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Lesson Focus

Lesson focuses on the many uses of periscopes and how this simple device was designed and is used in many applications. Students work in teams to design and build their own working periscope out of everyday materials. They design their periscope, build and test it, evaluate their designs and those of classmates, and share observations with their class.



Lesson Synopsis

The "Telescoping Periscope" lesson explores how a periscope works and is used. Students work in teams to devise their own periscope. It must have adjustable mirrors and be able to telescope as well. Teams may make a simple periscope or engineer an elaborate design - - teams earn points for creativity. Teams sketch their plans, build their periscope, test it, reflect on the challenge, and present to the class.

Age Levels

8-18.

Objectives

- ◆ Learn about engineering design and redesign.
- ◆ Learn about periscopes and optical devices.
- ◆ Learn how engineering can help solve society's challenges.
- ◆ Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- ◆ engineering design
- ◆ mirrors and light
- ◆ teamwork

Lesson Activities

Students explore how devices -- such as the periscope -- have evolved over time to meet societal needs. Students work in teams to develop a periscope that can be used to identify a series of objects that are out of direct sight. They are encouraged to be creative in their end product and will develop a design, present it to the class, build the periscope, test it, and reflect on the activity.

Telescoping Periscope

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Resources/Materials

- ◆ Teacher Resource Documents (attached)
- ◆ Student Resource Sheet (attached)
- ◆ Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- ◆ TryEngineering (www.tryengineering.org)
- ◆ Wikipedia Periscope: (<https://en.wikipedia.org/wiki/Periscope>)
- ◆ GuS GmbH & Co. Periscope Manufacturer (<https://www.gus-germany.com/en/>)
- ◆ Kollmorgen Electro-Optical Periscope Manufacturer History (<https://www.kollmorgen.com/uploadedFiles/kollmorgencom/Company/HistoryofKollmorgenAnniversaryBook-mobile.pdf>)

Recommended Reading

- ◆ Illustrated Directory of Submarines of the World (ISBN: 978-0760313459)

Optional Writing Activity

- ◆ Write an essay or a paragraph about how an invention such as the periscope helped save lives in World War I.

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For Teachers: Teacher Resource

◆ Lesson Goal

The "Telescoping Periscope" lesson explores how a periscope works and is used. Students work in teams to devise their own periscope that can telescope and incorporates adjustable mirrors. Younger students may make a simpler periscope. Students use their periscope to identify a series of three items that are out of direct lines of sight. Teams sketch their plans, build their periscope, test it, reflect on the challenge, and present to the class.

◆ Lesson Objectives

- ◆ Learn about engineering design and redesign.
- ◆ Learn about periscopes and optical devices.
- ◆ Learn how engineering can help solve society's challenges.
- ◆ Learn about teamwork and problem solving.

◆ Materials

- ◆ Student Resource Sheets
- ◆ Student Worksheets
- ◆ Classroom Materials (several small objects teacher will display to the periscope for testing -- rotate through a few items such as a flower, a pen, a button, a coin)
- ◆ Student Team Materials: tape, cardboard, empty milk cartons, scissors, small mirror with safety edges (cosmetic mirrors work great), rubber bands, paper clips, tubes, pvc piping, tubes, pencil, paper, cups, foil, glue, or other items available in the classroom.

◆ Safety Notes

When working with very young children consider using reflective materials instead of mirrors, or buying mirrors at arts stores that have smooth edges. Cosmetic mirrors are ideal! Options for mirror alternatives include "mirrored" or reflective contact paper or multipurpose mirrored tape which can be purchased at home improvement or hardware stores - - but these surfaces are not as clearly reflective as a regular mirror so instead of identifying an object, have students determine which color you are showing around the corner and use different colored construction paper as the "object" you test with. Or, use flexible plastic mirrors, or cut pieces from a single sheet of mirror polystyrene which can be purchased from amazon.com or via educational supply houses.



