Project: Problem-Solving with Materials

FOR THE TEACHER

Summary
In this project, students will develop a presentation to explain how and why a specific material can solve a problem. The explanation will involve researching the properties of the material and how its properties are suited for solving a specific problem.

Grade Level
High School

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

- **HS-PS2-6**: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
- **HS-ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- **Scientific and Engineering Practices**:
  - Obtaining, Evaluating, and Communicating Information

Objectives
By the end of this project, students should be able to

- Identify features of a chemical compound based on its components.
- State and describe how a material can be used to solve a real-word problem.
- Develop a visual aid to enhance a presentation.

Chemistry Topics
This project supports students’ understanding of

- Materials Science
- Molecular structure
- Intermolecular forces
- Intramolecular forces
- Bonding (ionic, covalent, metallic)
- Polarity

Time
**Teacher Preparation**: 10 minutes
**Lesson**: 2 weeks (will vary based research timeline and presentations)

Materials
- Access to computers/devices with internet

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

Teacher Notes
- Prior to the assignment, I show students a collection of videos and articles about current technology and materials that are being used in a problem-solution manner. This helps my class...
talk about how to begin thinking through the research. Below are links to the videos and articles that I have used.

- **Videos:**
  - Graphene, How Stuff Works - (4 minutes)
  - Shape-memory Alloys, How Stuff Works - (3 minutes 30 seconds)
  - Kevlar, National Science Foundation (4 minutes)
  - Aerogel, How It's Made (5 minutes)
  - Aerogel, QUEST Lab (2 minutes)
  - Graphene Project, Billions in Change (3 minutes)

- **Articles:**
  - Thermoelectric devices, MIT News
  - Nanoscale sculpturing, Science Daily
  - High-Nitrogen Materials, Discover Magazine
  - Carbon Nanotubes, Discover Magazine
  - Transparent Metal, Discover Magazine
  - Hyperelastic bone, Discover Magazine
  - Triboelectric nanogenerator, Discover Magazine

- Choose a way for students to submit the presentation to you. I found it is easier on the teacher if students submit to Google Classroom or Turnitin.com. This provides one location for the teacher to pull up the presentations and reduces the down-time between presenters.

- I prefer to have students work in groups of 3-4 due to the amount of class time it takes for the presentations. If time permits, groups of 2 would be more desirable.

- I have found that some students struggle on identifying the specific problem that the material is used to solve. You may need to suggest that they look into *why* is this material better to use than other materials (cost, environmentally friendly, availability, etc.)

- Depending on how comfortable your students are with MLA or APA format, you might want to suggest an online citation generator such as easybib.com, bibme.org, or citationmachine.net.

- **Suggestions on differentiation:**
  - Lower level students may need more guidance on how to locate credible sources online. [This link](#) can be helpful.
  - If you have students with accommodations that restrict being able to verbally present in front of others, suggest recording their voice at home to place into the presentation.

- During presentations, I have students take notes about the materials that others present. The note-taking format that I have used in the past is included in the student section. After all presentations are complete, you could collect and award points for the notes, or use this as an opportunity for students to discuss what was presented. Possibly call on students and ask questions such as:
  - Which was your favorite material presented? Why?
  - Which material do you think would impact your life the most? Why?
  - If you were an investor (like on Shark Tank), which material would you choose to financial support? Why?

- I have students randomly draw for topics in class. This helps to reduce the chance of repeated topics in a class period. Possible materials to investigate include:
  - Aerogel
  - Kevlar
  - Graphene
  - Carbon Nanotubes
  - High-density polyethylene (HDPE)
  - Electric ink
  - Shrilk
  - Pykrete
  - Self-healing concrete
  - Hyperelastic bone
  - Transparent metal
  - Triboelectric nanogenerators
  - Metamaterials
  - Superhydrophobic materials
  - Hyperdiamonds
  - Metallic foam
• When working with groups, I may include a group evaluation following presentations. This allows students to communicate how the group worked together. I tell the students that I will be the only person that will be able to view the forms. A copy of the group evaluation rubric is available for download.

FOR THE STUDENT
Lesson

Materials Science Presentations

Background
Discovering and utilizing the properties of materials is a quickly advancing field. The careful selection of the type and design of a material at the atomic level, has allowed technology to progress rapidly over the last few decades. Technology and science depend on one another. As we gain more knowledge, we can develop better technology. This then leads us to advancing our knowledge again. Often the path to discovery is driven by a need to solve a modern day problem that we are facing.

Problem
How do materials impact our world?

Materials
• Computer or device with internet access

Instructions
Research the following information about your material.

