STUDENT LAB SHEETS

Lab sheets are available for each lesson in the 5E format for use at the teacher's discretion.

The lesson is labeled in the top right corner of the first sheet. Ex: EXPLORE

Suggestions include:

- completion by students and inserted into science journal
- concepts, vocabulary, drawings, and information written into science journal
- use part or all of the lab sheets as content, time, and materials allow or are desired

ENGAGE

What Do You See?

KEY VOCABULARY complete as you go

emission of light:

transmission of light:

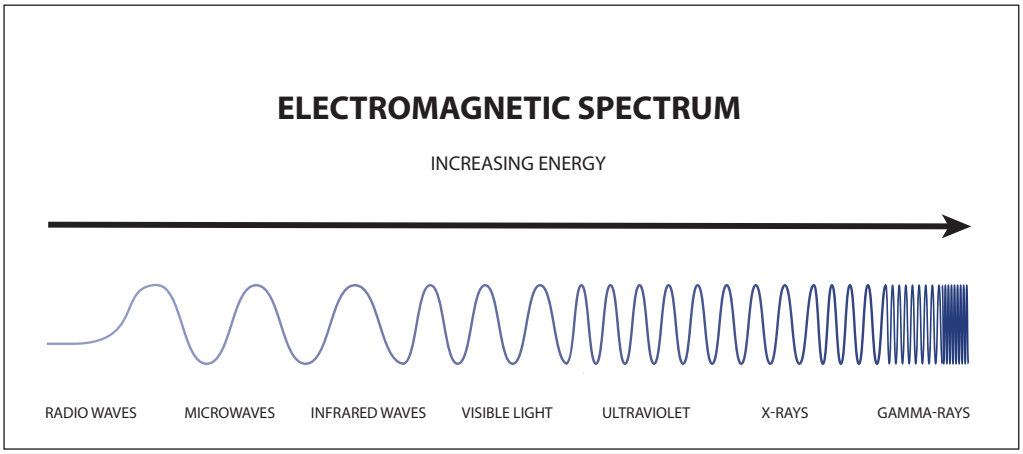
absorption of light:

Light is **emitted** from a source. The white light comes in contact with objects. Some objects **transmit** the light or let it shine right through, such as clear plastic or the glasses you put on. Some objects take in the light and change the energy into heat. This is known as **absorption**. Other objects bounce the light right off a surface. We call this reflection. Many objects do a bit of all of these. When we look at objects we see what color or colors are reflected to our eyes. Since all colors are contained in white light, objects that appear white to our eyes bounce back all the colors together and we see white.

When we look at a ripe banana, all of the colors shine on the banana. The banana absorbs all the colors (ROYGBIV) except yellow. Yellow reflects back to our eyes and we see a yellow banana. **Using this logic, explain to a partner why plants are green.**

How Does Light Travel?

The sun emits energy in the form of waves. These waves travel through space at the speed of light and make up the electromagnetic spectrum. Each type of wave has a different wavelength (the distance between each wave). As the distance between the waves gets smaller, the energy of the wave increases because there are more waves in a shorter amount of time. Within these different wavelengths is a special group of waves called visible light. This light is what allows us to see all the objects around us. The other waves in the electromagnetic spectrum are invisible to our eyes but are able to be detected using specialized equipment.



1. Which waves have the most energy?

2. Where is visible light located on the electromagnetic spectrum above? What does this tell us about its energy?

3. What other waves have you heard of on the electromagnetic spectrum? List them below and then share out loud with a partner or the class what you know about each.

TEACHER DEMONSTRATION RAINBOW OF LIGHT

Based on your observations, answer the following questions.

