Project: Molecular Modeling

FOR THE TEACHER

Summary
In this project, students will research a molecule selected from the teacher approved list, construct a three-dimensional model of the molecule, and present their research to the class in a 7-10 minute oral presentation.

Grade Level
High School

NGSS Alignment
This project will help prepare your students to meet the performance expectations in the following standards:

- **HS-PS1-1**: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
- **HS-PS1-2**: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- **HS-PS1-3**: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- **HS-PS1-7**: Use mathematical representation to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
- **HS-PS2-6**: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

**Scientific and Engineering Practices:**
- Developing and Using Models
- Analyzing and Interpreting Data
- Obtaining, Evaluating, and Communicating Information

Objectives
By the end of this project, students should be able to
- Describe and understand their molecule's:
  - Name and chemical formula
  - Industrial and/or consumer uses
  - Chemical and physical properties (i.e. melting/boiling point, density, molar mass, reactivity, etc.)
  - Synthesis reaction, including possible by-products
  - Possible environmental issues
- Draw their molecule's Lewis Structure including all bonding and nonbonding electrons
- Determine their molecule's VSEPR shape with corresponding bond angle(s)
- Analyze their molecule's dipole moments to determine overall molecular polarity
- Create a PowerPoint or Prezi presentation from gathered research information
- Construct a three-dimensional model of their molecule including:
  - All bonding and nonbonding electrons
  - Atoms built to relative scale in terms of atomic radius
  - Bonds built to relative scale in terms of bond length of single, double, or triple bonds
  - Bond angles built to relative scale in terms of VSEPR shape
  - The base that the model is mounted on must be decorated to reflect the molecule's uses
- Explain all of the pertinent information about their molecule in a 7-10 minute oral presentation
**Chemistry Topics**

This project supports students’ understanding of

- Molecules and Bonding
- Covalent Bonding
- Lewis Structures
- VSEPR Shapes
- Electronegativity
- Polarity
- Atomic Structure
- Atomic Radius
- Valence Electrons

**Time**

**Teacher Preparation:** 30-60 minutes

**Lesson:** 30 minutes in class, and 3 weeks outside of class

**Materials**

- Project assignment handouts
- Molecule sign-up sheets with teacher approved molecules
- Optional: one example of the three-dimensional model
- Optional: one example of the PowerPoint or Prezi presentation

**Safety**

- No specific safety precautions need to be observed for this project.

**Teacher Notes**

- Possible teacher-approved molecules: NH₃, HOCl, HNO₃, C₂H₂, CHCl₃, CCl₄, H₂O₂, CH₃OH, CO₂, CH₄, H₂S, CS₂, O₃, Recommended for Honors Level only: C₂H₄, H₂CO₃, NO₂, H₂SO₄, N₂O, N₂H₄
- Teacher may want to create an example or have a previous student example of project including three-dimensional model and/or PowerPoint or Prezi presentation. Note that this will cause the “Teacher Preparation Time” indicated above to be longer.
- Teacher may or may not want to use the sample rubric shown below in the student handout.
- The 30 minute in-class time frame is for the teacher to explain and introduce the project. If a teacher wants to give more in-class time to work on the project, then he or she may do so.
- Teachers can decide whether they want students to work alone or in a group. If students are going to work in a group, it is suggested that the group should be no larger than three total people and that these students are friends so that they can easily get together outside of school to work on the project (especially if no in-class time is being provided).
- Students are required to provide their own supplies (unless the teacher or school wants to contribute).
- It is optional whether or not the teacher wants to check-in with the students and/or require a draft to be turned in during the three week time frame.
- The website for Prezi is: [http://www.prezi.com](http://www.prezi.com).
- Allow for 7-10 minute presentations per group (groups of 1-3).
- Sample model projects:
FOR THE STUDENT
Lesson

Molecular Modeling Project

Directions
You may work individually or in a group (no more than 3 TOTAL people in the group) to complete this project!

Due Date: _____________________________

You will construct a 3-D model depicting your molecule and a PowerPoint or Prezi presentation to be presented in class in a 7-10 minute oral presentation. Information regarding each part of this project is outlined below. Molecules will be chosen from an approved list provided by your teacher.

