Science Objectives

- Students will recognize that the number of atoms of each element is conserved in a chemical reaction.
- Students will balance given chemical equations.

Vocabulary

- reactant
- product
- neutralization
- combination (synthesis)
- single replacement
- double replacement

About the Lesson

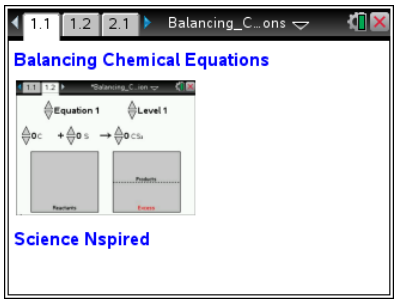
- Students will use simulation to generate chemical equations and to balance these equations by observing how products are formed from reactants. They will be able to adjust coefficients for the reactants until all reactants are used to form the products. This will lead them to the understanding of conservation of atoms in a balanced reaction.
- The activity asks students to balance equations at three different levels. At Level 1, students work with synthesis reactions. At Level 2, students work with single replacement reactions and at Level 3 students will balance double replacement reactions (which also includes example of neutralization). There are five equations for each level.
- Students will answer conceptual questions developed using Question application.
- As a result, students will:
  - Reinforce understanding that the number of atoms is conserved in a chemical reaction
  - Recognize the meaning of coefficients and subscripts in a chemical equation.

TI-Nspire™ Navigator™

- Send out the *Balancing_Chemical_Equations.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to allow students to show how they balance equations.

Activity Materials

- TI-Nspire™ Technology



TI-Nspire™ Technology Skills:

- Open a document
- Move between pages
- Use a minimized slider

Tech Tips:

In order to access directions for the use of simulation, students should select **Menu > Balancing Equations > Directions**.

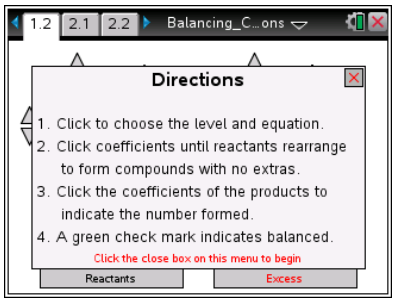
Lesson Materials:

Student Activity

- Balancing_Chemical_Equations_Student.doc
- Balancing_Chemical_Equations_Student.pdf
- Balancing_Chemical_Equations.tns

Discussion Points and Possible Answers

Move to page 1.2.

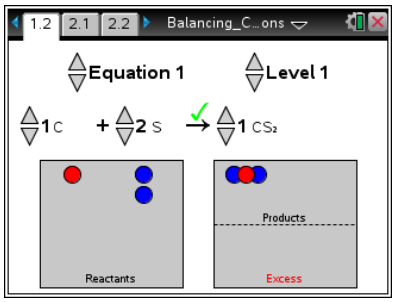


1. Students are to read directions on how to use the simulation. When they are finished, they can close the directions by clicking the red X in the top right corner of the pop-up box. They can view the directions at any time during the activity by pressing menu. The types of equations students will find in each level are:

   Level 1 – combination equations

   Level 2 – single replacement equations

   Level 3 – double replacement equations



2. Students will start with Equation 1 in Level 1, which appears automatically when they move to page 1.2. They are to use the up and down arrows to adjust the coefficients that appear in front of each reactant until the product is formed without any excess.

Have students answer questions 1 and 2 on the activity sheet.

Q1. Record the balanced equation and draw the molecular representations of the reaction. Explain how this representation was derived.

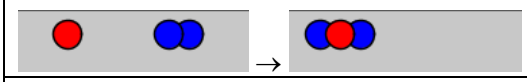
__C +__ S →__ CS_2

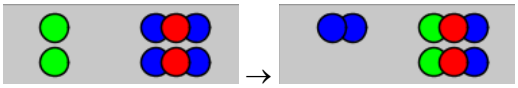
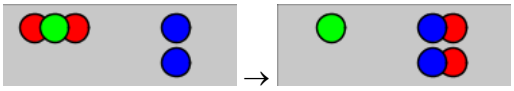
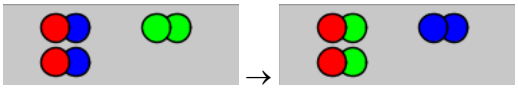
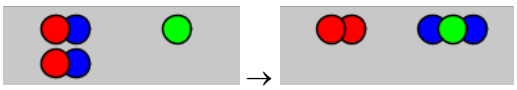
Answer: C + 2S → CS_2; see the screenshot above for the representation; the molecular representation is based on the law of conservation of matter and molecular structure of each compound

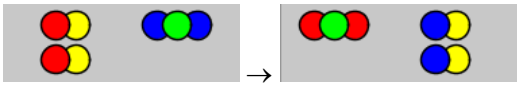
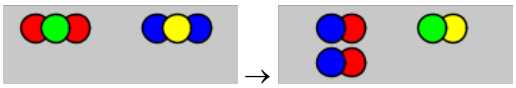
Q2. What is the relationship between the "reactants" and "products" atoms? Show work that supports your answer.

Answer: the number of atoms of each element in the reactants is the same as the number of atoms of the same element in the products.

3. Students are to balance the remaining equations in the tables for all three levels. As they did earlier, they should adjust the coefficients that appear in front of each reactant until products are formed without any excess. Once the equation is balanced, in the table, they are to record the coefficients, draw a molecular representation, and record the number of atoms for each element in reactants and products.

Level 1 – Combination Equation and Molecular Representation	# of atoms for each element Reactants	 Products
_**1**_C + _**1**_O_2 → _**1**_CO_2 	1 atom of C 2 atoms of O	1 atom of C 2 atoms of O
_**2**_K + _**1**_Cl_2 → _2_KCl 	2 atoms of K 2 atoms of Cl	2 atoms of K 2 atoms of Cl
__S + __F_2 → __SF_2 	1 atom of S 2 atoms of F	1 atom of S 2 atoms of F
_**2**_Na + _**1**_F_2 → _**2**_NaF 	2 atoms of Na 2 atoms of F	2 atoms of Na 2 atoms of F

Level 2 – Single Replacement Equation and Molecular Representation	# of atoms for each element Reactants	 Products
_**2**_Na + _**2**_H_2O → _**1**_H_2 + _**2**_NaOH 	2 atoms of Na 4 atoms of H 2 atoms of O	2 atoms of Na 4 atoms of H 2 atoms of O
_**1**_$FeCl_2$ +_**2**_ K → _**1**_Fe + _**2**_KCl 	1 atom of Fe 2 atoms of Cl 2 atoms of K	1 atom of Fe 2 atoms of Cl 2 atoms of K
_**2**_NaBr + _**1**_F_2 → _**2**_NaF + _**1**_Br_2 	2 atoms of Na 2 atoms of Br 2 atoms of F	2 atoms of Na 2 atoms of Br 2 atoms of F
_**2**_AgCl + _**1**_Cu → _**2**_Ag + _**1**_$CuCl_2$ 	2 atoms of Ag 2 atoms of Cl 1 atom of Cu	2 atoms of Ag 2 atoms of Cl 1 atom of Cu
_**2**_HCl + _**1**_Zn → _**1**_H_2 + _**1**_$ZnCl_2$ 	2 atoms of H 2 atoms of Cl 1 atom of Zn	2 atoms of H 2 atoms of Cl 1 atom of Zn

Level 3 – Double Replacement Equation and Molecular Representation	# of atoms for each element	
	Reactants	Products
_**1**_Na_2S + _**1**_PbF_2 → _**1**_PbS + _**2**_NaF 	2 atoms of Na 1 atom of S 1 atom of Pb 2 atoms of F	2 atoms of Na 1 atom of S 1 atom of Pb 2 atoms of F
_**1**_NaOH + _**1**_HCl → _**1**_H_2O + _**1**_NaCl 	1 atom of Na 1 atom of O 2 atoms of H 1 atom of Cl	1 atom of Na 1 atom of O 2 atoms of H 1 atom of Cl
_**1**_PbF_2 + _**1**_Na_2S → _**1**_PbS + _**2**_NaF 	1 atom of Pb 2 atoms of F 2 atoms of Na 1 atom of S	1 atom of Pb 2 atoms of F 2 atoms of Na 1 atom of S
_**2**_LiCl + _**1**_H_2S → _**1**_Li_2S + _**2**_HCl 	2 atoms of Li 2 atoms of Cl 2 atoms of H 1 atom of S	2 atoms of Li 2 atoms of Cl 2 atoms of H 1 atom of S
_**1**_$CaBr_2$ + _**1**_K_2S → _**2**_KBr + _**1**_CaS 	1 atom of Ca 2 atoms of Br 2 atoms of K 1 atom of S	1 atom of Ca 2 atoms of Br 2 atoms of K 1 atom of S

