Lesson 5: Synthesizing a Synthetic

Lesson Big Idea(s):

- All synthetic materials are made from natural resources that come from the Earth.
- Natural resources are processed through chemical and physical changes to create the synthetic materials humans use.

Lesson Question(s):

- How are substances processed to make synthetic materials?
- Where do these substances come from?

Lesson Introduction:

In previous lessons within Unit 7.3, students have learned the difference between physical and chemical properties, how these properties relate to thermal energy transfer, and how these properties can change as materials are processed by humans. In this lesson, students will think critically about the process of synthesizing the materials we use in our everyday lives. They will discover that synthetic materials originate from natural resources, both renewable and nonrenewable, that undergo chemical and/or physical changes to enhance the properties that humans find valuable for specific needs. Scientists and engineers are constantly examining the properties of natural resources and determining new ways to fashion these resources into common or completely new synthetic materials to meet societal needs.

In this lesson, natural resources are defined as materials that have useful properties that can be found within the environment. A natural resource exists in an undisturbed state in nature. Then, it is removed from its natural environment and processed. A tree is processed into usable timber. An ore is processed into usable iron. Slate is quarried and cut into roof shingles. Salt is mined for seasoning food and deicing roads. Tree pulp, basalt rock, petroleum, and silica sand are all processed into different insulation materials. All of these materials have gone through changes such that the materials do not exist in the same form in nature. Dictionaries typically define synthetic materials like this;

> *Synthetic; "(Of a substance) made by chemical synthesis, especially to imitate a natural product; e.g. synthetic rubber."*

For the purposes of this unit, the term synthetic will also refer to materials that have been processed significantly but might not involve a chemical change. The discussions of natural resources being turned into useful synthetic materials in this lesson will provide background as students move on to future lessons in the unit, where they learn about the physical locations of natural resources and the consequences of natural resource use by human societies.

Additional Resources to Support Teacher Background Knowledge:

- General Chemistry Online: Ten signs of chemical Change: http://antoine.frostburg.edu/chem/senese/101/reactions/symptoms.shtml
- Beautiful Chemistry: http://www.beautifulchemistry.net/reaction

NGSS Connections

Semester Unifying Crosscutting Concept: **Energy & Matter**
Primary Subcomponents

SEP: Science & Engineering Practices

Obtaining, Evaluating, and Communicating Information: Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS PS1-3)

DCI: Disciplinary Core Ideas

PS1.B: Chemical Reactions: Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3, MS-PS1-2, MS-PS1-5)

PS1.A: Structure and Properties of Matter: Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3, MS-PS1-2)

CCC: Crosscutting Concepts

Structure and Function: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)

Supporting Subcomponents

CCC: Crosscutting Concepts

Energy and Matter: Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)

Prior and Future Knowledge

Within previous middle school MI-STAR units or lessons students will have covered the following NGSS subcomponents relevant for this lesson:

- MS-ESS2.A: Earth's Materials and Systems
    - Cycling of Earth materials
- MS-LS1.C: Organization for Matter and Energy Flow in Organisms
    - Food is rearranged through chemical reactions forming new molecules.
- MS-PS1.B Chemical Reactions:
    - New substances formed from chemical reactions have different properties and molecular structure than the reactants.

Earlier in the unit student have become familiar with the following vocabulary:

- Synthetic Material
- Natural Resource
- Processed Materials
- Manufacturing Process

Lesson Learning Performances

Learning Performances	Evidence of Student Learning

Students will be able to:
obtain and synthesize information that describes how synthetic materials, via physical and chemical processes, come from natural resources.
	• Students obtain information from published, grade-level sources.
	• Students determine the credibility, accuracy, and possible bias of each source of information.
	• Students synthesize information from those sources to describe how:
	  ○ All synthetics are derived from natural resources and/or other human-made substances.
	  ○ Synthetics and manufactured products are the outputs created through chemical and/or physical processes.
	  ○ Manufactured material(s) have physical and chemical properties that make them structurally different from the natural resource(s) from which they are derived.

Students will be able to:
construct an explanation from evidence to determine if a chemical reaction (a rearrangement of atoms) has occurred by identifying new chemical and/or physical properties.
	• Students construct oral or written explanations and arguments based on evidence to determine that:
	  ○ A chemical reaction has or has not occurred during a manufacturing process.
	  ○ Whether a material can be consider synthetic.

