PHYC 463 Advanced Optics I

Fall 2007

Homework #3, Due Wednesday Sept. 12

1. Metal Optics

(a) Consider a material ($\tilde{n} = n - i\kappa$) with κ>>n. Show that reflectivity at normal incidence can be given by: *(2 points)*

$$R \approx 1 - \frac{4n}{1+\kappa^2}$$

(b) Write down the expression $\tilde{n}^2$ for a metal (i.e. only N free electrons) assuming a finite collision time τ. (Ignore local field effects.) *(2 points)*

(c) In the visible to mid-infrared part of the spectrum we may take ωτ>>1. Show that for $\omega<\omega_p$, we can write: *(4 points)*

$$\kappa = \sqrt{\frac{\omega_p^2}{\omega^2} - 1} \qquad \text{and} \qquad n = \frac{1+\kappa^2}{\kappa} \times \frac{1}{\omega\tau}$$

(d) Show that reflectivity at normal incidence from a metal surface can be given by:

$$R \approx 1 - \frac{2\delta}{c\tau},$$

where δ=c/ωκ is the classical skin depth and c is the speed of light in vacuum. *(2 points)*

(e) For the metal described by Fig. 2.19 and its caption (K&F), calculate the normal incidence reflectivity for λ=600 nm and λ=400 nm. (2 points)

2. Snell's Law

A ray is incident on a dielectric sphere (radius *R* and refractive index *n*) at a distance *d* from the axis (as shown). Calculate the deviation angle θ_D for the exiting ray after one internal reflection. *(8 points)*