PHYSICS 631 : SET # 11 Due 9th November, 2009

1.(8pts.) Griffiths Prob. 2.33

You only need consider the cases $E = V_0$ and $E > V_0$ ($E < V_0$ was discussed in class). For both cases, set up the calculation from scratch, i.e. write down the t-independent Schrödinger equation, solve it and then impose boundary conditions. What happens for $E \to \infty$? Are there finite values for E ($E > V_0$) for which the reflection coefficient vanishes (total transmission) ?

Plot the transmission coefficient, T, as a function of E ($0 \le E < \infty$).

2.(2pts.)

Electrons can be extracted from a metal at room temperature by applying a sufficiently strong external electric field $\vec{\mathcal{E}}$ (phenomenon of "cold emission"). We found the following formula in class for the WKB transmission coefficient,

$$T = e^{-\frac{4}{3}\frac{\sqrt{2m}W^{3/2}}{e\mathcal{E}\hbar}} \equiv e^{-\sigma}$$

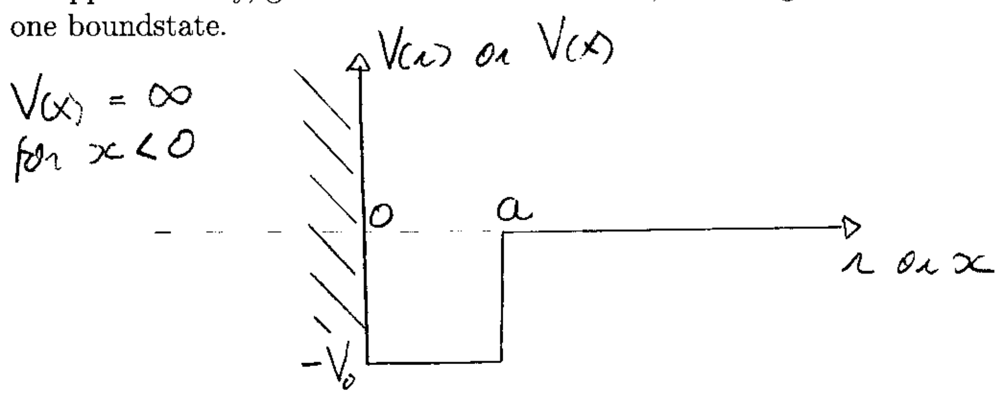
What is the condition on σ such that the transmission coefficient > 0.01 ?

How large must $e\mathcal{E}$ be (in $eV/\AA$) ? Let $W \sim 1eV$ and use convenient units where $\hbar c = 1.97 \times 10^3 eV\,\AA$ and $mc^2 = 5 \times 10^5 eV$ ($\AA \equiv 1$ Angstrom $= 10^{-8}cm$).

PHYSICS 631 : SET # 12 Due 12th November, 2009

1.(6pts.) Griffiths Prob. 2.29

2.(4pts.) The Deuteron is a proton-neutron bound state. It is a system that has only one boundstate energy level of energy $E = -|E| = -2.23MeV$. We will approximately describe the system via a 1D potential shown below with $a = 2.3 \times 10^{-13}cm$ (typical nuclear distance). We wish to estimate what the depth, V_0 , of the well should be approximately, given the above information, including the fact that there is only one boundstate.



(a) Describe how you can mimic this 1D potential via a regular square well potential with the well extending between $-a < x < a$. What kind of solutions of the square well problem should you be looking at ?

(b) Estimate V_0 assuming $V_0 >> |E|$. This condition will make us focus attention on the region close to $cot(z) \approx 0$ (why is this ?), which in turn will allow you to replace z_0 with a specific number and estimate V_0.

Use $\hbar c = 1.97 \times 10^3 eV \,\AA = 1.97 \times 10^{-5} eV\, cm$ and $M_{proton}c^2 \approx M_{neutron}c^2 = 9.38 \times 10^8 eV$.

Remember that we are rewriting a 2-body 3D problem to mimic a 1D potential problem. What implications does this have for what mass to use.

Verify that your answer for V_0 is reasonably consistent with the assumption $V_0 >> |E|$.