Course and Section_______ Names ___________________________

Date___________________ ___________________________

LENSES AND MIRRORS SIMULATION

Introduction

The purpose of this activity is to study image formation by mirrors and lenses: the physical principles and the laws which describe them.

Basic equations for Mirrors and Lenses

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f} \qquad M=\frac{h'}{h}=-\frac{q}{p}$$

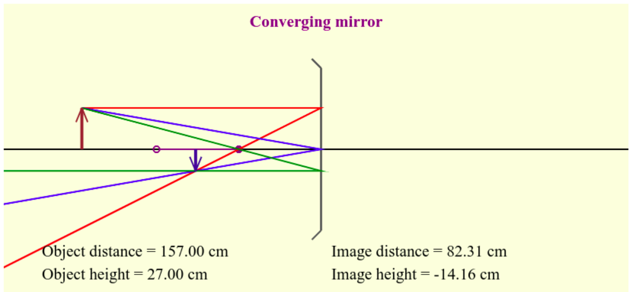
p : object distance
q : image distance
f : focal length

M : magnification
h': image height (size)
h : object height (size)

Submit your answers using Blackboard.

1 – Mirrors: Image Proprieties

Open the simulation (http://physics.bu.edu/~duffy/HTML5/Mirrors.html)



Converging Mirror

Set and keep the Object distance greater than the focal length

1. How does the Image distance change as you decrease the Object distance?
2. How does the Image height change as you decrease the Object distance?
3. How does the focal length change as you decrease the Object distance?
4. Is the image a virtual image?

Set and keep the Object distance smaller than the focal length

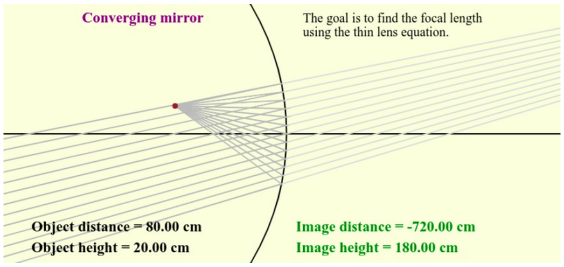
5. How does the Object height change as you decrease the Object distance?
6. How does the Image height change when changing the Object height?
7. Is the image a virtual image?

Diverging Mirror

8. How does the Image height change as you decrease the Object distance?
9. Is it possible to adjust any of the parameters to form real images?

2 – Mirrors: Image Formation

Open the simulation (https://pages.physics.ua.edu/lab10x/2em/SIM/applet/Curved_Mirror.html)

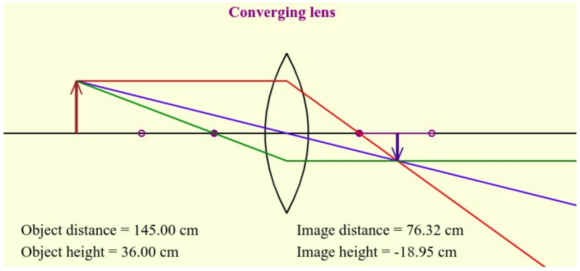


You can change the Object distance by moving the red dot.

Pick an Object distance and find the corresponding Image distance
10. Calculate the focal length. (cm) (use the Mirror Equation)

3 – Lenses: Image Proprieties

To study image formation open (http://physics.bu.edu/~duffy/HTML5/lenses_revised.html)



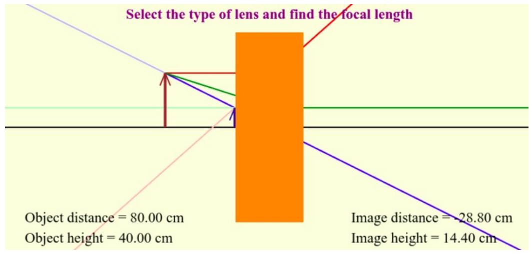
Set and keep the Object distance greater than the focal length
11. How does the Image distance change as you decrease the Object distance?
12. How does the Image height change as you decrease the Object distance?
13. How does the focal length change as you decrease the Object distance?
14. Is the image a virtual image?

Set the object distance to 120 cm and the focal length to 40 cm.
15. Calculate the magnification using Image height and the Object height.
16. Calculate the magnification using the Image distance and the Object distance.
17. What is the percentage difference of your answers in questions 15 and 16?

Set and keep the Object distance smaller than the focal length
18. How does the Object height change as you decrease the Object distance?
19. How does the Image height change as you decrease the Object height?
20. Is the image a virtual image?

4 – Mystery Lenses

Open the simulation https://pages.physics.ua.edu/lab10x/2em/SIM/applet/The_Focal_Point.html

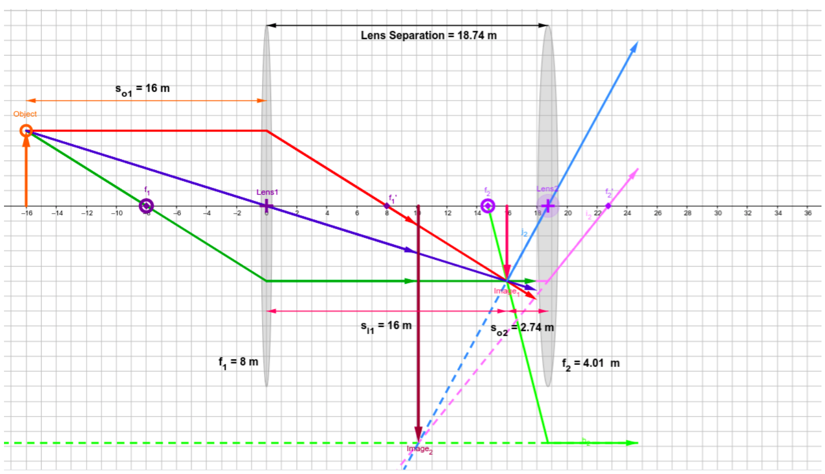


You can change the Object distance by moving the level on the bar.

21. What is the focal length of the mystery lens behind the orange curtain? (cm)

5 – The Telescope

Open the simulation (https://www.geogebra.org/m/EB97GwWD)



The simulation gives the possibility to study lenses combination. A very basic telescope can be built using only two lenses. Move the lens on the right toward the lens on the left (click the violet plus sign at the center of the lens and drag it). When the focal point $\mathbf{f_2}$ (the violet circle) passes over **Image**$_1$ (the pink arrow) formed by the lens on the left), the **Image**$_2$ (violet arrow) forms between the two lenses (you might have to zoom out). Imagine that the Object (orange arrow) to be the Moon in the night sky. If you were to look at the Moon with this telescope, by standing on the right of the lenses combinations, and look leftward at the moon, you would be looking at **Image**$_2$ which should appear bigger, a telescope indeed.
The lens on the left is called the objective, the lens on the right is called the eyepiece.

22. Is **Image**$_2$ a real image?
23. How does the size of **Image**$_2$ compare to the size of the Object?

Make sure that the distance from lens 2 to **Image**$_1$ is always smaller in magnitude then the focal length $\mathbf{f_2}$, (If the distance is larger then $\mathbf{f_2}$ this setup no longer works as a telescope).
24. If you decrease the focal length $\mathbf{f_2}$ of eyepiece how does the size of **Image**$_2$ change?
25. If you move the eyepiece away from the objective how does the size of **Image**$_2$ change?

Set these values $\mathbf{f_1}$ = 8 m, $\mathbf{f_2}$ = 4 m, Object distance $\mathbf{s_{o1}}$ **=** 16 m and Lens Separation = 19 m. (the values don't have to be exact). The goal is to calculate the magnification of your telescope

Magnification = (size of **Image**$_{\mathbf{2}}$)/(size of Object) = how much bigger the Moon appears

Assume each square of the grid has dimensions 1m by 1m. Set the height of the object 2m. The size of Image2 first increases and later decreases when f2 moves to the right of Image1. To find **Image**$_{\mathbf{2}}$ first you need to find the size of **Image**$_{\mathbf{1}}$. Also **Image**$_{\mathbf{1}}$ corresponds to the 'object' for the eyepiece.

26. What is the magnification of the objective? (use the appropriate distances)
27. What is size of **Image**$_{\mathbf{1}}$? (m)
28. What is magnification of the eyepiece? (use the appropriate distances)
29. What is the size of **Image**$_{\mathbf{2}}$? (m)
30. Finally, what is the magnification of your telescope?