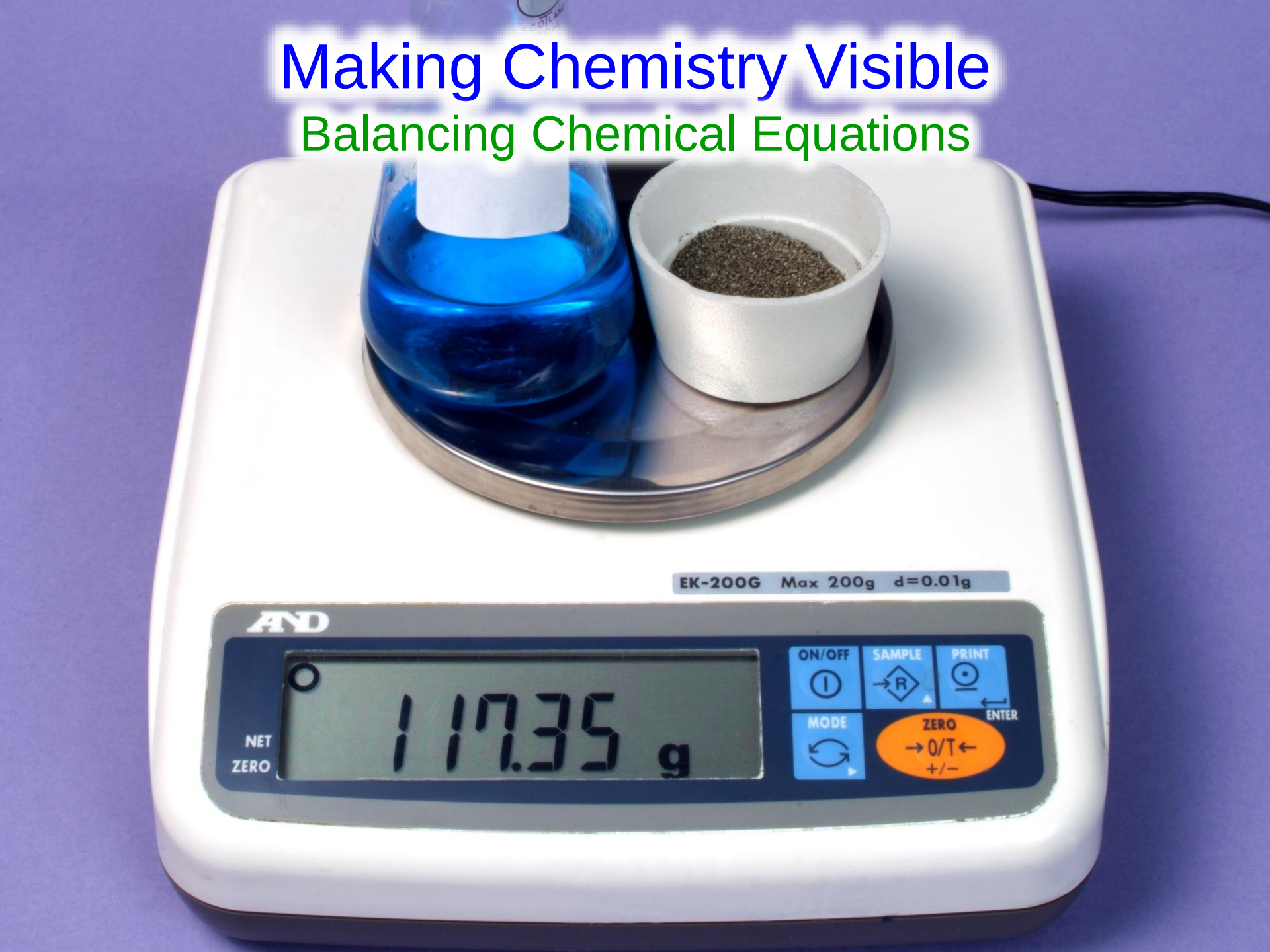
Balancing Chemical Equations



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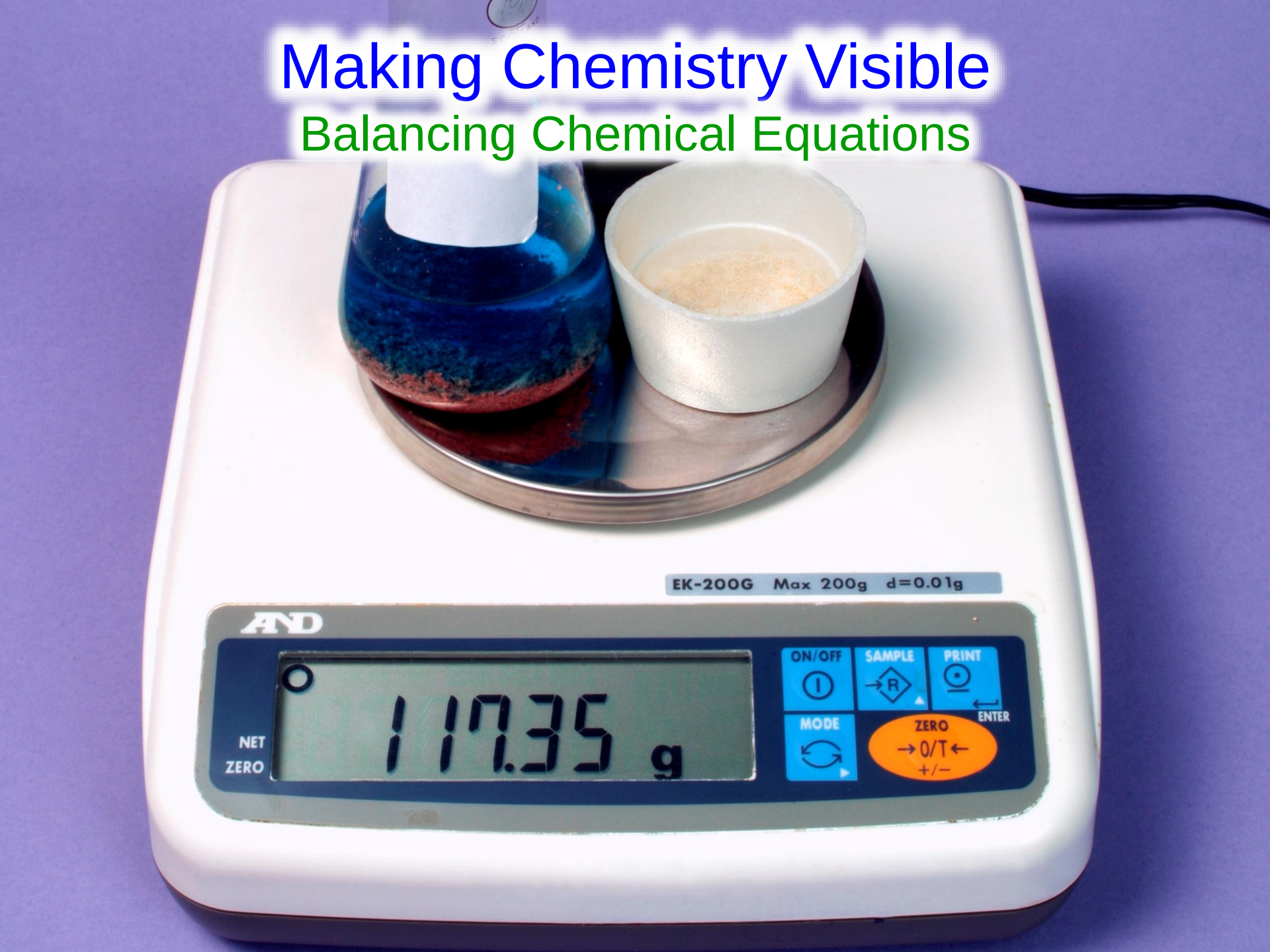
Balancing Chemical Equations



