Physics 125b

Problem Set 4, Due Wednesday Mar. 01, 2017

Problem 1

Consider a particle with charge q and mass m in the ground state of the spherically symmetric potential

$$V(r) = \frac{1}{2}m\omega^2(r^2 - r_0^2) \text{ for } r < r_0 \text{ and } V(r) = 0 \text{ for } r > r_0.$$

Derive and expression for the probability that an incident electromagnetic wave $\vec{A}(\vec{r}, t) = \vec{A}_0 \cos(\vec{k} \cdot \vec{r} - \omega t)$ pops the particle out of the potential well. Approximate the ground state as the harmonic oscillator ground state and then make the same assumptions and approximations as when we discussed the ionization of the hydrogen atom by an incident electromagnetic wave in class.

Problem 2

Use the Born approximation to derive and expression for the cross section for a particle of mass m scattering off the potential $V(r) = -V_0\theta(r_0 - r)$. What does it become in the limit $kr_0 \to 0$. Recall that the theta function is defined by $\theta(z) = 1$ for $z > 0$ and $\theta(z) = 0$ for $z < 0$.

Problem 3

Using Born approximation, calculate:

(a) the differential cross section $\frac{d\sigma}{d\Omega}$,

(b) the total cross section σ,

for a particle of mass m scattering off the Gaussian potential,

$$V(r) = V_0 e^{-r^2/r_0^2}.$$