<table>
<thead>
<tr>
<th>Category</th>
<th>Ideas for Writing</th>
<th>Value</th>
</tr>
</thead>
</table>
| History and Discovery of the Material | -What is the material?  
-When/where was it discovered/created?  
-Who discovered/created it?  
-Why was it discovered/created? (What problem was trying to be solved? Was it created on accident?) | 5 points |
| Science of the Material           | Provide as many of these things as you can find:  
-Chemical Formula (elements)  
-Structure / model of compound  
-Intermolecular forces, type of compound  
-Physical properties (MP, BP, molecular mass, color, flexibility, etc...)  
-Chemical Properties (combustible, etc...)  
-How is it created? | 10 points |
| Current Use and Technology        | -What is it currently being used for?  
-What problems is the material solving? Why is it a problem? (cost-benefits) Who and what does the problem affect? What is the cause of (or reason) for the problem?  
-To what extent is the solution solving the problem? How is the solution making a difference?  
-What technology can it be found in? | 15 points |
<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
<th>Points</th>
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<tbody>
<tr>
<td>How is it used in your life?</td>
<td>- What could we use it for in the future?</td>
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<td>- How is it being studied for new inventions?</td>
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<td>- How could it be improved even more?</td>
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<td>Future Uses and Technology</td>
<td>- What are some arguments for / against the solution?</td>
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<td>- What are the consequences (both good and bad) of the science applied</td>
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<td></td>
<td>with one of these aspects: moral, ethical, social, economic, political,</td>
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<td></td>
<td>cultural, and environmental?</td>
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<tr>
<td>Implications of Using the</td>
<td>- Are chemistry terms used correctly?</td>
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<tr>
<td>Material</td>
<td>- Are there any grammar and spelling errors?</td>
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<td></td>
<td>- Can a reader understand the concepts presented?</td>
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<tr>
<td>Scientific Content</td>
<td>- Are there citations, as appropriate?</td>
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<td>- Is there a Works Cited page with at least 3 sources documented</td>
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<td>correctly with MLA or APA format?</td>
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<td>- Did you support with evidence from credible sources?</td>
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<td>The student has documented</td>
<td>4-5 minute presentation (8-10 min if in a group)</td>
<td>5</td>
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<td>sources completely, including</td>
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<td>in-text citations when</td>
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<td>appropriate.</td>
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<tr>
<td>Presentation Length</td>
<td>eye contact, voice clarity, posture, etc…</td>
<td>5</td>
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<td>Presentation Skills</td>
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<tr>
<td>Visual Aid</td>
<td>neatness, images, appropriate length, overall effort</td>
<td>10</td>
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<tr>
<td><strong>Total Points Possible:</strong></td>
<td></td>
<td>75</td>
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**Tips for making an Effective Power Point**

1. Write a script.
   a. Use your outline to generate a script of information that should be included.
   b. Use this to make notecards as a reference for your presentation.

2. One thing at a time, please.
   a. Try not to put too much on one slide. “Chunk” your information.

3. No paragraphs.
   a. Use shortened phrases and sentences on the power point.
   b. Explain and give detail verbally to support your power point information.

4. Pay attention to design.
   a. Font should be large enough to see in the back of the room.
   b. Choose a background that makes the font visible.

5. Use images sparingly.
   a. Images should support your presentation, not distract the audience.
   b. If you include the image, reference it when you speak.

6. Think outside the screen.
   a. You should talk about more than just the words written on the power point.
   b. The screen helps your presentation; it does not “stand alone”.

American Association of Chemistry Teachers
Presentation Note-Taking
Use the following outline to help guide you through your research.

A. Notes on the history and discovery of the material you chose:

Web Source(s):

B. Notes on the science of the material:

Web Source(s):

C. Notes on current uses and technology for the material:

Web Source(s):

D. Notes on the specific problem the material is solving:

Web Source(s):

E. Notes on future uses and technology for the material:

Web Source(s):

F. Notes on the implications (both good and bad) of the science applied to solve the problem with ONE of these aspects:

**Moral:** having to do with personal beliefs about right and wrong  
**Ethical:** having to do with what society considers to be right or wrong  
**Social:** having to do with people interacting and sharing a common location  
**Economic:** having to do with money  
**Political:** having to do with politics, policies, laws, government  
**Cultural:** having to do with beliefs, behaviors, objects, and other characteristics common to the members of a group or society
*Environmental*: having to do with the environment

Web Source(s):

**Don’t forget to make an MLA or APA formatted Works Cited Slide!**

**Analysis**

While other students are presenting, take notes about their material being presented.

<table>
<thead>
<tr>
<th>Material</th>
<th>Properties</th>
<th>Uses</th>
<th>Implications</th>
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Conclusion
After presenting and watching others present, answer the following reflection questions.

1. Do you feel that your/your group effectively presented all of the requirements of the project? Why / why not?

2. Were there any groups that you thought were very effective in communicating all of the requirements of the project?

3. If you could re-do your presentation, what would you want to change? Why?