Activity Book

TA Orientation
School of Physics and Astronomy
University of Minnesota

Fall, 2005

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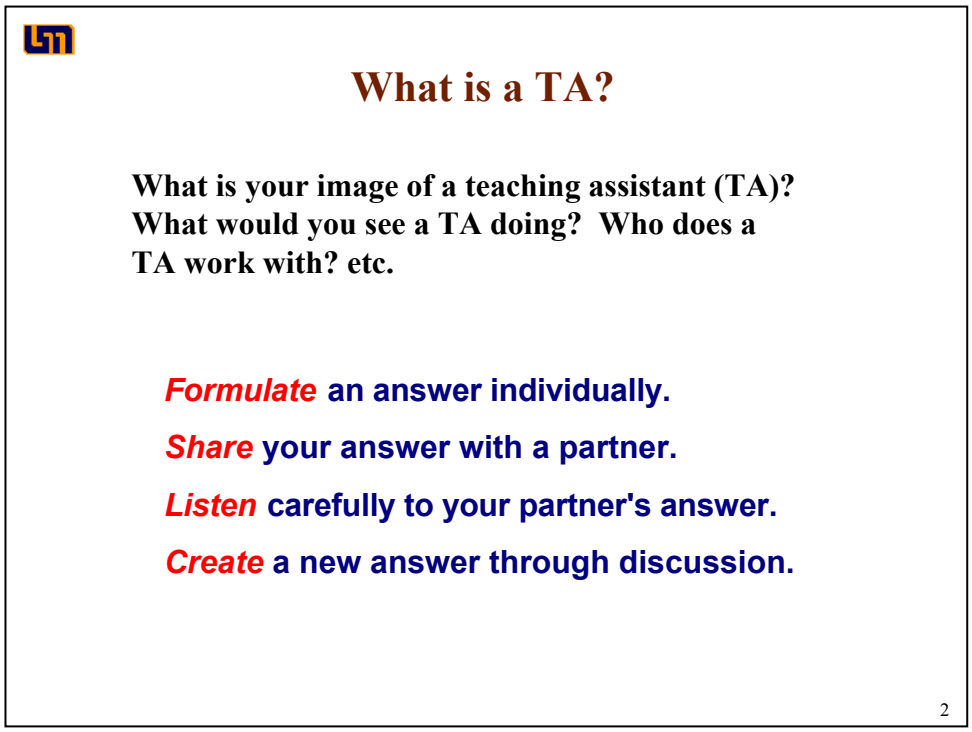
FOR CLASS ACTIVITIES

Activity 1: UMn Model for Introductory Courses



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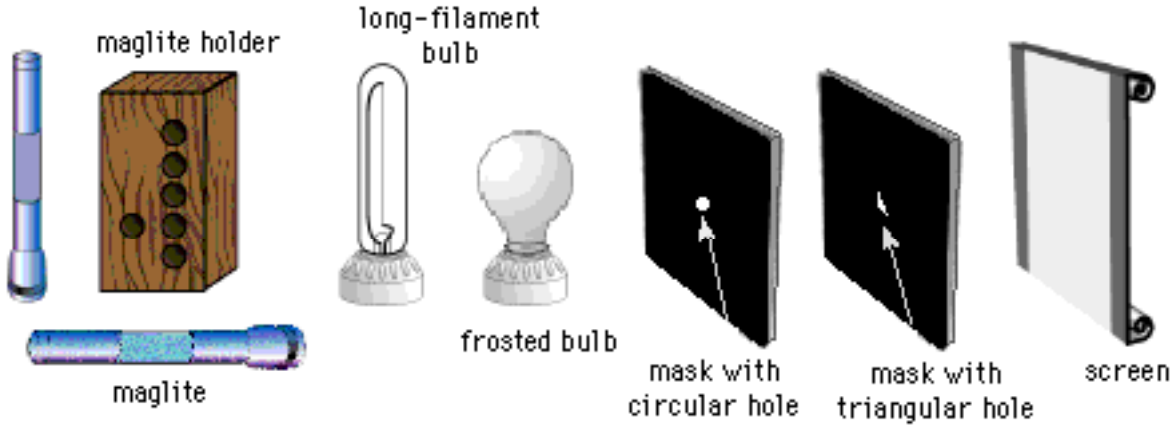
EXPLORATORY PROBLEM #1:
Light Patterns

Because of your physics background, you have been asked to consult for the FBI on an industrial espionage investigation. A new invention has been stolen from a workroom, and the FBI is trying to determine the time of the crime. They have found several witnesses who were walking outside the building that evening, but their only recollections are of unusual light patterns on the side of the building opposite the workroom. These patterns were caused by light from the workroom coming through two holes in the window shade, a circular hole and a triangular hole. The room has several lights in it, including two long workbench bulbs. During the theft, the burglar hit one of the workbench lamps and broke the supporting wire, leaving it hanging straight down. Together with the other bulb, it forms a large "L" shape. Going outside, you see that the lamps do leave interesting patterns on the sidewalk. Your job is to determine, based on the light patterns the witnesses recall seeing, when the theft took place. You decide to model the crime scene in your lab using the equipment shown below.

