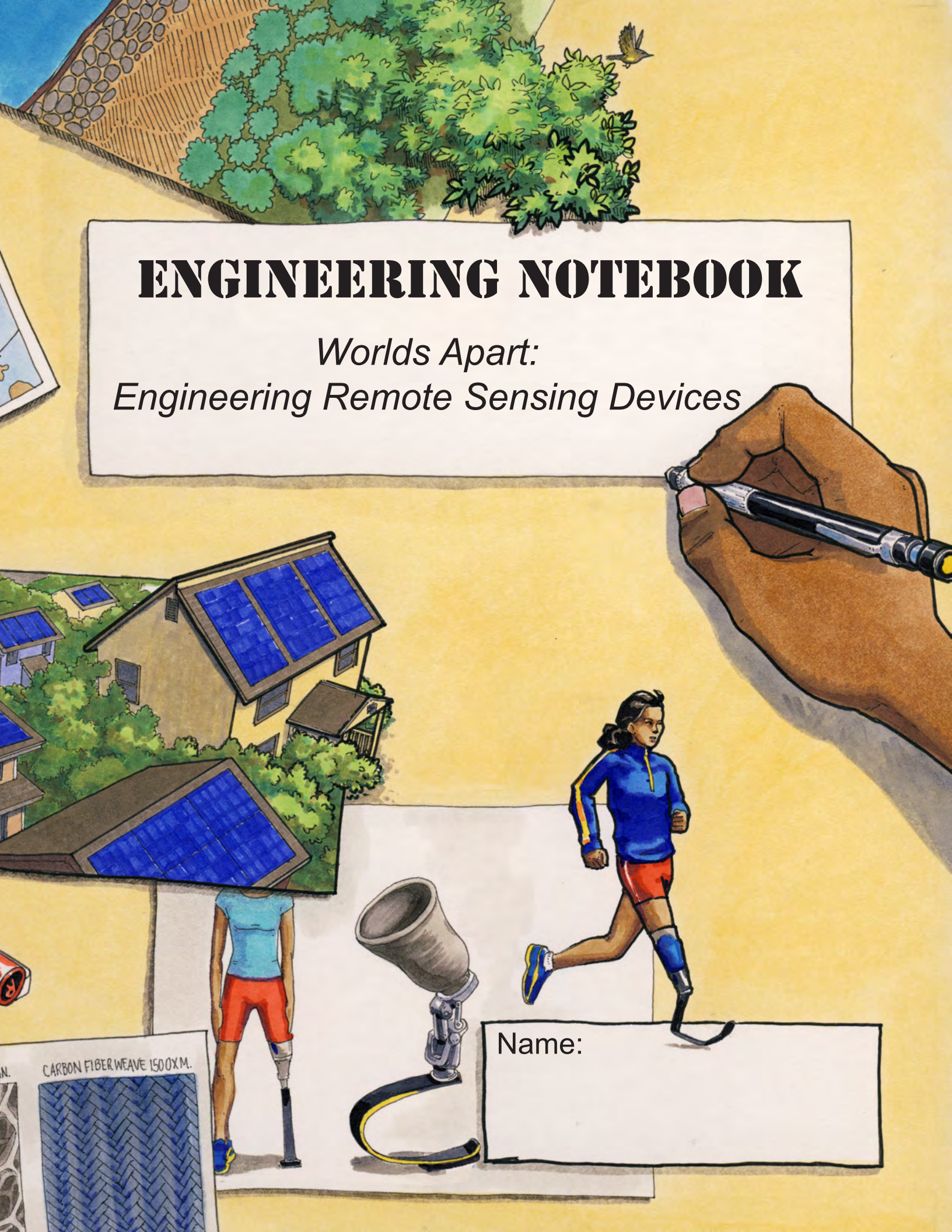


ENGINEERING NOTEBOOK

Worlds Apart:
Engineering Remote Sensing Devices

Name:

