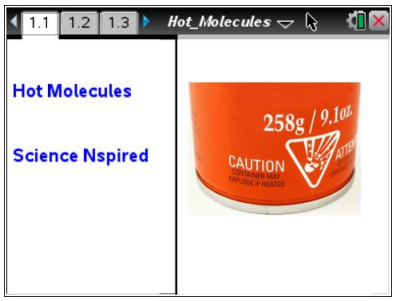
Science Objectives

- Students will observe the motion of molecules with changes in temperature.
- Students will observe the relationship between temperature and pressure of a confined gas.
- Students will predict the effect of a change in temperature on the pressure of a confined gas.



Vocabulary

- gas
- heat
- molecule
- pressure
- temperature

About the Lesson

- This lesson requires students to observe and make predictions about the motion and pressure of the molecules of a confined gas as the temperature is increased or decreased.

TI-Nspire™ Navigator™

- Send out the *Hot_Molecules.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 class 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

- Hot_Molecules_Student.doc
- Hot_Molecules_Student.pdf

TI-Nspire document

- Hot_Molecules.tns

Discussion Points and Possible Answers

TI-Nspire Navigator Opportunities

TI-Nspire Navigator can be used to make screen shots to follow student progress. A visual check can be made to see which students are successful and which are struggling.

Use Quick Poll on any page with a question to check for understanding during the course of the activity. For students using iPad or those teachers without the TI-Nspire Navigator, the questions are set up in in Self-Check. Teachers with TI-Nspire Navigator should change questions to Exam mode for assessment and to discuss using the Review Workspace after the file is collected. On any question page select the Teacher Tool Palette. Then select Question Properties. Change the Document Type from Self-Check to Exam. Then send the file to the students.

Discussion

On the student activity sheet, students read about the Kinetic Molecular Theory of Gases , which explains the motion of ideal gases. This theory states:

- Gases consist of tiny particles (atoms or molecules).
- These particles are small, compared to the distance between them, and therefore, their volume can be considered to be negligible.
- The particles are in constant random motion, colliding with each other and with the walls of the container causing pressure on the container.
- The particles are assumed to have negligible attraction or repulsion for each other.
- The average kinetic energy of the gas particles is directly proportional to the Kelvin temperature.

In this simulation, students observe the changes that occur in the motion of the molecules in a rigid container with a constant volume. They also observe the relationship between the pressure and temperature of the gas in the container.

Move to page 1.2 – 1.6.

Have students answer these questions to gauge prior knowledge needed to understand the simulation.

Q1. What theory governs the motion of molecules in a gas?

Answer: D. Kinetic Molecular

Q2. Gas particles are considered to have _____ attraction or repulsion for other gas molecules.

Answer: B. zero

Q3. Particles of a gas are in _____ motion.

Answer: A. contant, random

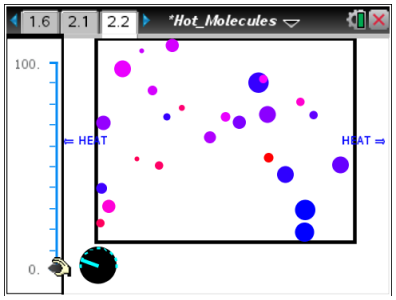
Q4. Based on the Kinetic Molecular Theory, predict what will happen to the pressure of a gas in a closed container as the temperature rises.

Answer: C. increases

Q5. Based on the Kinetic Molecular Theory, predict what will happen to the average motion of the particles of gas in a closed container as the temperature is increased.

Answer: C. The particles will speed up.

Move to pages 2.1 and 2.2.



1. On page 2.2, students will grab the slide bar on the temperature scale and adjust it.
   NOTE: The simulation uses color to represent particle energy. If their handhelds do not support color, students are directed to skip questions related to observations of simulation colors.
   NOTE: The simulation uses the Kelvin temperatures, for which pressure changes are proportional to temperature changes.

> **Teacher Tip:** The gauge on the bottom left of the screen does not adjust instantly. Students will need to change the temperature and then allow the molecules' motion to change, which in turns increases the pressure. They will see the pressure increase as the temperature increases.

2. Students observe the gas at 0 K.
3. Students increase the temperature one mark at a time and observe the color, motion, and pressure.
4. After moving the slider to 100 K and making observations, students decrease the temperature one mark at a time and observe the color, motion, and pressure.

Move to pages 3.1 – 3.9.

Have students answer the questions on either the handheld, on the activity sheet, or both.

Q6. As a temperature of 100 K, the color of most of the molecules changes to_____.

Answer: D. red

Q7. The color change observed in Question 6 indicates that the molecules have _____ average kinetic energy at a higher temperature.

Answer: B. increased

Q8. As the temperature of the gas decreases, what slowly happens to the pressure?

Answer: A. It decreases.

Q9. At a temperature of 0 K, all of the particles are_____.

Answer: D. blue

Q10. From the observation in Question 9, the kinetic energy of the particles at 0 K is _____.

Answer: A. a theoretical minimum

Q11. When the molecules hit the walls of the container, they _____.

Answer: D. bounce off the walls

Q12. Observe the size of the molecules in the simulation carefully. Which would best describe the composition of the gas in the container? The gas is made up of_____ substance(s).

Answer: D. four

Q13. Move the temperature slider one third of the way toward 100 degrees. Sometimes when molecules collide with each other there is a color change for one or both molecules. Explain the meaning of this observation in terms of the energy of the molecules.

Answer: The molecule that becomes more blue loses energy to the molecule that becomes more red.

Q14. Why do aerosol cans have a warning that the container may explode if heated?

Answer: The can is a closed container. If the can is heated, the gas pressure will build up. At some point the pressure would be great enough to cause an explosion.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions by opening it in the Review Workspace.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Review Workspace can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.