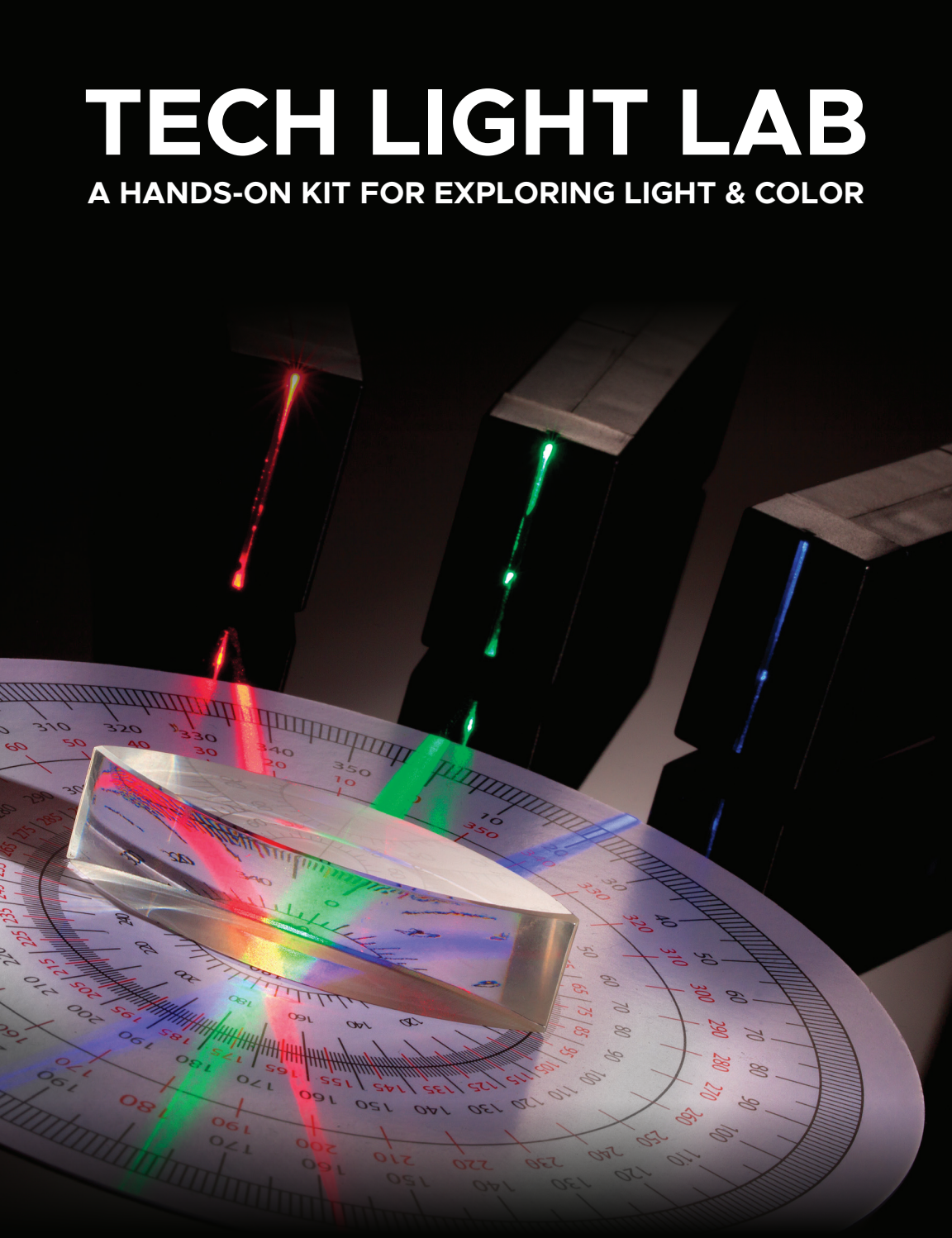
TECH LIGHT LAB

A HANDS-ON KIT FOR EXPLORING LIGHT & COLOR



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INTRODUCTION

Light is a fascinating and familiar topic for young kids. It's also rich and complex, which is great if you are teaching a graduate level course in Quantum Mechanics. But how do you lay the foundation for this exciting topic? What do you teach to the youngest would-be scientists? And how?

The Tech Light Lab and the following activities were developed to answer those questions. With sturdy, hands-on equipment, and easy to follow instructions and worksheets, abstract concepts become concrete and visible. Rather than focusing on discreet facts, the guide allows you to take advantage of student's natural curiosity as they learn the concepts, skills and practices of a scientist.

While each lesson/activity can certainly stand alone, the activities, when have been designed and arranged to lead students through a though process that builds their understanding of some broad fundamentals about light and vision. From the simple experience of how light makes vision possible to color, reflection and refraction, you have everything you need to create an engaging and exciting unit on light for ages 8-12.

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Find more kits and equipment or to download additional lessons, activities and demonstrations around light, lasers and optics visit www.laserclassroom.com.

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BIG IDEAS

- Light allows us to see.
- Light originates from a source.

WHAT YOU'LL NEED

- White LED or Flash Light
- Blankets / Boxes
- Paper Doll Template
- Aluminum Foil
- Construction Paper (white and black)

LIGHT IS FOR SEEING!

You can begin a unit on light by having a classroom discussion that introduces the idea that light is what allows us to see.

1. Close the shades, cover the windows and turn on off the lights; then invite students to complete a task such as coloring or reading. When they respond "we can't!!", ask them why?
2. Ask students to brainstorm a list of dark places - cave, deep sea, movie theater.
3. Ask students WHY are those places dark? Facilitate a conversation that leads students to realize that without a source of light, there is no light; and with no light, there is no seeing!
4. Once students are clear that light is what allows them to see, introduce the idea that light comes from a source.
5. Brainstorm sources of light: candle, light bulbs, stars/sun, holiday lights. Light comes from a source.

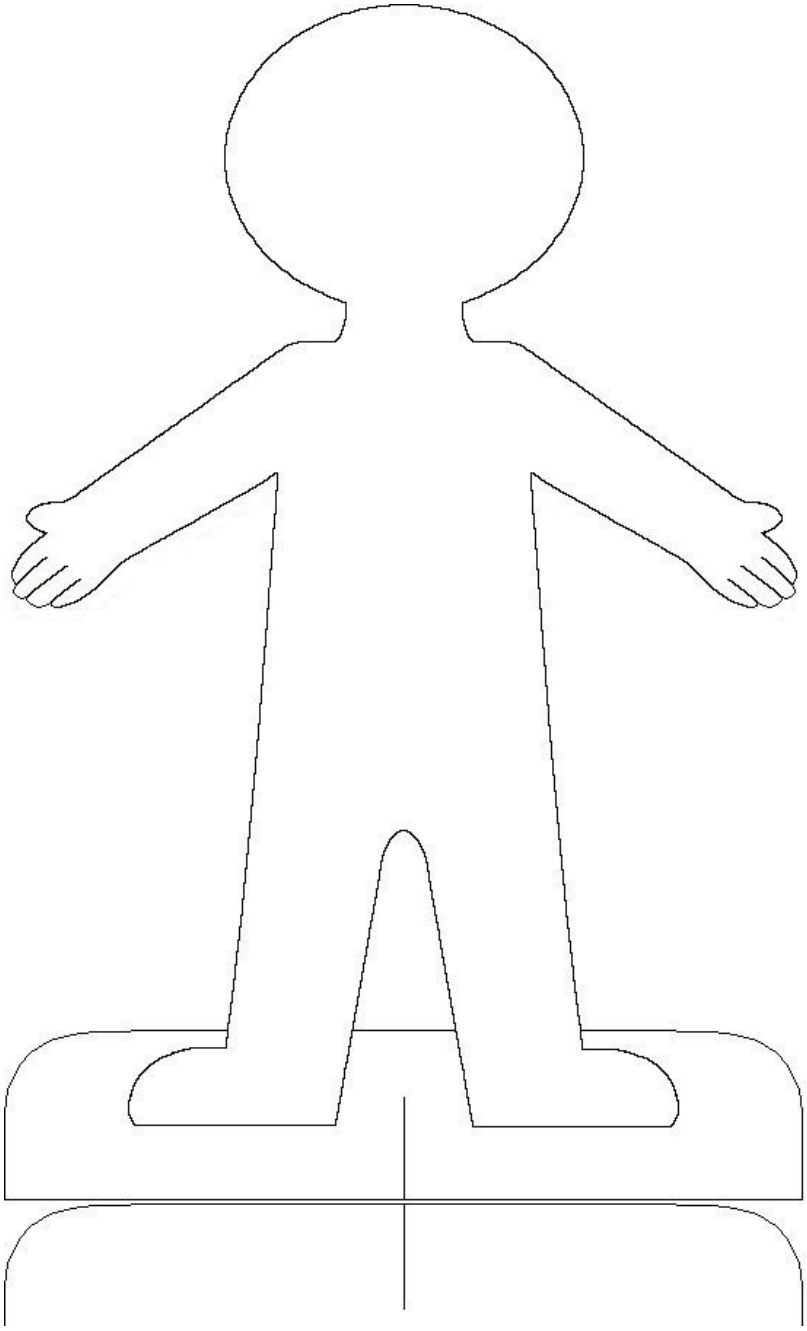
The following Activity: Classroom Cave, gives students a chance to use science to refine their understanding of light and sight. By predicting, testing, changing a variable and testing again, students learn the process of science along with the content: light allows us to see.