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Balancing Chemical Equations

- Matter / mass are *conserved* during a chemical reaction.
- The atoms present at the start of the reaction must be present in the same number at the end of the reaction. Atoms cannot vanish or appear out of nowhere.
- Because of this, chemical equations must be *balanced* to show that matter is conserved during the reaction.

Making Chemistry Visible

Balancing Chemical Equations

Example One:

- Hydrogen (H_2) reacts with chlorine (Cl_2) to form hydrogen chloride (HCl).

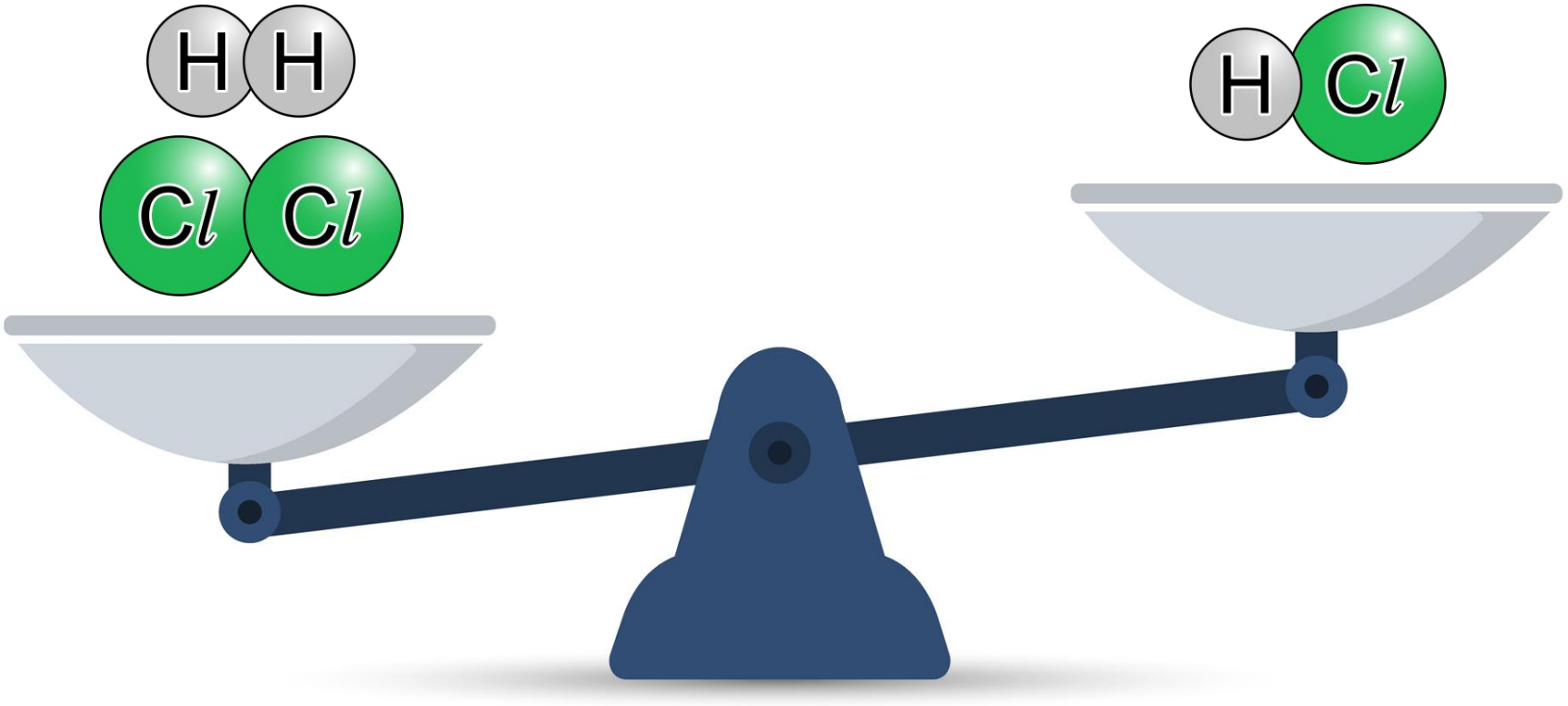
$$H_2 + Cl_2 \rightarrow HCl$$

(unbalanced)

- Guided by visual representations of the molecules, let us see how the balanced chemical equation for this reaction is written.

