PERISCOPES

Lesson Type: Engineering/Do-It-Yourself
Target Grade: Elementary/High School
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Semester: Spring 2013

NOTE: When writing the lesson plan, be on the constant look-out for how the lesson plan should be portrayed and presented to the students and write that into the lesson plan as well.

Brief Overview/Challenge

Build a periscope.

Teaching Goals

- Learn about physics/optics.
- Understand about the Law of Reflection and how mirrors work.

Agenda

Agenda for engineering type modules should mostly follow this outline

- **Introduction** (~10-15 min)
    - Introduce the lesson
      -Ask if anyone knows what a periscope is.
      -Talk about periscopes and relate them to real life (submarines)
      -Go over instructions on how to build the periscope.
      -Have materials ready to be passed out.
- **Build** (~30 min)
    - Distribute materials.
    - Have mentors help the students if necessary. Answer questions. Mainly let the students have free reign unless they ask for help.
    - **o** Let students test their periscopes.
- **Recap** (10-15 min)
    - **o** Ask if everyone was able to make their periscope.
    - **o** Ask what would change if you changed the length of the periscope.

Materials

- o Each student will make their own periscope.

- Periscope Materials (per each student)
  - Periscope paper template printed on cardstock (standard 8.5 by 11 in)
    -(Periscope body)
    http://www.sciencetoymaker.org/periscope/images/periscpBody.gif
    -(Triangular cutouts)
    http://www.sciencetoymaker.org/periscope/images/periscopTri.gif
  - 2 mirrors (~1.5 in squares/can be any shape)
- Scissors
- Tape

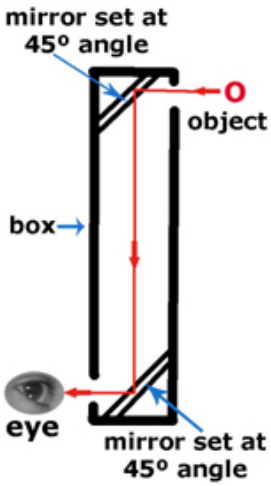
Procedure/Tips for building

1. Cut out the periscope body and triangular mounts.
   -Make sure students do not cut on the dotted lines
2. Fold both the periscope body and the triangle mounts on the dashed lines. Do it on the sharp edge of a desk.
   -Kids may have a hard time applying enough pressure to make the fold while at same time trying to be accurate and stay on the dashed line so encourage them to help each other for this part.
3. Tape the mirrors to the mounts and the mounts to the periscope.
   -The mirrors have to be taped to the hypotenuse of the triangle. This is the longer side opposite the taped ends. The triangles are right triangles (have a 90 degree angle), isosceles (have 2 sides of equal length) and they have two 45 degree angles.

Material to Teach

How a Periscope Works:

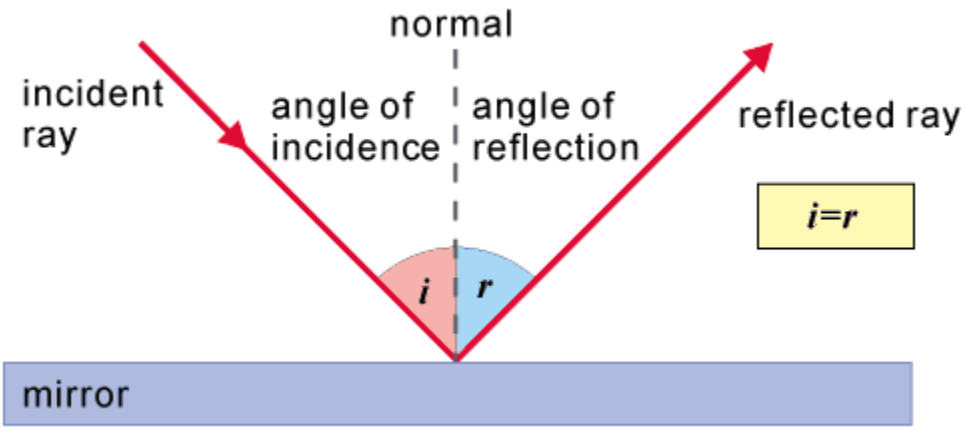
- Light always reflects away from a mirror at the same angle that it hits the mirror. In your periscope, light hits the top mirror at a 45-degree angle and reflects away at the same angle, which bounces it down to the bottom mirror. That reflected light hits the second mirror at a 45-degree angle and reflects away at the same angle, right into your eye.
- Why the mirrors have to be at a 45-degree angle:
  -when you aim a light source to a mirror, it gets reflected in the following way:
  the angle of incidence respect to the perpendicular of the mirror's surface is equal to the angle of reflection so if you aim it at 45 degrees, it would get reflected 45 degrees the other way, adding to a total of 90 degrees (best to show this with a diagram)