What patterns of light are produced with different shaped holes and light sources?

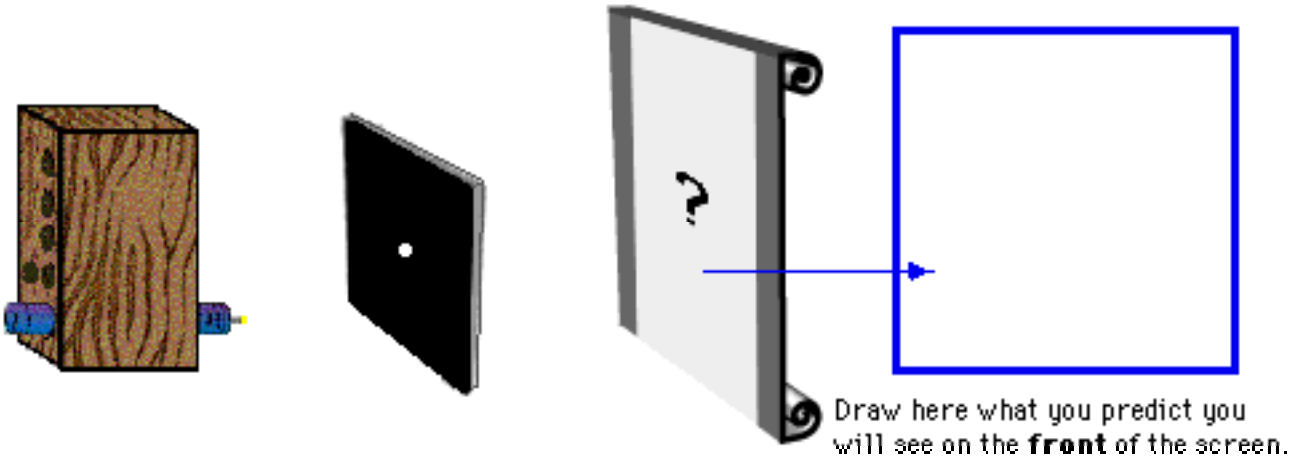
EQUIPMENT



You will have: a maglite holder; two mini maglites; a clear tubular bulb with a straight filament mounted in a socket (representing a long workbench bulb); two cardboard masks, one with a circular hole and one with a triangular hole (representing the holes in the window shade); and a large white cardboard screen (representing the side of the building).

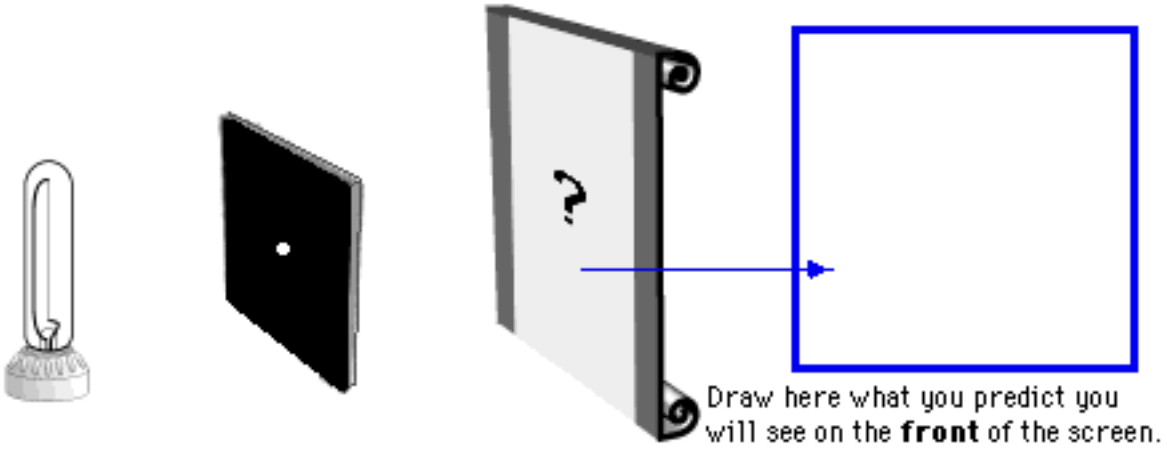
PREDICTIONS

1. Suppose you took a Maglite flashlight, took the cover off, and held it close to a card with a small circular hole in it. What would you see on the screen behind the card? Draw what you think you would see on the screen.



