Teacher Toolkit - Curved Mirrors

Objectives:

1. To state the general rules of reflection of light off concave and convex mirror and to draw three sets of principal rays and their corresponding reflected rays for each mirror.
2. To construct ray diagrams for any given object location in front of a concave or convex mirror in order to determine the image location, relative size and orientation of the image.
3. To describe how images are formed by curved mirrors and to explain the distinction between real and virtual images.
4. To describe how the characteristics of an image (location, orientation, size, and type) formed by a curved mirror are vary with object location.
5. To use the mirror equation and the magnification ratio equation to solve word problems involving concave and convex mirrors.

Readings:

The Physics Classroom Tutorial, Reflection and the Ray Model of Light Chapter, Lesson 3
The Physics Classroom Tutorial, Reflection and the Ray Model of Light Chapter, Lesson 4

Interactive Simulations:

1. Optics Bench Interactive http://www.physicsclassroom.com/Physics-Interactives/Reflection-and-Mirrors/Optics-Bench
   The HTML5 Optics Bench interactive is a great way to explore the images formed by mirrors or lenses. Adjust the focal length, the height of the object, and drag the object back and forth along the principal axis and observe position, size, and orientation of the image. Includes two classroom-ready student actvitities.
2. Name That Image http://www.physicsclassroom.com/Physics-Interactives/Reflection-and-Mirrors/Name-That-Image
   Try Name That Image to challenge your students to an intense mental workout.. Learners are presented with an object location for a concave or convex mirror and must decide the location, orientation, and relative size of the corresponding image. Student progress is monitored and displayed on screen.
3. Physlet Physics: Mirrors http://www.compadre.org/Physlets/optics/intro33.cfm
   The Physlet Mirrors collection is a good candidate for a full-class discussion. Choose from seven guided explorations or eight problems that present more complex challenges.

Video and Animation:

1. UCLA Physics Videos: Concave and Convex Mirrors https://www.youtube.com/watch?v=jtTBOMVMSYM
   This well-produced short video on image formation in concave and convex mirrors shows how a real image differs from a virtual image and discusses why mirrors (not lenses) are used in most telescopes.
2. Education Commons: Mirrors and Optical Instruments https://www.youtube.com/watch?v=UR7DRJFrPlE
   This video takes a deeper dive into the differences between concave and convex mirrors and their use in optical instruments, explaining why mirrors, not lenses, are used in today's large telescopes.
3. ESOcast: How a Giant Telescope Works https://www.youtube.com/watch?v=Muk4F_LvbYs
   This 7-minute video explores the technology behind the Very Large Telescope (VLT), located in the Atacama desert in Chile. Breathtaking images make this a very engaging supplementary resource.
4. Optics Learning Module https://people.fh-landshut.de/~hoeling/ReflectionMirrors/ReflectionMirrors.html
   This set of interactive animations opens with plane mirrors and Law of Reflection, then works up to light reflection in convex and concave mirrors, finding focal length, and the Mirror Equation.

Labs and Investigations: http://www.physicsclassroom.com/lab#refln

The Physics Classroom, The Laboratory:

1. Exploring Curved Mirrors 2. Finding Smiley 3. Magnification Ratio

Demonstration Ideas: **Complete Details Available at the Teacher Toolkits Section of our Website**

1. Green Power Science: Make A Parabolic Mirror
2. Homemade Science: Concave Mirror Real Image Demo

Real-Life Applications

1. Driver's Side Mirror with No Blind Spot http://wqad.com/2012/06/08/disco-ball-inspired-mirror-gets-rid-of-drivers-blind-spot/# In 2012 a mathematician at Drexel University, Andrew Hicks, invented a curved side mirror for cars that greatly increases the field-of-view to eliminate blind spots. Learn the science behind the technology.
2. Corning Museum of Glass: Reflecting Telescopes Interactive http://telescopes.cmog.org/ Beautifully produced interactive takes you on a journey through the evolution of the reflecting telescope – large concave glass mirrors that opened our door to the universe.
3. Corning Museum of Glass: The 200-Inch Disk http://www.cmog.org/video/60-years-200-inch-disk Sometimes students don't appreciate that failure can be an inherent part of the design process and teach your students about the inportance of both failure and success.
4. How to Begin a Career in Photonics http://www.laserfocusworld.com/articles/print/volume-48/issue-04/features/how-to-begin-a-career-in-photonics.html Scientists with advanced degrees in photonics can command land jobs with very rewarding salaries. This article takes a candid look at the best optics/photonics programs in the U.S., Europe, and Asia.

Minds On Physics Internet Modules: http://www.physicsclassroom.com/mop

The Minds On Physics Internet Modules are a collection of interactive questioning modules that target a student's conceptual understanding. Each question is accompanied by detailed help that addresses the various components of the question.

Reflection and Mirrors Module:

RM5 - Ray Tracing for Concave Mirrors
RM6 - Image Characteristics – Concave Mirrors
RM7 - Mathematics of Concave Mirrors
RM8 - Ray Diagramming for Convex Mirrors
RM9 - Image Characteristics – Convex Mirrors
RM10 - Mathematics of Convex Mirrors
RM11 – Real and Virtual Images

Concept Building Exercises: http://www.physicsclassroom.com/curriculum/refln

The Curriculum Corner, Reflection and Mirrors:

1. Curved Mirrors and the Law of Reflection2
2. Spherical Mirrors
3. Ray Diagrams for Concave Mirrors
4. Ray Diagrams for Convex Mirrors
5. Mathematics of Curved Mirrors
6. Object-Image Relations

Problem-Solving Exercises: http://www.physicsclassroom.com/calcpad/circuits

The Calculator Pad, Ray Optics: Reflection and Mirrors, Problems #7 - #26

Science Reasoning Activities: http://www.physicsclassroom.com/reasoning/reflection

1. Science Reasoning Center, Reflection and Mirrors, Concave Mirrors
2. Science Reasoning Center, Reflection and Mirrors, Object-Image Relationships

Common Misconceptions **Complete Details Available at the Teacher Toolkits Section of our Website**

1. Images are Located on the Mirror Surface
2. Covering a Mirror Removes a Portion of the Image

Standards: **Complete Details Available at the Teacher Toolkits Section of our Website**

A. Next Generation Science Standards (NGSS)

Performance Expectations

MS-PS4-2: Physical Science: Waves - Electromagnetic Radiation

Disciplinary Core Ideas – Middle School Physical Science: Electromagnetic Radiation

Crosscutting Concepts

High School: Structure and Function

Middle School: Patterns

Science and Engineering Practices

Practice: Developing and Using Models – High School

Practice: Engaging in Argument from Evidence – High School

Practice: Obtaining, Evaluating, and Communicating Information – High School

Practice: Using Mathematics and Computational Thinking – High School