7-2012

Geometric Optics [11th-12th grade]

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UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: Geometric Optics

Grade Level: 11^{th} – 12^{th}

Subject/Topic Area(s): Physics

Designed By: Amanda Chapman

Time Frame: 11 Days

School District: North East Independent School District

School: Robert E. Lee High School

School Address and Phone: 1400 Jackson Keller, San Antonio, TX 78213

Brief Summary of Unit (Including curricular context and unit goals):

Students will be given the task as forensic specialist to analyze a portfolio of evidence and report on their findings. As a class will then compare their findings to a list of suspects provided by the police. As an extension, students will discuss to what degree forensic evidence is irrefutable (the CSI Effect). While completing this unit, student will learn the properties of reflection and refraction of light. Specially, students will be able to use Snell's Law, The Law of Reflection, and diagrams to predict image location, height, magnification, orientation, and type. This unit is designed to follow after the waves and light units.

The task students are asked to complete has been purposefully designed to be short. Unlike the first semester of the course that (that contains large units), the second semester contains many small topics. This unit is an attempt to connect a few small activities I have done with students and link them together in a meaningful. It also builds upon the driving questions of the course: 1. What are the methods used by scientist to understand our universe? 2. How do science and society interact? and 3. How do you use physics in your life? 4. To what degree are scientific findings irrefutable?

Stage 1 – Desired Results

2012 TEKS

- (P.7) D: Investigate behaviors of waves, including reflection & refraction
- (P7) E: Describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens
- (P7) F: Describe the role of wave characteristics and behaviors in medical and industrial applications.

Transfer

*Students will independently use their learning to…*apply their knowledge and understanding of optics to solve a crime.

Meaning

Understandings
Students will understand that….

- How plane, concave, and convex mirrors produce images and the properties of those images.
- Light bends as a result of a change in speed.
- How lenses produce images and the properties of those images (height, orientation, magnification, type, and location).

Essential Questions

- How is Physics used to determine what happened at an accident/crime scene?
- How do we see things?
- How are images produced by lenses and mirrors?
- To what degree is forensic evidence irrefutable?

Acquisition

Knowledge
Students will know…

- Reflection, refraction, and diffraction of light
- Diffuse reflection, specular reflection, spherical aberration
- The angle of incidence, the angle of reflection, the normal line to a surface
- The angle of incidence is equal to the angle of reflection
- Snell's Law
- Total internal reflection occurs when traveling from a dense to a less dense medium when the angle of incidence is greater than the critical angle
- The eye, telescopes, and microscopes work.

Skills
Students will be able to…

- Apply the law of reflection to predict where and what kind of image will form from a plane, concave, & convex mirrors.
- Use Snell's Law to predict the angle light will refract when crossing the boundary between to media and calculate the index of refraction for a material
- Determine if total internal reflection will occur for a given boundary

Stage 2 – Evidence

Performance Task(s)
Students will demonstrate meaning-making and transfer by…

Students will be given the task as forensic specialist to analyze a portfolio of evidence and report on their findings. As a class will then compare their findings to a list of suspects provided by the police. As an extension, students will discuss to what degree forensic evidence is irrefutable (the CSI Effect).

Tasks to complete in their portfolio:

- Find the index of refraction for 3 pieces of glass to determine their sources.
- Determine the height and location of 3 suspects from the images (plane mirror, concave mirror, and convex mirror).
- Write a report of their findings, their methods, and sources of error in their methods.

Other Evidence (e.g., formative)

- Daily Homework (reviewed the next day)
- Quiz
- Two stations activities
- Various informal checks for understanding (thumbs up, check with your partner, etc.)

Stage 3 – Learning Plan

Pre-Assessment
How will you check students' prior knowledge, skill levels, and potential misconceptions?

Learning Activities
Formative Assessment: Blue
Summative Assessment: Red

Day 1

1. Introduction
    - CSI Effect Article & Discussion (http://www.economist.com/node/15949089/print)
    - Pre-assessment Quiz
2. Present task & KWL chart

Day 2

3. Plane mirrors: Who can see whom?
    - A long plane mirror will be places up front and we will discuss who students are capable of seeing. This will lead to a discussion that there must be a law to describe what angle light is reflecting at.

4. Law of Reflection Mini-Investigation
    - Students will complete the attached Mini-Investigation to discover the angle of incidence is equal to the angle of reflection.

5. Cylinder Demo & Diffuse and Specular Reflection Demo, & Practice
    - Students will then take notes on their findings and discuss how they apply in diffuse and specular reflection.
    - Students will complete a problem set for homework.

Day 3

6. Plane Mirror Diagram Lab Investigation
    - Students will complete the attached investigation to learn the properties of an image in a plane mirror and how to draw a ray diagram.

7. Debrief / Guided & Independent Practice
    - Students will then practice drawing a ray diagram as I do one on the Elmo.
    - Students will work on ray diagrams in their groups.

Day 4

8. Spoon Activity
    - Students will look at their image in the front and back of a spoon to begin a discussion of concave and convex mirrors.
    - Students will apply the law of reflection to two ray diagrams (one concave & one convex).
    - Students will then rotate through stations in groups to attempt other ray diagrams. We will discuss as a class.
    - Students will be given homework with a few diagram questions on it.