Making Chemistry Visible

Balancing Chemical Equations



$$H_2 + Cl_2 \rightarrow HCl$$

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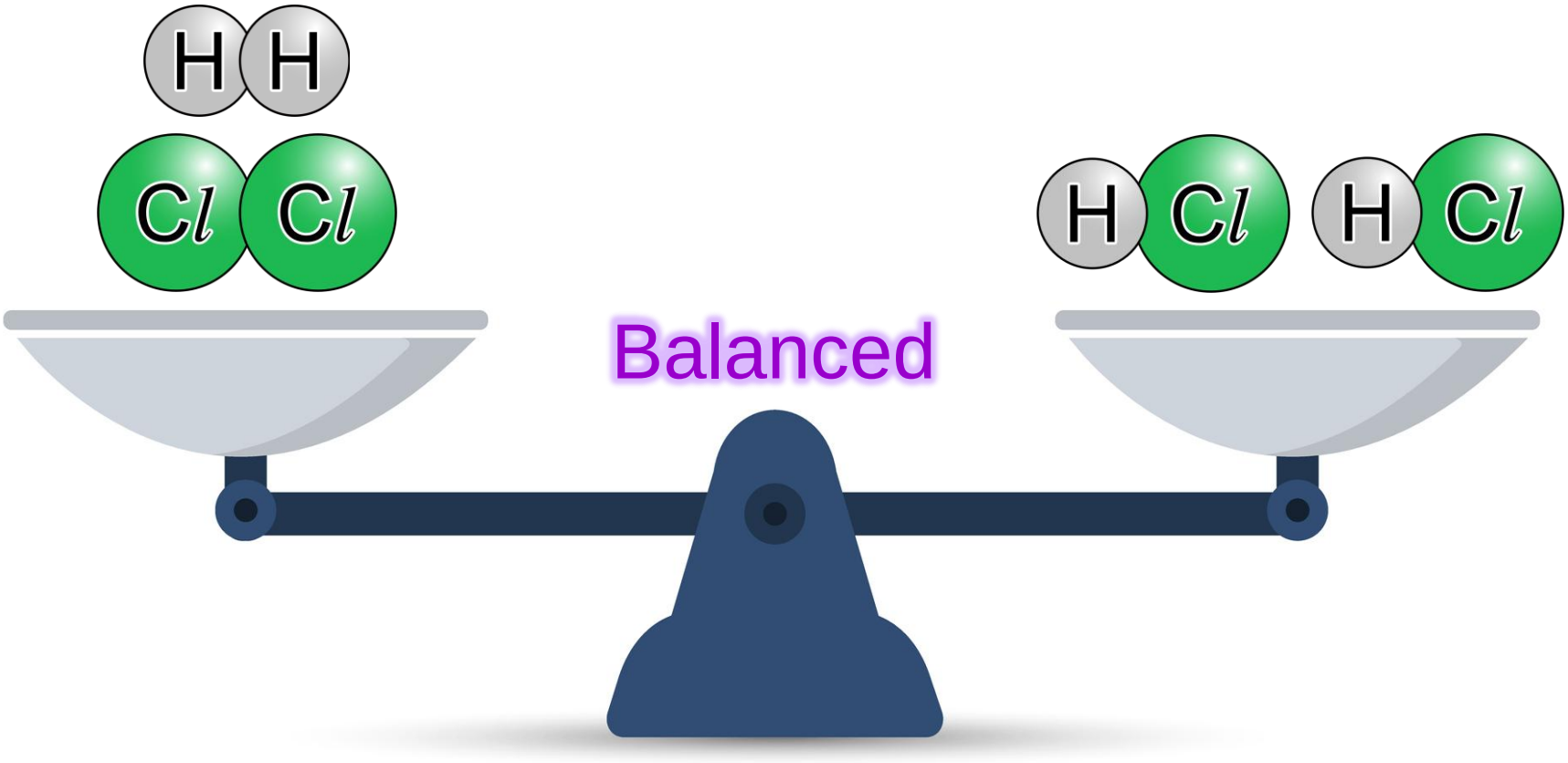
Balancing Chemical Equations



$$H_2 + Cl_2 \rightarrow 2HCl$$

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Balancing Chemical Equations

$$H_2 + Cl_2 \rightarrow HCl$$

2 × H & 2 × C*l*

1 × H & 1 × C*l*
needs 1 more H
and 1 more C*l*

Making Chemistry Visible

Balancing Chemical Equations

$$H_2 + Cl_2 \rightarrow HCl$$

2 × H & 2 × C*l*

1 × H & 1 × C*l*
needs 1 more H
and 1 more C*l*

- Can add one hydrogen and one chlorine to this side by adding a single molecule of HC*l*.

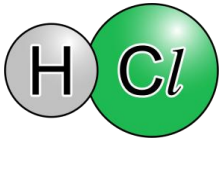
Making Chemistry Visible

Balancing Chemical Equations

$$H_2 + Cl_2 \rightarrow HCl$$

2 × H & 2 × C*l*

1 × H & 1 × C*l*
needs 1 more H
and 1 more C*l*

add 

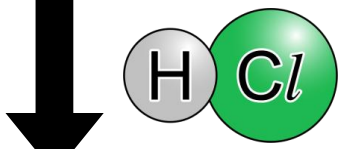
Making Chemistry Visible

Balancing Chemical Equations

$$H_2 + Cl_2 \rightarrow HCl$$

2 × H & 2 × C*l*

1 × H & 1 × C*l*
needs 1 more H
and 1 more C*l*

add 

$$H_2 + Cl_2 \rightarrow 2HCl$$

2 × H & 2 × C*l*

2 × H & 2 × C*l*

Balanced

Making Chemistry Visible

Balancing Chemical Equations

Example Two:

- Nitrogen (N_2) reacts with hydrogen (H_2) to form ammonia (NH_3).

