Physics 5403

Problem Set 8 – Due November 6, 2009

Problem 1

A particle is scattered by a potential at an energy sufficiently low so that the phase shifts $\delta_\ell = 0$ for $\ell > 1$. Let us assume that this system has a rotational symmetry.

(a). Show that the differential-scattering cross section has the form

$$\frac{d\sigma(\theta, \phi)}{d\Omega} = A + B\cos\theta + C\cos^2\theta$$

and determine A, B and C in terms of phase shifts.

(b). Determine the total cross section in terms of A, B and C.

(c). Assume that the differential cross section is known for $\theta = 90^o$ with $d\sigma/d\Omega = \alpha^2$; $\theta = 180^o$ with $d\sigma/d\Omega = \beta^2$; and $\theta = 45^o$ with $d\sigma/d\Omega = \gamma^2$. Determine $d\sigma(\theta, \phi)/d\Omega$ for $\theta = 0$ in terms of α, β and γ.

(d). Find the imaginary part of the forward scattering amplitude $[f(\theta, \phi)]$ in terms of α, β and γ.

Problem 2

Find the value of $a^2 V_0$ for an attractive three dimensional square well so that the scattering cross section is zero at zero bombarding energy (Ramsauer-Townsend effect with $\tan ka = ka$).

Problem 3

Determine the total scattering cross section for particles of low energy in a potential

$$V(\vec{r}) = \frac{\alpha}{r^4}, \quad \alpha > 0\ .$$