



Reflecting on Light

with Judy & Nancy

#OpticsAtHome

#SeeTheLight

LET'S WONDER

Optics Magic with Judy & Nancy: Reflecting on Light

WHAT REFLECTS LIGHT?

CAN YOU FIGURE OUT A RULE TO PREDICT THE PATH OF REFLECTED LIGHT?

In this lesson, you will test a number of different objects to see if they reflect light. Then you will use a protractor and math to generate a rule for reflection.

MATERIALS:

Activity 1 – What reflects light?

1. Flashlight
2. CD jewel case (or a small mirror). Lining the CD case with black paper will make a better reflector and prevent light from passing through
3. Assortment of objects such as finished and unfinished wood samples, plastic or metal spoons, paper, cardboard, etc.

Activity 2 – Law of Reflection

1. Printed protractor
2. Small mirrors that can be made to stand vertical. Mirrors can be hard to find (see Resources) so for this activity a CD jewel case lined with black paper will work- it can even stand vertically on a table
3. A flashlight with a narrow beam or a laser pointer (preferred).

OPTIONAL ACTIVITIES:

There are lots of activities involving mirrors and reflection! Included in this document is the Laser Target Shoot, but you can find more in the Dumpster Optics lesson in the Resources below

PARENT AND TEACHER NOTES:

Many students (and adults) believe that only mirrors and other shiny objects reflect light. In the first activity, we help children to understand that if you see a non-luminous object, it's reflecting light into your eyes.

ACTIVITY 1 – WHAT REFLECTS LIGHT? Our surveys of fifth grade students indicate that most understand that mirrors reflect light. A good place to start is to show how a mirror can reflect a beam of light onto a surface where it can be seen. We'll call this the "reflection test" and state that if an object can redirect a beam of light as a mirror does, then it's reflecting light. To do the reflection test, hold a flash light pointing somewhat upward and then move the CD case or small mirror over the beam. (It works best if the room is darkened a little.) Tip the mirror as needed so that there is an obvious patch of light on the table, where the light reflects from the mirror. (Figure 1) You can also do this by reflecting light onto a wall.

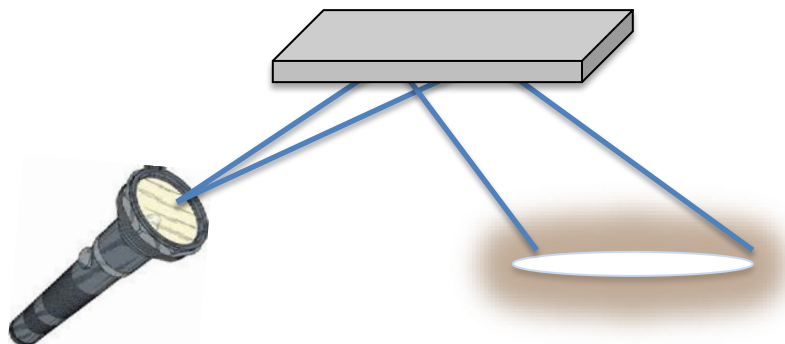


Figure 1 – the light from the flashlight is reflected from the CD case (or mirror) and back onto the table. Moving the CD case to the side, out of the beam, the glow on the table disappears. This is the "reflection test".

In this activity children will test a variety of items and decide which ones reflect light and which ones do not. Before testing each object students should first predict whether or not they expect it to reflect light. The test is performed as in shown in Figure 1: the object is moved into the flashlight beam and the reflection is observed on the table beneath. Children can test objects of their own choosing and as long as the room isn't too bright they will see that every object they test reflects at least some light.

Make sure the objects are large enough to produce sufficient reflection to be seen. For example, spaghetti reflects light but the light reflected from a single strand will be difficult to see. On the other hand, reflected light from a bunch of spaghetti will be bright enough to be visible. Good objects to use include paper plates, spoons, pieces of paper (various colors, textures), cardboard, etc. Children can also test their own hands, arms – one child tested his head and his partner confirmed that yes, his head reflected light. Since their own hands reflect light children need to be reminded to keep their hands out of the beam when testing other objects.