Day 5

9. Challenge problem: Ray Diagrams

10. Mirror Equation Stations

Day 6

11. Mirror Quiz (summative over reflection)
12. Thin Lens Mini Lab

Day 7

13. Fish Voting (Introduction to Refraction)
    - Students will vote if they think a spear needs to be aimed above, at, or below the image of the fish a fisher sees. Students will then be asked to

pair up with a student that voted differently until both students agree on one answer (students will be reminded that it isn't possible for both people to be correct). A second round of voting will then occur. The teacher will then aim a meter stick at a penny in a fish tank of water to confirm the correct answer.
- Students will then be asked if a laser pointer should be pointed above, below, or at the image of a fish. The same voting method listed above will be performed. The teacher will confirm the correct answer by pointing a laser at a penny in the water (with the lights out).
- Hopefully students will discuss that light bends when passing between two mediums with different densities. Examples such as a pencil in water,

14. Marching Soldiers
    - Students will be asked how we can determine the direction that light bends.
    - A line of masking tape will be placed on the floor in an open area or hallway.
    - A row of 5-7 students will march (to a metronome) 90 degrees to the normal line. The students will then slow down when the reach the boundary. The students direction will not change
    - The students will then repeat the last step, but approach the boundary at an angle other than 90 degrees to the normal. The line of soldiers will bend. This process will be repeated, but going slow to fast.

15. Define Refraction
    - Students will return to the classroom and apply their findings to a tractor and racecar.
    - Students will a few homework questions that ask them to complete similar tasks.

Day 8

16. Thin Lens Investigation
    - Students will describe properties of images formed in each location: in front of the focal point, at the focal point, between the focal point and center of curvature, at the center of curvature, and beyond the center of curvature.
17. Thin Lens Equation
    - Students will then use the thin lens equation (from the previous unit) to predict the location and type of image.

Day 8

15. How do eyes, telescopes, and microscopes work?
    - Students will complete stations to discover how each of the listed applications of lenses and/or mirrors work.
    - We will discuss spherical aberration and applications like the Hubble Telescope.

16. Thin Lens Exit Ticket
    - Students will complete a thin lens exit ticket to help me identify who is still struggling with the concept. I will work on who is struggling and other students will have time work on their task.
17. Task work time

Day 9

17. Task work day / hand out review sheet

Day 10

18. Go over findings as a class
    - We will compare our class findings to list provided by the “police” and discuss how irrefutable their forensic evidence is using four corners
19. Review game

Day 11

20. Test Day

Chapman Physics – Optics and Forensics

Forensic Analyst: _____

Assignment: Preform the analysis listed below in your lab. Return your findings including graphs, table, or charts and your report.

Task 1: The provided pieces of glass were found at the scene of a crime. Please identify the likely source of each glass. To increase the accuracy of your findings, identify the glass using two different methods.

Task 2: The attached photographs were taken at the scene of a crime by a security camera. The type of photograph and any required distances or focal lengths are provided. Identify the height and approximate weight of the suspect(s).

Task 3: Attach a report of your findings including an explanation of how credible your findings are (sources of error in your methods, how close your findings from different sources were, research found online, etc.). See the attached rubric for all requirements.

Optics and Forensics Report Rubric

	Emerging (1 point)	Developing (3 points)	Proficient (5 points)
Task 1	Incorrectly found the index of refraction with first method.	Found the index of refraction with a few errors.	Correctly found the index of refraction for all pieces of glass using one method.
	Incorrectly found the index of refraction using a second method.	Found the index of refraction for the glass with a few errors.	Correctly found the index of refraction for the glass using a second method.
	Incorrectly identified the possible source of each piece of glass	Identified the possible source of each glass with a few errors.	Correctly identified the possible source of each piece of glass.
Task 2	Incorrectly found the height of suspect 1 using the wrong method.	Method of finding the height of suspect 1 was correct, but there were small errors in the calculations.	Correctly found the height of suspect 1 (plane mirror).
	Incorrectly found the height of suspect 2 using the wrong method.	Method of finding the height of suspect 2 was correct, but there were small errors in the calculations.	Correctly found the height of suspect 2 (concave mirror).
	Incorrectly found the height of suspect 3 using the wrong method.	Method of finding the height of suspect 3 was correct, but there were small errors in the calculations.	Correctly found the height of suspect 3 (convex mirror).
Report	Included all requirements listed, but has many errors.	Includes all requirements listed, but has a few errors.	Includes the following: • Results of Task 1 • Calculations for Task 1 • Results of Task 2 • Calculations for Task 2 • Explanation of how credible your findings are (sources of error in your methods, how close your findings from different sources were, any research found online).
Communication	Report contains many spelling and grammar errors.	Report contains a few spelling and grammar errors.	Report contains proper spelling and grammar.
	Cited sources with many errors.	Cited all sources with a few errors.	Properly cited all sources.

Comments:

Total Points: _____ / 40

Name: _____ Date: _____ Period: _____

Mini Lab: The Law of Reflection

Purpose: To determine how the angle of incident light (from your laser) relates to the angle of reflection (from the mirror).

Safety Note: Make sure your laser is never pointed at another student. Point your laser down & be careful about where the reflected beam will hit!

1. Shine the laser on your mirror. Sketch the following:
    a. the incident beam (from the laser)
    b. the reflected beam (from the mirror)
    c. the mirror
    d. the normal line (the line perpendicular to the surface of the mirror).

2. Using a protractor, measure the angle of incidence (between the incident beam and the normal line). Record your measurement on your diagram.

3. Using a protractor, measure the angle of reflection (between the reflected beam and the normal line). Record your measurement on your diagram.

4. Try out a few different angles to see if you can find a patter. You do not have to record these.

5. Create a law to summarize your findings below: