Molecules: The Movement of Atoms

Subject Area(s): Organic Chemistry, Engineering, Technology

Associated Unit: None

Associated Lesson: None

Activity Title: Understanding the stereo chemistry of molecules

Header: Insert image 1 here, right justified to wrap

Image 1

ADA Description: Students with robotic molecular model

Caption: Molecular Model Robot

Image file name: Molecular _model_robot_image1.jpg

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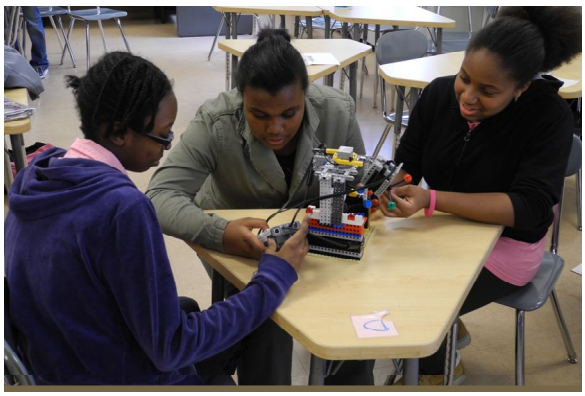

Level: (11 and 12)

Activity Dependency: None

Time Required: 50 minutes

Group Size: Five

Expendable Cost per Group US $3.00

Insert Image 2 here, centered

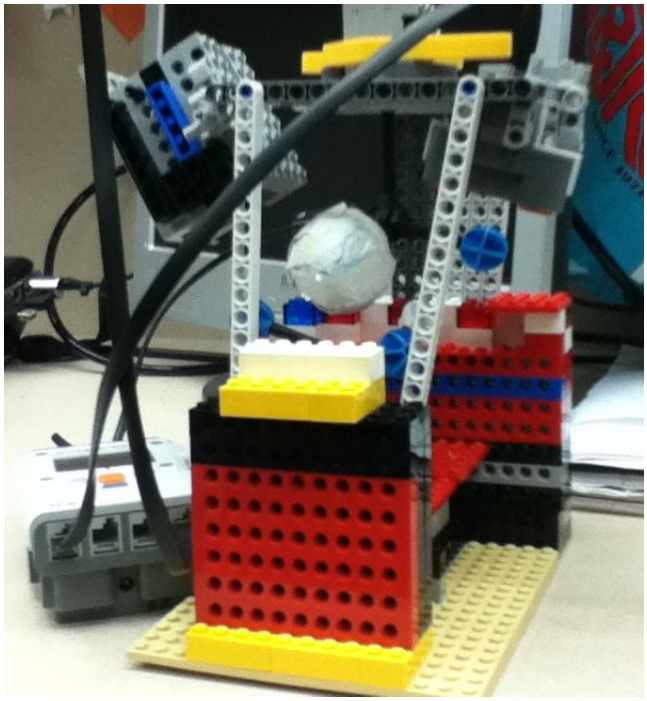

Image 2
ADA Description: Molecular Model Robot
Caption: Molecular Model Robot
Image file name: Molecular _model_robot_image2.jpg

Summary

Students will work as engineers and learn about the properties molecules and how they move in 3D space. They will learn about these concepts through the robotic movements of the molecules and the robotic sensors. The concepts that are learned will cover the size of atoms, newman projections, and the relationship energy and strain on an atom. The information they gather from this activity will allow them to handle rigorous molecular modeling programs.

Engineering Connection

Students will learn to design a molecular model and be able to use different sensors to control the movement of the molecular simulation. Specifically, they will monitor the movement of the molecules through the display screen on the NXT brick, which displays to the output of the sensor. Learning how to program and how to use programs for modeling requires a heavy amount of engineering. Students will learn how to apply their chemistry skills to robotics.

Engineering Category

Relates organic chemistry to engineering

Keywords

Chemistry, molecular modeling, stereochemistry, technology and engineering

Educational Standards

- New York State Standards
  - New York science: 4.4, 4.5
  - New York Technology 5.1, 5.3, 5.4

Pre-Requisite Knowledge: Chemistry concepts about atoms and technology (basic programming skills)

Learning Objectives

After this activity, students will be able to:

- Design a Lego robot as seen in image 2
- Program a robot with NXT MindStorms software
- Be able to program the light sensor and ultrasonic sensor to detect the different color and different size molecules
- Be able to program the response from the light sensor and ultra sonic sensor to the display screen of the NXT
- Learn about steric hindrance of molecules and terms such as newman projections, staggered and eclipsed
- Be able to relate energies with staggered and eclipsed

