

Physics 7C, Spring 2004, Section 1, Instructor: Prof. Adrian Lee  
First Midterm Examination, Monday February 23, 2004

Please do work in your bluebooks. You may use one double-sided 3.5" x 5" index card of notes. Test duration is 120 minutes.

1a) (20 points total) Consider the generation of an electromagnetic wave from a  $1/4$  wavelength long dipole antenna. In the dipole, electrons move up and down sinusoidally. For several phases of the varying current, sketch the E and B fields from the dipole antenna and indicate which way the current is flowing.

b) In the same sketch, show two launched "bubbles" of electromagnetic waves and indicate both the direction of propagation and the direction of the transverse E and B fields.

2a) (40 points total) Show that a thin converging lens of focal length  $f$  followed by a thin diverging lens of focal length  $-f$  will bring parallel light to a focus beyond the second lens provided that the separation of the lenses  $L$  satisfies  $0 < L < f$ . (20 points)

b) Does this property change if the lenses are interchanged? (10 points)

c) What happens when  $L = 0$ ? (10 points)

3) (40 points total) Isaac Newton invented the refracting telescope sketched above. Parallel light falls onto the objective mirror  $M$ . After reflection from a small flat mirror  $M'$ , the rays form a real inverted image in the focal plane  $F$ . This image is then viewed in an eyepiece.

(Hint: draw an equivalent two-lens system and ignore the flat mirror)

a) Show that the angular magnification is given by  $m_e = -f_{ob}/f_{eye}$ , where  $f_{ob}$  and  $f_{eye}$  are the focal lengths of the objective and eyepiece respectively.

b) The Mt. Palomar 200" telescope has a focal length of 16.8 meter. Estimate the size of the image in the focal plane when the object is a meter stick 2 km away. You can assume the rays coming in are parallel.

c) Consider another telescope that has an objective with a radius of 10m (even though the mirror is parabolic, you can define an effective radius). To get an angular magnification of 200 what is the focal length of the eyepiece?

4) A disabled tanker leaks kerosene ( $n = 1.2$ ) in the Persian Gulf, creating a large slick on top of the water ( $n = 1.33$ ). (40 points total)

a) If you are looking straight down from an airplane onto a region of the slick where its thickness is 460 nm, for which wavelengths of visible light is the reflection the greatest? (20 points)

b) If you are scuba-diving directly under this same region of the slick, for which wavelengths of visible light is the transmission strongest and weakest? (20 points)