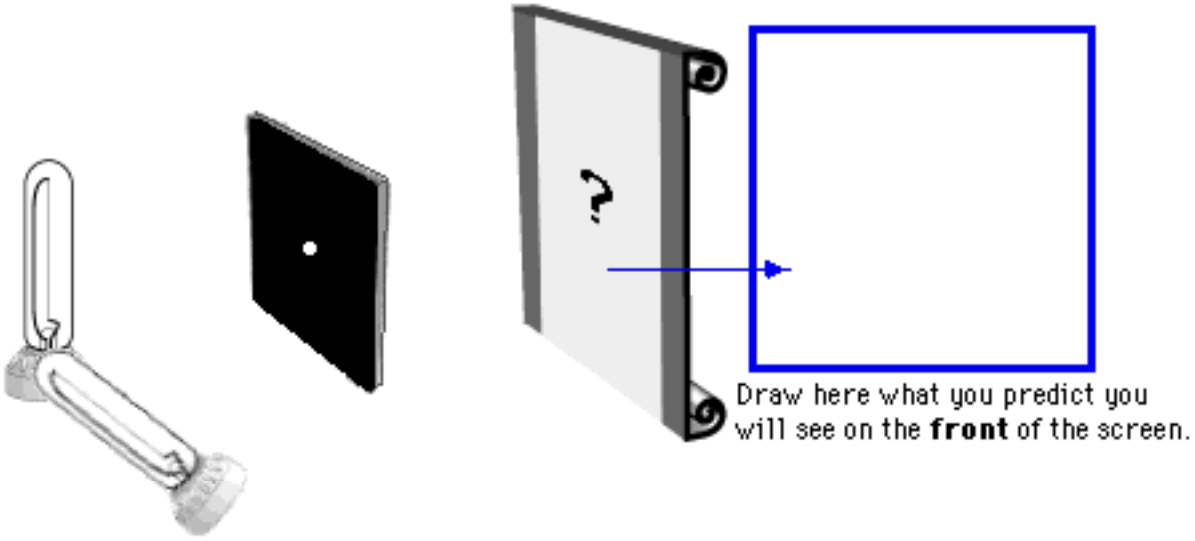
Explain your reasoning. Why do you think this is what you will see?

2. Now suppose you had a bulb with a long filament inside. Imagine you were to hold this near the card with a small circular hole in it. Draw what you predict you would see on the screen.



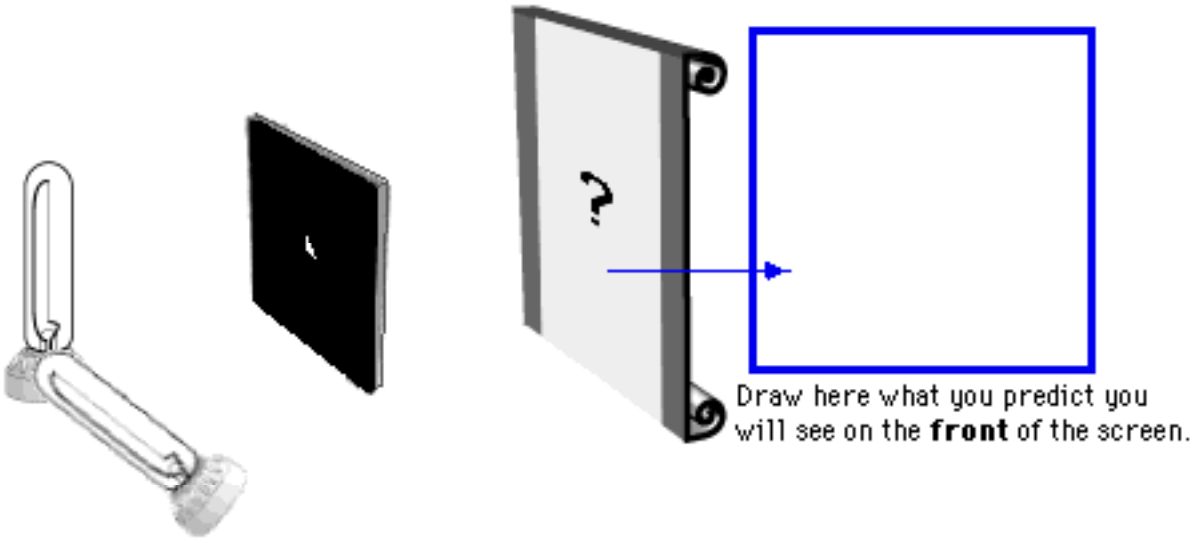
Why did you draw what you drew? Explain your reasoning.

3. Suppose you took two of the long filament bulbs and held them together to form an "L" shaped filament, and held this setup near a card with a small circular hole in it. What would you see on the screen? Draw your prediction.



