Reactants, Products and Leftovers

PhET Tips for Teachers

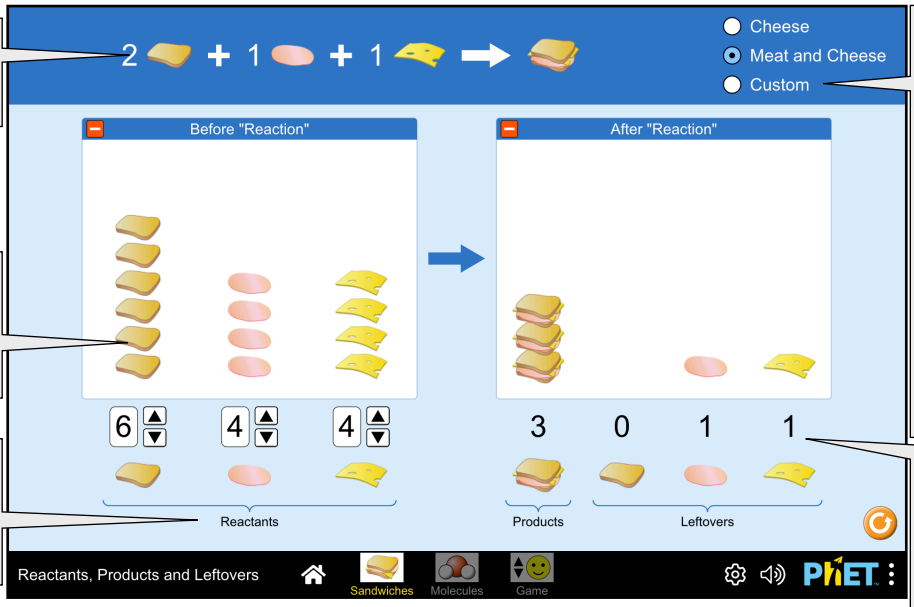
Sandwiches and Molecules Screens

The simulation is designed to give students a conceptual understanding of limiting reactants, rather than practice at solving algorithmic problems that require mass/mole conversions.

CHOOSE your sandwich recipe.

Items are stacked for easy comparison.

CHANGE the number of "reactants".



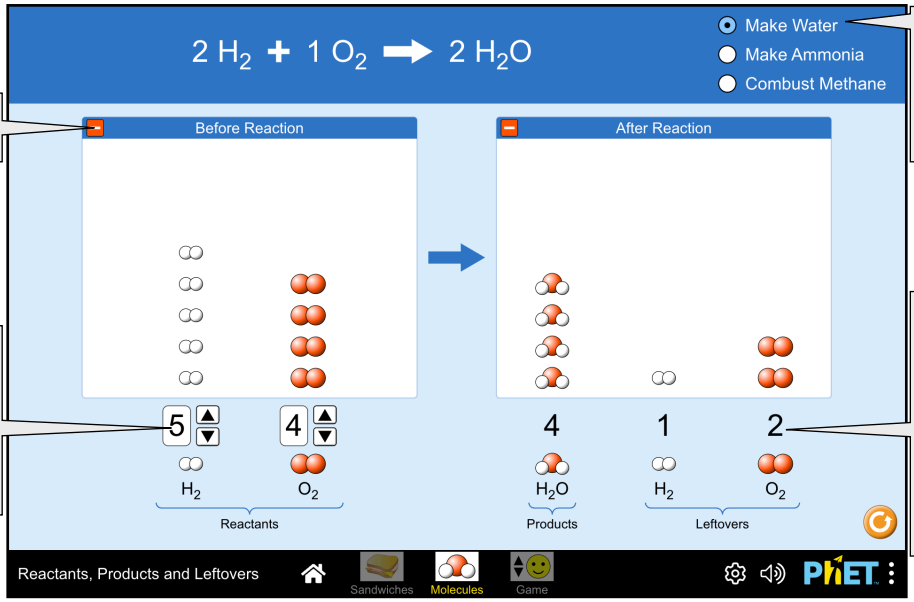
CREATE custom sandwich recipes to see how the coefficients affect which reactant is limiting.

Recipes must use at least 2 items.

SEE the number of product sandwiches and leftovers.

HIDE molecules

CHANGE the number of reactant molecules.



