

Workshop Tutorials for Introductory Physics

WI7: Lenses and Mirrors

A. Review of Basic Ideas:

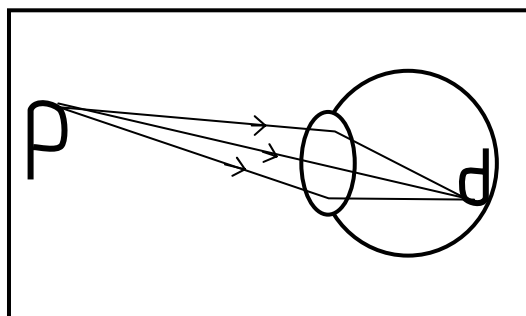
Use the following words to fill in the blanks:

enlarged, stars, diverging, sharp, retina, focal, optical, magnified, focused, virtual, converges

Seeing clearly - glasses, telescopes and microscopes

Most people will need glasses at some time in their life. Why do we need glasses and what do they do?

The eye is a special _____ instrument. The front of the eye acts as a lens and bends light as it passes through it. This way an image of the object we are viewing is formed on the _____. Think about one letter of the print in front of you. Light enters your eye from each part of the letter. Your eye bends the light so that all the light from one point on the letter is focused onto one point of the retina. The light from each part of the letter is thus _____ on the retina and an image of the letter is formed.



Why do we need glasses? Because often the inbuilt lens in our eye cannot bend the light exactly the right amount to form a _____ image on the retina. If you are longsighted you can't see objects that are close to you. Light rays from a close object have a larger angle cone of light and hence need to be bent more to focus on the retina. If your eye cannot bend the light enough you need a lens that _____ the light rays. The power of the lens, or its ability to focus, is related to the _____ length of the lens, which depends on the curvature of the sides of the lens and the material from which it is made.

Short sighted people have the opposite problem – their eyes bend the light too much and they have trouble seeing things a long way off.

So long sighted people need converging (convex) lenses, while short sighted people need _____ (concave) lenses.

Optical instruments, such as microscopes and telescopes, have a series of lenses usually with the aim of providing a _____ image of the original object. For instance a telescope gives a magnified image of distant _____, while a microscope gives a magnified image of a very small object that is quite close. The image may be real as in a slide projector, or _____ as in a magnifying glass. In a projector light actually passes through the image and is projected on a screen. A virtual image is one where the light only appears to come from the image. A good example of a virtual image is the enlarged image you see through a magnifying glass. Light is bent as it passes through the magnifying glass to your eye so that it appears to have come from an _____ image but the path of the light is just from the print through the lens to your eye. The image is a virtual one.

Discussion Question:

In the book *Lord of the Flies* by William Golding there is character called Piggy, who wears glasses. He uses them to start a fire, so that the group of boys stranded on the island can cook and stay warm. Later in the book he gets into a fight and his glasses are smashed. He then has trouble seeing because he is extremely short sighted. Why does this not make sense, given what you know about optics?.

B. Activity Questions:

1. Lenses – concave and convex

Observe how the different lenses change the direction of the light rays.

Feel the different shapes and relate the shapes to the effect of the lens.

Which ones are converging? Which ones are diverging?

2. Lenses – finding the focal length of a convex lens

Hold the lens up to the window and hold a piece of paper behind it (on the other side of the lens from the window). Move the paper until you get a sharp image of the world outside the windows (or distant object such as a tree).

What is the focal length of the lens?

3. Half a lens

Hold the lens up so that an image of the light is formed on a piece of paper.

Predict what will happen if half the lens is covered with another piece of paper.

Now get someone else to cover half the lens.

What happens to the image? Was your prediction correct?

Explain your observations.

4. Right angled mirrors

Look at your image in the mirror.

What do you notice when you move your hands?

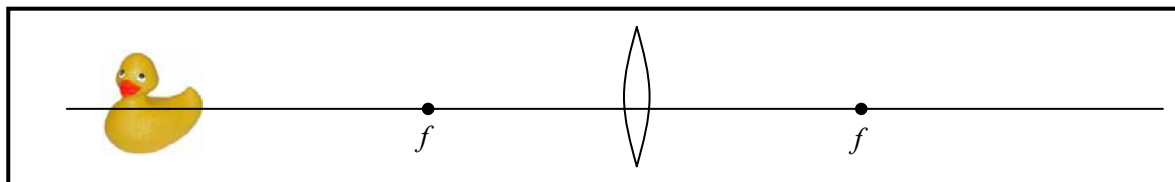
How is this different to a single mirror?

C. Qualitative Questions:

1. You want to buy a mirror to put in the inside of your closet door so you can check how you look in the morning before setting off to uni, but you don't want to spend a lot of money getting a bigger mirror than you actually need.

- How big a mirror would you need to just be able to see yourself from top to toe?
- At what height should the mirror be mounted?
- Why are left and right reversed in a mirror but not up and down?

2. Sketch a ray diagram for the situation shown and describe the image (size, orientation, real or virtual).

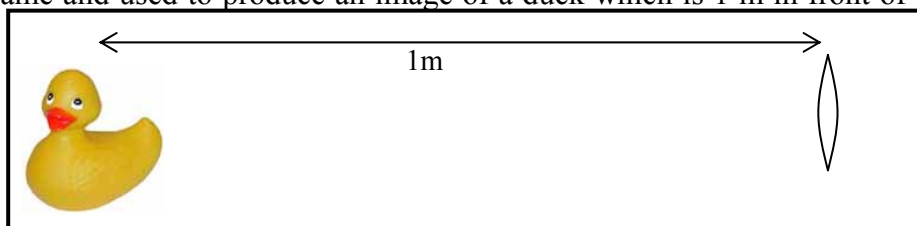


D. Quantitative Question:

The first handheld spectacles were in use at least 700 years ago. It took another hundred years for someone to invent a way of attaching them to the head, however wearing them in public was considered bad taste until quite recently. Optometrists write prescriptions with the lens strength measured in diopters, D . A diopter is the reciprocal of the focal length; $D = 1/f$.

a. A pair of glasses has lenses with strength 1.5 D. What is the focal length of these lenses?

One lens is pulled out of the frame and used to produce an image of a duck which is 1 m in front of the lens. (See figure.)



b. Use the lens formula to locate the image.

c. What sort of image is this?

(Hint: Is the light actually coming from where the image appears to be?)