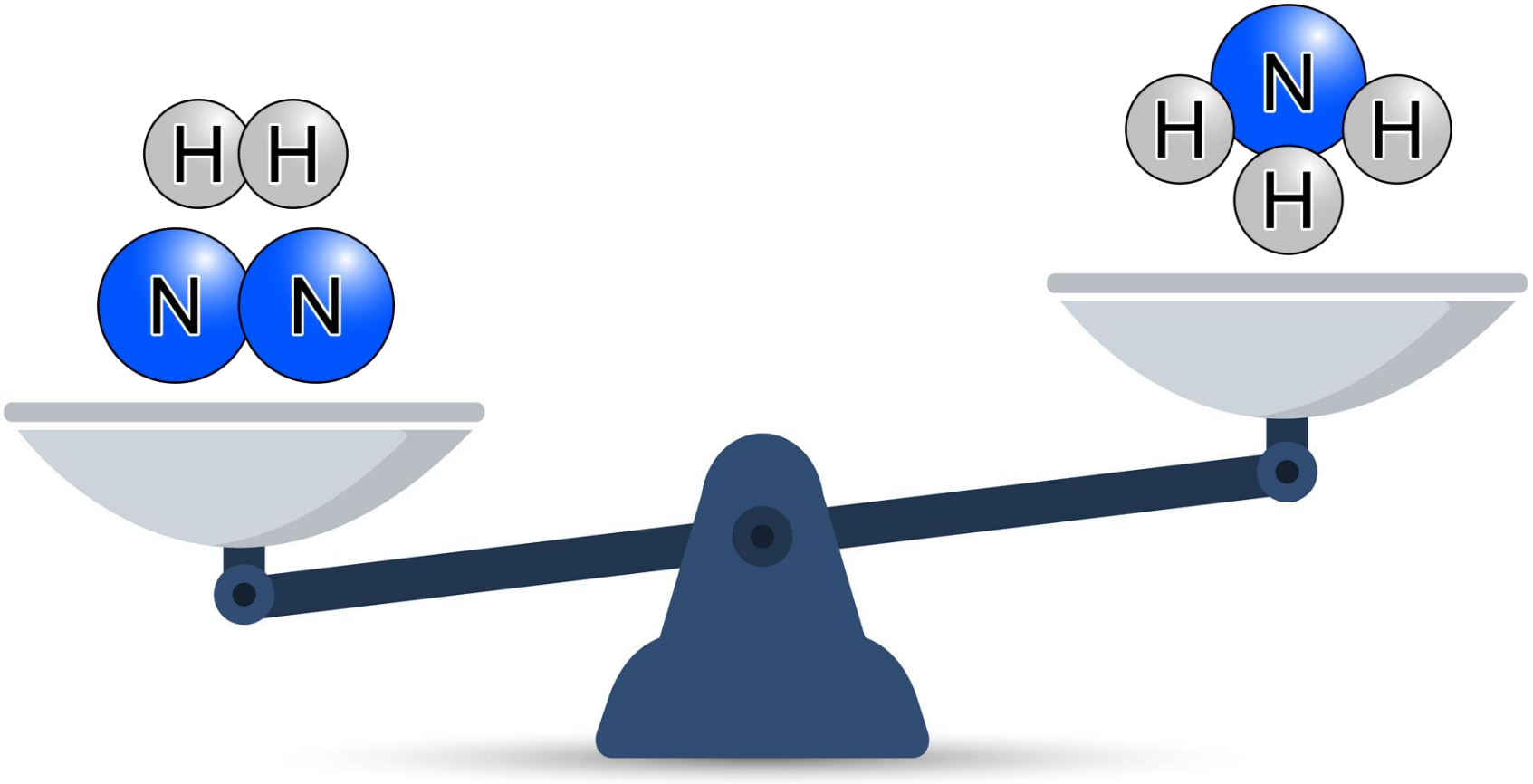
$$N_2 + H_2 \rightarrow NH_3$$

(unbalanced)

- Guided by visual representations of the molecules, let us see how the balanced chemical equation for this reaction is written.

