4-1) A 50 mm focal length thin lens in air is used to image a 250 x 250 mm object onto a 10 x 10 mm detector. What is the overall object-to-image distance? Do both the exact solution as well as the solution by reasonable approximation.

4-2) Two stars are separated by 10 arc sec. What is the separation of the star images in the focal plane of a telescope/camera with a focal length of 1000 mm?

4-3) A 1 cm diameter detector is used to image a scene at infinity. What is the angular field of view (FOV) when using a lens with the following focal lengths: 10 mm, 25 mm, 50 mm, 100 mm, 200 mm, 1000 mm? Assume a thin lens, and report the FOV in degrees. The center of the detector is aligned with the optical axis of the lens.

4-4) a) An object is located a depth d under a water/air interface. For an observer in air, how far below the water surface does the object appear to be? \( n_{\text{water}} = 1.33 \)

b) What if the observer is underwater (for example, a fish), and the object is in air (d above the water)?

c) What happens if the underwater observer is wearing a diving mask (flat window) and is looking straight up at the object in air (d above the water)?

4-5) You are the proud owner of a very special crystal ball. Light from a distant object is focused by the front surface of the sphere onto the opposite side of the sphere. What is the index of refraction of the sphere? The sphere is in air.
4-6) A variety of imaging configurations are given, each showing an object. Determine the image location and size by using a ray construction. Do not use the ray through the center of the lens. Both real and virtual objects are shown. Indicate if the image is real or virtual.

Positive Thin Lens:
Negative Thin Lens: