

PHYS-4602 Homework 10 Due 12 April 2021

This homework is due to <https://uwcloud.uwinnipeg.ca/s/ptx3smosp2xFtmE> by 10:59PM on the due date. You may submit a PDF either scanned from handwriting or generated with L^AT_EX or a word processor (with an equation editor).

1. Scattering from a Spherical Shell Potential *from Griffiths & Schroeter 10.13*

Consider scattering from a spherical shell potential $V(r) = \alpha\delta(r - a)$ for constant a, α . Work in the Born approximation. Note that the scattering amplitude $f(\theta, \phi) = f(\theta)$ depends only on the scattering angle due to spherical symmetry. The scattered particle has mass m .

- Find the scattering amplitude for low energy scattering $ka \ll 1$.
- Use the spherical symmetry to find the scattering amplitude as a function of the incoming wave energy E for all energies. Show that you find your previous result in the low energy limit.
- What are the differential cross section and total cross section in the low energy limit?

2. Yukawa Potential Scattering *extended from Griffiths & Schroeter 10.11 & 10.12*

The attractive Yukawa potential (in 3D) is a central potential given by

$$V(r) = -\beta \frac{e^{-\mu r}}{r}, \quad (1)$$

where β, μ are constants. This is the potential for electromagnetism with massive photons and a (very oversimplified) model for the strong force between neutrons and protons.

- Find the scattering amplitude of a particle of mass m as a function of the incoming wavevector k and scattering angle θ at first order in the Born approximation (see example 10.5 but show how to evaluate the integral).
- Find the differential cross section and total cross section in the Born approximation using your result from above. Write your answers in terms of the incoming energy E and (when appropriate) the scattering angle θ .
- Using your result from the previous part, find the total cross section at low energies (in the Born approximation). Verify that it is $4\pi|f|^2$ as expected in this limit.