What was your reasoning?

4. Now imagine you kept the bulbs in the shape of an "L", but now replace the hole in the card with a triangle instead of a circle. Predict what you would see on the screen, and draw your prediction.

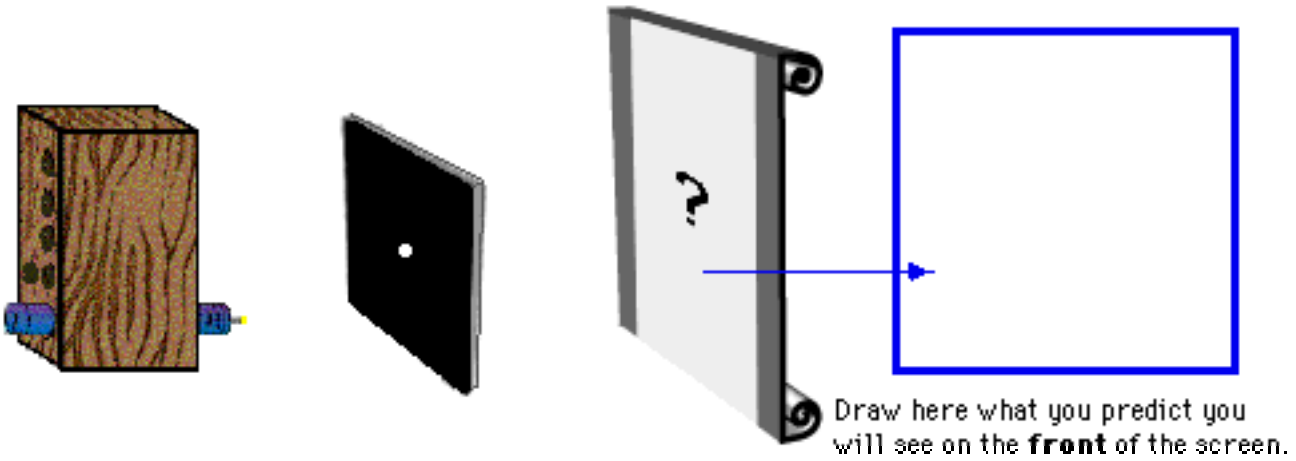


Explain your reasoning.

EXPLORATION

Before you tackle the complex problem, you decide to explore the different light patterns you can get on a screen when light from different kinds of sources shine through holes with different shapes.

1. Suppose you had a maglite, arranged as shown below, close to a card with a small circular hole. **Predict** what you would see on the screen with a lit maglite in a darkened room.



Explain your reasoning.

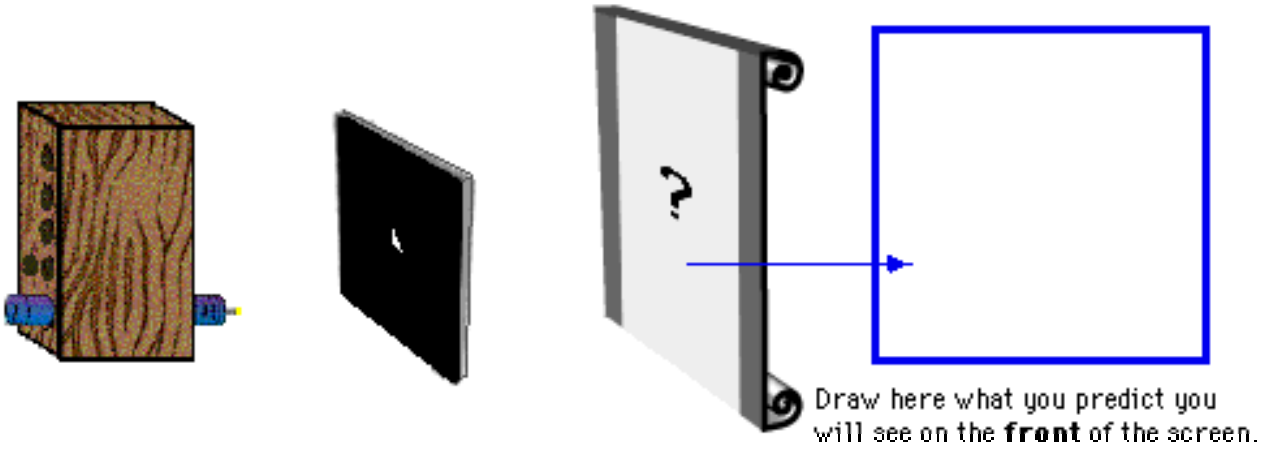
Predict how moving the maglite upward would effect what you see on the screen. Explain.

