Intro Screen

Three unbalanced equations with small coefficients help familiarize students with what needs to be balanced and what can be varied to generate a balanced chemical equation.

VARY coefficients in the equation (from 0-3) until it's balanced

✔ Balanced

CHOOSE from 3 unbalanced equations

View ▼

CHOOSE representation to aid in balancing

None

HIDE molecules
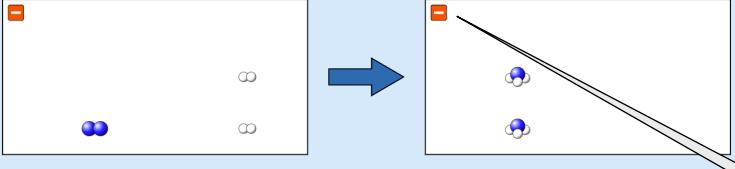
Products

$$1\ N_2\ +\ 2\ H_2\ \longrightarrow\ 2\ NH_3$$

○ Make Ammonia   ○ Separate Water   ○ Combust Methane

Balancing Chemical Equations   Intro   Equations   Game

Equations Screen

Several unbalanced equations representing synthesis, decomposition, and combustion reactions are available to help students develop strategies for balancing equations.

VARY coefficients until the equation is balanced *and* in simplest terms

✔ Balanced
✔ Simplified

CHOOSE from 3 reaction types

View ▼

2 C = 2 C

4 H = 4 H

2 O ≠ 6 O

SELECT an equation to start balancing

□ C_2H_4 + □ O_2 ➔ □ CO_2 + □ H_2O
□ C_2H_5OH + □ O_2 ➔ □ CO_2 + □ H_2O
□ CH_3OH + □ O_2 ➔ □ CO_2 + □ H_2O
□ C_2H_2 + □ O_2 ➔ □ CO_2 + □ H_2O
□ C_2H_4 + □ O_2 ➔ □ CO_2 + □ H_2O
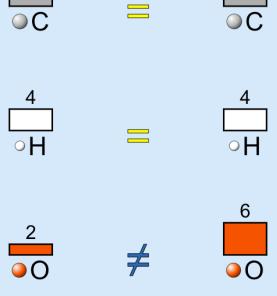
$$1\ C_2H_4\ +\ 1\ O_2\ \longrightarrow\ 2\ CO_2\ +\ 2\ H_2O$$

○ Synthesis   ○ Decomposition   ○ Combustion   □ C_2H_4 + □ O_2 ➔ □ CO_2 + □ H_2O ▲

Balancing Chemical Equations   Intro   Equations   Game

Game Screen

The Game challenges students to balance 5 randomized equations per level, with coefficients from 1-7.

Level 1: Equations with 3 coefficients. (*i.e.* combination or decomposition)

Levels 2 and 3: Equations with 4 coefficients. Those at Level 3 are more challenging and have larger coefficients.

TRACK highest score.

ENABLE a timer before starting a level.

Students can submit up to 2 attempts per question for feedback, but there are no scales or bar charts.

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '?' to the sim URL, and separating each query parameter with a '&'. The general URL pattern is:

…html?queryParameter1&queryParameter2&queryParameter3

For example, in Balancing Chemical Equations, if you want to change the screen order (screens=2,1,3), with the 2nd screen open by default (initialScreen=2) use:

https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_all.html?screens=2,1,3&initialScreen=2

To run this in Spanish (locale=es), the URL would become:

https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_all.html?locale=es&screens=2,1,3&initialScreen=2

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links
⚙ initialCoefficient - sets the initial coefficient for every term, in every equation.	initialCoefficient=1
gameLevels - specifies which levels appear in the game.	gameLevels=2,3
screens - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the Help Center.	screens=1 screens=2,1

Query Parameter and Description	Example Links
`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=2`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
⚙ `audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`

Model Simplifications

Scale analogy
Note that the balance scales appear level when all coefficients are zero, even though the equation is not balanced. This limitation of the analogy doesn't affect student usage or interpretation of the scales. Also, as each atom type is balanced, the scale turns yellow to highlight the difference.
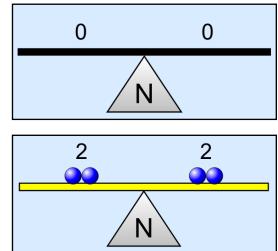
Insights into Student Use

Scales and Bar charts
Students first learning to balance equations may at first rely solely on the balance scales or bar charts for balancing. This gives them a great working definition of a balanced equation, but it is the Equations screen which helps them to move beyond these tools to more general strategies for balancing, and focuses their attention on the symbols and molecules.

Equation and Game Feedback

- On all screens, students will receive feedback when an equation is balanced. On the Intro screen, a smiley face and a checkmark with the word "Balanced" will appear. The Equations and Game screens have additional feedback indicating whether the balanced equation is in simplest form.
- For the Game, when the equation is balanced but not with the lowest coefficients (*e.g.*, 2A + 2B → 2AB), we count the answer as incorrect, but ask them to try again with the prompt shown at the right:
- For the Game, when students submit an unbalanced equation on their first attempt, they have the option to "Show Why". This feature uses a different representation for each level: Level 1 uses balance scales, Level 3 uses bar charts, and Level 2 uses a mix of both representations.
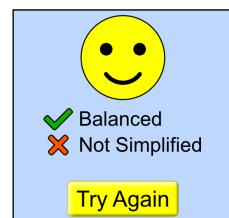
Suggestions for Use

- Hide the molecules and ask students to <u>balance</u> an equation and <u>draw</u> the molecules represented. *This can reinforce differences between subscripts and coefficients, and get students comfortable switching between both symbols and molecular-scale pictures*.
- Compare strategies: Ask student groups to compare <u>how</u> they arrived at a balanced equation on the Equations screen, and brainstorm all of the different strategies that groups used for balancing, especially for the more challenging equations for Combustion.
- Discuss coefficients and subscripts: Ask students why they think the simulation uses only whole number coefficients, and why changing coefficients is allowed while changing subscripts isn't.

What's New in the 2.0 Release

- An additional screen, Equations, containing 12 unbalanced equations representing synthesis, decomposition, and combustion reactions has been added.
- On the Intro and Equations Screens:
  - The particle view (Reactants and Products boxes) has been moved to the dropdown menu. It is no longer possible to show the particle view and other views, such as balances, at the same time.
  - The dropdown menu title has been changed from *Tools* to *View.*
  - The balances and bar charts are now displayed vertically so that is it easier to compare atoms on reactant and product sides of the equation.
  - The balances and bar charts will turn yellow as each type of atom becomes balanced, instead of when the entire equation is balanced.
- A new preference, *initial coefficient,* has been added to the simulation tab of the preferences menu ⚙ . Users now have the ability to set the initial coefficients for all equations to 1 instead of zero.
- Equation and game feedback have been improved. See the *Equation and Game Feedback* section above.

See all published activities for Balancing Chemical Equations here.
For more tips on using PhET sims with your students, see Tips for Using PhET.