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◆ Procedure

1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework. Visit Wikipedia Page on Periscopes at <https://en.wikipedia.org/wiki/Periscope> to review principle of how mirrors and reflections are key to periscope operation.
2. Teams of 3-4 students will review the challenge, consider available materials and develop a detailed drawing showing their planned periscope including a list of materials they will need to build it.
3. Students build their periscope -- bearing in mind that there will be extra credit for "uniqueness" (how different the design is from all others) and "creativity" (how pleasing it looks to the eye.)
4. Teams will have to use their telescoping periscopes to read a series of clues that are out of direct sight. These can be taped on the inside of a closet, placed atop a door ledge, or other areas that will be a challenge. Clue one can point students to the location of clue two, etc. For extra challenge, have a clue underwater, so the periscope may have to be waterproof, or have a clue in a dark location, so the periscope must incorporate a light source. It is up to the teacher to make this as simple or as complicated as best suits the class age, mix, and available time..
5. Teams reflect on the challenge, and consider the designs created by other student teams, and present their experiences to the class.



◆ Time Needed

One to three 45 minute sessions.

◆ Extension Ideas

Challenge older or more advanced students to create a periscope that incorporates a webcam.

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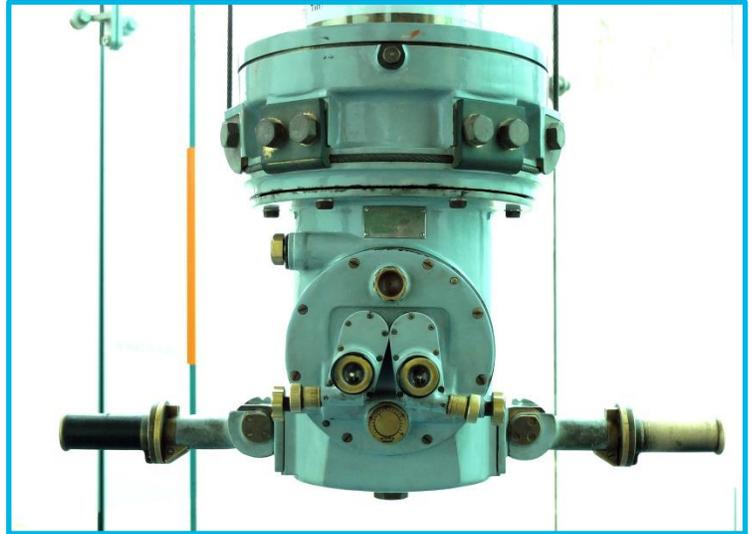
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Student Resource: What is a Periscope?

A periscope is an instrument used to observe something from a concealed position. In its simplest form it consists of an outer case with mirrors at each end set parallel to each other at a 45-degree angle. Using this form of periscope, with the addition of two simple lenses, troops fighting in World War I could see out of their trenches and not put their lives at risk by lifting their heads in front of an enemy. This simple form is also used to peek around a corner to view wildlife, or to look over a crowd of taller people at an event.



The image to the right shows a simple periscope where a person is peering in at the bottom to see the bird that is around a corner or out a window and not in direct sight. More complex periscopes use prisms instead of mirrors to provide magnification and higher image quality. These are the types of periscopes often found on submarines.

◆ **History and Inventors**

Johann Gutenberg, better known for his contribution to printing technology, marketed a kind of periscope in the 1430s to enable pilgrims to see over the heads of the crowd at religious festivals. Johannes Hevelius described an early periscope with lenses in 1647 and saw military applications for his invention.

Periscopes served in World War I to enable soldiers to see over the tops of trenches, in order to see with less exposure to enemy fire. Tanks use periscopes extensively: they enable drivers or tank commanders to inspect their situation without leaving the safety of the tank. An important development, the Gundlach rotary periscope, incorporated a rotating top; this allowed a tank commander to obtain a 360-degree field of view without moving his seat. Periscopes are also used in naval efforts, and allow a submarine, when submerged at a shallow depth, to search visually for nearby targets and threats on the surface of the water and in the air. When not in use, a submarine's periscope retracts into the hull. Newer periscopes can record digital video of what the periscope "sees" and some have embedded displays that incorporate GPS information and night vision capabilities.

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Student Worksheet:

◆ Engineering Teamwork and Planning

You are part of a team of engineers given the challenge of developing your own periscope out of everyday materials. You have many materials to choose from. A simple periscope (like the one to the right) can be made by opening a slot in two milk cartons and inserting two mirrors at 45 degree angles on each end. You can use a long box, two milk cartons that you will connect....or come up with our own design!

In your challenge, however your periscope must be able to telescope to change length, and your mirrors must both be adjustable.



In this challenge your periscope must be able to allow your team to correctly read and follow a series of clues that are out of your direct line of sight. But, you will also be judged on how unique and creative your design is!