Test your predictions. Ask an instructor for a maglite. Unscrew the top of a maglite, and mount the maglite in the lowest hole of the maglite holder, as shown above. Place the card with the circular hole between the maglite and the screen.

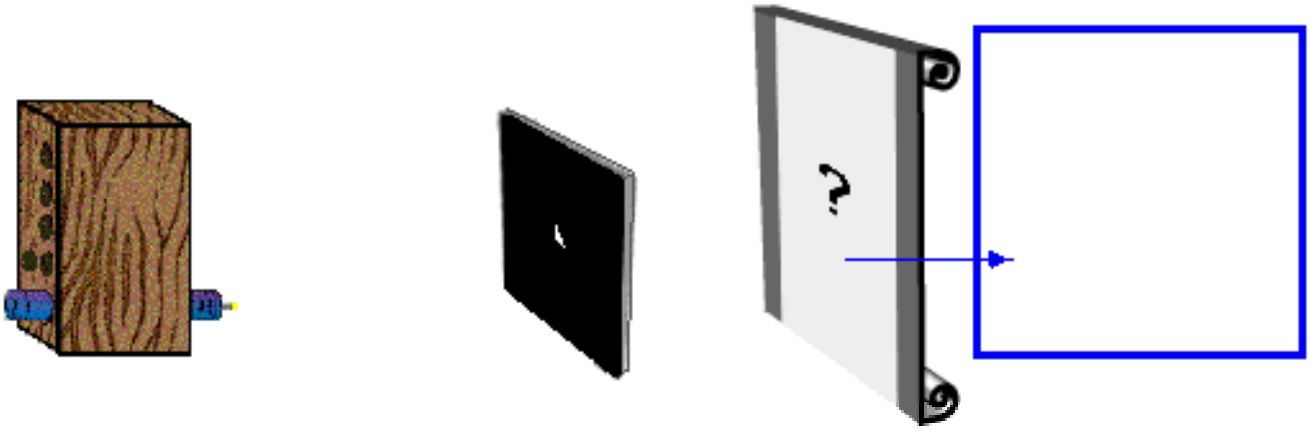
If any of your predictions were incorrect, resolve the inconsistency.

2. **Predict** how each of the following changes would affect what you see on the screen. Explain your reasoning and include sketches that support your reasoning.

A. The mask is replaced by a mask with a triangular hole.

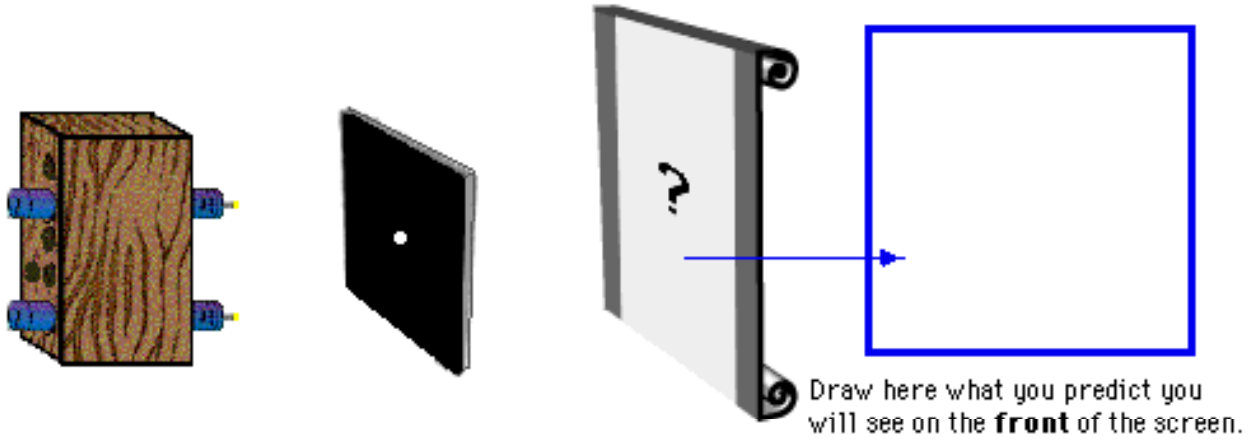


B. The bulb is moved further from the mask.



C. **Test your predictions.** Ask your instructor for a card with a triangular hole, and perform the experiments. If any of your predictions were incorrect, resolve the inconsistency.

3. **Predict** how placing a second maglite above the first would affect what you see on the screen.

