

Chemical Engineering

Lesson Summary:

Chemical engineering involves the design, construction, and operation of plants and machinery to make products such as acids, dyes, drugs, plastics, and synthetic materials. Chemical engineers develop and produce a wide range of chemical-based products.

This field of engineering also produces high-performance composite materials for aerospace, automotive, biomedical, electronic, environmental, and military applications. In the emerging area of nanotechnology, for example, researchers are developing materials that are extremely light weight. Nanotube Composite Materials, made of tiny carbon tubes, will help automakers produce more fuel-efficient cars. According to The National Science Foundation, nanotubes are 100 times stronger than steel at a sixth of its weight.

This two-day lesson introduces the topic of chemical engineering as a career choice, with a particular focus on nanotechnology. On Day One, students will take a pre-assessment of their knowledge about engineering and chemical engineers. They will log their observations as they view an eleven-minute video interview with two Air Force chemical engineers from Wright Patterson Air Force Base in Dayton, Ohio. The lesson culminates on Day Two with an introduction to nanotechnology and a virtual tour of a nanotechnology laboratory at Stanford University in California.

Estimated Duration: Three days, 55 minutes each for instruction and group presentations

Ohio Academic Content Standards

Grade

6



Content Area/Discipline:

Technology

Standard:

Design

Benchmark: B

Recognize the role of engineering design and of testing the design process.

Indicator: 3

Describe what an engineer does (e.g., analyze information found on engineering society Web sites).

Content Area/Discipline:

Science

Standard:

Science and Society

Benchmark: C

Give examples of how thinking scientifically is helpful in everyday life.

Indicator: 4

Describe how the pursuit of scientific knowledge is beneficial for every career and in everyday life.

Grade

7



Content Area/Discipline:
Standard:
Benchmark: B

Technology

Design

Recognize the role of engineering design and of testing the design process.

Indicator: 2

Describe the relationship between engineering, science, mathematics.

Content Area/Discipline:
Standard:
Benchmark: C

Science

Scientific Ways of Knowing

Give examples of how thinking scientifically is helpful in daily life.

Indicator: 3

Describe how the work of science requires a variety of human abilities and qualities that are helpful in daily life (e.g., reasoning, creativity, skepticism, and openness.)

Grade

8



Content Area/Discipline:
Standard:
Benchmark: B

Technology

Design

Recognize the role of engineering design and of testing in the design process.

Indicator: 1

Summarize the role of engineering design.

Indicator: 2

Describe the relationship between engineering, science, and mathematics.

Content Area/Discipline:
Standard:
Benchmark: A

Science

Science and Technology

Find examples of how technological advances, influenced by scientific knowledge, affect the quality of life.

Indicator: 1

Examine how science and technology have advanced through the contributions of many different people, cultures, and times in history.

Grade

9



Content Area/Discipline:
Standard:
Benchmark: B

Technology

Design

Recognize the role of teamwork in engineering design and prototyping in the design process.

Indicator: 5

Describe how engineering design is influenced by personal characteristics such as creativity, resourcefulness, and the ability to visualize and think abstractly.

Content Area/Discipline:
Standard:
Benchmark: D

Science

Scientific Ways of Knowing

Recognize that scientific literacy is part of being a knowledgeable citizen.

Indicator: 8

investigate how the knowledge, skills and interests learned in science classes apply to careers students plan to pursue.

Vocabulary



Nanotechnology :	research and development of lightweight, durable materials at the atomic molecular level
Pharmaceuticals :	chemicals used for medications
SI:	standard international metric unit of measurement
Acceleration:	motion caused by force applied to an object
Potential:	energy-stored energy
Thermodynamics:	the study of the transformation of energy
Chlorination :	a chemical process used for making large batches of products
Chemical reactions:	the process of making synthetics from chemicals
Composite:	material made from recycled materials
Bio-compatible material:	material used for implants and prosthetics
Atom:	the smallest particle of an element that can exist either alone or in combination
Technology:	human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. The innovation, change, or modification of the natural environment to satisfy perceived human needs and wants.
Nanometer:	a measure of length. 1 nm- 0.000000001 meter (1 billionth of a meter)
Periodic Table:	an arrangement of chemical elements based on their atomic structure and properties
Nanoparticle:	a microscopic particle whose size is measured in nanometers (nm)
Photon:	the ultimate unit of light energy
Photoresist:	a light sensitive material used in several industrial processes to create a patterned coating on a surface
Carbon nanotubes:	cylindrical carbon molecules exhibiting unusual strength and unique electrical properties that make them useful for extremely small scale electronic and mechanical applications

