SCSU CRISP CCSA Kit Pages 2016

Title of Module: Lighting and Optics

Subject or Unit of Study: _________Waves and Electromagnetic Radiation_________________________________

GRADE LEVEL________7-12______________ **LENGTH OF DEMO/LESSON**: _______1-2 class periods_____

STUDENT OBJECTIVES

1) Students will be able to compare the focal length of plane, circular, and parabolic mirror at varying distances from a light source
2) Students will be able to compare the optical scattering of square, convex, and concave translucent mediums at varying distances from a light source

NEXT GENERATION SCIENCE STANDARDS

NGSS Performance Tasks	**MS-PS4-2.** • Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. **HS-PS4-1.** • Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. **HS-PS4-3.** • Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
NGSS Disciplinary Core Ideas (DSI)	**PS4.B: Electromagnetic Radiation** • An object can be seen when light reflected from its surface enters the eyes. • Photoelectric materials emit electrons when they absorb light of a high-enough frequency. **PS4.A: Wave Properties** • A sound wave needs a medium through which it is transmitted. **PS4.B: Electromagnetic Radiation** • When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. • A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. • However, because light can travel through space, it cannot be a matter wave, like sound or water waves. **PS4.C: Information Technologies and Instrumentation** • Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.

NGSS Cross-Cutting Concepts (CCC)	**CC-2 Cause and Effect** • Cause and effect relationships are routinely identified. **CC-6 Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. **HS CC-2 Cause and Effect** • Systems can be designed to cause a desired effect. **Interdependence of Science, Engineering, and Technology** • Science and engineering complement each other in the cycle known as research and development (R&D). • Influence of Engineering, Technology, and Science on Society and the Natural World • Modern civilization depends on major technological systems.
NGSS Science and Engineering Practices (SEP)	**SEP 2- Developing and Using Models** • Use models to describe phenomena. **SEP 7- Obtaining, Evaluating and Communicating Data** • Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

COMMON CORE STANDARDS

CC-ELA/Literacy Standards	**SL.4.5** • Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-PS4-2) **SL.8.5** • Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-2) **RST.11-12.8** • Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
CC-Math	**MP.2** • Reason abstractly and quantitatively. **MP.4** • Model with mathematics

MATERIALS

Hodson Optics Kit
12V power source or adapter (for standard outlets) to accommodate banana plugs

SAFETY
Avoid directing bright lights into eyes

LEARNER BACKGROUND
None required

LEARNING ACTIVITY OR PROCEDURE: See below or Hodson Kit Manual

ASSESSMENT: *Post-lab questions provided via attached document*

ADDITIONAL RESOURCES:

Hodson Optics Kit Manual and Resource Guide – http://www.iecpl.com.au/z_exp/hl2060-001book.pdf
Reading on optics and lighting at http://www.bbc.co.uk/education/guides/zdwnb9q/revision/2
More available via the CRISP website

TEACHER NOTES:
Describe any tips/tricks for implementing this lesson/demonstration that might be helpful to future educators. Provide answer keys if applicable.

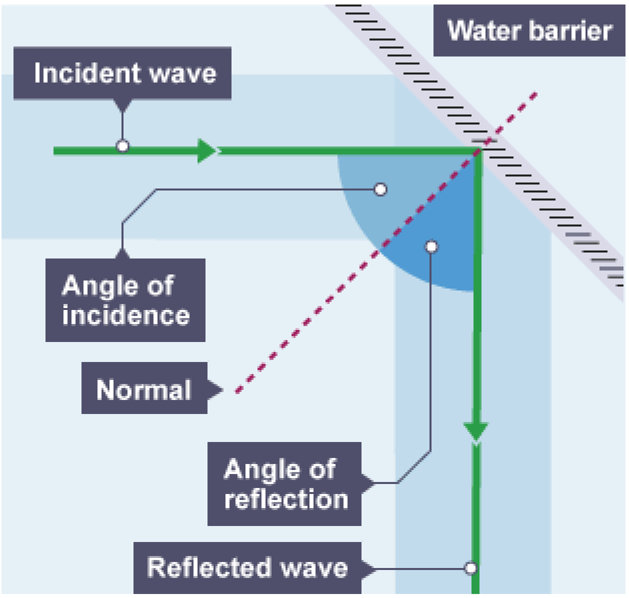
STEM CAREERS:

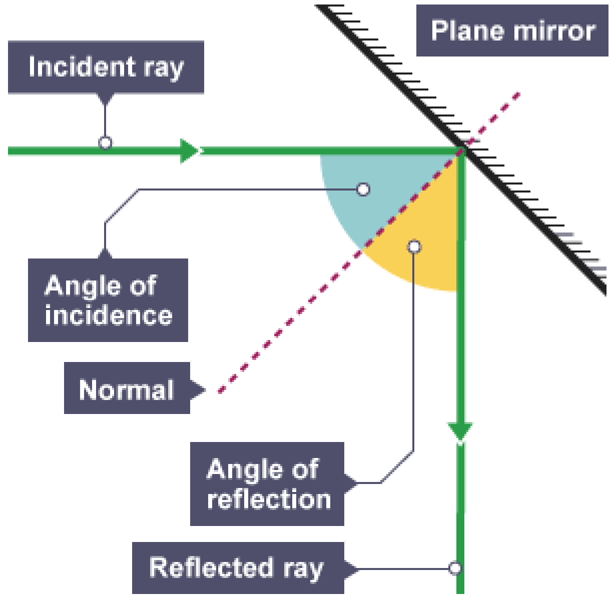
CRISP | Reflection & Refraction Lab | Name: _________________ Date: _________

Background information from www.bbc.co.uk/education/guides/zdwnb9q/revision/2

The law of reflection

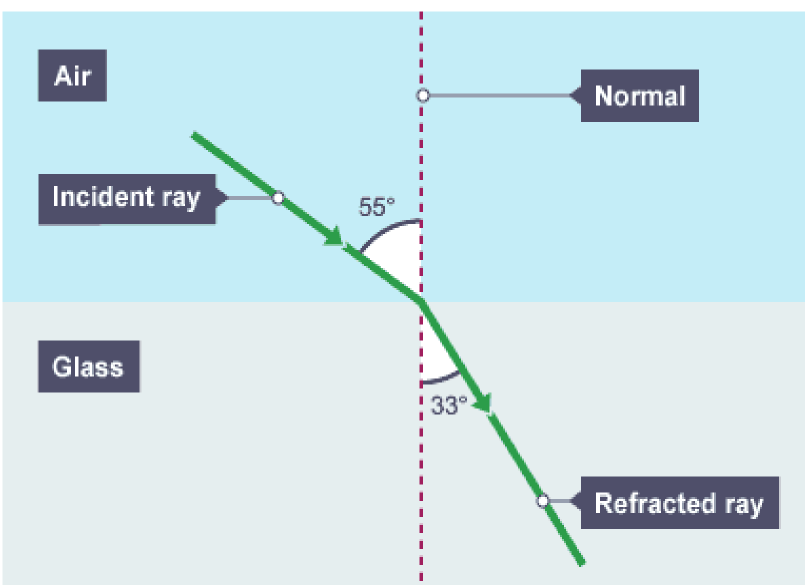
Sound waves and light waves **reflect** from surfaces. The **angle of incidence** equals the **angle of reflection**. This is called the **law of reflection**. So, if a wave hits a mirror at an angle of 36°, it will be reflected at the same angle (36°).





Refraction

Sound waves and light waves **change speed** when they pass across the boundary between two substances with different **densities**, such as air and glass. This causes them to **change direction** and this effect is called **refraction**. We can use water waves in a ripple tank to show this effect.



crisp Center for Research on Interface Structures and Phenomena

Objectives:

1) Compare the focal length of plane, circular, and parabolic mirror at varying distances from a light source
2) Compare the optical scattering of square, convex, and concave translucent mediums at varying distances from a light source

Materials:

Light source; 4-slit beam-splitter; ruler; separate sheet of paper; plane, circular, and parabolic mirrors; square, convex, and concave translucent mediums

Lab procedures

1) <u>Reflecting light</u>

- **a)** plug the light source into the power supply
- **b)** install the 4-slit beam-splitter into the light source
- **c)** arrange the circular mirror, perpendicular to and approximately 2 inches from the light source so that all 4 beams (of light) strike the mirror
- **d)** trace the proximal side of the mirror with your pencil, and draw a dot at the point where the reflected beams cross each other's path (i.e., focal point)
- **e)** measure, and note the distance of the focal point from the mirror (i.e., focal length)
- **f)** repeat steps c-e approximately 3 inches from the light source
- **g)** repeat steps c-e approximately 4 inches from the light source
- **h)** repeat steps c-g with the parabolic mirror
- **i)** repeat steps c-g with the plane mirror (if you can)

2) <u>Refracting light</u>

- **a)** plug the light source into the power supply
- **b)** install the 4-slit beam-splitter into the light source
- **c)** arrange the convex translucent medium, perpendicular to and approximately 2 inches from the light source so that all 4 beams (of light) strike the medium (if 4 is not possible, then do this for at least 3 beams of light)
- **d)** draw dots indicating where the beams enter and exit medium with your pencil
- **e)** draw a dot at the point where the refracted beams cross each other's path (i.e., focal point)
- **f)** measure, and note the distance of the focal point from the mirror (i.e., focal length)
- **g)** repeat steps c-f approximately 3 inches from the light source
- **h)** repeat steps c-f approximately 4 inches from the light source
- **i)** repeat steps c-h with the concave translucent medium
- **j)** repeat steps c-h with the square translucent medium (if you can)

Observation, worksheet for reflection ("x" indicates the position of the light source)

x ____

x ____

x ____

Observation, worksheet for <u>refraction</u> ("x" indicates the position of the light source)

x ____

x ____

x ____

Post-lab activity, reflection questions

1. What did you notice about the intensity of the beams (of light) as the mirrors were moved further and further from the light source?

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2. As you moved the circular mirror further from the light source what happened to the focal length (of the different mirrors)?

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3. How does the focal length of the circular mirror compare to the parabolic mirror? Explain.

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4. How does the focal length of the circular mirror compare to the plane mirror? Explain.

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5. If you were designing a light fixture, do you think that it is better to have the light source very close to or further away from the reflective surface? Explain.

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Post-lab activity, refraction questions

6. What did you notice about the intensity of the beams (of light) as the translucent mediums were moved further and further from the light source?

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7. As you moved the convex medium further from the light source what happened to the focal length (of the different mirrors)?

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8. How does the focal length of the convex medium compare to the concave medium? Explain your answer.

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9. How does the focal length of the convex medium compare to the square medium? Explain your answer.

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10. Explain how you could use a refractive medium to light up a 4’ by 4’ section of a wall from a distance of 4’. Be specific.

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