Making Chemistry Visible

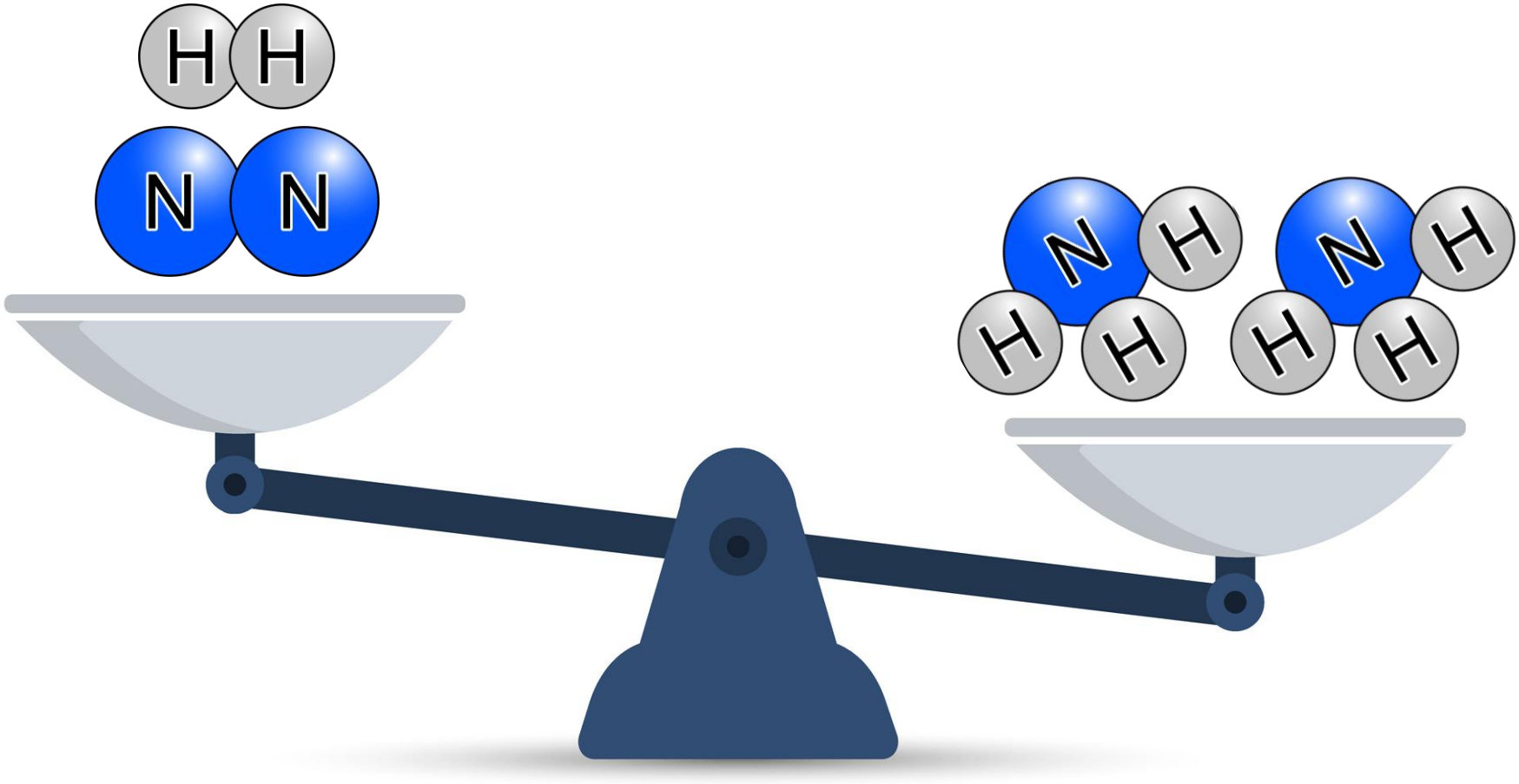
Balancing Chemical Equations



$$N_2 + H_2 \rightarrow NH_3$$

Making Chemistry Visible

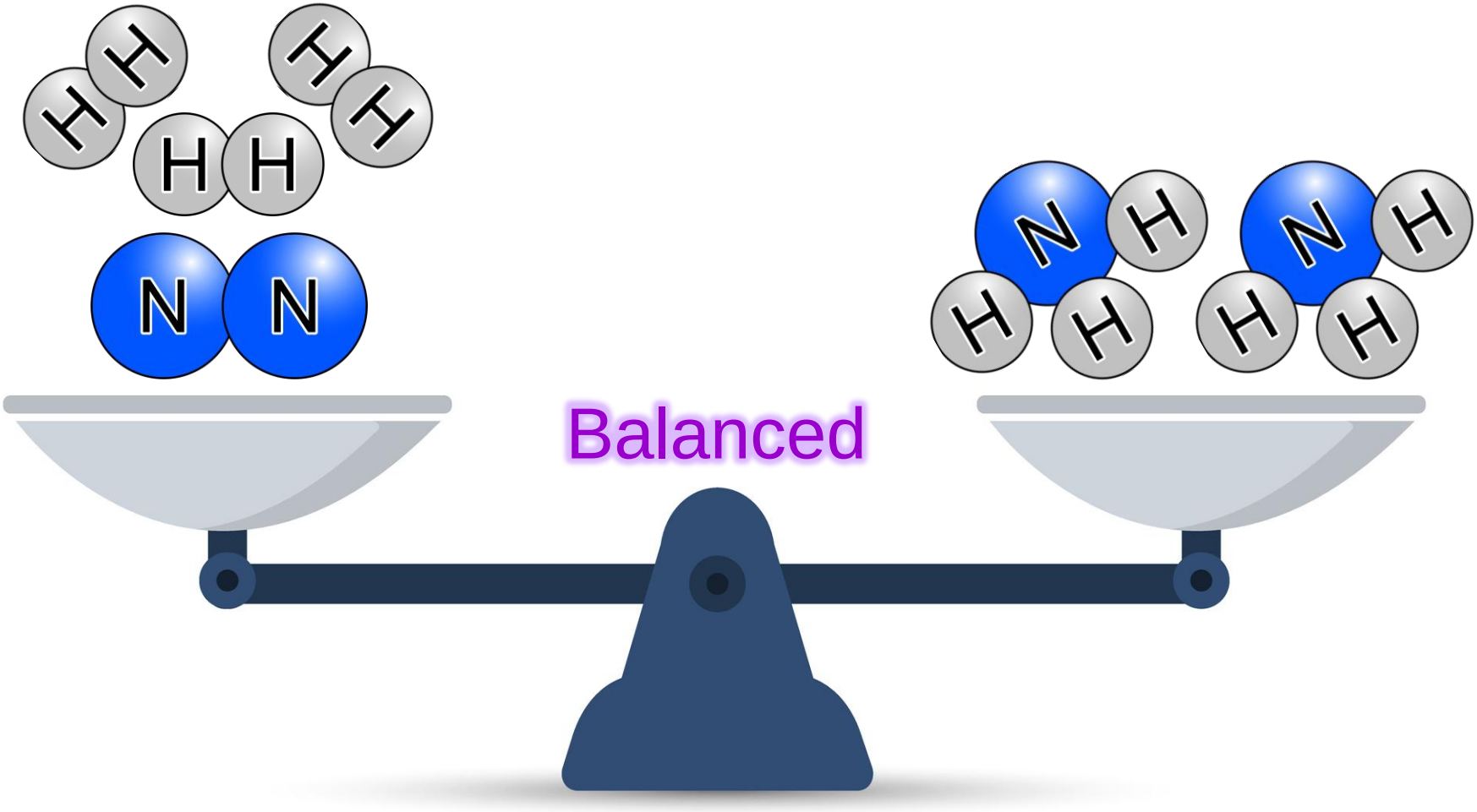
Balancing Chemical Equations



$$N_2 + H_2 \rightarrow 2NH_3$$

Making Chemistry Visible

Balancing Chemical Equations



$$N_2 + 3H_2 \rightarrow 2NH_3$$

Making Chemistry Visible

Balancing Chemical Equations

$$N_2 + H_2 \rightarrow NH_3$$

2 × N & 2 × H
needs 1 more H

1 × N & 3 × H
needs 1 more N

Making Chemistry Visible

Balancing Chemical Equations

$$N_2 + H_2 \rightarrow NH_3$$

2 × N & 2 × H
needs 1 more H

1 × N & 3 × H
needs 1 more N

- Difficult to add just one hydrogen to this side because they are bonded together in pairs.