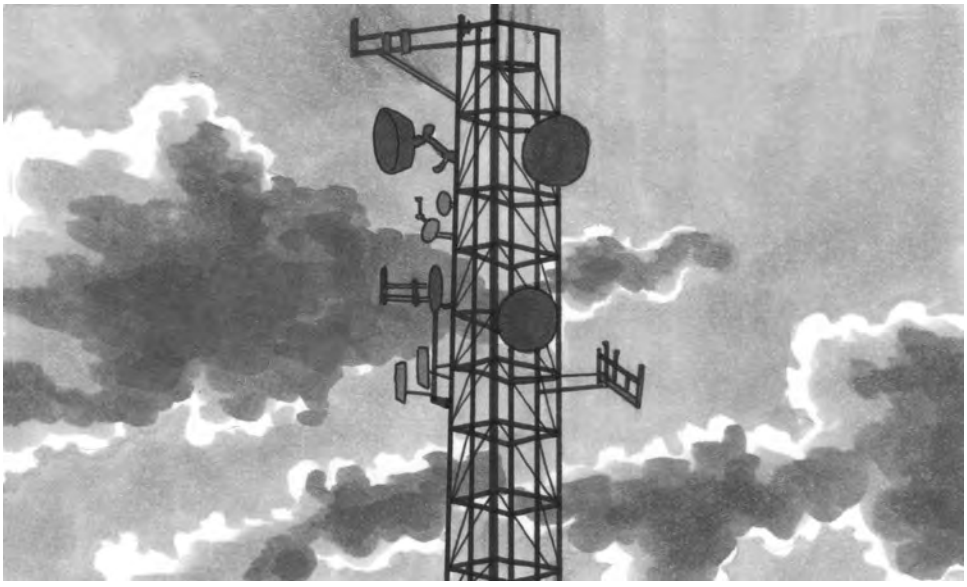
Criteria and Constraints

In engineering, guidelines for your design are called criteria and constraints.

GOAL: Engineer a tower that can support an antenna.

CRITERIA **Things you or your design needs to do**
You will work in groups to engineer your tower.
Your tower must be at least 1 foot tall, not including the antenna.
Your tower must hold the antenna for at least 10 seconds.

CONSTRAINTS **Ways you and your design are limited**
You will have 100 index cards, masking tape, a ruler, and a pair of scissors.
The scissors and ruler cannot be used as a part of the tower.
You only have 20 minutes to *create* your tower.
You can hold the model antenna as you build, but you cannot *test* with it until the official testing time begins.



What is Technology?

Prep Activity 2

Technology is any thing designed by people to help solve a problem.

1. What problem does your technology solve?

2. When you find your technology match, record it below.

Older Technology	Newer Technology

4. Can you *imagine* ways to *improve* the modern technology from your technology match? Draw or write your ideas below.

Prep Activity 2

My Engineering Profile

Check off the skills YOU bring to the table.

☐ **Communication**
- I give valuable feedback to others
- I like giving presentations

☐ **Creativity**
- I imagine lots of ideas
- I come up with new ways of doing something

☐ **Critical Thinking**
- I solve problems
- I make sense of complicated information

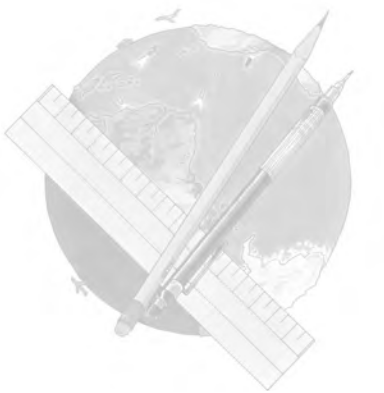
☐ **Leadership**
- I lead teams well
- I make sure everyone has a voice

☐ **Persistence**
- I learn from failure
- I keep trying until I succeed

☐ **Teamwork**
- I work well in teams
- I like giving and receiving feedback on my work

☐ **Technical Skills**
- I make things
- I like working with different materials

Which skills do you want **to use**?	Which skills do you want **to learn**?



