

Unit 7.3

“The Stuff We Use and Where it Comes From”: Life Cycle of Building Materials

Public Preview

Unit Summary

Students use product life cycle models to explore the relationships between the things we manufacture and use to meet society's needs and the natural resources utilized to make these things. Throughout the unit students are challenged to discover and use scientific evidence to select the best wall insulation material for a community building.

The uneven distribution of mineral, energy, and groundwater resources is due to geological and earth processes that have occurred on a variety of timescales and have operated over vast periods of time (ESS 3-1). Many of these resources are nonrenewable, but are very important for the health and prosperity of human populations (ESS 3-4). For example, the availability of natural resources impacts the production of synthetic materials that we rely on to effectively insulate our homes (PS 1-3). The use of insulation then helps to reduce negative impacts of energy use for heating and cooling, so we will study thermal energy and the transfer of thermal energy (heat) and apply this learning to the use of building insulation (PS3-3).

Unit Challenge Questions:

- How can growing societies reduce impacts on earth systems and conserve natural resources through their choice of building materials?

Unit Big Ideas:

- Science and engineering can explain how building materials are obtained, manufactured, and used to maximize performance.
- Science and engineering can help with conserving natural resources and reducing negative impacts on earth systems.

Connection to 21st Century Issues:

In this unit we will consider the products and material we use to construct our communities' buildings. We encounter buildings everywhere, yet we do not often consider how the materials that buildings are made of impacts our lives. Our continually growing human population depends on natural resources created through earth processes. All of the useful products we use in our daily lives are made from limited non-renewable resources (e.g. minerals) and renewable resources (e.g. fish and trees) that require making management decisions to ensure their availability for future generations. Each of these products impacts earth systems throughout its 'lifetime', which can be described as several stages: 1) the acquisition of the natural resources, 2) production of the product, 3) transporting the product (which can happen during several of these phases), 4) use of the product, and 5) disposal (which could be recycling, reuse, or landfilling). Together, these steps make up what is called a "product life cycle". In order to ensure a bright future for Michigan, we must think about how our decisions to purchase new products or develop new technology impacts our environment. The application of science and engineering practices in decision making and life cycle analysis helps to ensure resource conservation and reduce the negative impact on earth systems.

Due to the limited availability of resources, conservation and/or more efficient use are key components of natural resource management. In this unit, students use several science and engineering practices to construct a life cycle model of products used for building insulation. Then, the model and other evidence is used to decide which material should be used for a new building.

Unit Challenge

Unit Challenge Summary:

Students use science and engineering practices to apply their understanding of disciplinary core ideas to develop a life cycle model of an insulation material. Students gather and examine evidence regarding insulation materials in order to construct an explanation of the properties and functions of a particular insulation material. Students compile new knowledge and evidence throughout the unit into a Unit Summary Table that will help students as they continually build a life cycle model. The final life cycle model, the unit

summary table, and information from student notebooks will all be used at the end of the unit to complete an Evidence Matrix. Students use evidence to support their reasoning for a choice of which insulation material maximizes the conservation of natural resources and minimizes negative impacts on earth systems while serving the desired function, which is to effectively insulate a building. Students will make final recommendations as to the “best” insulation material as outlined in the Unit Challenge Scenario.

Unit Challenge Scenario

Note: Phrases in **bold** are likely to be beyond the knowledge of students as they begin this unit. This is OK because they will be coming back to these ideas several times throughout the unit.

The mayor of your town is competing for an **environmental** award which, if won, will provide many benefits to the community. The mayor has decided to plan a new community center building to win this award. In order to win, the mayor has commissioned your class to investigate individual **insulation materials** for the walls of the building. Your class will provide an explanation based on science and engineering ideas to choose the best insulation material; that is, the one which does the best job of saving energy used to heat and cool the building and also **minimizes negative impacts** on earth systems during its entire **life cycle**. The class will divide into small research teams, each one examining one specific insulation material. The teams will use knowledge from the lessons in the unit to complete a **life cycle model** for their insulation material. This model will be used along with other learning to create an **evidence matrix**, which is an engineering tool to help determine that material’s suitability for use in the community building. At the end of the unit, each research team will share the findings for their insulation material. Finally class will use the evidence presented by all of the research teams to decide which material is best to use for the community building and give the project the best chance of winning. A recommendation on which material to use, and why it was chosen, will be made to the mayor.

Teacher note: Details of this scenario can be adapted to fit your region and students. For example, the students could be researching insulation materials to build dog houses for the Humane Society as part of a community initiative. The students could be researching insulation that will be used in a new wing of their school building. Teachers are encouraged to adjust the audience (mayor), purpose (community center), and other aspects of the scenario in order make it most relevant to their students.