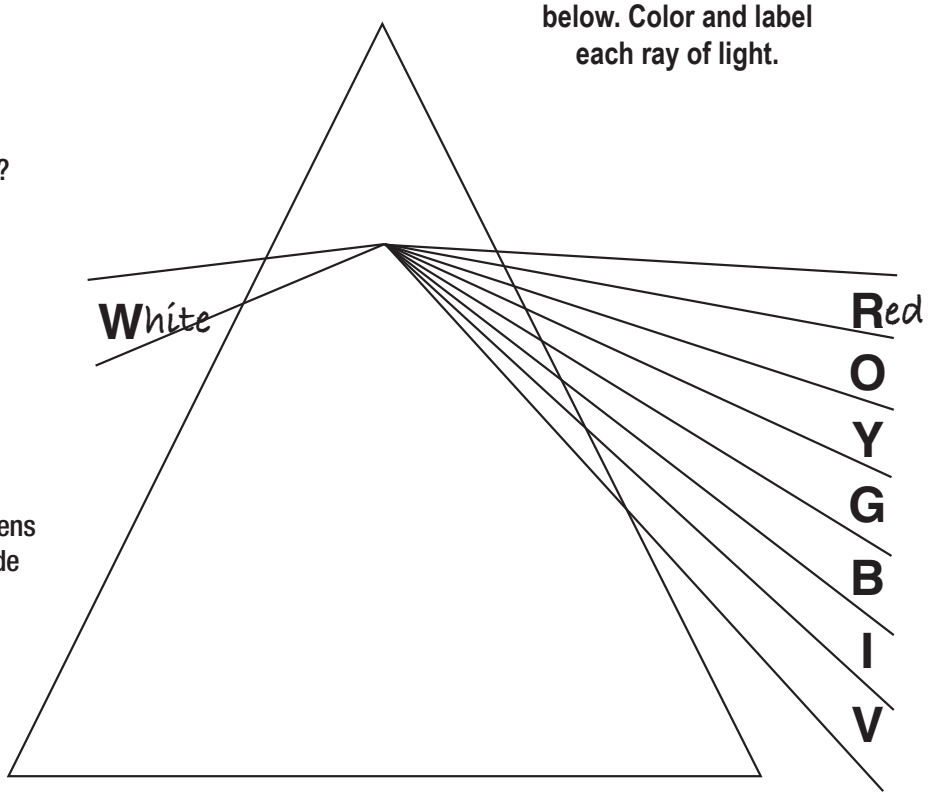
1. What is visible light?

2. List three objects that produce and emit light?

3. What color does light appear to be?

4. We call natural light “white light”. What happens to the white light as it shines out the other side of the prism?

Complete the diagram below. Color and label each ray of light.



STUDENT ACTIVITY - 1

RAINBOW GLASSES

Using the rainbow glasses provided in the kit, look into the lights around your classroom.

1. Pick your favorite light pattern. In the box, illustrate and describe what patterns and colors you see.

2. The glasses tell you about the lights that shine around you. How is it different than looking just with your eyes?

DRAW AND EXPLAIN HERE:

STUDENT ACTIVITY - 2 COMPARISON OF COLORS, REFLECTION, AND ABSORPTION

Place the pieces of construction paper on the desk or table in front of you. With the lights off, shine the flashlight on the center of each color and rank the colored paper from brightest (1) to the least bright or dimmest (4).

PAPER COLOR	WAS MORE LIGHT ABSORBED OR MORE LIGHT REFLECTED?	RANK

1. Does absorption or reflection make an object appear brighter? Explain your thoughts.

2. If objects that absorb light convert the light energy to heat energy, which color object would absorb the most light and increase in temperature most easily: black or yellow? Explain your answer.

3. In conclusion, explain how reflection and absorption determine which colors we see and how bright a color appears to our eyes. You may use an example to help explain your answer.

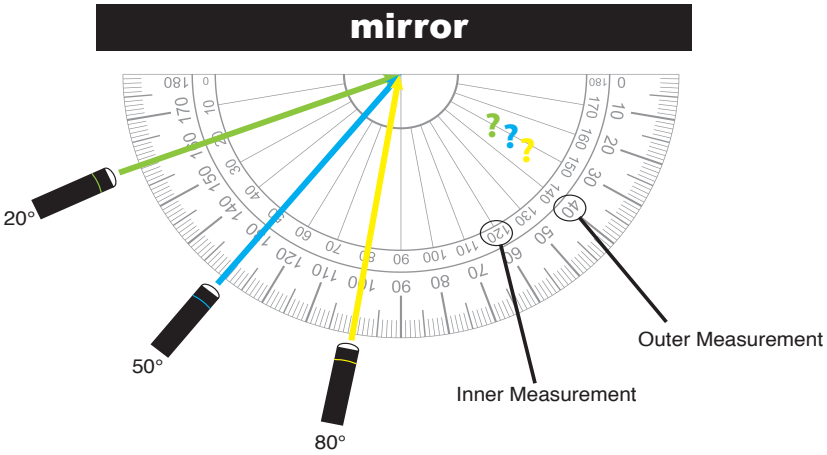
How does light travel?

Light travels on waves in a straight line at the speed of light, 300,000 kilometers per second, through space. As light travels or is transmitted or moves through other materials the light is slowed down. Sometimes the light bends, or is refracted. Other times it is reflected, absorbed or diffused. Some objects are better at reflecting light, others are better at absorbing light. Let's explore some materials and see where the light goes!

STUDENT ACTIVITY - 1

ANGLE OF REFLECTION

Let's see if we can figure out what the angle of reflection is by doing a test. We will be shining the laser at an angle of 20°, 50°, and 80°, where do you think the light will go? Fill in below. With the protractor sitting against a standing mirror, shine the laser down the left side using the inner measurements. While one team member holds the laser steady have another team member measure the angle of the reflected laser on the right using the outer angles. **Draw lines on the diagram to the right to show where your light travels each time. Round to the nearest 10 degrees. Also, fill in below.**



	HYPOTHESIS	OBSERVED
20°		
50°		
80°		

CONCLUSION:

1. Is the angle that light hits and reflects the same or different?

2. If you were to shine your headlights on a street sign that is off to your right, where do you think the light would go?

3. Would it be easy or difficult to see that sign at night? **Explain.**

STUDENT ACTIVITY - 2 DIFFUSION

Take a piece of clear plastic wrap. Wad it up into a ball so that it stays together, but not too tight. Hold it a few inches above the surface of the table. Shine the laser pointer into the top from about 2-3 inces above. Answer questions about where the light goes below:

1. Is any light reflected off the plastic?

2. Is any of the light absorbed?

3. Is any light transmitted through the plastic to the table?

4. This investigation demonstrates DIFFUSION. Based on your observations, how would you define diffusion?

5. How would diffusion of light be helpful or harmful in transportation? Explain your thinking.

STUDENT ACTIVITY - 3 REFRACTION

Using a 300ml beaker or clear drinking glasses, fill it 2/3 with water. First place a straw in the middle of the glass.

Looking beside the glass from the front, draw what you see in the water below. Repeat for number 2, placing the straw closer to the edge of the glass.

1 2

Describe what you see in each glass.

1. Glass #1:

2. Glass #2:

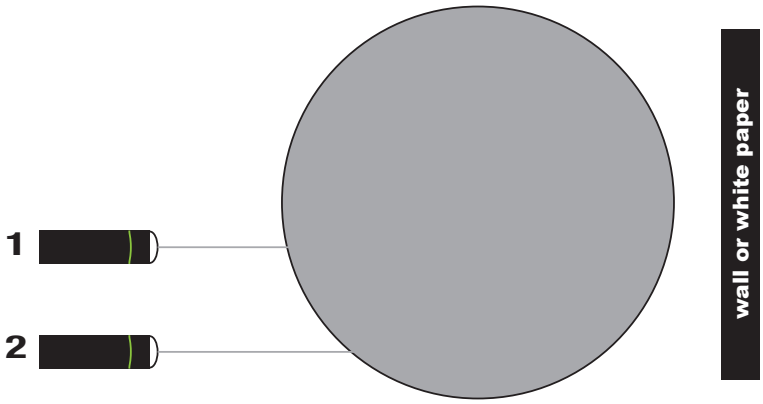
3. What do both paths have in common?

4. Which path shows the greatest difference from the actual straw? **Explain.**

STUDENT ACTIVITY - 3 REFRACTION CONTINUED

Shine a laser light through the liquid and look through the top of the glass. First shine the light through the middle and then through closer to the side.

Draw the path of the laser light for each below.



Describe what you see in each glass above.

1. Laser #1:

2. Laser #2:

3. What do both paths have in common?

4. Which shows the greatest difference from the entry light? **Explain.**

REFRACTION refers to the bending of light. Based on your above observations, answer the following questions.