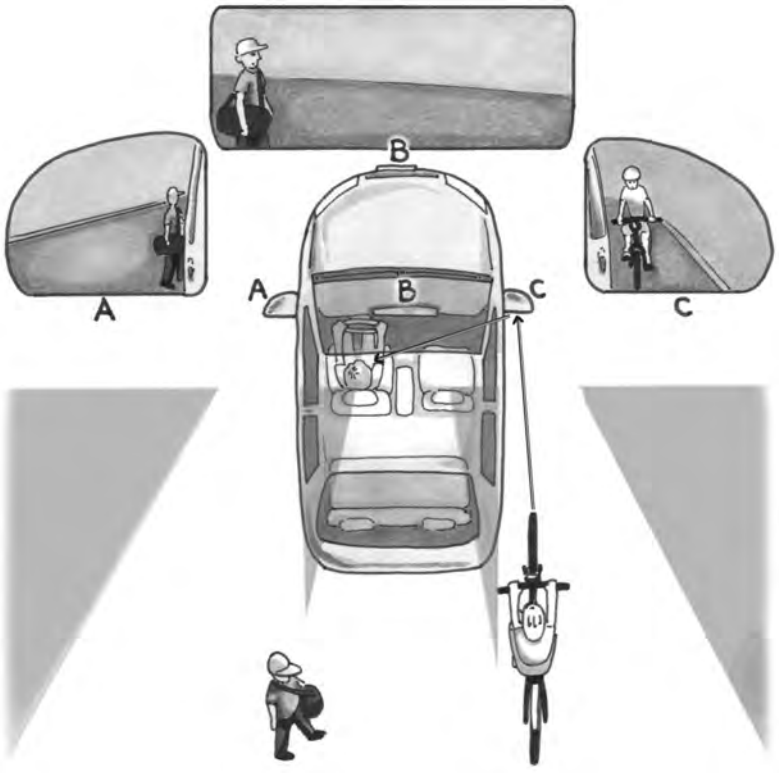
Manipulating Light

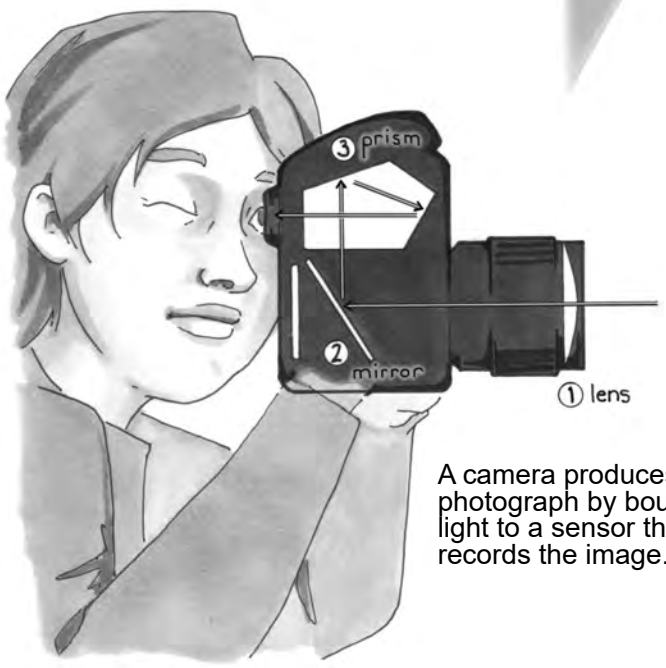
Activity 1

Lots of technologies use mirrors to change the way light travels from an object to your eye. See if you can trace the path of light in the technologies below!

A telescope helps magnify and focus images from space.

The rear and side view mirrors in a car help you see what's in your blind spot while driving.



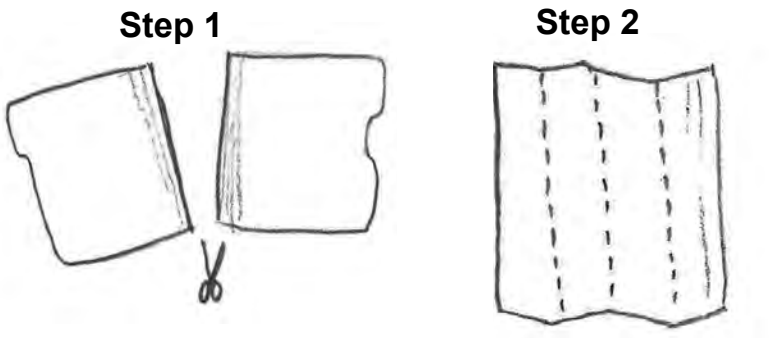


A camera produces a photograph by bouncing light to a sensor that records the image.

Did You Know?
There are lots of different kinds of telescopes, including the James Webb Space Telescope, which includes 18 hexagonal mirrors that unfold into a giant curved mirror after the telescope is launched into space.