ACTIVITY: CLASSROOM CAVE

This activity allows students to simply have the experience that a light source illuminates objects and allows us to see; it creates the foundation for the rest of the activities which lead students through the various properties of light and back around to how we see in our every day life.

1. Prepare a very dark “cave” in your classroom with blankets and/or boxes that students can easily climb in and block out light from the room. You can do this in advance, or have students brainstorm and create it with you, working together to make it as dark as possible.
2. Use the template on the next page and some construction paper to cut out 6 paper dolls: 2 white, 2 black and 2 aluminum foil.
3. “Hide” one of each doll inside the cave.
4. Show students the dolls and invite them to predict which doll(s) they will be able to see inside the cave (without taking a light in with them). Write down their predictions.
5. Invite one or two students at a time to go into the dark cave without a light to look for the hidden dolls..
6. Soon, students realize, they can not find any dolls. Discuss what they predicted vs. what actually happened.
7. Ask, why they found no dolls. What do they need? LIGHT!
8. Invite students to predict which dolls they will find if they take a flash light with them into the cave?
9. Give each student or small group of students a flash light or LED and allow them to use the light to look for the hidden dolls.
10. Discuss both their findings and the process of predicting, testing, changing a variable (light) and predicting and testing again. THIS IS SCIENCE!!

TEMPLATE: PAPER DOLLS



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BIG IDEAS

- Light travels in straight lines.
- Light spreads out as it gets further away from the source.

WHAT YOU'LL NEED

- Activity sheets
- 3 index cards with one hole punched in the same place in each
- A set of Light Blox (one each red, green, blue)
- A plain piece of white paper
- Mirror stand
- A blank wall or screen

FOLLOW THE BEAM!

Students experience light as something that simply appears and then disappears. But actually, light travels - so fast that it's difficult to experience. These two activities provide some experience with the fact that light travels - and it travels in straight lines that spread out over a distance.

With the first activity, students will use a Light Blox and 3 index cards to observe how light travels in straight lines.

With the second activity, students will use a Light Blox and a blank wall to observe that light spreads out as it travels over a distance.

Have students complete each activity (one at a time). Hold a classroom conversation after each one that incorporates students' findings and covers the main discussion points.

MAIN DISCUSSION POINTS

- Light travels in a straight line
- As light travels from the source (Light Blox) to the wall or paper, it "spreads" out and takes up more room. As the light source (Light Blox) is moved further from the wall, it gets "bigger" and dimmer.
- As the light source is moved closer to the wall, it gets "smaller" and brighter.

ACTIVITY SHEET 1: STRAIGHT LINES

REMOVE the line cap from the front of the Light Blox.

1. Use the binder clips to stand up your index cards.
2. Remove the line cap from your Light Blox.
3. Arrange your index cards so that the light travels through all three holes.
4. How did you arrange your cards?

_____

_____

_____

5. What happens when you move the center card? Can the light "get around" the card and pass through the last hole? Why?

_____

_____

_____

ACTIVITY SHEET 2: LIGHT SPREADS

REMOVE the line cap from the front of the Light Blox.

