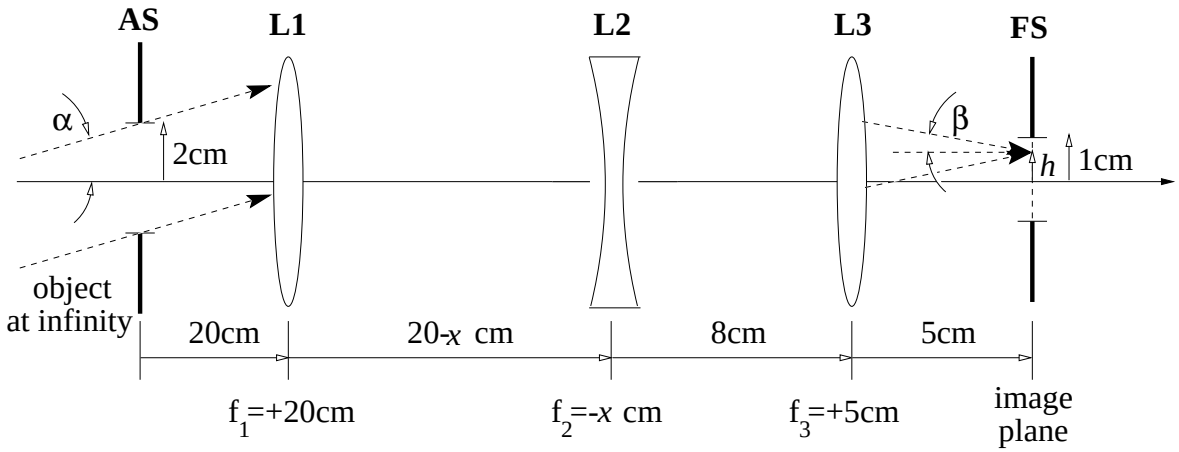
2.710

Quiz 1

50 min (7:35–8:25pm)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

2.710 Optics **Spring '08**
QUIZ 1 Wednesday, March 5th, 2008



The optical instrument shown above (not to scale) consists of three lenses L1, L2, L3. Lenses L1, L3 are positive with focal lengths $f_1 = +20$ cm and $f_3 = +5$ cm, as shown. Lens L2 is negative, with focal length $f_2 = -x$ cm, where $x > 0$ is to be specified. The distance between L1 and L2 is $(20 - x)$ cm, as shown; that is, once we specify x this distance is also specified. The distance between L2 and L3 is fixed to 8 cm, as shown.

The system's aperture stop (AS) is located 20 cm to the left of L1, and its half–size is 2 cm. The system's field stop (FS) is located 5 cm to the right of L3, overlapping with the image plane. The FS half–size is 1 cm.

The instrument is intended for imaging objects at infinity. If a parallel ray bundle from such an object arrives at angle α with respect to the optical axis, the instrument is required to form a real image of height $h = \pm 50\alpha$ at the image plane. Use the paraxial approximation to answer the following questions.

1. **(30%)** Specify x to meet the imaging requirement. Is the image erect or inverted in your design? What is the Field of View (FoV)?

2. **(30%)** What is the value of the angle β in your design? (The quantity 2β is the Numerical Aperture of this instrument.) Hint: It is easiest to compute β for an on–axis object at infinity, *i.e.* $\alpha = 0$.

3. **(10%)** Where is the 2nd Principal Plane (2ndPP) located, and what is the Effective Focal Length (EFL)?

4. **(30%)** What is the location and size of the Exit Pupil (ExP)?

GOOD LUCK!

2.71 / 2.710 Optics

Spring 2014