1. Consider a beam of articles of $m$ moving with velocity $v$ towards a target. The beam has a density of particles of $\rho$ and is kept on for a time $T$. Scattering from the target is known to be isotropic (all directions are the same) and to have a total cross section of $\sigma$ (for particles incident with an energy of $\frac{1}{2}mv^2$). There is a detector of cross sectional area $A$ located a distance $R$ from the target and at an angle $\theta$ relative to the beam direction. Find an expression for the total number of particles hitting the detector under the assumption that $A \ll R^2$.

2. Consider the following scattering state wave function.

$$\psi(\vec{r}, t) = e^{ikz} \left( -\frac{\sin(kr) + i(1 - e^{-\beta r^2})\cos(kr)}{kr} \right)$$

which is valid for all distances and where $\beta$ is a constant.

a. Show that the $f(\vartheta) = i/k$ for all scattering angles.
b. Find the differential cross-section.
c. Find the total cross-section.
d. Show that the only partial wave with a nonzero $c_l$ is the s wave ($l=0$).
e. Find $c_0$.
f. Find the phase shift $\delta_0$. 