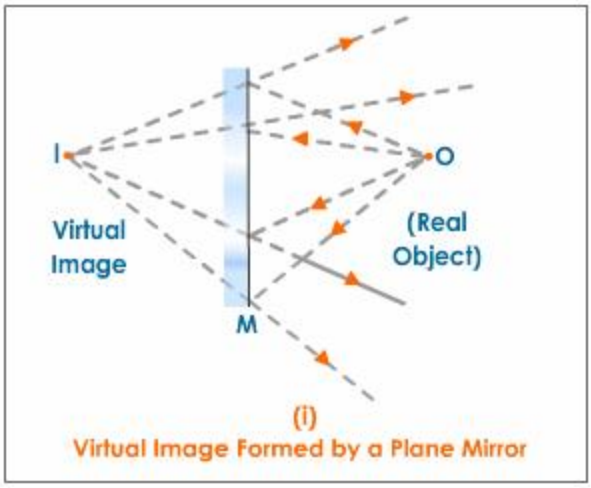
About Mirrors in General (if you have time)

- **Law of reflection**
  1) The incident ray, reflected ray, normal lies on the **same plane**.
  2) $\theta_i = \theta_r$, i.e., the angle of incidence is equal to the angle of reflection.

  - When the light rays are stroked on a curved mirror, the normal is perpendicular to the tangent of the curve at that point. e.g., when parallel rays are stroked on a coven mirror, they are all reflected and converge in front of the mirror.
  (It may be helpful to draw the diagram below on a board.)



- **Properties of the image**: the object that we see through the mirror is not the real position of it, but we can imagine that the light rays from the object comes behind the mirror and we call that an image. They have the properties:
  1) Distance from image/object to the mirror is equal. i.e., **image distance is equal to object distance**.
  2) IO is perpendicular to the mirror.
  3) The image formed is l**aterally inverted, of the same size as the object and is virtual**.



Background for Mentors

- Periscope, an optical device used for viewing objects that are out of the line of sight. Periscopes are used in tanks and submarines where it is necessary to see from a protected position. They have also been used for viewing the interiors of nuclear reactors. Simple periscopes are sometimes used by onlookers at parades, for seeing over the heads of the crowd.
- A simple periscope consists of a tube and two mirrors. The mirrors are set at angles of 45° to the length of the tube. If the mirrors are parallel to each other, the periscope "looks" forward and the object seen is rightside-up. In high-quality periscopes, reflecting prisms are often used instead of mirrors. Submarine periscopes have systems of lenses in addition to the mirrors or prisms to provide an enlarged view of the object or scene.

Questions to ask

- What would happen if you made the periscope longer?
  -The longer the tube is, the smaller the image you'll see.
  -Fun fact: periscopes in tanks and submarines have magnifying lenses between the mirrors to make the reflected image bigger.
  - http://www.sciencetoymaker.org/periscope/asmblCD.htm

References

- http://allmaths.blogspot.com/2011_01_13_archive.html
- http://www.sciencetoymaker.org/periscope/asmblCD.htm

Summary Materials Table

For 1 site:

Material	Amount per Group	Expected $$	Vendor (or online link)
Cardstock (to print periscope template on)	1 per student	~$10	http://www.amazon.com/Wausau-Brightness-Letter-Sheets-49411/dp/B000ETXY78/ref=sr_1_4?ie=UTF8&qid=1358184486&sr=8-4&keywords=cardstock
Small Mirrors	2 per student	~$10-$15	http://www.amazon.com/Mirror-Tile-1-5-SQUARE-50pcs/dp/B0018STVW6/ref=pd_sim_hg_4 (best fit)
Chromalux (alternative to mirrors)	1 sheets	~$5/sheet	Any craft store (Michaels)
Scissors	1 per student		
Tape	1 roll		

For all sites:

Material	Amount per Group	Expected $$	Vendor (or online link)
Cardstock (to print periscope template on)	1 per student	~$10	http://www.amazon.com/Wausau-Brightness-Letter-Sheets-49411/dp/B000ETXY78/ref=sr_1_4?ie=UTF8&qid=1358184486&sr=8-4&keywords=cardstock
Small Mirrors	2 per student	~$40-60	http://www.amazon.com/Mirror-Tile-1-5-SQUARE-50pcs/dp/B0018STVW6/ref=pd_sim_hg_4 (best fit for template) or http://www.amazon.com/Mosaic-Mercantile-Mirror-Tile-SQUARE/dp/B0018STVSU/ref=pd_sim_ac_2 or http://www.amazon.com/Mirror-Round-Inch-25-

			Pcs/dp/B0018N66YC/ref=pd_sim_hg_1
Chromalux (alternative to mirrors)	1 sheets	~$10	Any craft store (Michaels)
Scissors	1 per student		
Tape	1 roll		