Ph195c study problem for 4/24/02

1. Assume that we have a central scattering potential given by

$$V(r) = \frac{V_0}{r^\alpha},$$

where α and V_0 are independent of (r, θ, φ).

a. Specify V_0 and α such that the following is a valid stationary scattering state:

$$\psi_1(r, \theta, \varphi) \propto \frac{\sin(kr)}{kr} Y_m^l(\theta, \varphi),$$

where Y_m^l is a Spherical Harmonic with $l > 0$. You may leave your answer in terms of the unspecified integers l and m.

b. Specify V_0 and α such that the following is a valid asymptotic expression ($r \to \infty$) for a stationary scattering state:

$$\psi_2(r, \theta, \varphi) \propto \frac{\exp(-ikr)}{r} + c\frac{\exp(+ikr)}{r} \cos\theta.$$

You may choose an arbitrary non-zero value for the constant c.

2. [Merzbacher Ch. 13, Problem 1] Using the first three partial waves, compute and display on a polar graph the differential cross section for an impenetrable hard sphere when the de Broglie wavelength of the incident particle equals the circumference of the sphere. Evaluate the total cross section and estimate the accuracy of the result. Also discuss what happens if the wavelength becomes very large compared with the size of the sphere.