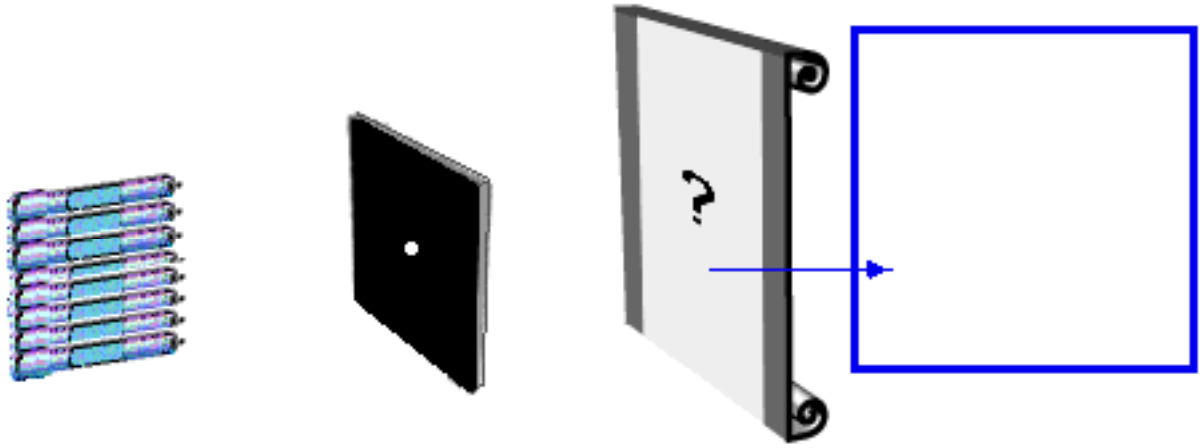


Explain your reasoning.

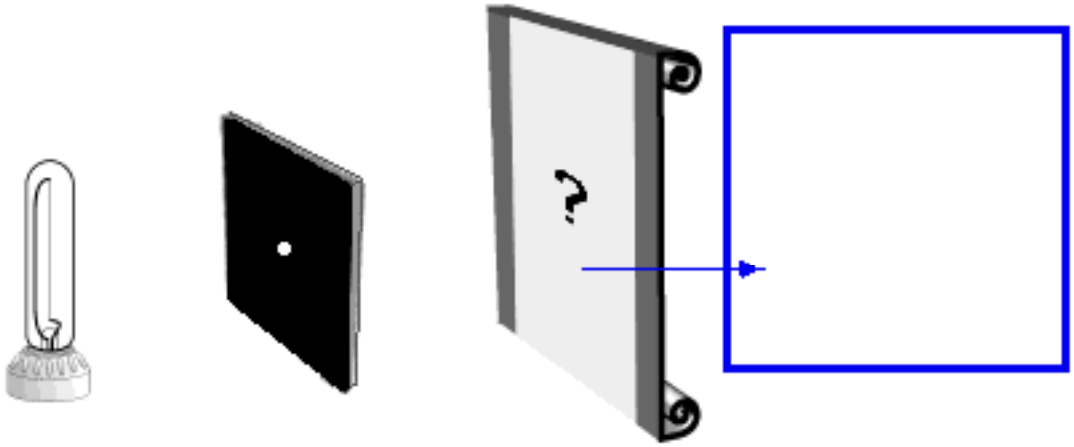
Test your predictions. Ask an instructor for a second maglite, and perform the experiments. If any of your predictions were incorrect, resolve the inconsistency.

4. What do your observations suggest about the **path** taken by the light from the maglite to the screen?

5. Imagine that you had several maglites held close together, as shown below. **Predict** what you would see son the screen. Explain.

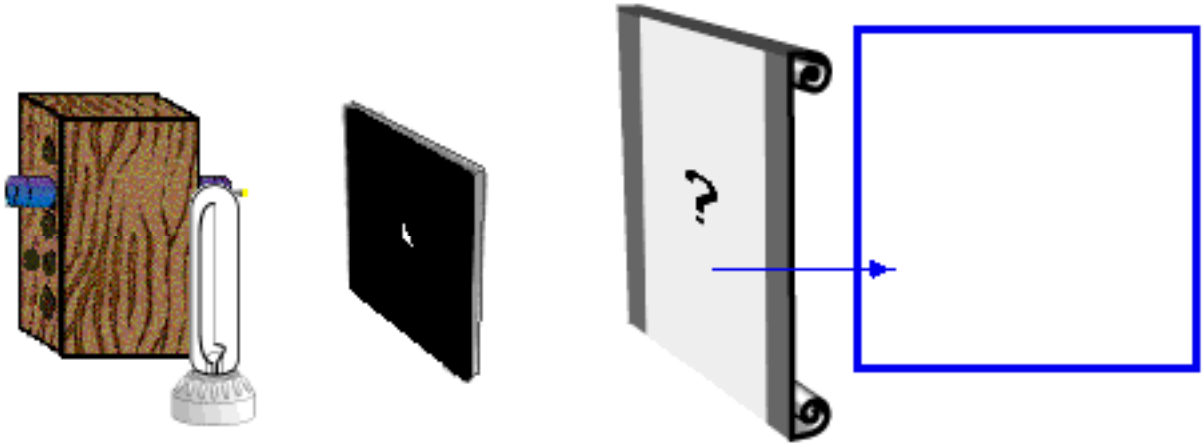


Predict what you would see on the screen if you used a bulb with a long filament instead, as shown below. Explain.



Test your predictions. Ask an instructor for a long filament bulb, and perform the experiments. If any of your predictions were incorrect, resolve the inconsistency.

6. **Individually predict** what you would see on the screen if you had both a maglite and a long filament bulb arranged side by side, as shown at right and below.



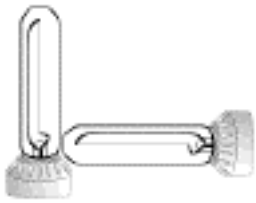
Explain your reasoning.

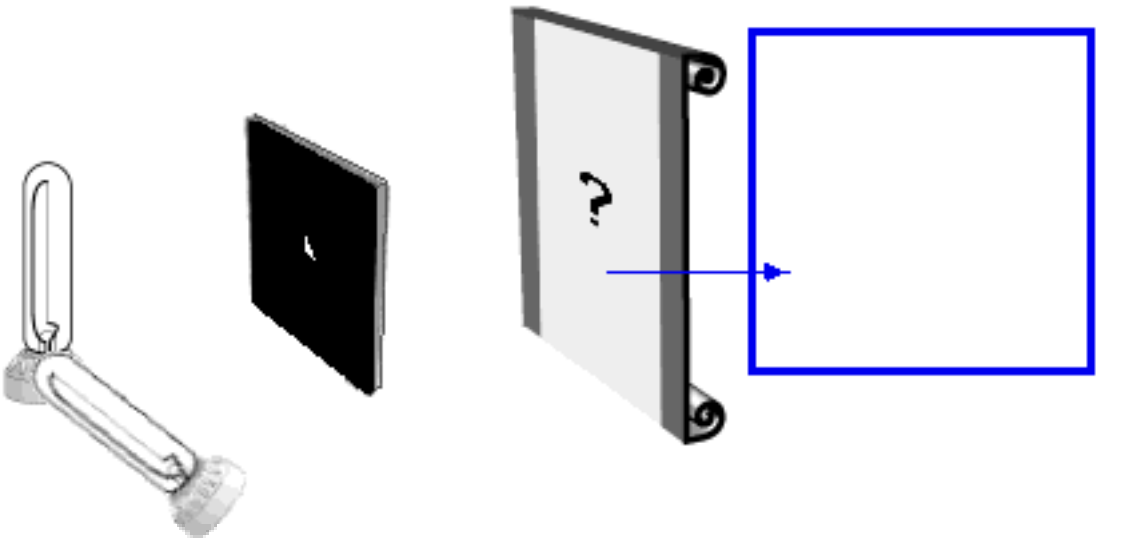
Compare your prediction with those of your partners. After you and your partners have come to an agreement, **test your prediction** by performing the experiment. Resolve any inconsistencies.

MEASUREMENT & ANALYSIS

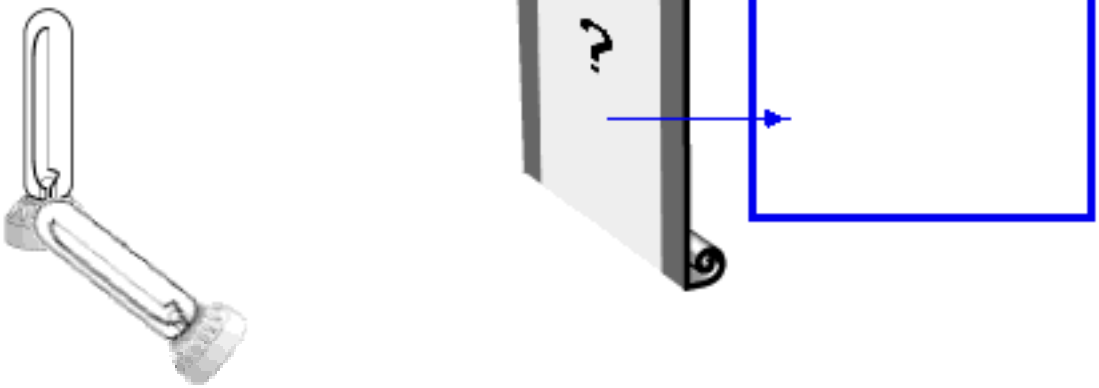
You are now ready to investigate the light patterns that would be seen by the witnesses who passed the crime scene.

1. **Predict** what you would see on the screen if you had two long filament bulbs arranged as shown at right and below.





Predict what you would see on the screen if the mask were *removed*.