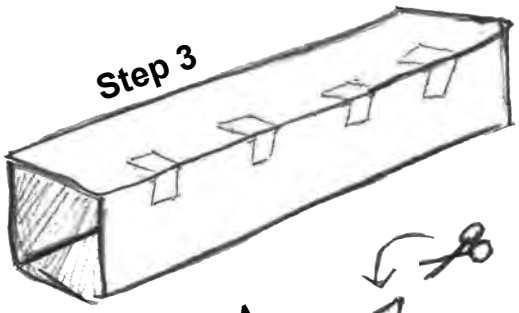
Getting Started with Periscopes

1. Cut the manila folder in half to get two sheets. Put one half aside.

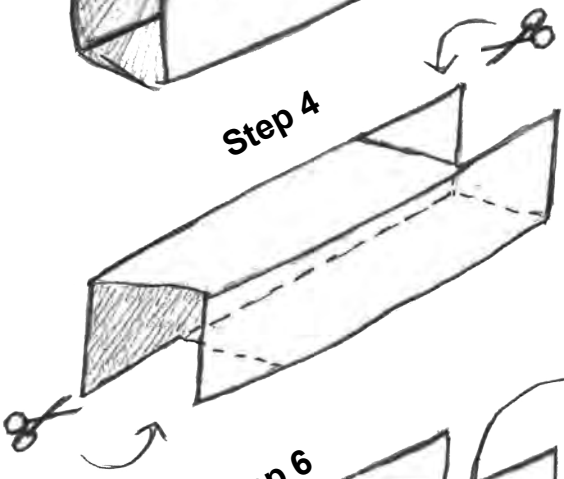


2. Fold one manila sheet in half longways, then fold it in half longways a second time. Unfold the manila sheet.

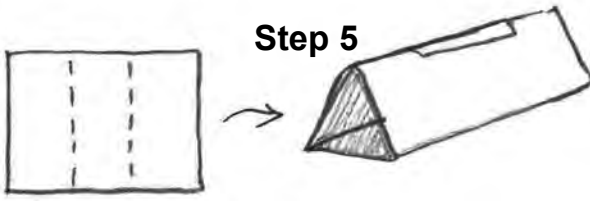
3. Fold the manila sheet into a box shape and tape it closed to make the periscope body.

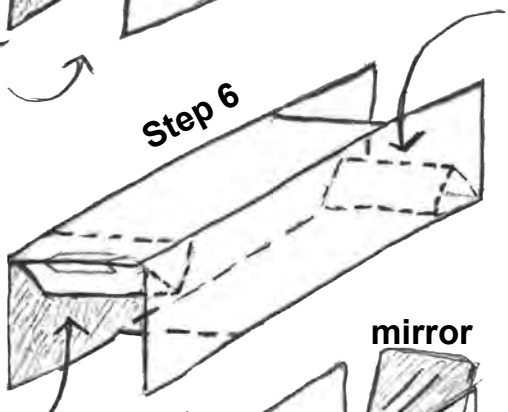


4. Cut two mirror-sized rectangles out of the box on **opposite sides and opposite ends** of the box. Save these rectangles for the next step.



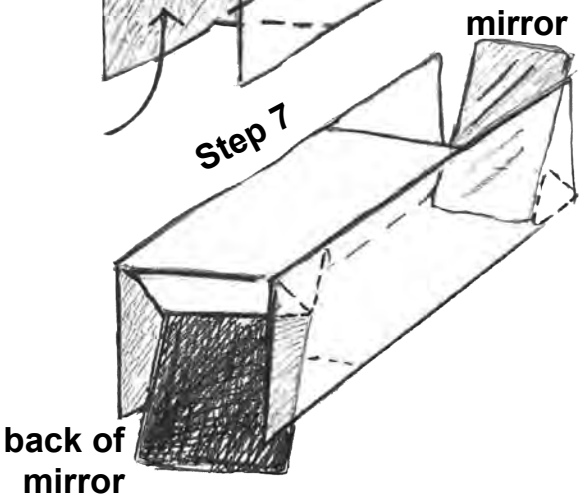
5. Use the two rectangles to create mirror stands. Fold and tape the rectangles into a triangle shape
.





6. Tape the triangles (mirror stands) inside the box at the long ends.

7. Position a mirror at each end of the box so it is resting against the triangle. Explore which angle is best for the mirrors before taping them down.



8. Test out your periscope! What can you see?

Now that you have the basics figured out, how can you *improve* the periscope?

Improved Periscope Challenge

Activity 1

Can you engineer an *improved* periscope that can help you meet one or more of the following goals?

- ☐ Read words from across the room
- ☐ See over a very tall obstacle
- ☐ Look side to side without moving your head
- ☐ Meet a remote sensing goal that you decide!

