How light reacts through different mediums | experiment

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Abstract:

The goal of this experiment was to determine how does light react when it travels through different mediums. The student had to answer one question: “ How does light react as it goes through lenses and as it traverses liquids?” And her possible hypotheses were: “ If I use the Geometric Optics program to see how light reacts when passing through different lenses, then I will see that light either converges, concave lenses, or diverges, concave lenses, because light either reflects or refracts” and “ If I use Bending Light software to see how light reacts when passing through a fluid, then I will be able to see that it bends depending on the angle because of the law of refraction and the index of refraction.” In an experiment in which the student used the Geometric Optics program and the Bending Light program, she concluded that her hypothesis was right, because as she changed the mediums in the virtual lab, light’s direction changed.

Lab 12. 8 – Light:

During this experiment, the student had to find out how does light react as it goes through lenses and as it traverses liquids. In order to answer this question, she created two hypotheses: If I use the Geometric Optics program to see how light reacts when passing through different lenses, then I will see that light either converges, concave lenses, or diverges, concave lenses, because light either reflects or refracts” and “ If I use Bending Light software to see how light reacts when passing through a fluid, then I will be able to see that it bends depending on the angle because of the law of refraction and the index of refraction."

The relationship between the focal length f, image distance d_i, and object distance d_o is a formula: $1/d_o + 1/di = 1/f$. In a spherical mirror, an object or image behind the mirror has negative distance and is virtual. The focal length of a convex mirror is negative and the image distance is always negative. An object placedfarther or closer than the focal point in front of a convex mirror produces a reduced, upright, virtual image. An object that is closer to the concave mirror than the focal point always produces an enlarged and virtual image. An object that is beyond the focal point always produces an inverted, real image. Rays of light that pass through the convex lens move closer together or converge. Rays of light that pass through the concave lens spread out or diverge. (Nirenberg, Kim, & Kim, Sect. 20. 2) The Lensmaker's equation is: P = 1/f = (n-1) (1/R1 – 1/R2 + (n-1) d/nR1R1). The spherometer consists of a base circle of three outer legs, a ring, or the equivalent, having a known radius of the base circle, a central leg, and a reading device for measuring the distance the central leg is moved. (Wikipedia, 2014) Three principal rays form part in the construction of ray diagrams for convex mirrors: a ray that would pass through the focal point is reflected parallel to the principal axis; a ray that is parallel to the principal axis reflects as if in line with the focal point; a ray that would pass through the center of curvature is reflected back upon itself. (Nirenberg, Kim, & Kim, Sect. 20. 2) The minimum value that the index of refraction can have is 1. The index of refraction of air is: 1. 000293, water: 1. 3330, ordinary glass: 1. 50, and polycarbonate plastic: 1. 5849. (Wikipedia, 2014) The speed of light in a vacuum is 3. 00 x 10^{8} m/s. (Nirenberg, Kim, & Kim, Sect. 19. 4) The relationship between the speed of light and the index of refraction is the formula: n = c/v. (HyperPhysics, 2012)

Methods:

The student used a computer, Geometric Optics simulation program, and Bending light simulation program. She ran both programs: http://phet. colorado. edu/en/simulation/geometric-opticsandhttp://phet. colorado. edu/en/simulation/bending-lightand tried to learn how to use them. The student analyzed the differences that exist between a real image and a virtual image. Later, using the ruler, she gathered data to solve for focal distance and magnification of the lens using the mirror formula. Later she openedhttp://phet. colorado. edu/en/simulation/bending-lightand familiarized with the program. She recorded what happened when she changed the index of refraction of one or two materials. The student also analyzed which tool was better for measuring angles, and what beam was better also for the angles. After following each possible step properly, the class ended, so the student had to continue her methods at her house on the following days.