1. Turn on ONE Light Blox and shine the light at the wall. Move the Light Blox closer to the wall. What happens to the light as it gets closer to the wall?

_____

_____

_____

2. Turn on ONE Light Blox and shine the light at the wall. Move the Light Blox further away from the wall. What happens to the light as it gets further away from the wall?

_____

_____

_____

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BIG IDEAS

- You can make new colors with light.
- White light is made up of many colors.

WHAT YOU'LL NEED

- Activity Sheet 3
- Set of 3 Light Blox
- A diffraction grating

LIGHT & COLOR

Many students begin with the misconception that the light they experience every day is "clear" and that things create color. In reality, everyday light is composed of many colors, and the colors they see are the result of the interaction between light and matter.

The next activity familiarizes students with light and color. It exposes students to the fact that white light is composed of many colors of light. Students will see white light "broken" into a spectrum of colors by a diffraction grating, and they will combine three colors of light to make white light.

The focus of these activities is on providing materials and guidance to enable exploration and observation. Students record their observations and begin to make sense of their investigations by looking beyond the obvious and forming their own conclusions.

BACKGROUND FOR THE TEACHER

Light can be thought of as either a wave or as a particle. There are many types of light, each with a different wavelength. Only a very small number of wavelengths are visible to the human eye. Microwaves and radio waves, for example, are light waves that are not detected by the human eye.

Each of the wavelengths that are visible to the human eye is defined and experienced by us as a color. Red has the longest wavelength, and blue or violet has the shortest wavelength. When waves of light combine with each other, they "change" color! When the three primary colors of light (red, green and blue) are combined, they create white light.

ACTIVITY SHEET 3: LIGHT & COLOR

1. Hold the diffraction grating up to your eye and look through it toward the lights in the room (DO NOT LOOK AT THE SUN). Look to the edge of the slide - what do you see?

2. Remove the line caps from all three Light Blox; turn them on and set them on a piece of plain white paper so that you can see the colors.
3. Move the Light Blox so that two colors overlap to make a new color. What colors did you use to make a new color? What new color did you make?

4. How many new colors can you make? List the colors you used and the new color for each combination.
   EXAMPLE: RED + GREEN = YELLOW

5. What happens when you combine all three colors? Can you make “white” light?

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LET THE LIGHT SHINE!

BIG IDEAS

- Light does different things when it hits different kinds of materials - light can be absorbed (blocked) or transmitted (passed through).

WHAT YOU'LL NEED

- Activity sheets
- A clear plastic bag or transparency
- A piece of cardboard
- A piece of waxed paper
- A set of Light Blox (one each red, green, blue)

Light travels until it encounters something. The following activity will allow students to explore some things that can happen to light when it encounters matter: it can be absorbed (blocked) by a material or it can be transmitted (allowed to pass through) the material.

Set up each group of students with one Light Blox with the slit caps removed, and Activity Sheet 4: Let the Light Shine. Have students complete their investigations, fill out their worksheets and then hold a classroom conversation that incorporates students' findings and covers the main discussion points.

MAIN DISCUSSION POINTS

- Light that is absorbed loses light as it passes through a material, generally due to its conversion to other forms of energy such as heat. Students at this stage will experience absorption of light as light being blocked/stopped.
- A material that absorbs (blocks) light is called OPAQUE.
- Waxed paper will allow some light to pass through, but it will also block some light.
- Students may notice that light is also reflected by some of these materials as well. We will explore reflection in another activity.

ACTIVITY SHEET 4: LET THE LIGHT SHINE

REMOVE the line cap from the front of the Light Blox.

1. Turn on ONE Light Blox. Place the clear plastic bag in front of the light and point it towards the table or the wall. What happens to the light when it hits the bag?

_____

_____

2. Turn on ONE Light Blox. Place the piece of waxed paper in front of the light and point it towards the table or the wall. What happens to the light?

_____

_____

3. Turn on ONE Light Blox. Place the piece of cardboard in front of the light and point it towards the table or the wall. What happens to the light?

_____

_____

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BIG IDEAS

- Shadows are created when light is blocked.
- Shadows change shape and size, depending on the location of the light and the object.