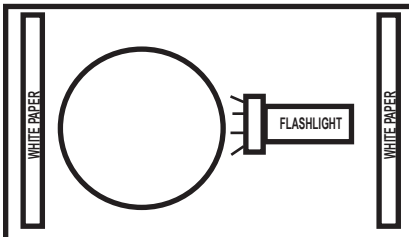
1. Did light from the straw and the laser bend more or less when closer to the outside curved surface of the glass?

2. If water bends light, where or how might what a driver sees change in the rain or snow?

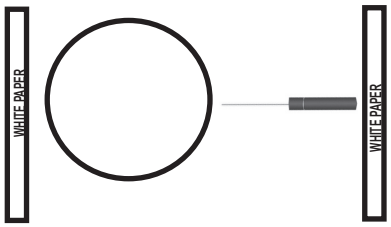
EXPLAIN

Can we change what we see?

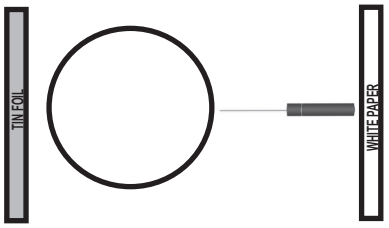
TEACHER DEMONSTRATION LIGHT THROUGH A GLASS SPHERE



1. Where does the light from the flashlight go as it is transmitted through the glass ball? Illustrate and describe.



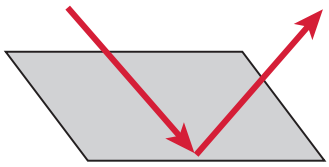
2. Where does the light from the laser go as it is transmitted through the glass ball? Illustrate and describe.



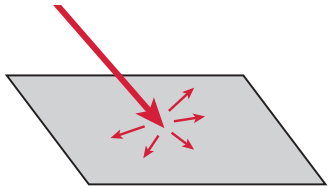
3. When metal is placed behind the glass ball, does this change what you see from the laser pointer? Illustrate and describe.

What happens when the teacher wraps the foil on the back of the glass sphere?

When people drive their vehicles they need to be able to see signs that are high in the air and on the side of the road. For this to happen we need to combine reflection, refraction and diffusion so that the light from the headlights returns to the vehicle.

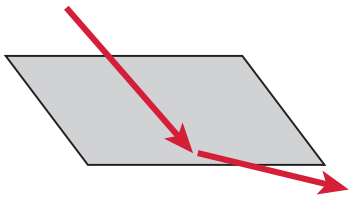


REFLECTION

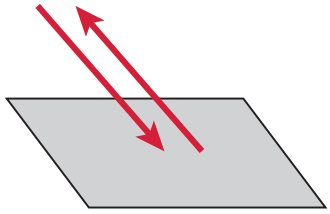


DIFFUSION

Briefly describe what the light is doing in each picture.



REFRACTION



RETROREFLECTION

RETROREFLECTION combines reflection with refraction and some diffusion to help drivers better see road signs.
Based on your observations, describe how retroreflection works.

STUDENT ACTIVITY - 1 DOES COLOR MATTER?

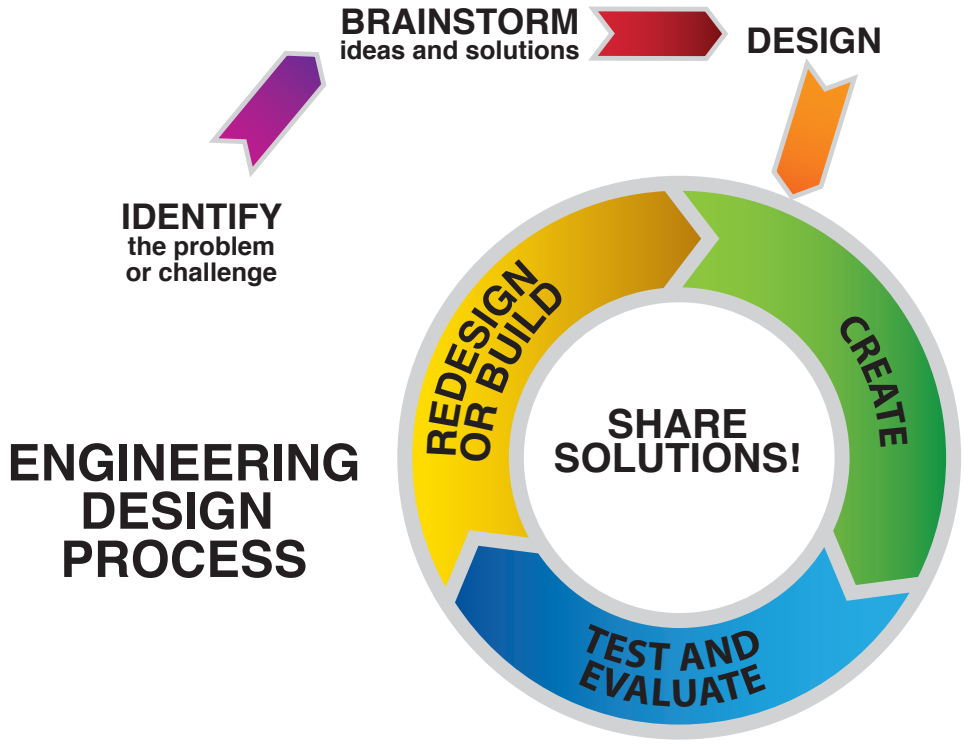
Place the five various colored marbles on a white or light colored surface. Holding the flashlight in front of your chin, shine the light at each marble and record what you see. Describe how the light retroreflected with each color and rate them 1-5, brightest=1, dimmest=5.