Remember that a periscope is an instrument that uses a system of prisms, lenses, or mirrors to reflect images through a tube. In the simple example to the right, light from a distant object strikes the top mirror and is then reflected at an angle of 90 degrees down the periscope tube. At the bottom of the periscope, the light strikes another mirror and is then reflected into a viewer's eye. Periscope comes from two Greek words, peri, meaning "around," and scopus, "to look."

Telescoping in mechanics describes the movement of one part sliding out from another, lengthening an object (such as your periscope) from its resting position.

◆ Research Phase

Read the materials provided to you by your teacher. Think about how light will need to travel from the object to your eye through the periscope your team develops. Consider not only the functionality of the periscope you will develop but also how unique and creative the final tool will be!



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Student Worksheet (continued):

◆ Planning and Design Phase

Draw a diagram of your periscope including the path a ray of light would follow as it travels through your periscope design -- from an object, through the periscope, and into your eye or a camera.

List the materials you think you will need:

Telescoping Periscope



Student Worksheet:

◆ Presentation Phase

Present your plan and drawing to the class, and consider the plans of other teams. You may wish to fine tune your own design.

◆ Build it! Test it!

Next build your periscope and test it. You may share unused building materials with other teams and trade materials. Be sure to watch what other teams are doing and consider the aspects of different designs that might be an improvement on your team's plan.

◆ Scoring

Use the box below to determine your score on this project!

Was your team able to correctly follow the clues your teacher planned for you? Yes: 80 points No: 0	Unique Score (voted by your peers with your teacher providing final point) (scale 0-10)	Creative Score (voted by your peers with your teacher providing final point) (scale 0-10)	Final Score

◆ Reflection

Complete the reflection questions below:

1. How similar was your original design to the actual periscope your team built?
2. If your team found you needed to make changes during the construction phase, describe why revisions were needed.
3. Which periscope that another team made was the most interesting to you? Why?
4. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?
5. If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?
6. Do you think that engineers often change their designs when they enter the manufacturing phase of a new product development? Why or why not?

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For Teachers:

Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (<http://www.nextgenscience.org/>)
- International Technology Education Association's Standards for Technological Literacy (<http://www.iteea.org/TAA/PDFs/xstnd.pdf>)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (<http://www.nctm.org/standards/content.aspx?id=16909>)
- U.S. Common Core State Standards for Mathematics (<http://www.corestandards.org/Math>)
- Computer Science Teachers Association K-12 Computer Science Standards (<http://csta.acm.org/Curriculum/sub/K12Standards.html>)

◆ National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ◆ Abilities necessary to do scientific inquiry
- ◆ Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- ◆ Properties of objects and materials
- ◆ Position and motion of objects
- ◆ Light, heat, electricity, and magnetism

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ◆ Abilities of technological design

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ◆ Types of resources
- ◆ Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- ◆ Science as a human endeavor

◆ National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ◆ Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- ◆ Properties and changes of properties in matter

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- ◆ Abilities of technological design
- ◆ Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ◆ Risks and benefits
- ◆ Science and technology in society

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For Teachers:

Alignment to Curriculum Frameworks

◆ National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- ◆ Science as a human endeavor
- ◆ History of science

◆ National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ◆ Abilities necessary to do scientific inquiry
- ◆ Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- ◆ Interactions of energy and matter

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ◆ Abilities of technological design
- ◆ Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ◆ Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- ◆ Science as a human endeavor
- ◆ Historical perspectives

◆ Next Generation Science Standards Grades 3-5 (Ages 8-11)

Waves and Their Applications in Technologies for Information Transfer

- ◆ 4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

Engineering Design

Students who demonstrate understanding can:

- ◆ 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- ◆ 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- ◆ 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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For Teachers:

Alignment to Curriculum Frameworks

◆ Next Generation Science Standards Grades 6-8 (Ages 11-14)

Engineering Design

Students who demonstrate understanding can:

- ◆ MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- ◆ MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

◆ Standards for Technological Literacy - All Ages

The Nature of Technology

- ◆ Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- ◆ Standard 2: Students will develop an understanding of the core concepts of technology.
- ◆ Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- ◆ Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- ◆ Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- ◆ Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- ◆ Standard 8: Students will develop an understanding of the attributes of design.
- ◆ Standard 9: Students will develop an understanding of engineering design.
- ◆ Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- ◆ Standard 11: Students will develop abilities to apply the design process.

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