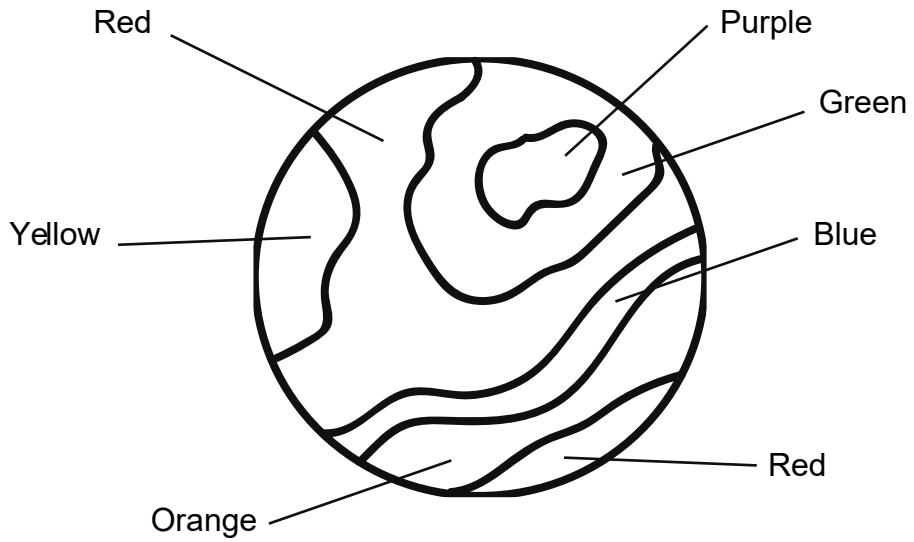
Did You Know?
Periscopes are used in space travel. For example, the Russian Soyuz spacecraft has periscopes that help people dock the spacecraft at the Space Station.

Draw a *plan* for your improved periscope below.

Did You Know?
Radio waves, x-rays, gamma rays, and heat are different forms of light.

Optical Filters

Use a different color crayon to fill in each piece of the Mystery Moon image.



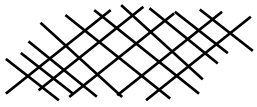
What happens when you look at these colors under the red filter?

How do the colors change under the blue filter? Why do you think so?

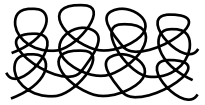
Try layering different colors, patterns, and writing materials to explore the effects of red and blue filters. Circle the combinations that work best to reveal information.

You might try: Yellow highlighter cross-hatching and pink highlighter squiggles

Cross-hatching



Squiggles



Hidden Messages

Use what you found out about colors, patterns, and optical filters to hide and reveal a hidden message in the following challenges:

Criteria The requirements of a design	**Constraints** Factors that limit how you can solve a problem
Create a hidden message that can be read from across the room.	The entire message must fit on one sheet of copy paper.

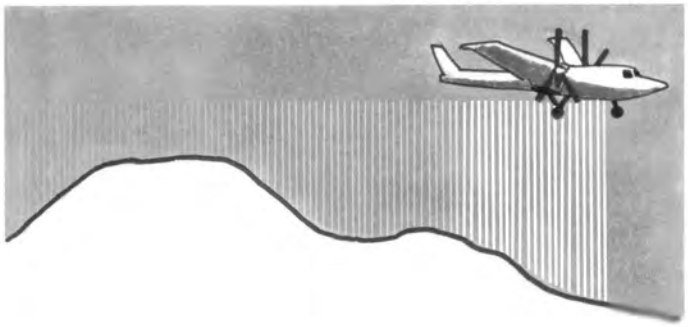
Make up your own challenge	
Criteria	**Constraints**

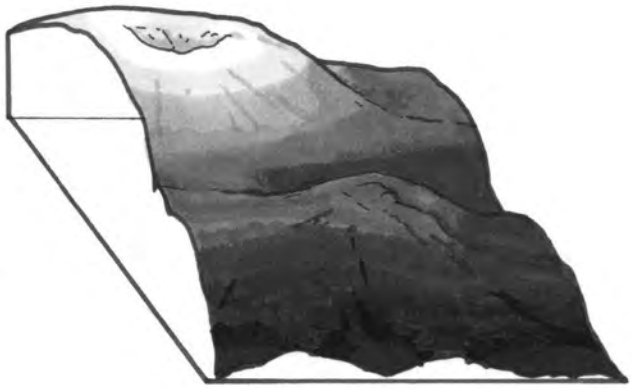
What types of information do you think you could reveal by combining optical filters with remote sensing devices, like cameras or periscopes?