COLOR:	COLOR 1:	COLOR 2:	COLOR 3:	COLOR 4:
CLEAR				
RANK	RANK	RANK	RANK	RANK

ELABORATE

Can we control what we see?

Engineering is about developing new solutions to problems and challenges in our world. The Texas A&M Transportation Institute works every day towards solutions in all aspects of transportation. They conduct over 700 research projects each year on the land, sea and in the air.



ENGINEERING DESIGN PROCESS

The engineering design process is fluid. It does not have to begin or end at a particular point. One important aspect of the process is to share solutions along the way with others. Engineering is the design and building of new ideas.

TEAM CHALLENGE:

Design and build a directional sign to achieve maximum retroreflection to the driver with headlights at night.

MATERIALS:

12 marbles
clay or play-doh
rulers
foil
8"x 11" manila folder
construction paper
scissors
glue
clear tape

KEY VOCABULARY

As a class, define each of the following words and determine how they are important components of engineering.

effective:

criteria:

STUDENT ACTIVITY - 1 ENGINEERING DESIGN PROCESS CHALLENGE!

PART I: DEFINE THE PROBLEM OR CHALLENGE

With your team, state your challenge. What is it that you are trying to accomplish? Decide this as a group.

ONCE YOU HAVE DEFINED THE PROBLEM OR CHALLENGE AS A TEAM, YOU WILL WORK ALONE ON THE NEXT TWO STEPS!

BRAINSTORM: ALL ideas are good ideas at this stage. Here is where creativity is needed and no reasonable idea is bad or wrong. This part of the process helps us use what we know and combine it with imagination. Did you ever hear the saying, " two heads are better than one?" Well here EACH team member should come up with their own idea or ideas to share with the group. **Work independently and write down all your ideas here.**

PART 2: DESIGN

INDIVIDUAL: Continue to work alone to complete your design. Now it is time to work through all of the pros and cons of each idea. Here you will design a sign that tells drivers to turn right. You can use pictures or words or both on your sign. Make sure your sign fulfills the criteria and uses only the materials allowed. This design is your very own idea that you will share with the group after completing your design and answering the first two questions below. Be creative.

YOUR PERSONAL IDEA FOR THE SIGN

What do you like best about your personal idea? Why?

What do you have the most concern about your personal idea? Explain.

PART 3: TEAM DESIGN

With your team, design again. Combine each member's design into one so that you maximize your great ideas for a successful design that meets the criteria. Be very detailed in your drawing and label all items. While not every idea will be a part of the team sign, all ideas help generate solutions. Part of the engineering design process is working through ideas to find the best solutions to the problem. 3M Engineer Tim Hoopman said, "Be a risk taker. Let your failures be your education and your successes be your legacy."

TEAM SIGN DESIGN (everyone should have the same sign here)

MATERIALS LIST:

Be very specific, ex: 3 red marbles. Remember you can ONLY use materials from the original list.

CREATE: Make a sign using the team's best ideas.

TEST & EVALUATE: Test out your sign and evaluate the results. Record all positive and negative results.