- Can add one nitrogen to this side by adding a single molecule of NH_3.

Making Chemistry Visible

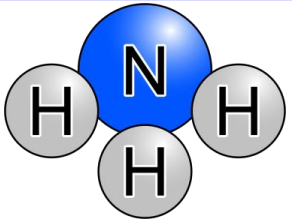
Balancing Chemical Equations

$$N_2 + H_2 \rightarrow NH_3$$

2 × N & 2 × H
needs 1 more H

1 × N & 3 × H
needs 1 more N

add



Making Chemistry Visible

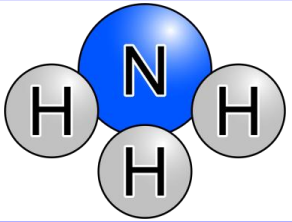
Balancing Chemical Equations

$$N_2 + H_2 \rightarrow NH_3$$

2 × N & 2 × H
needs 1 more H

1 × N & 3 × H
needs 1 more N

add



$$N_2 + H_2 \rightarrow 2NH_3$$

2 × N & 2 × H
needs 4 more H

2 × N & 6 × H

Making Chemistry Visible

Balancing Chemical Equations

$$N_2 + H_2 \rightarrow 2NH_3$$

2 × N & 2 × H
needs 4 more H

2 × N & 6 × H

Making Chemistry Visible

Balancing Chemical Equations

$$N_2 + H_2 \rightarrow 2NH_3$$

2 × N & 2 × H
needs 4 more H

2 × N & 6 × H

- Can add four hydrogens to this side by adding two molecules of H_2.

Making Chemistry Visible

Balancing Chemical Equations

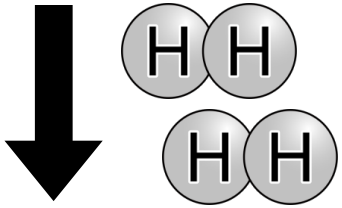
$$N_2 + H_2 \rightarrow 2NH_3$$

2 × N & 2 × H

needs 4 more H

2 × N & 6 × H

add



Making Chemistry Visible

Balancing Chemical Equations

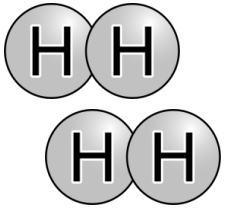
$$N_2 + H_2 \rightarrow 2NH_3$$

2 × N & 2 × H

needs 4 more H

2 × N & 6 × H

add



$$N_2 + 3H_2 \rightarrow 2NH_3$$

2 × N & 6 × H

2 × N & 6 × H

Balanced

Making Chemistry Visible

Balancing Chemical Equations

Example Three:

- Methane (CH_4) reacts with oxygen (O_2) to form carbon dioxide (CO_2) and water (H_2O).

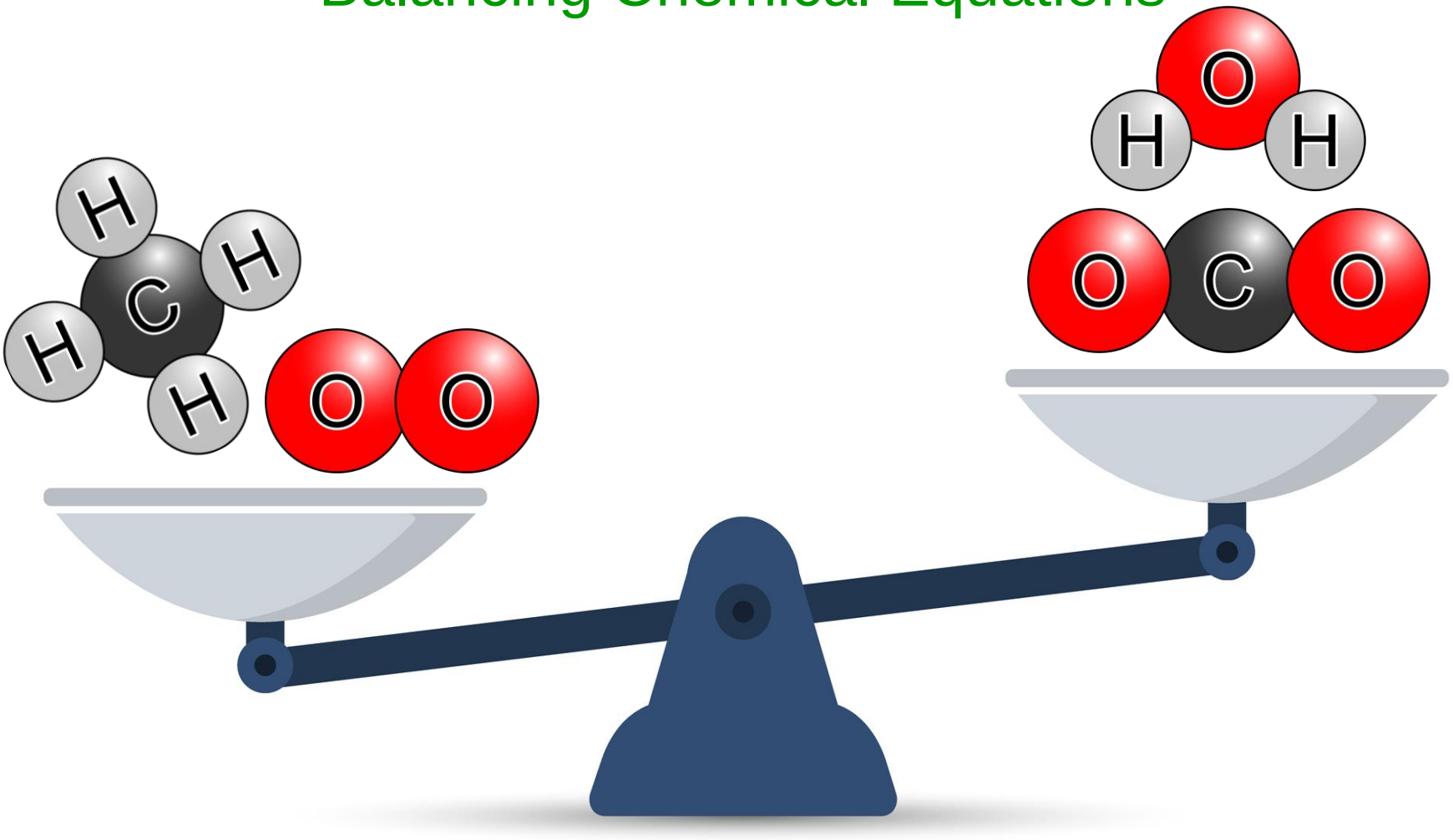
$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

(unbalanced)

- Guided by visual representations of the molecules, let us see how the balanced chemical equation for this reaction is written.

Making Chemistry Visible

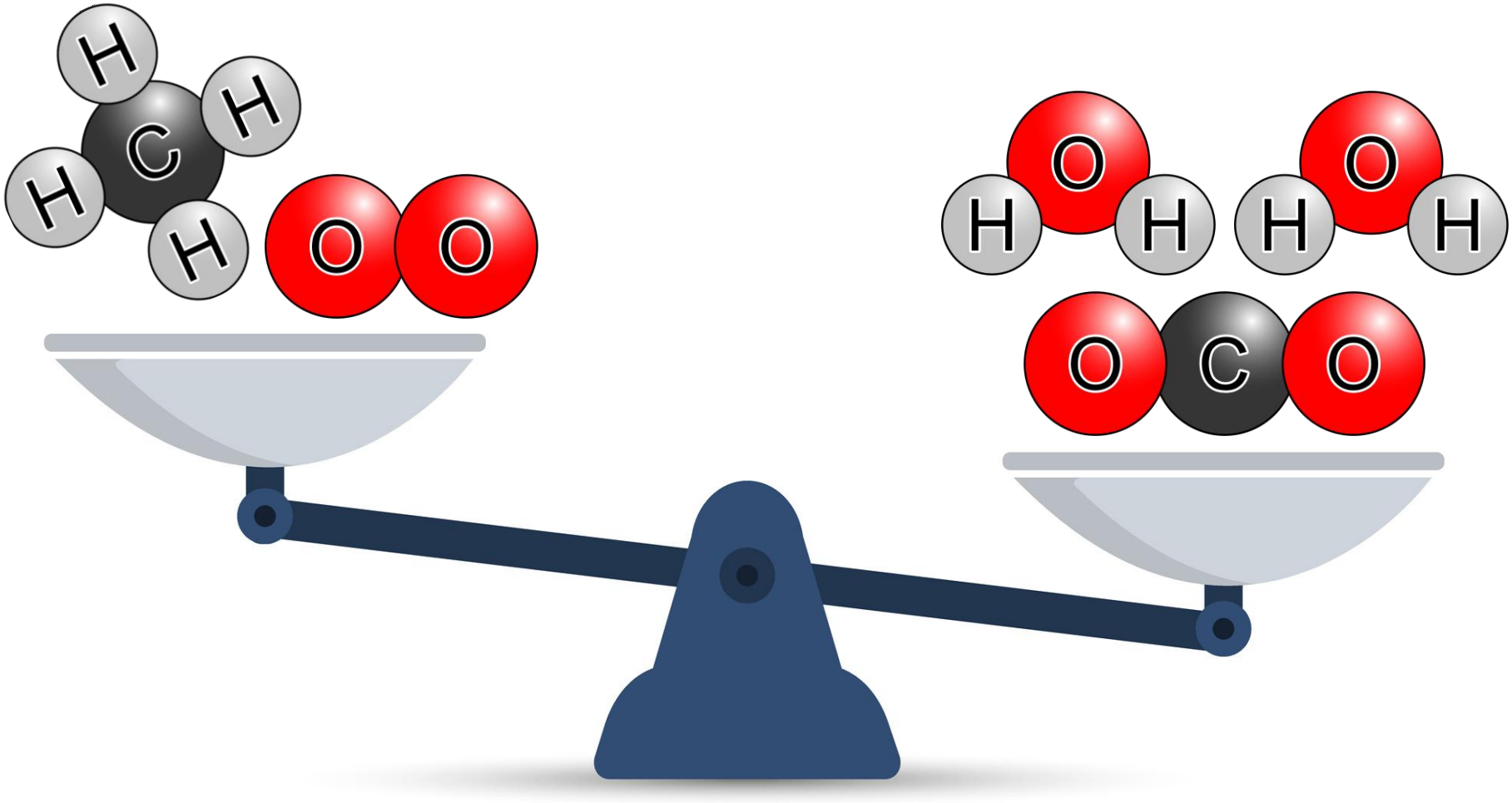
Balancing Chemical Equations



$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

Making Chemistry Visible

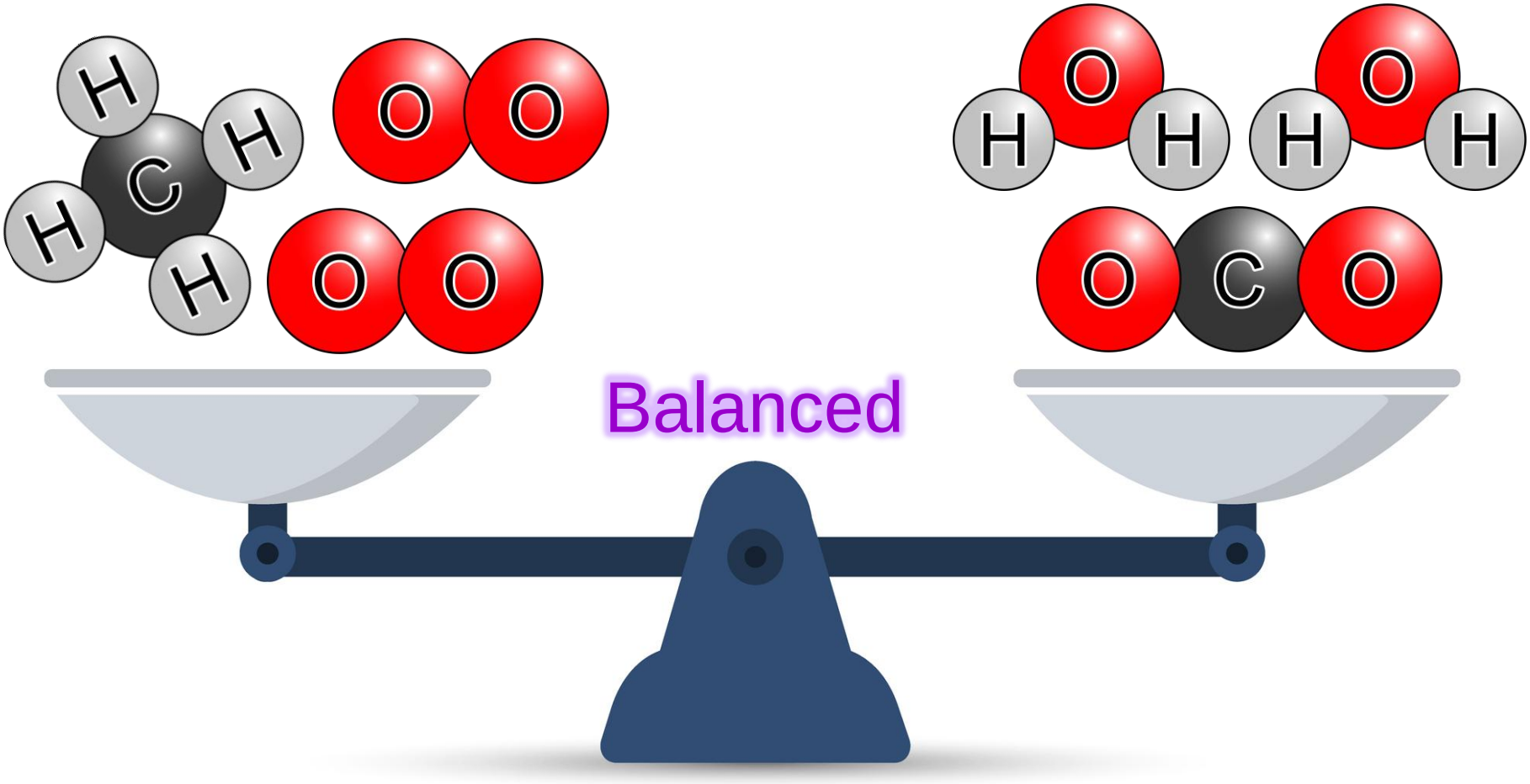
Balancing Chemical Equations



$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

Making Chemistry Visible

Balancing Chemical Equations



$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Making Chemistry Visible

Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

1 × C & 4 × H & 2 × O
needs 1 more O

1 × C & 2 × H & 3 × O
needs 2 more H

Making Chemistry Visible

Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

1 × C & 4 × H & 2 × O
needs 1 more O

1 × C & 2 × H & 3 × O
needs 2 more H

- Difficult to add just one oxygen to this side because they are bonded together in pairs.

- Can add two hydrogens to this side by adding a single molecule of H_2O.

Making Chemistry Visible

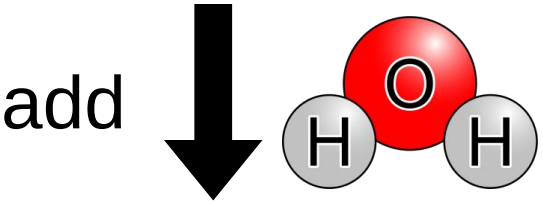
Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

1 × C & 4 × H & 2 × O
needs 1 more O

1 × C & 2 × H & 3 × O
needs 2 more H

add



Making Chemistry Visible

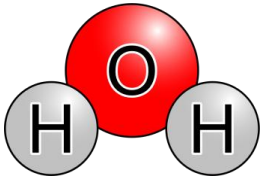
Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