Activity 3

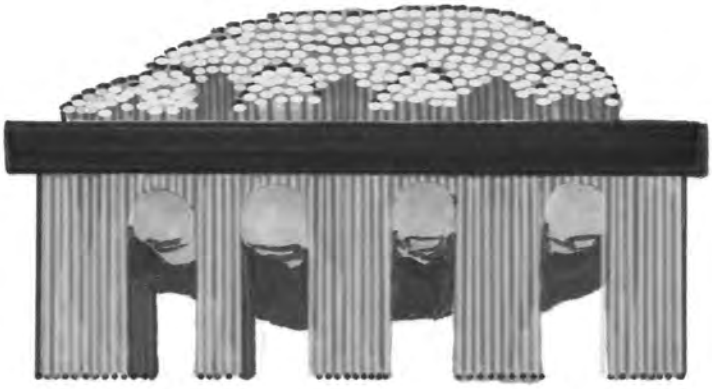
Pins and Pings

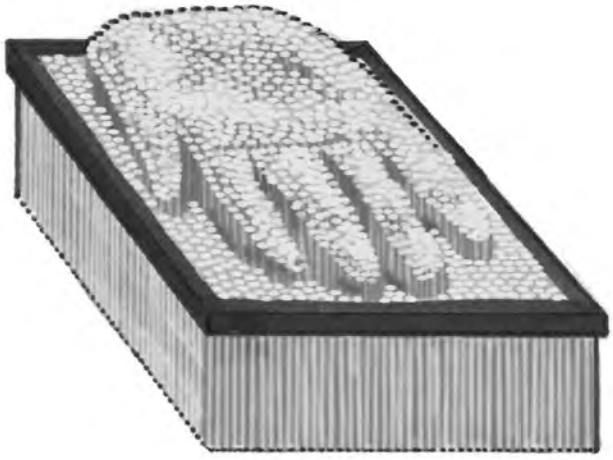
A LiDAR system measures topography, or the height of a landscape, using a laser pulse. It records the time it takes for a beam of light to travel to the ground and back, and converts that time into distance.





When all of those distances are placed together, they create a 3D image, similar to the way the pins on a pinscreen toy show the shape of the object underneath it.





Did You Know?
NASA uses lasers to collect many types of data. LiDAR can measure the height of landforms on planets, but lasers can also vaporize tiny bits of rocks from the Curiosity Rover on Mars to see what the rocks are made of.

Test Surface Elevation

Activity 3

Create a model LiDAR device that can map the topography of a surface. Keep this page open so other groups can see the data you collected.

Take a look at the data you collected using your model LiDAR device.

What shapes do you see in the pattern of the straws?

Test 1

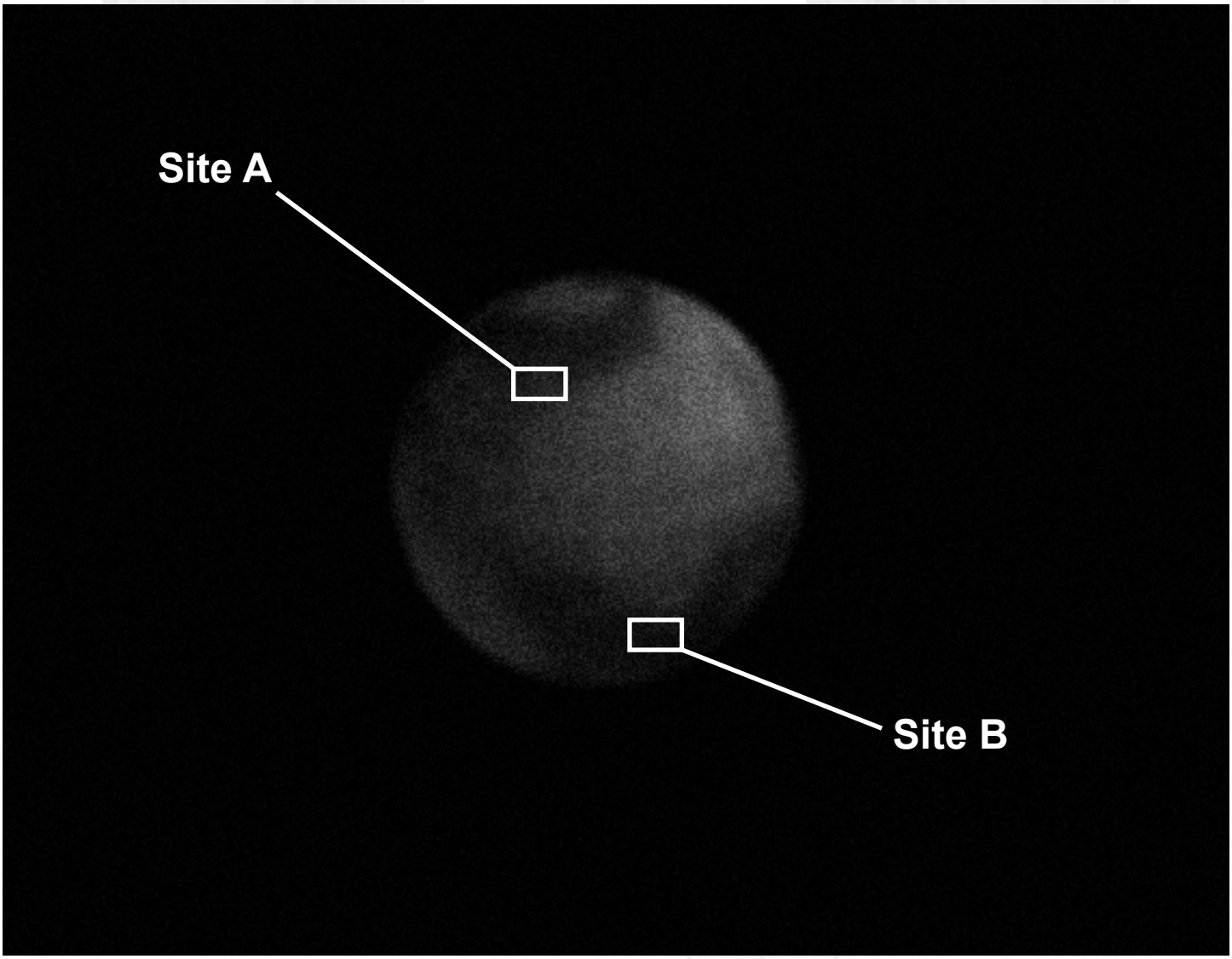
After you *improve* your device, draw a new picture of the data you collected in the space to the right. What changed?