Guiding questions for this activity:

- Do all the objects you are testing reflect light?
- How do you know?
- How can you tell if an object is reflecting light? (Answer: Because you can see it)

ACTIVITY 2 – A REFLECTION RULE (LAW OF REFLECTION):

For this (quantitative) activity and math application, the mirror needs to stand vertically on a table. A CD case is perfect for this since it can be opened with the front (mirror) lined with black paper and the back serving as a stand. You may have to improvise with a mirror, using binder clips or building blocks. Place the CD case carefully so that it is lined up along the “0” line of the printable protractor at the end of these notes. It’s actually easier to use a printed protractor because the mirror may wobble a bit on a plastic one. It’s important to keep the mirror vertical and aligned as shown in Figure 2.

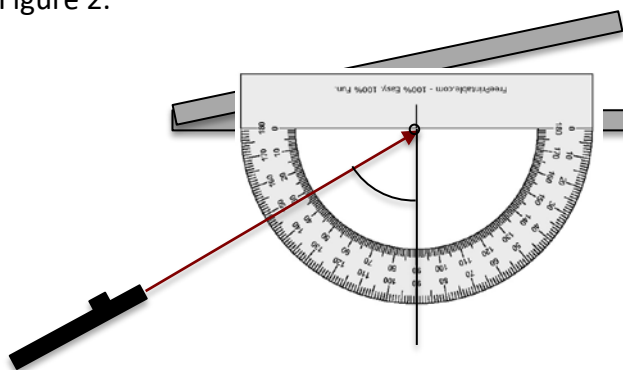


Figure 2 – Set up for determining a geometric rule for reflection (the Law of Reflection). Note that the beam strikes the CD/mirror at the center of the protractor zero line.

Aim the laser pointer at the center of the protractor (along the zero line). Be sure to have the children predict the reflected angle before measuring it. Record the results.

Repeat for a few more angles and see if children can come up with a rule that predicts what the reflected angle should be. (“Angle of reflection equals the angle of incidence.”)

Note that the angle is usually measured from the perpendicular line (the “normal”), not from the zero line. It’s probably easier for beginners to measure from zero, but if you count divisions from the normal it’s not that much more difficulty. In Figure 2, the angle of incidence is 60° .

One question children might ask is how is the reflection from a mirror different from the reflection from something that isn’t shiny, like a newspaper? Does the law of reflection apply to rough surfaces as well as shiny? If a beam of parallel light rays (like from a laser) strikes a shiny object, they hit at the same angle and are all reflected in the same direction. If the object is rough the law of reflection still applies, but since different parts of the beam strike “bumps” in the surface at different angles they are reflected in different directions (Figure 3).

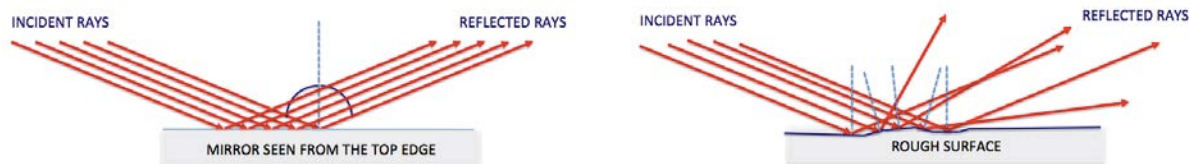


Figure 3 – A shiny surface reflects light rays in the same direction (left). A rough surface reflects light in all directions.

LASER SAFETY: Before allowing children to use the laser discuss rules for laser safety and the reason it is important to use the laser safely:

1. Keep lasers flat on the table
2. Only turn laser on for the duration of the measurement
3. Be aware of other people in the area and don't shine the beam on them
4. Make sure your beam doesn't go beyond the edge of your work space
5. No high sticking with the laser beam.

AN OPTIONAL ACTIVITY TO DO WITH CD CASES

LASER TARGET SHOOT: This is a fun way to reinforce the law of reflection and measurement with a protractor. You don't have to use all of these materials, just use what you need. This activity is popular with kids from 5th grade through college!

1. 1 laser pointer You may need to place it on a block to make beam high enough so it doesn't graze the table. Lego® blocks are perfect for this. The laser should be taped down so it cannot move. Do not allow it to be turned on until the mirrors are in place.
2. 1-3 CD jewel cases for mirrors; put black paper behind the side used as a mirror so light does not pass through. The more mirrors, the more difficult the challenge.
3. Printed protractor(s) as needed
4. String to help align mirrors
5. Meter stick or yard stick might be helpful for set up and alignment
6. Target (see below) Tape the target to a block of wood or other support so it stands upright. You can also use binder clips to make it stand upright. The target should be about one meter from the laser.

