Tutorial Name _____

Can an image float in empty space?

I. Watching from the side

A. Obtain a black box that produces five diverging beams of light (a "beam box") and an assortment of lenses and mirrors. The purpose of this activity is to familiarize you with how lenses affect light.

1. Draw a convex lens in the space at right. Experiment with the beam box to determine the effect that a convex lens has on beams of light. Sketch the paths of light you observe.

2. Draw a *concave* lens. Experiment with the beam box to determine this lens's effect on beams of light. Sketch the paths of light you observe.

3. Draw a convex mirror.
   i. **This time, draw what you expect to happen before you try it.**
   ii. Then try it and reconcile any discrepancies.

4. Draw a concave mirror. **Again, draw what you expect to happen before you try it,** then try it and reconcile any discrepancies.

B. Go back to the convex lens again. This time, take the circular lens and a blank sheet of unlined white paper (for a screen). In the darkened room, go to a place where you can observe some objects in a well-lit area through a door or window. Now adjust the lens and screen until you can see an image on the screen — make it as clear an image as you can, and then take careful note of the locations of the objects, lens, and screen.

1. What is the image an image of?
2. Draw a diagram to show how light moves from one of the objects you are seeing, through the lens, and to the screen.

3. From your diagram, is there any other place a screen could be held and still have a clear image on it? Explain. (Try moving the screen. What happens?)

4. In this particular case, are the diagrams mostly a way to explain what you understand to other people, or mostly way to make better sense of what's going on for you personally?

☆ *Check with your TA, if you like, before proceeding.*

II. Can you see the image without the screen?

Imagine you have set up the lens, and screen again, so that there's an image of the objects in the lit room on the screen. Note where the screen is and take the screen away.

A. Draw a diagram of how the light now moves, from one of the objects, through the lens, to where the screen used to be and then past that point (since it's no longer blocked by the screen).

Our model says that you see when light hits you in the eye. And, we've said, you can find the image (or object) you're looking at by tracing back the lines of light to the point in space where they intersect. (You did this in an earlier tutorial – remember the "Mel and Taylor technique.")

1. The diagram you just drew shows light converging at a location in space—where the screen used to be— and then diverging out again from that point. Suppose that light hits someone in the eye after passing the "crossing point." Where would they see that light as coming from?

2. Intuitively, where is the image of the object in the lit room in this scenario? Does your answer here agree with your answer to #1? Answer the question first, before you try it.

3. Try it! Set up the lens and screen so the image of an object is focused on the screen. Now remove the screen and place yourself where you can see the image of object. Use the method of parallax to decide where the image appears to be: Put your finger at the position you think the image is, shift your line of sight back and forth slightly, and see if your finger and the image stay lined up.

4. Does what you found agree with both our model and common sense? If not, can you reconcile the disagreement?

B. Would it be possible to project an image that you can see clearly on a screen with a concave lens? Explain how it might be done, or why it's not possible.