Test 2

Did You Know?
Scientists like to have others check their work. It's called "peer review" and they use it to avoid making mistakes in their conclusions.

Mystery Moon

This is the only picture we have of the newly discovered moon, taken through a telescope. There are two sites that scientists have decided to explore further with remote sensing technologies.



Remote Sensing Engineering Challenge:

Your final design challenge is to engineer a remote sensing device (or devices) to collect information about the surface of the Mystery Moon for one of the three scientists.

Scientist: Jaime, planetary geologist

"I am interested in the landscape of the moon. What color is the surface? Are there any mountains, valleys, or craters?"

Criteria	Constraints
Identify the landforms (mountains, valleys, craters) at Site A and Site B.	You may only use the available materials to complete your design.
Identify the colors at Site A and Site B.	You will have two sessions to engineer your remote sensing device(s).

Scientist: Caris, planetary geologist

"I am interested in landing a rover on this moon. Sending a rover will allow us to collect samples and more closely examine what the moon is made of. Is there a flat, open space where the rover could land safely?"

Criteria	Constraints
Identify an area for the rover to land.	You may only use the available materials to complete your design.
The landing area must be large enough for the rover to land safely (3" x 4").	You will have two sessions to engineer your remote sensing device(s).

Scientist: **Alex, biologist**

"I want to know if this moon can support life. One of the most important elements to support life is water. Are there any sites that show evidence of water?"

Criteria	Constraints
Identify places on the Mystery Moon where water (represented by a triangle shape) is present. Look for landforms, like canyons, that suggest the presence of water.	You may only use the available materials to complete your design. You will have two sessions to engineer your remote sensing device(s).

Did You Know?
Many animals can see a different range of colors than humans can, including the mantis shrimp, which has eyes that are like the color sensors NASA uses in spacecraft!

Did You Know?
NASA planetary scientists have telescopes that can tell us about solar systems far beyond our own.

Remote Sensing Plan

Activity 4

Sketch a *plan* for your remote sensing device(s) in the space below. After you *test*, mark areas of your design that you would like to *improve*.

What information is your scientist interested in?
What technologies will help you collect the data they need?

Scientist: _____ Criteria:_____

How will you *improve*? You can use new materials, try a different resolution, make your devices smaller and more compact, or *improve* in another way!

Activity 4

Guidelines for Collecting Data

When collecting data with your remote sensing device...

DO:

1. Only put your hands through the opening in the Space Screen to push down on straws.
2. Move device from left to right.
3. Be careful when using the Space Screen so it does not fall over or break.

DO NOT:

1. Peek around the sides or into the Space Screen opening.
2. Put your face closer to the Space Screen than the edge of the table.
3. Try to touch the inside of the model landscapes through the Space Screen.

Some of the scientists are interested in the minerals on the surface of the Mystery Moon. Use the key below to help decode your findings:

Minerals	Symbol
Water, ice	
Iron	
Magnesium	

Did You Know?
NASA scientists and engineers can sometimes make mistakes, so they plan, test, and re-plan all human missions several times, to make sure that the astronauts involved are kept as safe as possible.

Data Collection

Use this page to record any data that you collect using your remote sensing device(s). Be sure to visit Site A and Site B.

Site A

Did You Know?
Some of NASA's first spacecraft sent their data to Earth so slowly that engineers could color in the image by hand, dot-by-dot.

Use this page to record any data that you collect using your remote sensing device(s).

Site B

Data Collection: Improve

Use this page to record any data that you collect using your *improved* remote sensing device(s).

Site A

Data Collection: Improve

Use this page to record any data that you collect using your *improved* remote sensing device(s).

Site B

Presenting the Data

Activity 5

How will you *communicate* the data you collected to the scientists? Write or draw your ideas below.

I will present my data as:

- ☐ a graph
- ☐ a map
- ☐ something else: _____
- ☐ a sculpture
- ☐ an infographic

Communicate

During your presentation, you will share information about the Mystery Moon with the scientists, and talk about the engineering challenge. What are some things you might want to *communicate* about engineering remote sensing devices?

Did You Know?
NASA's spacecraft and remote sensing devices record their own notes about the data they collect. This is called "telemetry" and it helps scientists know all the details about how remote sensing data are collected.

My Engineering Profile 2

Activity 6

Think about how you have changed as an engineer, and update your engineering profile.

☐ **Communication**
- I give valuable feedback to others
- I like giving presentations

☐ **Creativity**
- I imagine lots of ideas
- I come up with new ways of doing something

☐ **Critical Thinking**
- I solve problems
- I make sense of complicated information

☐ **Leadership**
- I lead teams well
- I make sure everyone has a voice

☐ **Persistence**
- I learn from failure
- I keep trying until I succeed

☐ **Teamwork**
- I work well in teams
- I like giving and receiving feedback on my work

☐ **Technical Skills**
- I make things
- I like working with different materials

Which skills do you want **to use**?

Which skills do you want **to learn**?

Did You Know?
Science and engineering work is almost always done in teams. Each project involves different types of specialized information, from flight systems to biology to communication, so a variety of people with different skills and expertise are needed for it to be successful.

Remote Sensing Glossary

Constraint: A factor that limits how you can solve a problem.

Criteria: The requirements of a design.

Data: Information that is collected through scientific investigation.

Engineer: Someone who uses his or her creativity and knowledge of math and science to design technologies that solve problems.

Engineering Design Process: The steps that engineers use to design technologies to solve a problem.

Landform: A natural feature of a planet's surface, such as a hill, valley, mountain, canyon, or crater.

Laser: A device that generates an intense beam of light.

LiDAR (Light Detection And Ranging): A remote sensing technology that collects data from lasers to map the shape of a landscape.

Optical filter: A technology that manipulates light and color to help reveal visual information.

Periscope: A remote sensing technology that uses mirrors to change the path of light in order to see over or around an object.

Remote sensing: The process of using technology to obtain data about an object from a distance.

Technology: Any thing designed by people to solve a problem.

Topography: The arrangement, elevation, or height of the landforms in an area.

Engineering Design Process

Understand the engineering problem.

- Define the problem in your own words.

Gather details.

- Learn about what others have done.
- Explore possible materials or processes you could use for your design.
- Conduct science experiments to gather data.

Come up with different ways to solve the problem.

- Use your creativity to think of lots of ideas that could work.
- Evaluate the pros and cons of each idea.
- Pick one idea that is a good starting point.

Figure out the details of your design.

- Discuss how it will work.
- Draw diagrams and list materials.
- Decide how you will test and evaluate.

Build your design.

- Follow your plan.
- Fix small problems.
- Record any changes to your plan.

Evaluate how well your design works.

- Test multiple times.
- Record your observations and findings.
- Figure out which parts are working well and which parts are not.

Make changes to your design based on testing.

- Decide what to change.
- Put your changes into a new plan.
- Build your improved design and test again.

Share your solution with others.

- Explain strengths and weaknesses of your solution.
- Share how you used the Engineering Design Process.
- Ask people for feedback.


lines for streamlining and shock absorption
frontal view
lateral view
padding
center of
ventilation holes
20° from top to
PREVAILING WINDS IN HARBOR AREA
Wind Power Turbine
Gear box
Rotor blade
Nacelle
Hub
Brake
GERULON MICROFIBER