Unit Challenge Student Products & Teacher Resources

Exemplary Student Products and Other Teacher Resources:

- Exemplary Life Cycle Model for Insulation Materials
 1. Cellulose
 2. Rockwool
 3. Fiberglass
 4. Polystyrene
- Student Product photos from testing (to be added)
- Exemplar of completed Evidence Matrix
- Unit Summary Table - teacher version

Unit Challenge Student Resources:

- Lifecycle Model (one page) to give students an idea of the key stages of the Life Cycle. To be presented to students in L02 as a template to keep in mind during the development of their final product.
- Full Lifecycle Model (multi page) with separate page for each stage in the cycle. To be completed by students over the course of the unit.
- Evidence Matrix with evidence-based reasoning provided for each criteria rating.
- Unit Challenge Student Product Checklist for students to keep track of the things they will create and submit during the unit.
- CER assessment
- Unit Summary Table - for students to complete over the course of a unit. They may also do this in their science notebooks.

Lesson Sequencing Table			
Lesson #	Lesson Questions	What students do...	# days
1	[Unit Question] How can growing societies reduce impacts on Earth systems and conserve natural resources through their choice of building materials?	Students examine a range of home construction designs and materials from around the world and over time.. They receive their Unit Challenge: they are asked to determine which wall insulation material is best for a community building.	1-2
2	What are the stages of the life cycle of a product and what happens during each stage?	Student learn about the stages of product life cycles and how they are modeled. Students create an initial life cycle model.	2-3
3	- Why are different natural resources found in certain locations and not others, why is this important to society, and how do they form? - How long (relative to human life spans) does it take for various natural resources to form and/or be replenished?	Students use geologic data to figure out that natural resources result from past geologic processes and that resources are not distributed equally around Earth's surface. Students investigate the availability of natural resources needed for manufacturing wall insulation.	2-3
4	- What happens to Earth's resources as the human population grows or as individuals consume more of a particular resource? - How can we use science and technology to minimize the impact on our limited supply of natural resources?	Students perform simulations, using popcorn as a resource, to explore concepts related humans depending on Earth's natural resources for survival and advancement.	3-4
5	What are the properties of materials that make them useful to humans?	Students consider how the use of materials depend upon their properties and how, sometimes, materials are manufactured to have certain useful properties. Students make "Oobleck" and consider how its properties might make it useful.	3-4
6	- How do properties chemically and/or physically change when a material goes from natural to synthetic? - How do humans change the composition of substances to create new substances with useful properties?	Students investigate how we synthesize new materials from natural resources. They create "Flubber" (using a chemical change) and consider the changes that take place between the properties of the input materials to those of the product.	3-4
7	- How is temperature related to the motion of particles that make up a sample of matter (solid, liquid or gas)? - What are some important properties of materials, such as structure, that serve the function of limiting the amount of thermal	Students explore thermal energy and how it is transferred between objects and/or different regions of defined systems. They investigate the relationship between thermal energy and temperature. They apply what they've discovered to how	3-4

	energy transferred between objects or regions.	insulation is useful when used in building walls.	
8	- How do the stages of a product's life cycle impact Earth systems? - How can science and technology reduce a product's life cycle impact on Earth systems?	Students gather and use data from various sources to examine the environmental impacts associated with the life cycle of jeans and of their assigned insulation material. They revise their lifecycle model to reflect these impacts.	2-3
9	[Unit Question] How can growing societies reduce impacts on earth systems and conserve natural resources through their choice of building materials?	Students will revisit the anchor phase of Lesson 1 and present their conclusions for the Unit Challenge Scenario. Finally, students use their evidence matrix to help construct a CER (Claim, Evidence, Reasoning) writing assessment to justify why a specific insulation material is being recommended for the community building.	3-4

Select Assessment Tools

Performance Expectations Coverage Matrix: 7.3_PE_Coverage Matrix

Pre-Post Assessment:

- Unit 7.3 Pre-Post Assessment- Student Version
- Unit 7.3 Pre-Post Assessment- Teacher Version

Embedded Assessment:

- Lesson 06 Check Your Progress
 - 7.3_L06_Check_Teacher_EA_InstructionsRubric
 - 7.3_L06_Check_Student_EA_StudentCopy
 - 7.3_L06_Check_Teacher_EA_StudentExemplar
- Lesson 07 Check Your Progress
 - 7.3_L07_Check_Teacher_EA_InstructionsRubric
 - 7.3_L07_Check_Teacher_EA_StudentExemplar
 - 7.3_L07_Check_Student_EA_StudentCopy

Unit Challenge Student Product Proficiency Rubrics:

- 7.3_L9_Check_Teacher_InstructionsRubric

Unit Content Resources:

- [NGSS Connections](#)
- [Prior and Future Knowledge](#)
- [Unit Materials List](#)
- Compiled Gotta Have Checklist*
- Unit External Web Links*
- Teacher Background Content Resources*
- Unit Overview Video*

*Available to teachers who have completed the Unit Primer as part of the Mi-STAR Professional Learning Program

Unit Advance Preparation:

- Consult the Unit Materials Shopping List
- Complete the Unit Graphic Organizer