WHAT YOU'LL NEED

- Shadows worksheet
- Light Blox
- A piece of plain white paper
- A pencil or pen
- A mirror stand

SHADOWS

Very young children think of shadows as actual objects. But by grade school, most kids will understand that a shadow is a phenomenon caused by blocking light. Most, however, will not be able to articulate the relationship between the location of the light and the size and shape of the shadow. This exploration will give them a chance to develop an intuitive sense of light and shadow.

Set up each group of students with one Light Blox with the slit caps removed, and the worksheet for Activity 5: Shadows. Have students complete the worksheets and then hold a classroom conversation that incorporates students' findings and covers the main discussion points. You can extend the exploration by inviting students to make predictions about what they think will happen before they explore on their own.

MAIN DISCUSSION POINTS

- A shadow "grows" in the same direction as light travels. If you point the light from left to right, the shadow appears to the right of the object. If you point the light from right to left, the shadow appears to the left of the object.
- A shadow gets bigger as the light moves further from the object.
- A shadow disappears when light strikes an object from directly above it.

ACTIVITY SHEET 5: SHADOWS

REMOVE the line cap from the front of the Light Blox.

Stand up the pencil in the mirror stand.

1. Turn on **ONE** Light Blox. Shine the Light Blox at the pencil and observe the shadow. How can you make a shadow shine to your left?

_____

_____

2. How can you make the shadow bigger? How do you make the shadow smaller?

_____

_____

3. How can you make the shadow disappear while still shining the light on the pencil?

_____

_____

4. Turn on **TWO** Light Blox. Experiment with shadows made from two light sources coming from different directions. What do you notice?

_____

_____

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MODEL OF REFRACTION

This kinesthetic activity helps young scientists understand and remember how light bends and why.

BIG IDEAS

- Light slows down and bends when it travels from air into another medium, such as water or plastic.

WHAT YOU'LL NEED

- An outdoor sidewalk that runs along a grassy field

OR

- A large, flat area for marching students
- Masking Tape

1. Bring your whole classroom to your chosen spot:
   a. either an outdoor area with a sidewalk that lines a grassy field, in which case the sidewalk represents "air" and the grassy field represents another medium (water or plastic).
   b. OR, indoors, create a boundary on the floor with a long strip of masking tape.
2. First, get students to march in step with a uniform pace and then learn to change to steps half as long with the same frequency on your mark. It helps to count out "leftright, left-right" until they are able to march in both ways.
3. Line students up in fours, each tier with linked arms to imitate consecutive wavefronts. Then let them march on the sidewalk or on the "air" side of the tape - approaching the boundary at an angle (as in the drawing above).
4. As soon as each crosses the boundary s/he must change to steps half as long. This will slow down, as students crossing the boundary will cause the direction of the "light" to shift.
5. Once they have all crossed, have them travel in the other direction - taking half steps until they cross back out into air where they again resume full steps - causing the "light" to bend back to the angle that they began with!

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BIG IDEAS

- The shape of a lens impacts HOW light will bend.

WHAT YOU'LL NEED

- A set of 3 Light Blox with the slit caps on
- 3 Lenses - concave, convex, trapezoid

LENSES

REFRACTION THROUGH A LENS

One of the ways we manipulate light to make it do what we want to do is by using lenses to change the direction of light. This is some background information for you, the teacher. Allow students to explore the materials, using worksheets for guidance, and then hold a classroom discussion to highlight the main learning points.

CONVEX LENSES

A convex lens is thicker in the middle than at the ends and causes light to bend towards "normal", or the center of the lens. As three rays of light pass into and through the convex lens, you can see that they all converge to a point - that point is called the focal point. This focusing ability of convex lenses helps us to see images clearly - from the lenses in our eyes to the lenses in microscopes and telescopes.

CONCAVE LENSES

A concave lens on the other hand, is thinner in the middle than at the ends, and causes light to bend away from "normal", or the center of the lens. As three rays pass through the concave lens, you can see that they diverge, or spread out.

ACTIVITY SHEET 6: LENSES

PUT THE LINE CAP ON the front of the Light Blox.

1. Turn on ALL THREE Light Blox. Using the template page, set up three Light Blox and the CONCAVE lens as directed. On the template page, draw the beams that pass through the lens. Describe what happens to the light beams as they pass through the CONCAVE Lens.

_____

_____

_____

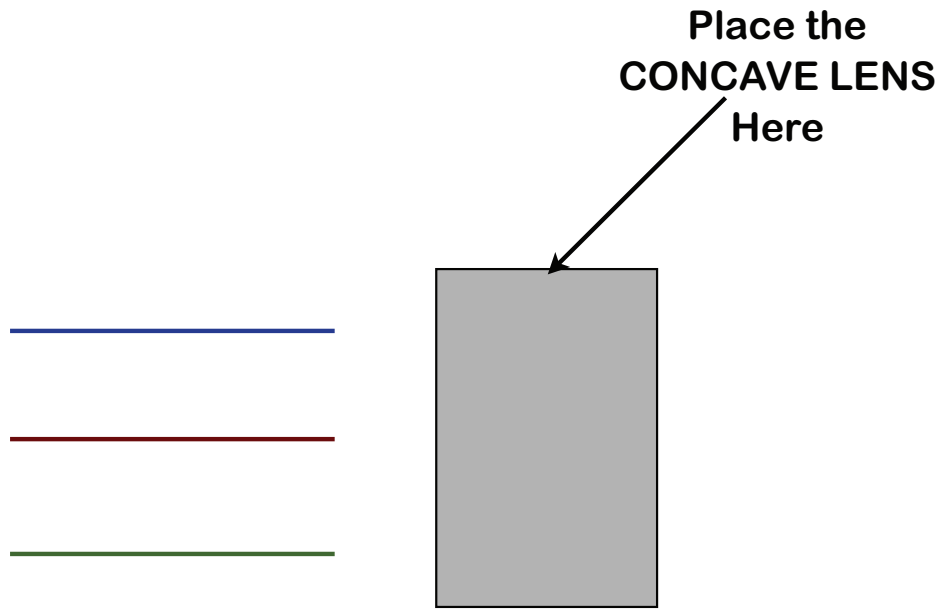
2. Now use the template page to set up three Light Blox and the CONVEX lens as directed. On the template page, draw the beams that pass through the lens. Describe what happens to the light beams as they pass through the CONVEX lens.

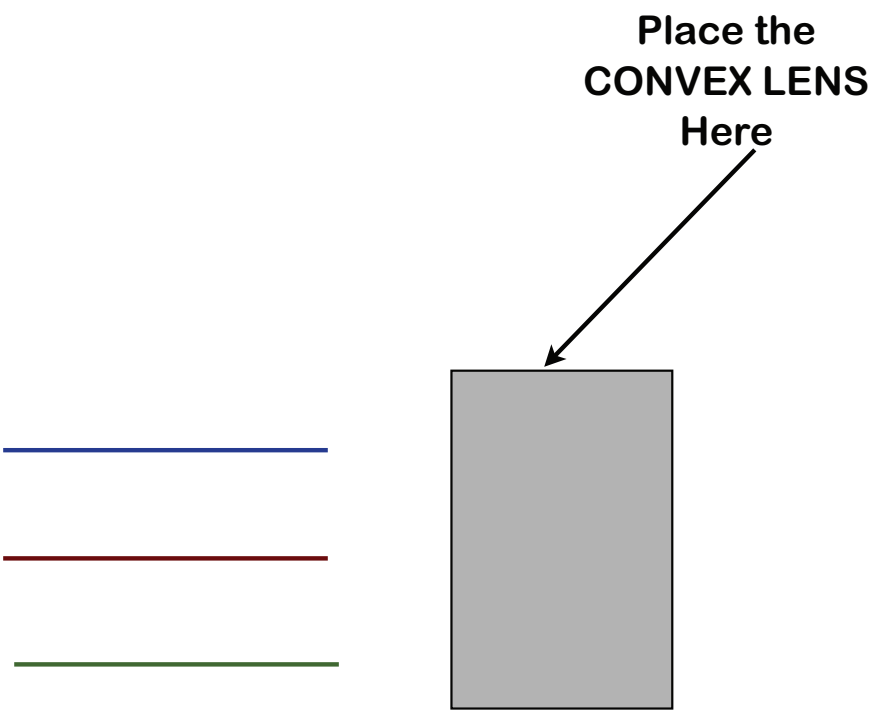
_____

_____

_____

TEMPLATE: LENSES





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BIG IDEAS

- Light Bounces.
- Light follows a strict rule about how it bounces.

