PHY6938 Proficieny Exam Spring 2003
March 28, 2003
Optics and Thermodynamics

1. Light of wavelength 300 nm strikes a metal plate, producing photoelectrons that move with speed of $0.002c$.

   (a) What is the work function of the metal ?

   (b) What is the critical wavelength for this metal, so that photoelectrons are produced ?

   (c) What is the significance of the critical wavelength ?

2. Two lenses are separated by 35 cm. An object is placed 20 cm to the left of the first lens, which is a converging lens of focal length 10 cm. The second lens is a diverging lens of focal length -15 cm. What is the position of the final image? Is the image real or virtual? Erect or inverted? What is the overall magnification of the image?

3. Consider a system consisting of N noninteracting spins $S = 1/2$ in a magnetic field H. The Helmholtz free energy due to the Zeeman splitting $g\mu_B H$ is given by

$$F = -NkT \ln[2\cosh(g\mu_B H/2kT)] \ ,$$

   where k is the Boltzmann constant and T is the temperature.

   (a) Obtain the magnetization using $M = -\partial F/\partial H$.

   (b) What is the maximum magnetization?

   (c) For $g\mu_B H \ll kT$ obtain the susceptibility defined as $\chi = M/H$.

   (d) Obtain the entropy using $S = -(\partial F/\partial T)_H$.

   (e) Discuss the entropy in the limits $H = 0$ and $g\mu_B H \gg kT$.

   (f) Obtain the specific heat and sketch C/Nk as a function of $g\mu_B H/kT$.