THE CHALLENGE

Round 1: You have 5 minutes to hit the target using ONE mirror.

Round 2: You have 10 minutes to hit the target using TWO mirrors.

Round 3: You have 15 minutes to hit the target using THREE mirrors.

⇒ In each round, the highest score will be recorded.

HOW IT WORKS- The Rules

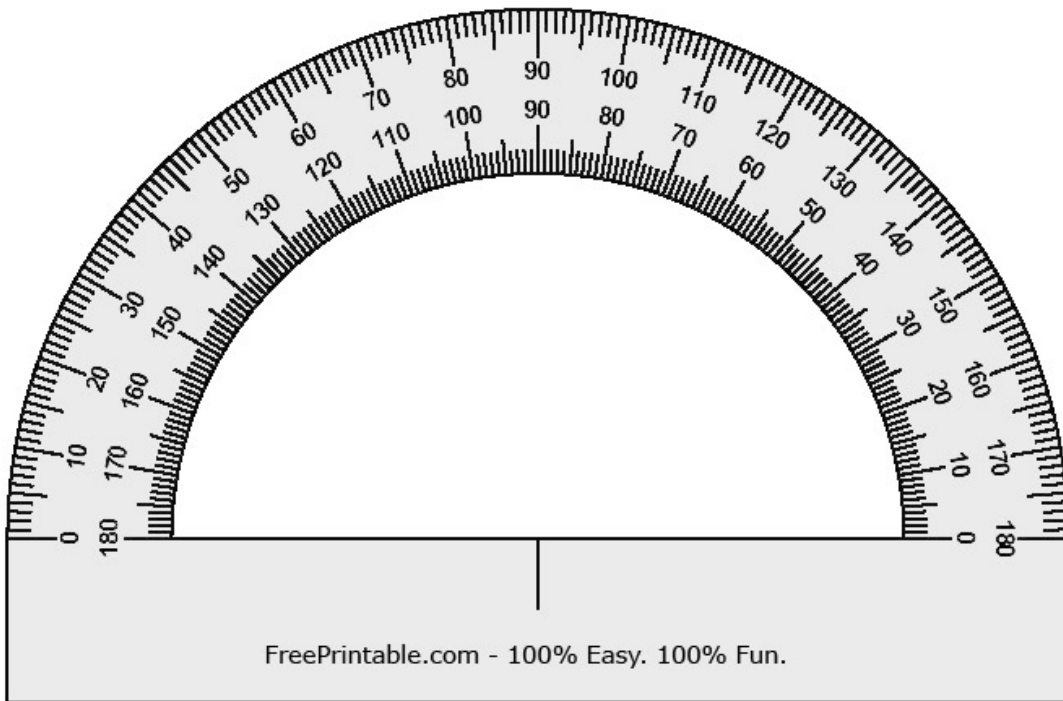
1. The laser and target will be set up for you by the instructor. You may not move either laser or target.
2. **The laser must be kept off until you have set up the mirror(s).** When you're ready, the instructor will turn on the laser. You may not move any mirrors when the laser is on.
3. If you don't get 100 points on your first try, the instructor will turn the laser off and you may move the mirror(s) and try again. You can keep trying until time is up for that round.
4. If the laser falls on a line between regions of the target, you will be awarded the average of the points on either side.

RESOURCES

1. If you want to purchase small plastic mirrors, one source is www.teachersource.com/
2. If you use a laser pointer, be sure it is low power (<5 mW). [Dollar Tree](http://DollarTree.com) sells laser pointers for 1 USD but you need to buy a minimum of 4.
3. For additional activities with mirrors, see the Dumpster Optics lessons at pblprojects.org. The lessons include teacher notes, student worksheets and PowerPoint slides in English and Spanish.
4. Videos of reflection activities can be found on the [PBL Projects YouTube](https://www.youtube.com/channel/UC...) channel.

PROTRACTOR AND TARGET

(Print the target and tape it to cardboard or print directly on cover stock.)



25

50

75

100

75

50

25