PhyzLab: Combination Conundrum

an investigation of pinholes and lenses

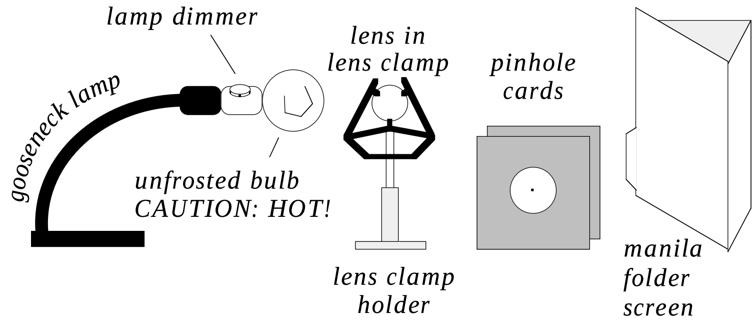
Based on "Pinholes and Lenses" by Dewey Dykstra and research by Lillian McDermott and Fred Goldberg.

• Purpose •

In this investigation, you will explore the differences in image formation by pinholes and lenses. Some findings will surprise you. You'll get nothing out of this investigation unless you give thoughtful consideration to your predictions, make careful observations, and construct thorough conclusions based on your observations.

• Apparatus •

___ gooseneck lamp with lamp dimmer
___ 40W unfrosted bulb with 4-sided filament
___ one-hole and three-hole pinhole cards
 cardboard or plastic card with opening
 aluminum foil to cover card opening
___ card holder ("goalposts" or equivalent)
___ lens in lens clamp
___ lens clamp holder
___ screen (manila folder or equivalent)
___ meterstick



• Procedure •

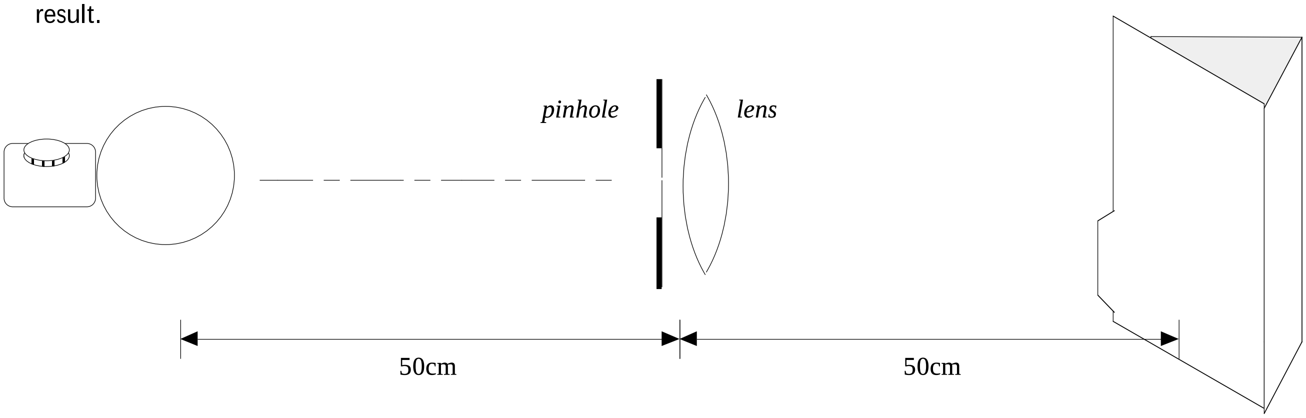
1. DOUBLE YOUR PLEASURE, DOUBLE YOUR FUN?

a. Prediction. What will appear on the screen if light from the filament passes through a pinhole **and** a lens (in series)? The set-up is shown in part b below. How will the image compare to images produced by a pinhole or by a lens (acting alone)? Will an image appear at all? Explain the reasoning behind your answer. **Include sketches of a pinhole image, a lens image, and your predicted pinhole and lens image.** Discuss your answer with your group. Do all members agree? If there are alternate opinions, record them.

pinhole only	**lens only**	**pinhole + lens**

b. Observation.

i. When the group is pretty sure of its ideas, do the following. Arrange the apparatus as shown (but with the screen down below. (Hold the pinhole card and lens as close together as possible). Then prop the screen up and sketch the result.



ii. How does the image on the screen compare to images produced by a pinhole or a lens (acting alone)? Consider size, focus, brightness, etc.

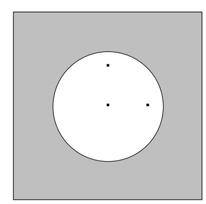
c. Conclusion. How do your observations compare to your prediction? Discuss the results with your group. Can the group explain any discrepancies between predictions and observations? If so, write the explanation; if not, write about the aspects that remain unclear.