Have students answer questions 3 – 6 on the activity sheet.

Q3. What is the difference between coefficients and subscripts in a chemical equation?

Answer: Subscripts tell how many atoms of each element are in a molecule, so they define the identity of the molecule and thus they cannot be changed. Coefficients tell how many molecules of reactants or products are in the chemical equation, they can be changed to balance the equation, since that does not change the identity of molecules.

Q4. Explain how you found the number of atoms for each reactant and product.

Answer: In order to find the total number of atoms of an element in reactants, multiply the coefficient in front of the molecule by the subscript of the element to get the number of atoms in a given compound. If the same element is present in another reactant, repeat the same procedure and add number of atoms. Same way you can find total number of atoms in products.

Q5. Can you use fractions as coefficients in the chemical equations?

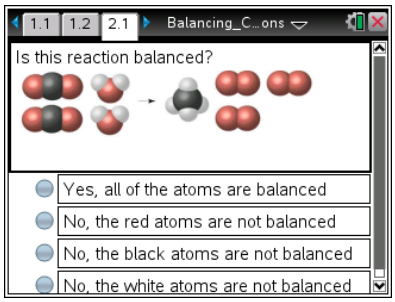
Answer: Since there cannot be half of a molecule or half of an atom, the final set of coefficients has to be whole numbers with no common factors other than one.

Q6. What are you not able to do when balancing chemical equations? Why?

Answer: You are not able to change a subscript, since that changes the identity of the compound. You cannot place a coefficient in the middle of a chemical formula, since the formula represents a molecule.

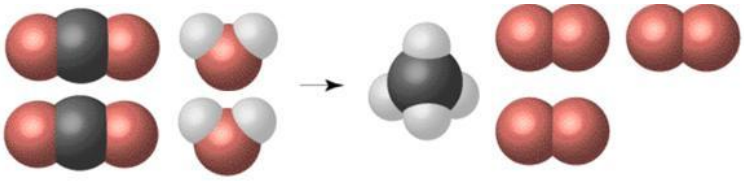
Move to pages 2.1 – 2.5.

4. Students will now apply what they've learned by answering several questions.



Have students answer questions 7–11 on the handheld, the activity sheet, or both.

Q7. Is this reaction balanced?



Answer: C. No, the black atoms are not balanced

Q8. What would you need to do to balance the equation $N_2 + H_2 \rightarrow NH_3$? (Select all that apply.)

Answer: B. Multiply coefficient of $H_2$by 3 ($3H_2$) and E. Double the coefficient of NH_3($2NH_3$)

Q9. Balance the equation given below.

$Au_2S_3 + H_2 \rightarrow Au + H_2S$.

Answer: $Au_2S_3 + 3H_2 \rightarrow 2Au + 3H_2S$

Q10. Select all equations that are NOT balanced.

Answer: A. $Ag + O_2 \rightarrow AgO$ and D. $KI + Pb(NO_3)_2 \rightarrow PBI_2 + KNO_3$

Q11. For the equation $Fe + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + H_2$ how many atoms of each element are on each side of the equation when it is balanced?

Answer: C. 2Fe, 6H, 3S, 12O

TI-Nspire™ Navigator™ Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the coefficients in the equation in order to balance it. Use Quick Poll to check for understanding during the course of the activity.

Wrap Up

When students are finished with the activity, send and retrieve the .tns file using TI-Nspire™ Navigator™. Save the grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Answers to questions are written into the student worksheet.
- Assessment consists of five questions in the tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.