1 × C & 4 × H & 2 × O
needs 1 more O

1 × C & 2 × H & 3 × O
needs 2 more H

add



$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

1 × C & 4 × H & 2 × O
needs 2 more O

1 × C & 4 × H & 4 × O

Making Chemistry Visible

Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

1 × C & 4 × H & 2 × O

needs 2 more O

1 × C & 4 × H & 4 × O

Making Chemistry Visible

Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

1 × C & 4 × H & 2 × O

needs 2 more O

1 × C & 4 × H & 4 × O

- Can add two oxygens to this side by adding a single molecule of O_2.

Making Chemistry Visible

Balancing Chemical Equations

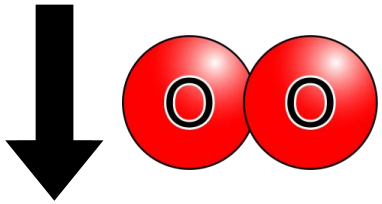
$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

1 × C & 4 × H & 2 × O

needs 2 more O

1 × C & 4 × H & 4 × O

add



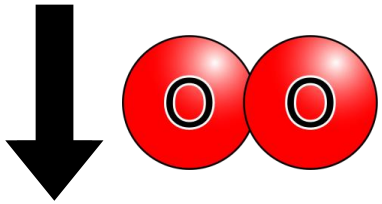
Making Chemistry Visible

Balancing Chemical Equations

$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

1 × C & 4 × H & 2 × O — needs 2 more O

1 × C & 4 × H & 4 × O

add 

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$ ✓

1 × C & 4 × H & 4 × O

1 × C & 4 × H & 4 × O

Balanced

Making Chemistry Visible

Balancing Chemical Equations

Presentation on

Making Thinking Visible:

Balancing Chemical Equations

by Dr. Chris Slatter

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5th April 2024