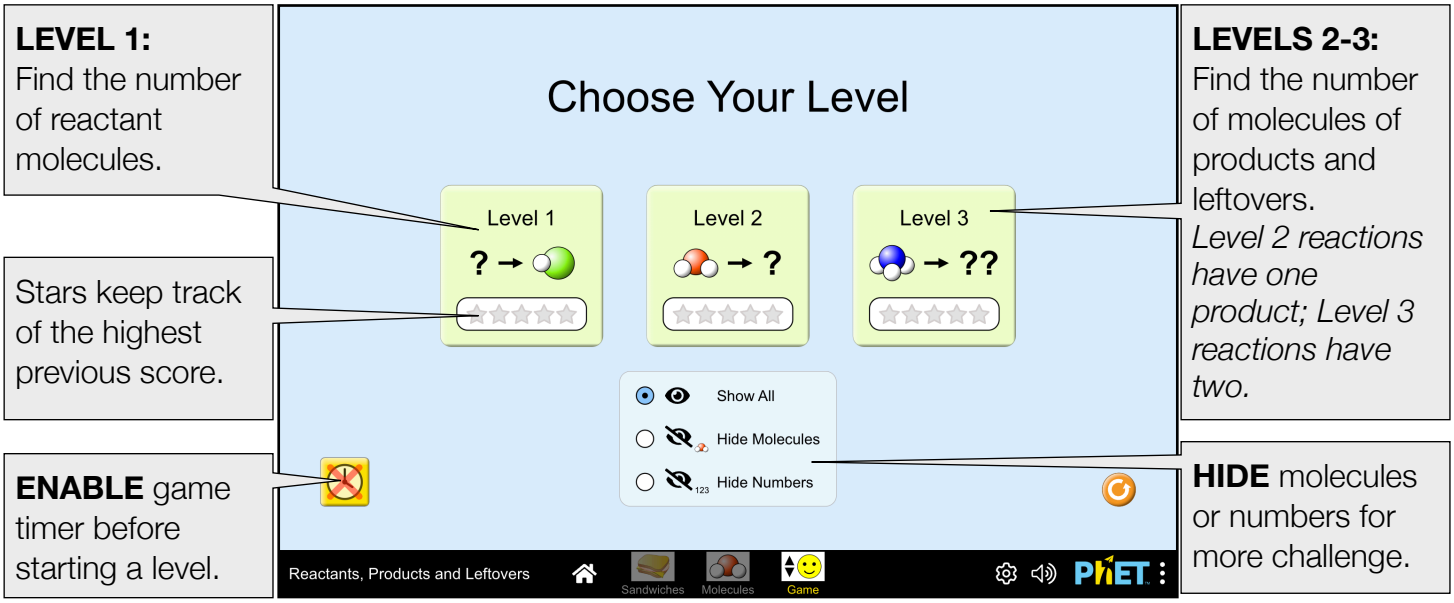
CHOOSE between three reactions.

Since we show molecules (not moles), there can be left over molecules of the limiting reactant.

Carpenter & Rouinfar, November 2024

Game Screen

Students are challenged to figure out the missing number of molecules in 5 random questions per level. Each level has one question where the proportions of reactants will not make any products. Students have 2 attempts per question; after 2 incorrect attempts, the sim shows the correct answer.



Model Simplifications

- In order to represent all particles as space-filling models, we did not include ionic compounds in the sim.
- On the sandwiches screen, students can investigate "reactions" that have 3 ingredients as an extension, but none of the chemical reactions in this sim have more than 2 reactants.

Insights into Student Use

Sandwiches and Molecules Screens

- During many students' initial exploration of these screens, they followed the chemical equation like a recipe, only entering the exact number of reactants that resulted in zero leftovers. Students tended to explore more diverse scenarios in these screens only after starting to play the Game, or after being given one or two challenging cases to compare.

Game Screen

- Many of the questions in Level 1 (Finding the number of reactant molecules) can be solved by students counting up the total atoms of each element after the reaction and using only these totals to figure out the number of reactant molecules - without ever making reference to the chemical equation. Level 2 and 3 (Finding the number of products and leftovers) cannot be solved this way, and require students to leverage the chemical equation.
- Students may need prompting that they can (and should) return to earlier screens to help them figure out a strategies as they tackle challenging Game questions. Students in interviews who did return to and make use of earlier screens during the Game made quicker conceptual progress and were more positive about their experience in the Game.

Carpenter & Rouinfar, November 2024

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 Reactants, Products and Leftovers, if you only want to include the 1st and 2nd screens (`screens=1,2`), with the 2nd screen open by default (`initialScreen=2`) use:
https://phet.colorado.edu/sims/html/reactants-products-and-leftovers/latest/reactants-products-and-leftovers_all.html?screens=1,2&initialScreen=2

To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/reactants-products-and-leftovers/latest/reactants-products-and-leftovers_all.html?locale=es&screens=1,2&initialScreen=2

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

Query Parameter and Description	Example Links
`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`

`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=3`
⚙ `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`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

Suggestions for Use

- **Compare coefficients:** Ask students to pick a number of sandwich ingredients to start.
  Challenge prompt:
  "Using only these ingredients, can you them to find a Custom sandwich recipe that makes the bread run out first? What about the cheese, or the meat? How are these recipes different?"
- **Compare molecules and moles:** Choose any example that results in leftover molecules of both reactants. Ask students to discuss what result they might expect if the numbers they were given were moles instead of molecules.
- **Compare strategies:** Ask student groups to compare how they figured out the number of leftovers in Level 2 or 3 of the Game. What information did they need?

See all published activities for Reactants, Products and Leftovers here.
For more tips on using PhET sims with your students, see Tips for Using PhET.