Students will be able to: **construct explanations for the chemical reaction of substances and the creation of synthetic materials based on evidence of change in their physical and chemical properties.**	

Example Gotta Have Checklist

- ✓ How the properties of the reactant(s) are similar or different than the product(s)?
- ✓ How and why the reactants changed during the reaction.
- ✓ How a synthetic material (product) can be made from natural resources (reactants).
- ✓ Why do some synthetic materials have an altered structure with enhanced properties that make them more useful to humans?

Lesson Basics

Teaching Time: 3-4 Class Periods (assuming 50 minute periods)
Instructional Setting: Classroom; Access to Computers with Internet Access

Advance Preparation:

- Prepare Borax Solution for each group of 2-4 students
    - Measure 2¼ cups of water into a cup or bottle. Add a teaspoon of Borax (normally sold under the brand name 20- Mule Team Borax at the grocery story). Mix well and label.
- Set up materials for the Uncover Your Ideas instructional phase activity
- Print any resources or student guides you choose to use
- Identify computers with internet access or download videos and other online sources of information needed for the Connect Your Ideas instructional phase activity

Materials & Resources Needed

Anchoring Experience Phase

- 7.3_L5_LessonSlides_ex
    - a computer that can display this PowerPoint.
- Common Materials ranging from naturally occurring to highly processed or Lesson 3 materials

Uncover Your Ideas Phase

Per Student:

- 7.3_L5_WS1_StudentGuide_Synthesizing_Flubber_ex
- 7.3 Unit Summary Table_Blank
- 7.3_Unit Summary Table_with expected answers

Per student group:

- Glue
- Borax Solution
- Spoon to measure
- 4 Cups
- Small sample of Borax
- Craft sticks or Spoons
- Permanent Marker

Connect Your Ideas Phase

- 7.3_L5_WS2_Elaborate Student Guide_ex
- CARS from https://www.literacyta.com/ecoach/evaluating-credibility-websites
- Computer with internet access or downloaded videos for each insulation material group

Check Your Progress Phase

- Unit 7.3 Lesson 5 Embedded Assessment Teacher Instructions & Rubric

Safety Considerations

- Students should take care when handling borax and wash hands after use.
    - Borax is harmful if swallowed and on rare occasions handling it may cause a rash.
- Safety goggles should be worn as appropriate.

Mi-STAR Instructional Phases

Anchoring Experience:

Anchoring Experience Phase Summary:
Students inspect a variety of natural and human-made materials and speculate as to their origin, those from the Earth and those not from the Earth. This activity builds toward the lesson questions: How are substances processed to make synthetic materials? Where do these substances come from?

Resources Needed For this Instructional Phase:
7.3_L5_LessonSlides_ex

Student Steps:

1. Students examine samples of familiar manufactured products or natural resources such as such as paper, apple/fruit, plastic bottle, rock, wooden desk, glass cup, computer, cell phone, rubber band, or aluminum can.
2. Through a think-pair-share or similar pedagogical activity students categorize the materials into two groups: 1) those that come from the Earth 2) those that don't.
    a. Students consider their ideas through a line of questioning similar to the following:
        i. Which of these materials occurs naturally?
        ii. Have any of these been processed in some way?
        iii. Which of these are synthetic? Why do you think that?
    b. Students communicate their ideas with each other and provide a rationale for their categorizations.
        i. **Teacher Note:** Likely the students will answer that some materials such as a computer, cell phone, rubber or aluminum don't come from the Earth, while other materials such as apples, rocks or paper do come from the Earth.
3. Students are introduced to the following claim and provide their initial reactions: "All materials come from the Earth". Students may provide these reactions using classroom discourse facilitated by the teacher.
    a. **Teacher Note:** This claim is intended to cause some discrepancy in student thinking. The discourse should be short as students will be exploring this claim further in this lesson.

4. Students are introduced to the Lesson Question:
    a. How are substances processed to make synthetic materials? Where do these substances come from?

