Physics 31B Final (300 pts Max.)
Fall 2004

Show your works with diagrams, explanations, and clear writings. No credit will be given for answers without diagrams, explanations, and clear writings.

1. (a) Two lenses with focal lengths f_1 = + 5.0 cm and f_2 = + 10.0 cm are located 5.0 cm apart. If an object 2.50 cm high is located 15.0 cm in front of the first lens, find (i) the position and (ii) the size of the final image.
   (b) A lantern slide 8.0 cm high is located 3.50 m from a projection screen. What is the focal length of the lens that will be required to project an image 1.0 m high?
2. (a) A microscope is fitted with an ocular having a focal length of 12.0 mm and an objective with a focal length of 3.20 mm. If the objective forms its image 16.0 cm beyond its secondary focal plane, find the total magnification.
   (b) An objective of an astronomical telescope has a diameter of 1.5 cm and a focal length of 85.0 cm. When it is used with an eyepiece having a focal length of 2.50 cm and a diameter of 1.50 cm, what will be (i) the angular magnification, (ii) the diameter of the exit pupil.
3. (a) The helium-neon laser puts out a bright red beam at a wavelength of 632.8 nm. Please determine the difference in energy between the two states defining the transition.
   (b) In the atomic domain, energy is often measured in electron-volts. Accordingly, arrive at an expression for the energy of a light-quantum in eV when the wavelength is in nanometers. What is the energy of a quantum of 500-nm light?
4. (a) Describe Young's experiment.
   (b) Derive the space between fringes on the screen in terms of wavelength, spacing between the two slits, and the distance between double slits and screen.
5. (a) The reflection of the sky coming off the surface of a pond (n = 1.33) is found to completely vanish when seen through a Polaroid filter. At what angle is the surface being examined? Give the answer to two significant figures.
   (b) A Michelson Interferometer is illuminated with monochromatic light. One of its mirrors is then moved 2.53×10^{-5} m, and it is observed that 92 fringe-pairs, bright and dark, pass by in the process. Determine the wavelength of the incident beam.
6. (a) If an object 200 cm from the vertex of a spherical concave mirror is imaged 400 cm in front of the mirror, what is the latter's focal length?
   (b) If your nose is 20 cm from a convex spherical mirror having a radius of 100 cm, locate its image. What will that image look like? Draw a ray diagram.
7. If the plate has a thickness τ, show that the emerging beam is laterally displaced by a perpendicular distance d from the incident beam where $d = \dfrac{\tau \sin(\theta_{i1} - \theta_{t1})}{\cos\theta_{t1}}$.
8. (a) A beam of unpolarized light with an irradiance of 1000 W/m^2 impinges on an ideal linear polarizer whose transmission axis is vertical. The light is studied using a second ideal linear polarizer, and it is found that the final emerging beam has an irradiance of 250 W/m^2. (i) How much light leaves the first polarizer? (ii) What is the orientation of the second polarizer?
   (b) Suppose we wish to make a microscope (which can be used with a relaxed eye) out of two positive lenses both of focal length 25 mm. Assuming the object is positioned 27 mm from the objective, (i) how far apart should the lenses be and (ii) what magnification can we expect?
   (c) A series circuit contains a 240-Ω resistor, a 3.80-μF capacitor, and a 550-mH inductor. It's placed across the terminals of an ac generator set to 100 Hz. If an ammeter in the circuit reads 250 mA effective, what is the maximum voltage of the generator?