WHAT YOU'LL NEED

- A single Light Blox with the slit cap on
- Masking tape
- Aluminum foil
- A small mirror and mirror stand
- A large mirror

REFLECTIONS

Reflection is what allows us to see objects - and the reason we see anything at all. Objects do not emit their own light (except for a few light sources), but we can see them because they do reflect light. Many students believe that only shiny objects like mirrors and aluminum foil reflect light - but actually ALL objects reflect light, and the only reason we can see them is because our eyes can detect and interpret that light.

The following activities will lead students through a process of understanding that reflected light is what allows them to see.

First, we will ground them in the fact that reflection involves two rays - an incoming or incident ray and an outgoing or reflected ray. In the first activity, they will use a Light Blox and a mirror to explore these rays and uncover the "law of reflection": the angle of incidence equals the angle of reflection.

Then we'll introduce what happens when there are many rays of light shining on an irregular surface - starting with aluminum foil and moving to...well, everything! Basically, so many rays of light bounce in so many directions that all we see is light, no rays. This leads them to understand that it's not only plain shiny surfaces that reflect light, and expands their understanding of how the reflection of light makes sight possible.

Facilitate the activities, one at a time. Follow each with discussion and explanations AFTER students have had time to explore and write down their findings.

ACTIVITY SHEET 7: REFLECTION & MIRRORS

PUT THE LINE CAP ON the front of the Light Blox.

1. Turn on ONE Light Blox. Stand the mirror in the stand and put the Light Blox on the table so that the line of light hits the mirror. What do you see?

_____

_____

2. Move the line of light so that it hits the mirror at an angle. Move the light again. What happens to the bounced beam when you move the light?

_____

_____

3. Pick a spot on the table not too far from the mirror. Can you shine the light at the mirror and make the light bounce to that spot? Move the mirror and the light until you can.

_____

_____

ACTIVITY SHEET 8: LAW OF REFLECTION

1. You need to work with a partner to do this activity. Find a place where there is a wall with plenty of space around it. Attach the mirror at eye level on a wall with masking tape. Cover the mirror with a piece of paper.
2. Now, both you and your partner should try to guess where you both need to stand to see each other's reflection on the mirror. When you both agree on the places, mark them on the floor with 6-inch pieces of masking tape.
3. Remove the paper from the mirror. Stand at your chosen place to determine if you can see each other in the mirror.
4. If you can't see each other, try different places until you can. Mark the places that work with the 6-inch pieces of masking tape.
5. Next, place long pieces of masking tape on the floor from the center of your 6-inch place markers to the wall straight under the center of the mirror. These should be straight lines.
6. Look at the angles made by the taped lines on the floor and the wall to see if they are the same size. Remember that light bounces off a mirror at the same angle that it arrives. Therefore, when the light from your face travels to the mirror on the wall, it should bounce off the mirror at the same angle to the eyes of your partner.
7. On a sheet of paper, write a description of what you did in this activity.

ACTIVITY SHEET 9: SO MANY REFLECTIONS!

So, if light bounces in straight lines, at very specific angles, why don't we see "streaks" of light everywhere? Why does it look like a "pool" of light?

1. Start with a sheet of aluminum foil and a Light Blox with the line cap on.
2. Fold the foil a couple of times to create a small "mirror". Can you see a reflected beam? How is it different from the beam from the "real mirror"?
3. Now crumple up the foil into a ball. Shine the beam at the foil. What do you see? What's happening? Can you see "a reflected beam"?

WRAPPING IT UP

The light still travels in straight lines! But because the surface of the foil is not smooth like the mirror, the light reflects off of each surface in a different direction. There are LOTS of reflected angles and they all bounce in straight lines, at the same angle as the incident beam hit the surface.

So light is bouncing in all directions off of everything all the time. What does this mean about how we see objects?

1. Turn out all the lights and make the room dark.
2. Give each group of students a light source and several small objects to observe.
3. Ask students to create an explanation as to how light allows them to see, incorporating what they have learned so far. They can use words, pictures, analogies.
4. Conduct a classroom discussion that allows students to share their ideas about how light allows us to see.
5. Conclude with: light from light sources bounces off of (illuminates) objects and enters our eyes.

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