Uncover Your Ideas

Uncover Your Ideas Phase Summary:
Students will create a synthetic material, flubber, from the mineral borax and glue. As students will come to recognize in the "Share your Idea" phase they are conducting chemical reactions. The ingredients are *reactants* and the resulting flubber is the *product* though these terms should not be introduced to students until later in the lesson. Students investigate how the properties of the reactants change as a result of mixing them. Students observe that by varying the concentration of reactants (glue and borax solution) in a mixture, the physical properties of the product (flubber) will also change. Students analyze the properties of each of the resulting four batches of flubber. Students notice that changing the amounts of each ingredient will produce a product with different properties. Students also observe that all of the ingredients combined in the mixture are part of the product. As a class, students select a concentration of the ingredients that creates flubber with properties desirable to the class.

Resources Needed For this Instructional Phase:
7.3_L5_WS1_StudentGuide_Synthesizing_Flubber_ex
7.3_UnitSummaryTable_StudentVersion

Student Steps:

1. Students learn that they will attempt to manufacture flubber in small groups to explore the lesson question further and, eventually, to better understand the manufacturing process that leads to the creation of the unit challenge insulation materials and their unique material properties.
2. Students are introduced to a picture of flubber (or silly putty) or play with a sample of flubber and discuss:
    a. What properties would you want a toy like flubber to have? *Examples may include bounce and stretch.*
    b. Where does flubber come from?
3. Each student may be provided with a **Synthesizing Flubber Student Guide** to steer their investigation of flubber.

4. Student groups are provided with a small sample of borax and glue and asked to describe the properties of small samples (e.g. solid, Liquid, white, sticky, smooth, etc.). They may record their thoughts under #1 in the Synthesizing Flubber Student Guide.
5. Students are asked to learn more about the origin of borax and glue. Students may find their own resources or use those provided by their teachers. Teachers may guide their thinking by asking the following questions:
    a. What is it made of?
    b. Where does it come from?
    c. Is it naturally occurring?
6. Students make four different batches of flubber using the procedure described in #3-8 in the Synthesizing Flubber Student Guide and the data table below.
    a. **Teacher Note**: Alternatively, students reproduce a manufacturer's recipe for flubber (provided by you) that does not meet desired property criteria--maybe the manufacturer's recipe creates flubber that is too runny or too chunky or does not bounce or stretch. Students record how their criteria are or are not met with the resultant flubber. Students brainstorm how the recipe could be changed to improve the product to meet their criteria. Students create their own investigation with a data table specifying the quantities of each reactant. Students test their own combinations. Students adjust their concentrations based on hypotheses about which concentrations will best meet the desired criteria.
7. As students are mixing the reactants they will complete the "Observations during the 'manufacturing' process" column of the data table and once the batch of flubber is completely mixed the student will complete the "Observations of the Flubber" column in the data table. Teacher may choose to guide the students' think with questions such as:
    a. What does the flubber feel like? Does it bounce or stretch?
    b. Does it have the desirable properties of our toy flubber?
    c. How would you change the reactants to get these desirable properties? Why?
8. Students review their observations in order to compare and contrast the properties of the reactant (borax and glue) and product (flubber). The students may answer the following question in the **Synthesizing Flubber Student Guide**:
    a. What properties of the flubber change as the amount of glue used increases?
    b. What are the properties of the 'best' flubber? What concentration of reactants produced a product that produced the best toy? Why?

   c. How are the properties of the flubber different than the properties of borax and glue?
9. In small groups or as a class students make an initial explanation for what happened to the borax and glue.
   a. Did what go into the reaction come out in the product? If so, how did the borax and glue change?
   b. **Teacher Note**: Try to scaffold students' understanding that a chemical reaction has taken place without using formal scientific terms that they will be introduced to in the next instructional phase of the lesson.
10. Students revisit the claim that 'All materials come from the Earth." Students should think about their experience making flubber from borax and glue when considering the claim.
11. Students will complete the "Lesson Question" and "What did we do?" column on their copy of **7.3_UnitSummaryTable_StudentVersion**.