Procedure

Day One

- 1) Welcome students to Engineering Your Future: An Introduction to the World of Engineering.
- 2) Distribute the pre-assessment **Student Survey** to all students and have them hand in after completed.
- 3) Distribute copies of the **Viewing Log**. Have students complete the **Assumptions** column based on their pre-knowledge of the chemical engineering field.
- 4) Introduce the field of Chemical and Materials Engineering, advise students that they will be watching an eleven-minute interview with two chemical engineers who work for an Air Force research laboratory in Dayton, Ohio. Ask that students take notes while watching and complete the **Viewing Log**.
- 5) While students are watching the video, look over the student surveys to help guide the discussion of the video.
- 6) Hold a short discussion of the video interview. What are some of the challenges of a career in chemical engineering and materials science as described by the engineers? What were some things you learned about chemical engineering that you did not know?
- 7) **Home work assignment:** Tell your students that the next class session will focus on an exciting area of research in chemical engineering called nanotechnology, which involves making discoveries about a world that is too small to see. For their assignment, ask students to use the library or a home computer to visit the Web site "Nanooze" www.nanooze.org for an introduction to the field of nanotechnology. Students should look closely at the Web site and begin a journal on chemical engineering.

Students should enter definitions for the following terms in their journals:

1. nanotechnology
2. nanometer
3. nanoparticle
4. photon
5. photo resist
6. carbon nanotubes

Students should also answer the following questions:

1. What is nanotechnology?
2. What is photolithography used for?
3. How can nanotechnology help diagnose and fight diseases like cancer?

Procedure

Day Two



- 1) Begin by discussing the homework assignment. With the classroom computer, go to www.nanooze.org Ask students what nanotechnology is? (Here's a scientific definition: Technology development at the atomic, molecular, or macromolecular range of approximately 1-100 nanometers to create and use structures, devices, and systems that have novel properties.) What does "nano" mean? "Nano comes from the Greek word for dwarf. It's also short for nanometer."
- 2) Tell the students they'll be taking a virtual field trip to a nanotechnology research and manufacturing facility at Stanford University in California. While exploring the virtual nanotechnology lab, students should take notes in their journals. **NOTE: You'll need an Internet-connected computer and a projector for this part of the lesson.**
- 3) Go to www.nanooze.org/english/blog.html and scroll down the list of nanotechnology applications in various fields. Be sure to point out medical applications for nanotechnology. Also point out the definition of "nanotubes."
- 4) Now go to the Web address: <http://snf.stanford.edu/Education/VirtualTour.html> This is the Location of the Stanford nanotechnology lab virtual tour. Begin by clicking on the link for "process flow," which takes you through the steps of making a nanostructure.
- 5) Next, explore the nanotechnology lab's floor plan to see what they do in each room. Start with the rooms labeled in red – there are ten of them – and tour them in sequence.
- 6) Lastly, divide students into cooperative groups of four to compare the Viewing Log, homework assignment, their notes on nanooze.org and the virtual tour. After comparing notes, have students answer the questions below on a piece of paper. Students should use two-three complete sentences for each question and hand in when complete:
 1. What is the nanotechnology lab process flow?
 2. What school subjects should students take if they plan on becoming chemical engineers?
 3. What are composite materials, and what are their uses?
 4. What are chemical engineers doing for Air Force research?
 5. What are some ways chemical engineers have contributed to the field of medicine?
- 7) While the groups are working, do informal assessment with each using the **Group Observation Form**.

Student Survey



Name _____

Date _____

Class _____

Period _____

Directions: Answer the following questions. Make a complete statement for each question.

- 1) What kind of education do you need to become an engineer?

- 2) List three different fields of engineering.

- 3) What do chemical engineers do?

- 4) What is nanotechnology?

- 5) List three applications of chemical engineering.

- 6) List three or more subjects students should study to become an engineer.

- 7) What tools are used by chemical engineers?

- 8) What fields do chemical engineers work in?

Student Viewing Log _____



Name _____

Date _____

Class _____

Period _____

Directions: Record your assumptions about the field of Chemical Engineering. While viewing the video, list the new information you learned in the appropriate column.

chemical engineering

assumptions

what i learned

What do chemical engineers do?

Are there different fields of chemical engineering? List any sub fields you are aware of.

Which courses in high school will help you prepare for an engineering career?

What kind of courses can you expect to study in a college level engineering program?

Is a college education necessary for a career as a chemical engineer?

Group Observation Form

Chemical Engineering



Group Members:

Research Topic:

Date:

Class:

Period:

Observed Questions	Clearly Understands	Understands	Does Not Understand
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What is nanotechnology?

What is the process flow?

What subjects should students take in High School if they plan on becoming Chemical Engineers?

What are Chemical Engineers doing for Air Force research?

What are some ways Chemical Engineers have contributed to the field of medicine?