

TITLE

Balancing Chemical Equations

AUTHORS

Timothy Herzog (Weber State University)

Yuen-ying Carpenter (University of Colorado Boulder)

COURSE

General Chemistry I *or* Preparatory Chemistry

TYPE

In-Class Guided-Inquiry Activity

TEACHING MODE

Facilitated Group Inquiry

LEARNING GOALS

Students will be able to:

- Determine required conditions for a reaction to be considered “balanced” and relate these conditions to laws of matter.
- Develop strategies to balance chemical equations.

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BALANCING CHEMICAL EQUATIONS

Load the simulation *Balancing Chemical Equations*
<http://phet.colorado.edu/en/simulation/balancing-chemical-equations>

CRITICAL THINKING QUESTIONS

- Explore the *Balancing Chemical Equations* simulation. Discuss with your group what you find.
 - What are the different ways that the simulation indicates when an equation is balanced?

- For each balanced reaction, indicate the total number of molecules in the table below.

Reaction	Total Number of Molecules	
	Reactant Side (Left)	Product Side (Right)
Make Ammonia		
Separate Water		
Combust Methane		

- Is the number of total molecules on the left side of a balanced equation always equal to the number of total molecules on the right side of the equation? Explain your answer.

- For each balanced reaction, indicate the total number of atoms in the table below.

Reaction	Total Number of Atoms	
	Reactant Side (Left)	Product Side (Right)
Make Ammonia		
Separate Water		
Combust Methane		

- Is the number of total atoms on the left side of a balanced equation always equal to the number of total atoms on the right side of the equation?

- What is the same on the left and right side of a balanced equation? Explain your answer.

- As a group, play level 1 of the balancing equation game. Write down the strategies your group uses to balance chemical equations.

Yuen-ying Carpenter 11/3/2014 10:57 AM

Comment [1]: The first six questions of the activity focus on students building a definition of a balanced chemical equation, while the remainder focus on developing their balancing practices

Yuen-ying Carpenter 11/3/2014 10:29 AM

Comment [2]: Facilitation tip: Initiate a whole-class discussion once all groups have completed up to this question. In particular, ask for student responses to Q6, making sure that students recognize that the number of atoms of *each element* is the same, not just the total number of atoms.

8. Start level 2 of the balancing equation game. Take turns in your group to balance the equations in the sim, using your strategies from Level 1, and adding new strategies as needed.

Each person should be in charge of balancing at least one equation, asking for help from the group as needed. As a group, write down the equations as you solve them.

9. In the simulation, were you able to use noninteger numbers (like $\frac{1}{2}$ or 0.43) for the coefficients in a balanced equation? Why do you think this is?

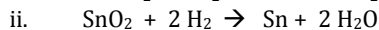
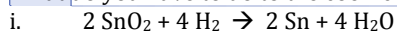
- a) Which of the following are coefficients you could use in a balanced equation?

$\frac{1}{2}$ $\frac{3}{4}$ 1 2 6 9

- b) If you were balancing an equation containing the O_2 molecule, which of the following would be correct representations of O_2 and its coefficient?

$\frac{1}{2}O_2$ O_2 $3O_2$ $6O_2$ 3O $5O_3$

10. What do you have to do to the coefficients of equation I below to get to equation II?



- a) Both equation I and II are balanced, but equation I is the correct way to write the balanced equation.
- b) Can you divide equation II by another factor and still have it be correct? Why or why not?
- c) In a complete sentence, write down a method you could use to determine if an equation is written in the correct way.
11. Start level 3 of the balancing equation game. Take turns and write down the equations as you solve them, along with any new strategies you needed for balancing.

Yuen-ying Carpenter 11/3/2014 11:06 AM

Comment [3]: Facilitation tip:

Students often find it challenging to explicitly articulate the strategies they are using to balance equations, and often focus only on 'where to start'. However, this can still be a great conversation starter for a whole class discussion, particularly as you ask students to think about what makes the questions at later levels more challenging to balance.

If students' only suggestions for strategies relate to where to start, it may be useful to ask them to,

(1) Attempt to balance an equation starting with a different molecule than they originally suggested – was it harder? Why or why not?

(2) Discuss how they decided what to balance second, so that they focus on their decision making throughout the balancing process

Yuen-ying Carpenter 11/3/2014 10:33 AM

Comment [4]: This question focuses on both (a) the use of whole number coefficients, and (b) that we cannot change subscripts in the equation

Yuen-ying Carpenter 11/3/2014 10:32 AM

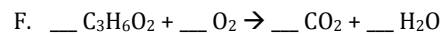
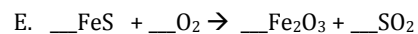
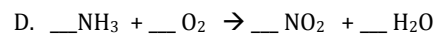
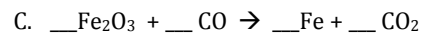
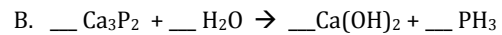
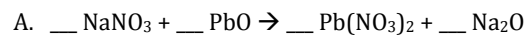
Comment [5]: This question focuses explicitly on the convention that balanced equations should be written with least coefficients.

Yuen-ying Carpenter 11/3/2014 10:45 AM

Comment [6]: Facilitation tip:

The equations presented to students at Level 3 are the most challenging and most valuable for developing expert-like balancing practices. A whole-class discussion once groups are starting to tackle these questions, with students sharing out about how they approached balancing some of these equations (or why they found them particularly challenging) is valuable.

CHALLENGE QUESTIONS: BALANCE THE EQUATIONS BELOW.



Yuen-ying Carpenter 11/3/2014 10:46 AM

Comment [7]: These questions could be left as a take-home practice exercise.