1. **Estimation:** The continents separated about 175 million years ago. Which is faster, the growth of your hair, or the movement of the continent you are standing on? *Clearly state your assumptions and how you came to the numbers you estimate.*

2. **Essay:** Roughly how big is the smallest object that can be seen with a conventional light microscope? Why? Give an example of a technique that can be used to see smaller objects, and explain how it works.

3. The interference of x-rays is a method for studying the properties of crystals. When an x-ray beam hits a crystal, each pair of molecules scatters the x-rays like the slits in an interference experiment.
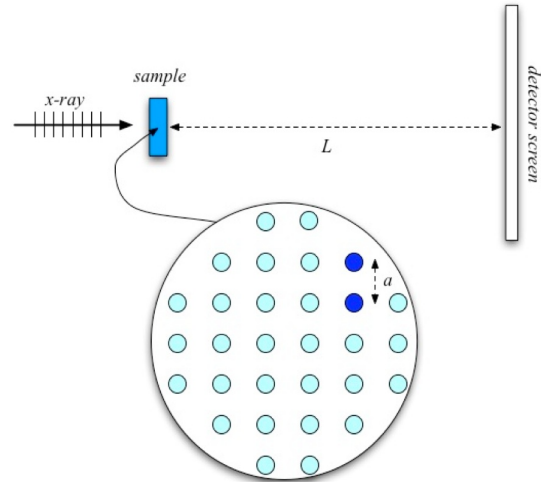
A. Consider the x-rays scattered from only the two molecules shown. Suppose the molecules are a distance a apart, the detector screen is a distance L from the sample, and the x-rays have a wavelength λ. The pattern produced by this pair of molecules is a string of beadlike spots separated from each other by a distance Δy. Construct an equation that will allow you to find a from measurements of L, Δy, and λ.

B. A typical wavelength for an x-ray is 1 nm. If your detector is 40 cm from the sample and the spot separation is 15 cm, find the spacing between the molecules.

4. A toy insect viewer for kids consists of a plastic container with a lens in the lid. The lid is 12 cm from the bottom of the container. The lens produces a magnified image of an insect on the bottom of the container. If the magnification is 4.0, what is the focal length of the lens? Draw a ray-tracing diagram to support your answer. (Hint: With a magnifying glass, the object lies *inside* the focal point and produces a *virtual* image.)

5. A microscope is a device where a first lens makes a magnified real image of an object, and a second lens makes a virtual image of that real image that is magnified further.

A. In the figure below, draw a ray diagram showing the formation of the real and virtual images. The "x" marks are the focal points of the first lens (left). The "o" marks are the focal points of the second lens (right). The figure is not to scale, but it is arranged so that the image formation works properly.
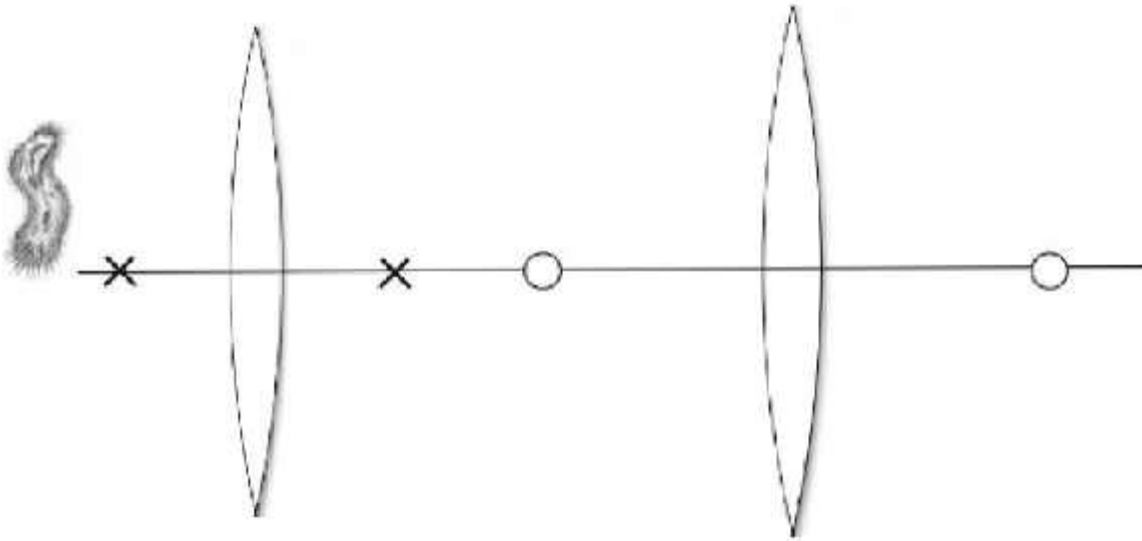
B. If the focal length of the left lens is 1 cm, the focal length of the right lens is 8 cm, and the distance between the two lenses is 15 cm, calculate the magnification of an object that is 1.125 cm from the left lens.