The Model
- You may use any materials you wish except food to construct your molecules. BE CREATIVE!
- The base that the model is mounted on must be decorated to reflect the molecule’s uses.
- All atoms must be labeled using a key.
- Each model of the molecule must contain/represent:
  - All bonds and lone (nonbonding) pairs of electrons around each atom.
  - Atoms built to relative scale in terms of atomic radius. (Example: If you were building a water molecule, the oxygen atom would be bigger in size than the two hydrogen atoms.)
o Bonds depicting the relative lengths of single, double, and triple bonds. (Example: If a molecule has single and double bonds, the double bond should be represented as being shorter than the single bonds.)
o Correct VSEPR shape and approximate bond angles. (Example: If the bond angle is 105°, the model’s bond angle should be bigger than a right angle of 90°.)

**PowerPoint Presentation or Prezi Presentation**
- Use as many pictures as possible. Make your presentation interesting.
- Slide 1: Title Slide—Include name and chemical formula of your molecule, names of student(s), Period X
- Slide 2: Molecule Uses—Include a description of industrial and/or consumer uses, include any relevant pictures
- Slide 3: Molecule Properties—Melting point, boiling point (or decomposition temperature), density, reactivity, etc.
- Slide 4: Lewis Structure—Indicate lone pairs and bonds within structure and include any relevant pictures
- Slide 5: VSEPR Shape—Describe molecular shape, bond angle(s) based on VSEPR theory, overall polarity of molecule, and include any relevant pictures
- Slide 6: Synthesis Reaction—Include a reaction needed to synthesize (manufacture or create) your molecule. (If you are unable to find a synthesis reaction, you can include a reaction that uses your molecule to synthesize another compound.) Include any by-products of the reaction and describe any issues associated with the by-products (like environmental issues, disposal issues, etc).
- Slide 7: Current/Recent Events—Any news concerning your molecule within the last 10 years or a SIGNIFICANT event from the past (prior to 10 years ago).
- Slide 8: Bibliography/Works Cited—MLA format

*You may have more than 8 slides if relevant information arises from your research.
**Be creative and colorful. Use as many pictures as possible. Make your presentation interesting!

**Oral Presentation**
- All members of project must take part in the oral presentation.
- Presentation should be between 7 and 10 minutes.
- Do not read directly from your PowerPoint or Prezi presentation. You may use notecards during your presentation if you like.
- Be sure to practice your oral presentation before the day of the presentation.

**Grading: This project is worth ONE test grade!**

<table>
<thead>
<tr>
<th>Model (35 points total)</th>
<th>Points Earned</th>
<th>Possible Points</th>
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<tbody>
<tr>
<td>Model includes all atoms</td>
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<td>5</td>
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<tr>
<td>Molecules/atoms are built to scale</td>
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</tr>
<tr>
<td>Bond lengths are representative of type of bond</td>
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<tr>
<td>Model includes key depicting molecules/atoms</td>
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<td>5</td>
</tr>
<tr>
<td>Model shows bonding/nonbonding electrons</td>
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<td>5</td>
</tr>
<tr>
<td>Model shows correct VSEPR shape and approximate bond angle(s)</td>
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<td>-------------------------------------------------------------</td>
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<tr>
<td>Base reflects uses of molecule</td>
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<table>
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<tr>
<th>PowerPoint or Prezi Presentation* (45 points total)</th>
<th>Points Earned</th>
<th>Possible Points</th>
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<tbody>
<tr>
<td>1 Title Slide</td>
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<tr>
<td>2 Molecule Uses</td>
<td>6</td>
<td></td>
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<tr>
<td>3 Molecule Properties</td>
<td>2</td>
<td></td>
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<tr>
<td>4 Lewis Structure</td>
<td>4</td>
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<tr>
<td>5 VSEPR Shape</td>
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<tr>
<td>6 Synthesis Reaction</td>
<td>6</td>
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</tr>
<tr>
<td>7 Current/Recent Events</td>
<td>6</td>
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</tr>
<tr>
<td>8 Bibliography/Works Cited</td>
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<tr>
<td>*Overall aesthetics of presentation</td>
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<table>
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<th>Oral Presentation (20 points total)</th>
<th>Points Earned</th>
<th>Possible Points</th>
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<tbody>
<tr>
<td>Students talk clearly and without reading directly from slides</td>
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<td>Students are knowledgeable about molecule and pertinent info.</td>
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<tr>
<td>Each student participates in presentation and project equally</td>
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**Total Points:** 100