Results/Data Collection/Calculations:

1. Lens's refractive index (n): 1. 8 and the radius of curvature (R): 0. 7m.

Focal distance (f)	Distance object (d_o)	Distance image (d_i)	Magnification (m)
43. 5cm	120. 0 cm	66. 0cm	-0. 550

43. 5cm	90. 0 cm	81. 0cm	-0. 900
43. 5cm	60. 0 cm	148. 9cm	-2. 48
45. 5cm	30. 0 cm	-88. 0cm	2. 93
-58. 8cm	15. 0 cm	-11. 9cm	0. 793

- 1/ d_o + 1/di = 1/f = 1/120. 0cm +1/66. 0cm = 0. 023cm $^{-1}$ = 43. 5cm
- M = -di/do = -66. 0cm/120. 0cm = -0. 550
- 1/ d_o + 1/di = 1/f = 1/90. 0cm + 1/81. 0cm = 0. 023cm $^{-1}$ = 43. 5cm
- M = -di/do = -81. 0cm/90. 0cm = -0. 900
- 1/ d_o + 1/di = 1/f = 1/60. 0cm + 1/148. 9cm = 0. 023cm $^{-1}$ = 43. 5cm
- M = -di/do = -148. 9cm/60. 0cm = -2. 48
- 1/ d_o + 1/di = 1/f = 1/30. 0cm + 1/-88. 0cm = 0. 022cm $^{-1}$ = 45. 5cm
- M = -di/do = 88. 0cm/30. 0cm = 2. 93
- 1/ d_o + 1/di = 1/f = 1/15. 0cm + 1/-11. 9cm = -0. 017cm $^{-1}$ = -58. 8cm
- M = -di/do = 11. 9cm/15. 0cm = 0. 793

2. Lens’s refractive index (n): 1. 25 and the radius of curvature (R): 0. 80m

Focal distance (f)	Distance object (d_o)	Distance image (d_i)	Magnification (m)
62. 5cm	120. 0 cm	130. 0cm	-1. 083

50cm	90. 0 cm	110. cm	-1. 22
34. 5cm	60. 0 cm	80. 0cm	-1. 33
17. 9cm	30. 0 cm	45. 0cm	-1. 50
10cm	15. 0 cm	30. 0cm	-2. 00

- 1/ d_o + 1/di = 1/f = 1/120. 0 + 1/130. 0cm = 0. 016cm $^{-1}$ = 62. 5cm
- M = -di/do = -130. 0cm/120. 0cm = -1. 083
- 1/ d_o + 1/di = 1/f = 1/90. 0cm + 1/110cm = 0. 020cm $^{-1}$ = 50cm
- M = -di/do = -110cm/90. 0cm = -1. 22
- 1/ d_o + 1/di = 1/f = 1/60. 0cm + 1/80. 0cm = 0. 029cm $^{-1}$ = 34. 5cm
- M = -di/do = -80. 0cm/60. 0cm = -1. 33
- 1/ d_o + 1/di = 1/f = 1/30. 0cm + 1/45. 0cm = 0. 056cm $^{-1}$ = 17. 9cm
- M = -di/do = -45. 0cm/30. 0cm = -1. 50
- 1/ d_o + 1/di = 1/f = 1/15. 0cm + 1/30. 0cm = 0. 100cm $^{-1}$ = 10cm
- M = -di/do = -30. 0cm/15. 0cm = -2. 00

Part 2- Air to Water

Angle of Refraction	Angle of Incidence
15Ëš	20Ëš

30Ëš	42Ëš
45Ëš	60Ëš
60Ëš	78Ëš
75Ëš	92Ëš
90Ëš	110Ëš

Analysis/Discussion/Conclusion:

The main goal of this experiment was to determine how does light react when it travels through different mediums. After she finished the experiment, she learned how light reacts as it goes through lenses and liquids. The student realized that both of her hypothesis were right: “” If I use the Geometric Optics program to see how light reacts when passing through different lenses, then I will see that light either converges, concave lenses, or diverges, concave lenses, because light either reflects or refracts” and “ If I use Bending Light software to see how light reacts when passing through a fluid, then I will be able to see that it bends depending on the angle because of the law of refraction and the index of refraction.” Her conclusion was that these hypotheses were right because light does not behave the same through different materials, and the bending of the light that she predicted in her hypotheses matched with the virtual lab. The student learned that with the increasing of the index of refraction of a material, the focal distance decreased. In the Bending Light part when she had to measure angles, the protractor was the best tool. Geometric Optics and Bending Light programs are a little complex, but they are helpful when it comes to understanding how does light act depending on the circumstances.

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