Container	Glue	Borax Mix	Observations during the 'manufacturing' process	Observations of the Flubber
Cup A	4 spoonfuls	2 spoonfuls		
Cup B	5 spoonfuls	2 spoonfuls		
Cup C	6 spoonfuls	2 spoonfuls		
Cup D	7 spoonfuls	2 spoonfuls		

Share Your Ideas

Share Your Ideas Phase Summary

Students develop explanations for the concepts and practices uncovered during their investigation of flubber in order to better understand the lesson question. Students will obtain and evaluate information from multiple sources (print, Internet, or textbooks) as needed to develop their explanations using evidence-based reasoning from their flubber investigation and includes the necessary science and engineering terminology. Throughout this instructional phase, students will develop a lesson level "**Gotta Have Checklist**" (Note: You can work with students to develop this list using the 'components of a Gotta Have Checklist' or you may choose to give it to the students). To develop this checklist the teacher will facilitate students' reflection on the properties of the reactants and products of the Flubber. Students then construct an explanation of why some properties change using a simplified chemical equation of the process. Students develop an argument for whether flubber is a synthetic material or not by considering whether chemical reaction has taken place during the manufacturing process. By the end of this instructional phase students will use the "Gotta Have Checklist" to revisit the "What did we do?" column and complete the "What evidence did we gather?" column for this lesson on the **Unit Summary Table**.

Resources Needed For this Instructional Phase:

7.3_L5_explain_notesheet

7.3_L5_Gotta have checklist

7.3_UnitSummaryTable_StudentVersion

Ten Signs of Chemical Change:

http://antoine.frostburg.edu/chem/senese/101/reactions/symptoms.shtml

Student Steps:

1. During the previous phase students recognized that the properties of the flubber are different than those of borax and glue, coming to a conclusion that some type of change occurred during the mixing of the flubber. Now, students should obtain information through published text and/or using lesson slides to develop their understanding of chemical reactions including the difference between reactants and

products. Students apply their new knowledge of chemical reactions to add information to the "**Gotta Have Checklist**" as appropriate.

2. Students apply the information and the evidence that they collected in their investigation of flubber to develop a scientifically based explanation for what occurred. The questions below can be used to focus students' thinking, and teachers should lead students to refer back to the "**Gotta Have Checklist**" as the students develop their explanation.
    a. What were the reactants and products? *The reactants were the borax mix and glue. The product was the flubber.*
    b. What would a simplified chemical equation for this process look like? *Borax+Glue→ Flubber*
    c. How did properties of the reactants and products change during the making of the product? *Students observations will vary depending on the product and the reactants used to make the product.*
    d. Did a chemical reaction take place during the explore activity? *Students should base their claim/argument on a comparison of their observations with a list of signs of chemical change such as this one:* Ten Signs of Chemical Change.
    e. Did the arrangement of molecules or atoms change between the reactants and products? *Students may develop or be provided a model to visualize the chemical reaction that occurred at a molecular and atomic level. The model should include a simplified, grade-level version of the chemical structure of the reactants and products (see "Is Flubber a New Substance" slide in the* **Lesson Slides***, or for an example activity, see page* F-7 of the Oregon Museum's "Choose Your Ooze" lesson *that explains that the number of atoms in the reactants and products have not changed, only been rearranged.*
    f. How is the molecular structure of the reactant or product related to their bulk properties? *The molecular structure of the reactants or products determines the unique bulk properties of the reactant or product.*
3. Now students construct an explanation for whether the flubber is a synthetic material using information they obtained from published sources. Students apply their new knowledge of chemical reactions to add information to the "**Gotta Have Checklist**" as appropriate.
4. The questions below can be used to focus students' thinking, and teachers should lead students to refer back to the "**Gotta Have Checklist**" as the students develop their explanations about synthetic materials. Encourage students to locate outside sources of information where necessary:

a. Is the product a synthetic material? Why or why not? *The product is a synthetic material because a chemical reaction occurred that created a human-made material and changed the physical and chemical properties of the original substances. Flubber cannot be found in nature. Humans must "process" the reactants to create flubber.*
b. Where do the reactants come from? Are they naturally occurring or synthetic? *In the case of flubber, glue is a synthetic created from a variety of natural resources (answers will depend on the information obtained in the 'Uncover Your Ideas" phase) and borax is a natural resource (a mineral). Synthetic materials are made by humans that cannot be found in the naturally occurring environment. Natural resources are materials or substances such as minerals, trees, water, and soil that occur in nature and can be used by humans.*
c. Where do the reactants for synthetic materials come from? *Even though synthetic materials are often called "man-made," all of the basic reactants used to produce the final product are derived from natural resources. In this case glue is a synthetic*
d. How do you know that the creation of a synthetic material is the result of a chemical reaction? What is the evidence that you have observed? *The atoms in the two original reactants (glue and borax) were rearranged; The properties of the product are different than those of the reactants.*
e. *Students may refer to the Ten Signs of Chemical Change as needed*

5. Students apply what they have learned about chemical reactions and synthetic materials to the lesson crosscutting concept, *Structure and Function:* Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.
    a. What function does the synthetic material provide that the natural resources alone could not?
    b. How might this be related to the structure of the atoms/molecule that make up each? *The molecule structure of the product creates bulk material properties (e.g. bouncy, stretchy) that are more useful for a particular function (e.g. playing with) than the reactants*
6. Students will complete the "What evidence did we gather?" and "What did we learn?" columns on their **Unit Summary Table** using the **Gotta Have Checklist** they have developed.

Connect Your Ideas (Connect to the Unit Challenge)

Connect Your Ideas Phase Summary:

Students connect back to the Unit Challenge in this phase. Individual students or unit challenge groups gather information from 'How its Made' Videos highlighting the manufacturing processes and the natural resources and other materials needed to create their insulation material. Students consider the credibility, possible bias, accuracy, and relevancy of the sources to support an argument. Then, using the Student Guide located in the resources section below, students will identify the reactants and products involved in the manufacturing process, describe the physical and/or chemical changes that have occurred, and identify how the altered structure of the material enhances its useful function. Students will communicate what they have learned by developing a simplified chemical equation of the manufacturing process for their insulation material. The students will revisit the "What evidence did we gather?" column and complete the "How does this evidence relate to the Unit Challenge" column in the evidence did in the **Unit Summary Table**. The knowledge that students build in the phase will also be used to update the manufacturing stage of the Life Cycle model of their insulation material. Students will discover that primary natural resource from which their insulation material is derived.

Resources Needed For this Instructional Phase:

7.3_L5_WS2_Elaborate Student Guide_ex
7.3_ESP_GraphicOrganizer_LifeCycleStages
7.3_SummaryTable_StudentVersion
CARS: https://www.literacyta.com/ecoach/evaluating-credibility-websites

Student Steps:

1. Students will gather information about the manufacturing of their insulation material from the following online videos and other published sources or locate their own sources of information.
    a. Polystyrene Foam Board:
        i. https://www.youtube.com/watch?v=q6OVD_2xliM
    b. Where Does Plastic Come From:
        i. https://www.youtube.com/watch?v=6eCt0VDg-Kc
        ii. If needed information from the following pages might be helpful:

1. http://www.nobelprize.org/educational/chemistry/plastics/readmore.html
2. http://science.howstuffworks.com/plastic5.htm

c. Cellulose Insulation:
   i. https://www.youtube.com/watch?v=6GZc07iQyIk
d. Where Does Paper Come From:
   i. https://www.youtube.com/watch?v=fZ3HQ9lBHuA
   ii. https://www.youtube.com/watch?v=9Kt5dHMBvYM
e. Fiberglass Insulation:
   i. https://www.youtube.com/watch?v=UfwIv0hvntw
f. Rock Wool / Stone Wool
   i. https://www.youtube.com/watch?v=t6FWPTZjwLo

2. Students evaluate the credibility, possible bias, accuracy, and relevancy of their sources. They make a written argument about the suitability of the source as a reference (question #4 in **7.3_L5_WS2_Elaborate Student Guide_ex**).
   a. Students may respond to questions from a **CARS checklist** to guide their evaluation.
3. Students will use the lesson "**Gotta Have Checklist**," as well as information that they entered into the "What did we learn?" column of their **Summary Table**, to synthesize the published information about the manufacturing of their insulation material and answer the lesson question in the context of the unit challenge. Students may use the questions below (same as #1-3, 5-8 on the **7.3_L5_WS2_Elaborate Student Guide_ex**) to facilitate the construction of their explanations.
   a. What are the reactants used to make the insulation material? *Add answers…*
   b. Which inputs are natural? Which are synthetic? *Add answers…*
   c. What process are involved in the manufacturing of the insulation material?
   d. Aside from the insulation material, are there any additional products from the manufacturing process? Are there any wastes? (e.g. wastewater, extra materials, exhaust gases).
   e. Compose a simple chemical equation for how matter changes during the creation of the insulation material. For example, a simple chemical equation for flubber would be: borax + glue + water → flubber.
   f. What are the properties of the reactants? What are the properties of the products? How do the properties of the reactants compare to the products?
      i. **Teacher Note:** Students will find information about the properties of the inputs on their property cards from Lesson 3. Students will need

to research or use their prior knowledge to determine the properties of waste outputs. Do the materials undergo a physical or chemical change? How do you know?

g. Is your insulation material a synthetic material? How do you know? *In their explanation, students should be sure to compare and contrast the properties of the reactants and products and consider whether any chemical have occurred. Students may refer to the resource Ten Signs of Chemical Change if needed.*

h. What function does the synthetic material provide that the natural resources alone could not? How might this be related to the structure of the atoms/molecule that make up each?

4. Students complete "How does this evidence relate to the unit challenge?" column in their **Unit Challenge Summary Table** using the Gotta Have Checklist developed in the "Share Your Ideas" phase.
5. Students will update the Material Processing Stage of their **Graphic Organizer** to show the life cycle of an insulation material model using the information that they have discovered during this instruction phase.

Check Your Progress

Check Your Progress Phase Summary:
Students will complete a three dimensional Mi-STAR embedded assessment associated with this phase. Instructions on how to implement and score the Embedded Assessment are included in the accompanying resource linked below. During the Embedded Assessment students will individually check their progress of the learning performances by gathering and synthesizing information about two provided synthetic materials and answering the lesson questions: "How are substances processed to make synthetic materials? Where do these substances come from?" Depending on the preferences of the teachers facilitating this lesson the students may use the lesson Gotta Have Checklist as a resource to develop their explanations or may be asked to create these explanations on their own.

Resources Needed for this Instructional Phase:
7.3_L5_EmbeddedAssessment_CheckYourProgressExemplar
CARS: https://www.literacyta.com/ecoach/evaluating-credibility-websites

Student Steps:

1. Students gather information from provided sources
    a. **Teacher Note**: The rubric provided as a resource assumes students picked a synthetic material (not a natural material, nor a natural material that only went through a physical change) to analyze, so if you are going to use this as an assessment you want to limit the objects students can analyze. We suggest a frisbee and/or plastic pop bottle because these two objects undergo both chemical and physical changes during manufacture so they are good examples for students to analyze.
    b. Example resources/sources for this list of objects and links to sources/resources that students could use:
        i. Frisbee
            1. http://www.madehow.com/Volume-5/Frisbee.html
            2. http://www.britannica.com/science/polyethylene
        ii. Plastic bottle
            1. http://www.thomasnet.com/articles/materials-handling/plastic-bottle-manufacturing
            2. https://www.youtube.com/watch?v=ZfyPCujUPms
2. Students evaluate the credibility, possible bias, accuracy, and relevancy of the provided sources using the **CARS checklist** or something similar.
3. Students synthesize the gathered information to write an explanation for the origin of the material that includes:
    a. A claim about the type of processing (chemical and/or physical) that the material went through in order to create the final product.
    b. Evidence for your claim about the type of processing that was used.
    c. Your reasoning about why you believe this evidence supports your claim.
        i. **Teacher Note**: If you want to shorten the activity you could ask your students to focus only on the chemical processing. If you want to scaffold this activity for your students, you could tell your students that their object involved both chemical and physical processing and that they need to describe and explain each.
4. Students describe how the processing (chemical and/or physical) changed the material so that it has the properties needed for the product to function.
    a. The following line of questioning may be used as prompts for students:
        i. What reactants are used to make this material? Which of these are natural? Which are synthetic?

   ii. Have natural materials undergone a chemical change to make the new material? How do you know?
   iii. What processes (chemical and/or physical) were involved to produce the new material?
   iv. Does all of the matter that goes into the manufacturing process as reactants come out as products?
   v. What function does the synthetic material provide that the natural resources alone could not? What specific properties does the synthetic material have that allow it to perform that function?
5. Students reflect on the lesson question and consider their learning throughout the phase. Once the **embedded assessment** is scored the students may further reflect on their learning by reviewing the rubric and their answers.

Sources

Oregon Museum and Science Center. "Choose Your Ooze".
http://www.omsi.edu/sites/all/FTP/files/chemistry/NH-PDF/NH-F1-ChooseOoze.pdf
(note, may not load correctly in all browsers. If it doesn't load, try a different browser like Firefox or Chrome)