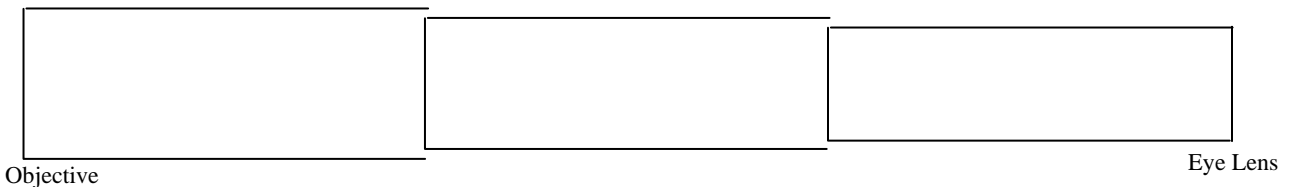


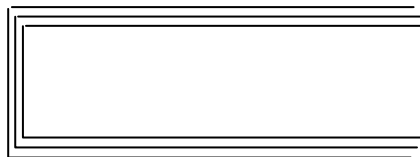
You have just accepted the position of chief optical engineer for Graybeard the Pirate, and you have been ordered to design a new collapsible or draw-tube telescope for the entire pirate fleet (no need for binoculars with these clients!!). This type of telescope is sometimes called a spyscope.

A draw-tube telescope is a monocular terrestrial telescope that is built in a series of nesting tubes so it can be expanded to full length for use, and then collapsed for convenient storage. All of the optical elements must be in fixed mounts/locations within their respective tube section.

Expanded:



Collapsed:



The telescope specifications are:

Magnifying power	15X (erect image)
Number of sections or tubes	3
Individual tube length	150 mm (all equal)
Telescope length when expanded	450 mm (ignore any mechanical considerations or overlap required to connect the tubes)
Telescope length when collapsed	about 150 mm (remember, we have thin lenses)
Tube inner diameters:	Front tube            50 mm
	Middle tube           48 mm
	Last tube              46 mm
Required eye relief to exit pupil	8.00 mm
Entrance pupil diameter	Provide the maximum possible
Number of optical elements	5 (all positive focal length)
Half field of view (unvignetted)	+/- 1 deg (Full Field: 105 feet at 1000 yds) (but assume the object is at infinity)

- A) Design the telescope using the mechanical constraints inherent to the nested tube configuration. The telescope should be designed as a Relayed Keplerian (Objective-Field Lens-Relay-Field Lens-Eye Lens). For this design, at least one lens element must be in each tube section.\*\* To simplify the design, both field lenses should be placed at the locations of the intermediate images. Provide focal lengths, diameters and spacings.

Since they are honest pirates, what specification or identification should be stamped into the telescope barrel (i.e. 15X??)? (In other words, which element serves as the limiting aperture and therefore defines the size of the entrance pupil?)

- B) What happens to the telescope design or its specifications if the eyepiece field lens is simply eliminated (keep the same values for the focal lengths and spacings of the other elements, and the same unvignetted HFOV)? Is this second field lens really necessary?
- C) Discuss the implications of the three equal-length tube sections on the design of the telescope. What changes might you make to the design if the three sections were not required to be of equal length or if more sections were permitted (but no more lens elements)?

\*\* Note that in many three section draw-tube telescope designs, all of the elements except the objective are placed in the third tube section. Also in many draw-tube telescopes, there is no first field lens, and the relay lens serves an erector lens. The erector lens produces an intermediate pupil and image for the eyepiece.