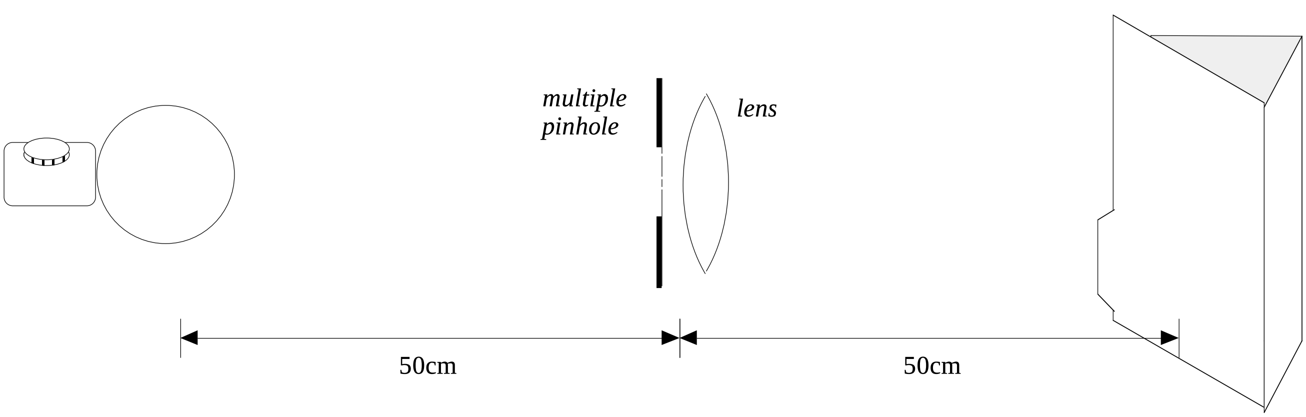
2. HOLEY ALUMINUM (AGAIN)

a. Prediction. What will appear on the screen if the light from the filament passes through **several** pinholes and a lens? The set-up is shown in part b below. How will this image compare to the one in the previous activity? **Include sketches of the pinhole and lens image and your prediction for the pinholes and lens image.** Discuss your answer with your group. Do all members agree? If there are alternate opinions, record them.

b. Observation.

i. When the group is pretty sure of its ideas, do the following. Using the three-hole pinhole card, arrange the apparatus as shown below. Describe and sketch the result.





ii. Does the pattern on the screen agree with the pattern you predicted? If not, how does it differ?

c. Conclusion. How do your observations compare to your prediction? Discuss the results with your group. Can the group explain any discrepancies between predictions and observations? If so, write the explanation; if not, write about the aspects that remain unclear.

3. STILL MORE MOVING PICTURES

a. Prediction. How will the image formed by the three pinholes and lens change if the screen is moved closer or farther from the pinholes and lens? Explain the reasoning behind your answer. Make **three sketches: one of the "standard" pinholes and lens image (as in the sketch from part 2.b.i.), one of what it will look like if you move the screen closer, and one of what it will look like if you move the screen farther.** Discuss your answer with your group. Do all members agree? If there are alternate opinions, record them.

standard	screen closer	screen farther

b. Observation. When the group is pretty sure of its ideas, do the following. Place the pinholes 50cm from the filament, place the lens right behind the pinholes, and put the screen 20cm from the lens. Slowly move the screen from 20cm to 120cm from the lens. Observe the changes that occur. Repeat several times, keeping the following questions in mind.

i. What—if anything—happens to the positions of the filament images? Do they move up, down, left, right, or what?

ii. What—if anything—happens to the focus of the filament images? Do they get sharper, more blurred, or what?

iii. What—if anything—happens to the size of the filament images? Do they get bigger, smaller, or what?

c. Continued observation. **Include a sketch for each observation.**

i. Place the screen 20cm from the lens. Cover the pinhole near the top of the pinhole card. Which image on the screen disappears?

ii. Cover the pinhole near the **side** (not **top**) of the pinhole card. Which image on the screen disappears?

iii. Place the screen 120cm from the lens. Cover the pinhole near the top of the pinhole card. Which image on the screen disappears?

iv. Cover the pinhole to near the side of the pinhole card. Which image on the screen disappears?

d. Continued observation. Repeat observation c without the lens. Do the results differ? If so, how?

e. Conclusion. How do your observations compare to your prediction? Discuss the results with your group. Can the group explain any discrepancies between predictions and observations? If so, write the explanation; if not, write about the aspects that remain unclear.

4. HOW DO THEY DO THAT?

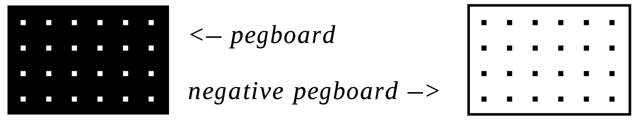
a. Why/how does a pinhole image get flipped (upside down, left-right)?

b. Why/how does a lens image get flipped (upside down, left-right)?

c. How many images are produced when light is passed through three pinholes and a lens? Does the answer change under certain circumstances (is it possible to converge multiple images into one image)?

5. PEGBOARD PLAYTIME

a. Obtain a piece of pegboard (or equivalent) and a piece of "negative" pegboard.



b. Observation.

i. Arrange the filament, lens, and screen so that you have a sharp image of the filament on the screen.

ii. Mark the location of the lens.

iii. Replace the lens with the pegboard and describe the result.

iv. Now return the lens to its marked location while keeping the pegboard pattern in place. What happened to the pinhole images that disappeared?

c. Prediction. Turn the light off or put the screen down.

i. What will you see if you remove the lens and replace the pegboard with negative pegboard ("dotboard")? Include a sketch and explain the reasoning behind your answer. Discuss your answer with your group. Do all members agree? If there are alternate opinions, record them.

ii. What will happen if—with the dotboard in place—you return the lens (as in part b. iv. above)? Include a sketch and explain the reasoning behind your answer. Discuss your answer with your group. Do all members agree? If there are alternate opinions, record them.

d. When the group is pretty sure of its ideas, make the observations described

i. in part c.i. above.

ii. in part c.ii. above.

e. Conclusion. How do your observations compare to your prediction? Discuss the results with your group. Can the group explain any discrepancies between predictions and observations? If so, write the explanation; if not, write about the aspects that remain unclear.