Science Objectives

- Students will observe the mass of a system before and after a chemical reaction to explore the law of conservation of matter.

- Students will explore how the number of particles in a chemical reaction is conserved.

Vocabulary

- conservation
- energy
- matter
- atom
- chemical reaction
- subatomic particle
- proton
- neutron
- electron
- mass
- compound

About the Lesson

- In this lesson, students will:
    - Observe the mass of an open and closed system before and after a chemical reaction.
    - Calculate and compare the number of subatomic particles in a system before and after a chemical reaction.
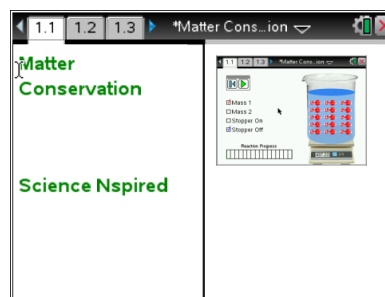
TI-Nspire™ Navigator™

- Send out the *Matter_Conservation.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: ▢ TI- Nspire™ CX Handhelds,
  ▢ TI-Nspire™ Apps for iPad®, ▢ TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.

- Watch for additional Tech Tips throughout the activity for the specific technology you are using.

- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:
Student Activity
- Matter_Conservation_Student.doc
- Matter_Conservation_Student.pdf

TI-Nspire document
- Matter_Conservation.tns

Discussion Points and Possible Answers

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1. In this simulation students will explore the chemical reaction between two different amounts of carbonic Acid (H_2CO_3) and water (H_2O). In addition, students can have the system open (Stopper Off) or closed (Stopper On). To begin, have students select Mass 1 with the Stopper off. They should record the initial mass of the system with the stopper off in the table on their student activity sheets.
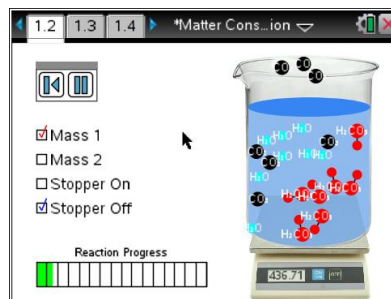
2. Once students have recorded the initial mass, they should select the Play button ▶ to run the simulation. Have students wait until the reaction is fully completed. Then, they should record the final mass of the system with the stopper off in the table.
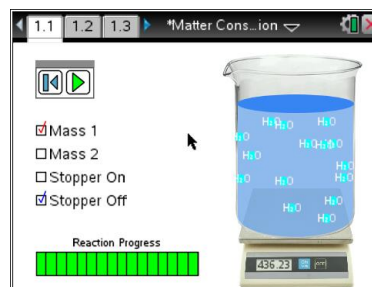
3. Have students select the reset button ◀ and then select Mass 2. They should repeat steps 1 and 2 for the new mass. Have them record the initial and final masses in the table.

> **Tech Tip:** To access the Directions again, select menu or **Document Tools (✄) > Matter Conservation > Directions.**

> **Tech Tip:** To access the Directions again, select 🔧 > **Matter Conservation > Directions.**

Amount of H_2CO_3	Initial Mass, Stopper Off	Final Mass, Stopper Off	Initial Mass, Stopper On	Final Mass, Stopper On
Mass 1	437.23 g	436.23 g	563.82 g	563.82 g
Mass 2	404.40 g	403.73 g	531.32 g	531.32 g

Move to Pages 1.3 - 1.4.

Have students observe the graph on page 1.3. This graph shows the rate at which the concentration of H_2CO_3 in the water changes during the course of the chemical reaction. Essentially, it tells students how quickly the chemical reaction takes place. Have students answer question 1 - 2 in the .tns file, the activity sheet, or both.

Q1.   What happens to the total mass of the system when the stopper is off of the beaker during the chemical reaction?

   Answer: B. The mass decreases.

Q2.   How does the concentration of H_2CO_3 in the water change during the course of the chemical reaction?

   Sample Answer: The concentration of H_2CO_3 decreases quickly at first and then slows down towards the end of the reaction.

Move back to Page 1.2.

4.   Have students select the Reset Button [icon] and then select Stopper On. They should now repeat steps 1 and 2 with the Stopper On. Be sure that they record the initial and final masses of the system in the table. (Note that the stopper adds some mass to the system.)

Move to Pages 1.3 - 1.8.

Have students observe the graph on Page 1.3. Then, have them answer the questions 3 - 6 in the .tns file, the activity sheet, or both.

Q3.   What happens to the total mass of the system when the stopper is on the beaker during the chemical reaction?

   Answer: C. The mass stays the same.

Q4.   Recall the graph of the concentration of H_2CO_3 with the stopper off. Now, compare it with the graph of H_2CO_3 with the stopper on. Did the rate at which the reaction takes place depend on whether or not the stopper was on the beaker?

   Answer: B. no

Q5.   In which scenario does the total mass of the system decrease? Can you explain why this happens?

   Sample Answer: The total mass of the system decreases when the stopper is off. This is because the system is not closed. During the reaction, CO_2 gas is formed. Because the system is not closed, this gas escapes from the container and reduces the total mass of the system.

Q6. How does this simulation demonstrate the law of conservation of matter?

Sample Answer: The law of conservation of matter states that the mass of a closed system will remain constant. In this simulation, the system with the stopper on is a closed system, and the mass of this system remains constant throughout the chemical reaction.

Move to Page 2.1.

5. Now, students will consider a new chemical reaction. If we combine two atoms of sodium (2Na) with a molecule of chlorine gas (Cl_2), we obtain common table salt. Have students use the Periodic Table to determine how many total protons, neutrons, and electrons are involved in each of these reactants. (Note that Cl_2 has two atoms of chlorine and 2Na has two atoms of sodium. This means that students will need to first obtain the number of subatomic particles in a single atom and them multiply this value by 2.) Students should fill in the table on their student activity sheets.

Have students use the following rules to fill in the table:
- The number of protons in an atom is equal to the atomic number.
- The number of electrons in a neutral atom is equal to the number of protons.
- The number of neutrons in an atom is equal to atomic mass – atomic number.
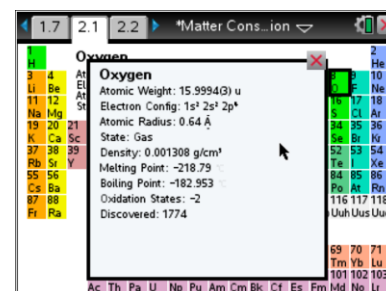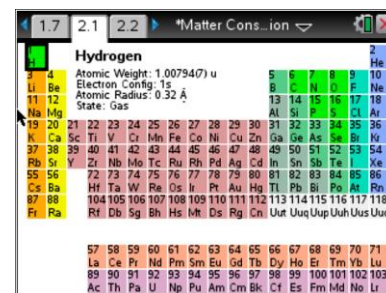
Reactant	Protons	Neutrons	Electrons
2Na	22	24	22
Cl_2	34	36	34
Total	56	60	56

Move to Pages 2.2 - 2.3.
Have students answer questions 7 - 8 in the .tns file, the activity sheet, or both.

Q7. NaCl is the empirical formula for common table salt. One NaCl compound has 28 protons, 28 electrons, and 30 neutrons. The chemical reaction between sodium and chloride is given by: 2Na + Cl_2 → 2NaCl. Calculate the total number of protons, electrons, and neutrons in the product of the reaction (2NaCl).

Sample Answer: In two NaCl compounds, there are 28 x 2 = 56 protons, 28 x 2 = 56 electrons, and 30 x 2 = 60 neutrons.

Q8. Is the total amount of matter conserved in this reaction? Use your calculations to defend your answer. (Hint: Compare the total amount of protons, neutrons, and electrons of the products in your table with the amounts calculated in question 7.)

Sample Answer: Yes, matter is conserved in this reaction. The total amount of protons, neutrons, and electrons in the reactants were 56, 60, and 56, respectively. The total number of particles in the product is the same, so matter is conserved.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate how to test one variable at a time during the simulation investigation. Throughout the activity, monitor student progress. At the end of the activity, collect the .tns file and save to Portfolio.

Wrap Up

Students should compose a lab report, which includes their data, analysis, and a discussion of the results of their test. Students may choose to use the TI-Nspire™ Student Edition software to convert their .tns files to PublishView Documents.

Extensions

Students can create closed system reactions on a balance. They can use a small amount of Alka-Seltzer and water or baking soda and vinegar. Make sure the amounts are small as to avoid the stopper being blown off.

Assessment

- Use the questions in the Nspire document as Quick Polls during the lesson as needed.
- The questions in the Nspire document can be Self-Check, so students can check their answers.