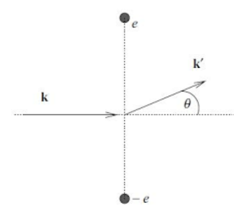
PHYS 314
Problem set # 9 (the last one!) *(due April 22)*

Each problem is 10 points, unless stated otherwise.

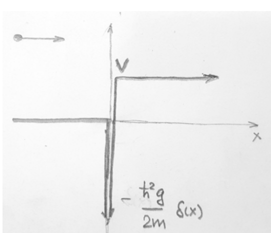
Griffiths: 11.10, 11.17

Q1 Consider an electric dipole consisting of two electric charges e and $-e$ at a mutual distance $2a$. Consider also a particule of charge e and mass m with an incident wave vector $\vec{k} = k\vec{e}_z$ perpendicular to the direction of the dipole. Calculate the scattering amplitude in the Born approximation. Find the directions at which the differential cross section is maximal.



Q2 Working in Born's approximation, express the scattering amplitude for two identical scatterers, separated by the distance a:
$V(\vec{r}) = V_0(r) + V_0(|\vec{r} + \vec{a}|)$
using the known scattering amplitude $f_0(\theta)$ for a single centrally-symmetric scatterer $V_0(r)$. Using this expression, discuss the connection between the differential scattering cross-sections of fast electrons on an atom and a diatomic molecule, consisting of two such identical atoms (or, for much more energetic electrons, a scattering on two valence quarks inside a meson). For a more realistic result, the molecular cross-section must be averaged with respect to different orientations of the molecule (*i.e.* for different directions of $\vec{a}$). Find the ratio between the differential cross-sections for a diatomic molecule (averaged over the molecular orientation) and a single atom. Suggest how you can use this to extract the information about the inter-atomic distance.

Q3
Consider a one-dimentional potential with a step function component and an attractive delta function component just at the edge:
$V(x) = V_0\Theta(x) - \frac{\hbar^2 g}{2m}\delta(x)$.



(a) Compute the reflection coefficient for particles with mass m incident from the left with energy $E > V_0$.

(b) Consider the limit of highly energetic particles $E \gg V_0$. Let's imaging that you need to design the experiment to distinguish between two possible models describing the scatterer: a plain potential step (i.e. $\alpha = 0$), or the potential step with the δ-function at $x = 0$. Show that you will be able to "detect" the presence of the δ potential component by analyzing the dependence of the reflection coefficient on the particle energy E.