

PhET Tips for Teachers : *Reactants, Products and Leftovers*

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Non-obvious controls:

- Try all the different tabs at the top of the simulation. The tabs are designed to help teachers scaffold lessons or make lessons age appropriate by using only some tabs.
- Values can be changed by either using the arrows or typing in the boxes, then press “Enter”
- If you are doing a lecture demonstration, set your screen resolution to 1024x768 so the simulation will fill the screen and be seen easily.

Important modeling notes / simplifications:

- 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.
- We allow students to alter the coefficients in the sandwich equation so they can explore how the *ratios* of the amounts of reactants determine how many products can form. You might want to reiterate that one cannot alter the coefficients of real reactions. The minimum requirements for a “reaction” are 2 of something; either 2 of one ingredient or one of 2 different ingredients.
- On the sandwich tab, 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.
- We chose particles that can be represented as space-filling models, so the sim does not include ionic compounds. The size of each *molecule* is the same, so the same *atom* in different molecules can be different sizes. Our interviews show that this does not bother students.

Information regarding the Game tab:

- Each game consists of 5 problems that are randomly generated from a pool of about 40 reactions. There is always one problem that does not have the correct proportions to make any products. Students get two attempts per problem. Points: correct on first try, 1; correct on second try, 0.5. After two attempts, the sim shows the correct answer. The game keeps track of the best time on each level, but only for games with a perfect score.
- In Level 1, the student enters the reactants in the “before” box; in Levels 2 and 3, the student enters the products and leftovers in the “after” box. In Level 1, the reactions can have one or two products, but in Level 2, the reactions *always* have one product, and in Level 3, the reactions *always* have two products. The sim has different animations for perfect scores on each level.
- Students can elect to “Hide” the molecules or numbers for an additional challenge, but we recommend doing so only *after* mastery of Levels 1-3.

Insights into student use / thinking:

- The purpose of the histograms is to give students a visual cue that the reactant with the least relative amount is not always the limiting reactant, but college students in our interviews tend not to use the histograms. You might include a question about why the sim provides the histograms to help students challenge, confirm, or correct their understanding of how to identify the limiting reactants.

Suggestions for sim use:

- For tips on using PhET sims with your students see: [Guidelines for Inquiry Contributions](#) and [Using PhET Sims](#)
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see [Teaching Physics using PhET Simulations](#)
- For activities and lesson plans written by the PhET team and other teachers, see: [Teacher Ideas & Activities](#)