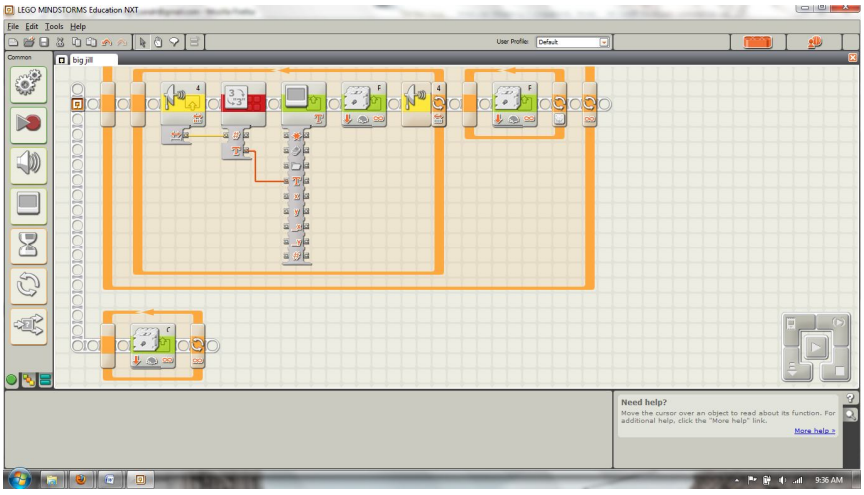

Image 3

ADA Description: Program for light sensor

Caption: Light sensor program

Image file name: Molecular _model_robot_image1.jpg

Materials List

Each group needs:

- Lego NXT Kit
- One NXT Brick
- Molecular modeling Kit
- Different size styrofoam balls with paper to cover them

To share with the entire class:

- Computer with NXT MindStorms programming software
- Computer with NXT MindStorms Data logging Program
- Chemdraw software

Introduction / Motivation

One of the most difficult topics addressed in a chemistry class is the movement of molecules. It is often hard for a student to imagine how molecule can move in 3-D space without seeing the actual movement. There are programs out there that try to help the student visualize the molecules in 3-D space, but they are often too hard to use if one does not have a proper foundation for the concepts.

In this experiment, we plan to enrich the students' knowledge of molecules and their movement of molecules in 3-D space. We plan to teach them about newman projections and staggered/ eclipsed conformations. We plan to go over the size of atoms and how the size of the atom affects the steric strain of the molecule. We also plan to teach them about the lego mindstorms sensors and programming.

Vocabulary/Definitions

Word	Definition
Atom	A basic unit of matter comprised of a dense nucleus with protons + neutrons and a cloud of electrons surrounding the nucleus
Newman Projections	Used to visualize chemical conformations of carbon-carbon bond with the front carbon represented as a dot and the back carbon represented as a circle
Steric Hindrance	When two atoms in a molecule try to fight for space and face overlapping electron clouds, which causes an increase in the energy for the molecule
Staggered Conformation	The energy minimum conformation, where the substituent's have the maximum distance from one another and requires torsion angles $60°$
Eclipsed Conformation	The maximum energy conformation where the adjacent atoms are in the closest proximity of one another

Procedure

Before the Activity

1. Students will work in groups the entire time
2. Have the students design their own molecular model robot
3. Have the students program the robot to detect the different sizes of atoms with the ultra sonic sensor and staggered and eclipsed conformations with the light sensor using different color atoms
4. Go over MindStorms Data logging program and show students how ultrasonic and light sensor. Show them how to program the sensor to detect for different size atoms and different color atoms. Show how to display output from sensors on NXT brick.
5. Teach the students the vocabulary words in the vocabulary box provided above
6. Ask students to try and program their atoms to move, and have big atoms get detected by the ultrasonic sensor. Also, ask them to program the atoms to slow down when the light sensor detects the white atoms lined up in the eclipsed conformation.
7. Teach the students about chemdraw and see if they can understand the models better with the aid of chemdraw

With the Students

1. Show the students the molecular model robot and show them how it works
2. Have the students see if they can create their own program to do the same thing that the demo molecular robot does
3. Students should fill out the worksheet in sync with the molecular model robot and chemdraw

Attachments

Molecular _model_Teach Engineering.doc
Molecular _model _Teach Engineering handout.doc
Molecular _model _robot_image1.jpg
Molecular _model _robot_image2.jpg
Molecular _model _robot_image3.jpg
Molecular _model _robot_image4.jpg

Safety Issues

- None

Troubleshooting Tips

Make sure that the program is proper and all wires are properly connected

Investigating Questions

How do atoms behave in a molecule? What happens to larger atoms in a molecule? Do they experience strain? What is the difference in energy requirement between staggered and eclipsed?

Assessment

Pre-Activity Assessment
Guessing game: Ask them to predict which conformation requires the most energy?

Activity Embedded Assessment
Design a robot: Tell the students to make a connection between the robot and chemdraw

Post-Activity Assessment
Tuning the equation: Challenge the students and ask them to relate conformational strain to energy?

Activity Scaling
- For lower grades: None
- For upper grades: Organic chemistry college students

Additional Multimedia Support
None

Other

None

Redirect URL

http://gk12.poly.edu/amps/

Owners
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 The development of this activity was supported by Project AMPS under a GK-12 Fellows grant 0741714 from the National Science Foundation.