Test your predictions. Ask your instructor for a second long-filament bulb, and perform the experiments. If any predictions were incorrect, resolve the inconsistency.

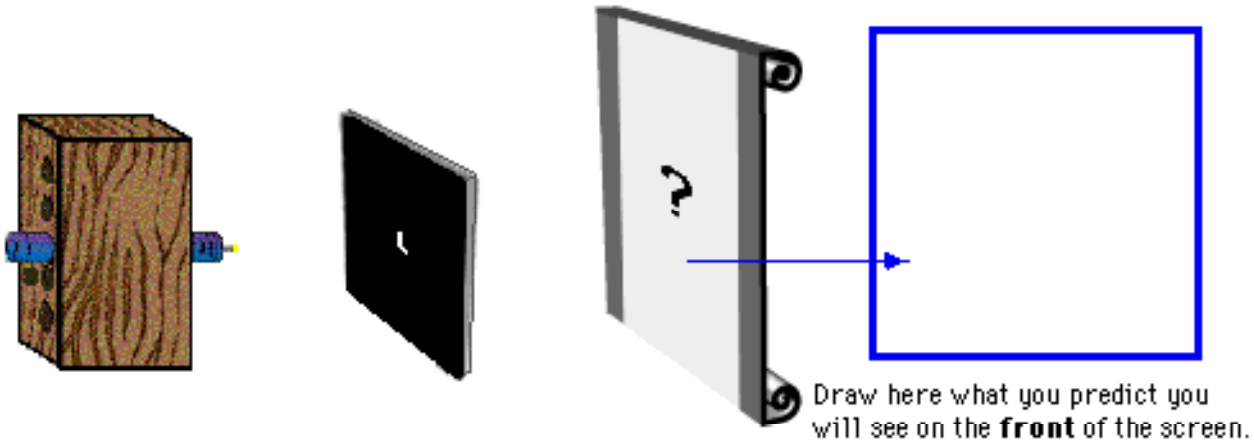
CONCLUSION

What pattern would a witness see on the building wall from two horizontal lit bulbs through a circular hole and a triangular hole in the window shade? What would a witness see when one bulb was horizontal but the other bulb was vertical? How would you determine the approximate time of the crime?

☑ CHECK YOUR UNDERSTANDING

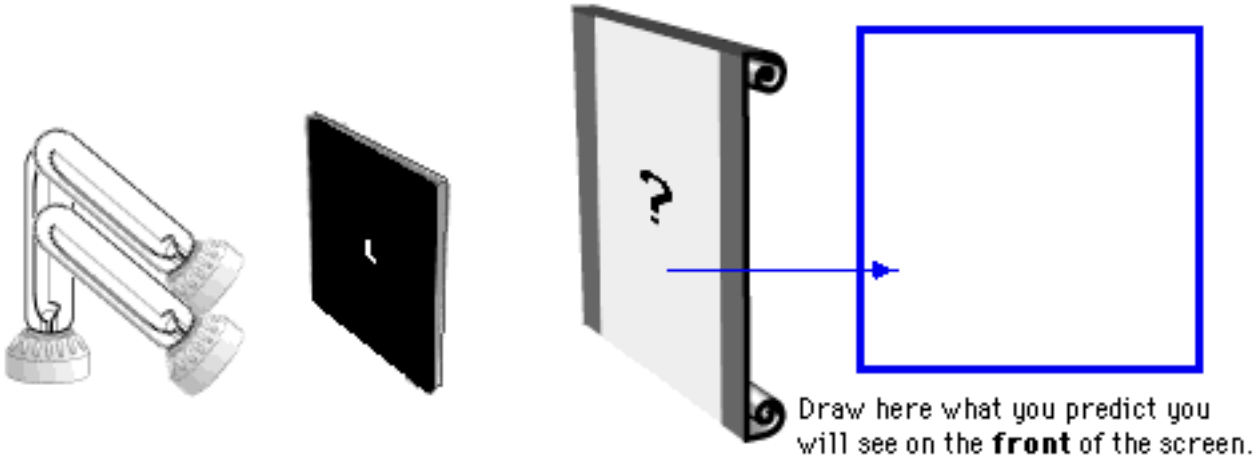
A mask containing a hole in the shape of the letter **L** is placed between the screen and a very small bulb of a maglite as shown below.

1. On the diagram below, sketch what you would see on the screen when the maglite is turned on.



2. The maglite is replaced by three long filament light bulbs that are arranged in the shape of the letter **F**, as shown at right a below.

   On the diagram, sketch what you would see on the screen when the bulbs are turned on. ***Explain how you determined your answer.***



3 **Predict** what you would see on the screen when an ordinary frosted bulb is held in front of the mask with the triangular hole, as pictured below. Explain your reasoning.