REDESIGN: Redesign to solve any problems with your sign. Document some things you might change to the design. Did you consider varying the depth of marbles, adjusting the spacing between marbles, or changing what is behind each marble or marbles?

FINAL TEAM SIGN DESIGN

SHARE SUCCESS:

Share successful solutions with the class, not only the finished product, but the steps you took along the way.

What are some features that successful projects have in common?

What was the best retroreflective feature on your project? Why?

What was the best retroreflective feature of another project? Why?

How could we combine all the team's best work for even better retroreflective results?

If you had more time, or other resources, how could you improve on your sign?

Can we make good better?

EVALUATE

STUDENT ACTIVITY - 1 A CLOSER LOOK!

Using the pocket microscope, look at each piece of sign sheeting material more closely. **Describe and illustrate what you see for each.**

1

2

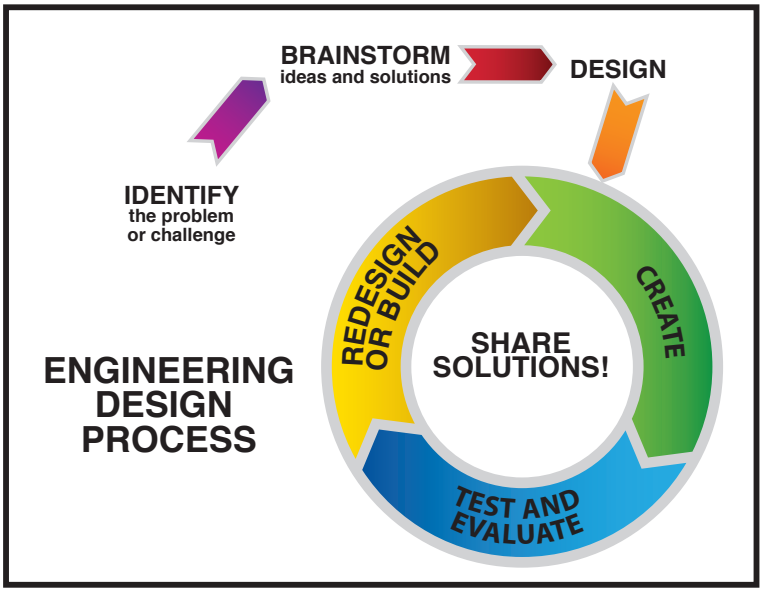
3

STUDENT ACTIVITY - 2 TEST ENGINEERING

As vehicles travel on our roads, some travel more slowly through neighborhoods or school crossings, while those traveling on the highways are going much faster. As you go faster, is it harder or easier to stop? Before answering, try this quick test. Walk around the classroom at a normal pace. Have someone in your group tell you when to stop. Have the others watch to see how quickly you are able to come to a complete stop. Next find a clear space that your teacher will allow you to run. Take off as fast as you can and again have someone in your group tell you when to stop and have the others observe. Discuss this quick investigation as a group to determine your results. Was it easier to stop quickly from a walk or a run? **Explain your reasoning**.

Now imagine vehicles on the roads, going slow and going fast. The important thing about traffic signs are that drivers are able to see and read them in time to follow them. Which of the reflective materials would allow drivers to read a sign sooner? In order to recommend one of these products you will need to use all of your prior investigative knowledge, as well as design an investigation to provide evidence that supports your recommendation with scientific proof.

Your group will act as test engineers on this activity. Test engineers design experiments they can test on products in order to assure they meet their requirements. You will be using the engineering design process to conduct your investigation. Rather than engineer a product, you will engineer a method of testing a product to verify its effectiveness to retroreflect.



IDENTIFY the problem or challenge. What is the problem you are working to solve or question you are trying to answer?

BRAINSTORM ways to solve the problem. What are some methods you could use to test the materials. Remember all ideas are worth writing down and considering!

DESIGN your investigation. After discussing your ideas, narrow your investigation down to the investigation that will give you answers that will best help you solve your problem. Describe your investigation design in detail.

CREATE your investigation. Set everything up and prepare to investigate!

TEST AND EVALUATE! Conduct your investigation and record ALL observations, data, and more below. Draw any data charts, graphs and more you will be using to collect and analyze your data. Use a separate piece of paper as needed.