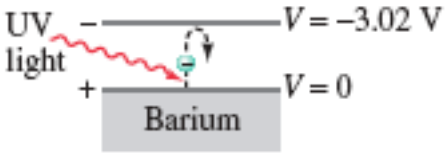
Physics 5K INTRODUCTORY PHYSICS – HONORS SECTION Spring 2012

Homework 1

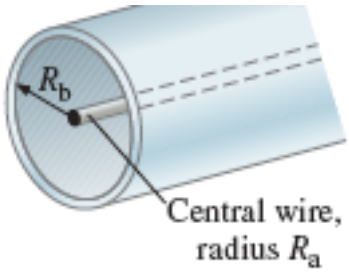
Due Friday April 27 in class

1. (10 points) Giancoli 23-63 – Nuclear fission.

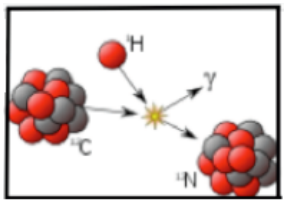
2. (5 points) Giancoli 23-75 – Photoelectric effect.



3. (10 points) Giancoli 23-83 – Geiger counter.



Nuclear fusion. A fusion reaction that plays a role in energy production in the sun involves capture of a proton by a carbon nucleus, which has six times the charge of the proton and a radius $r_0 \approx 2 \times 10^{-15}$ m.



4. (10 points) Estimate the Coulomb potential V experienced by a proton if it is at the surface of the carbon nucleus.

5. (10 points) A proton is incident upon the carbon nucleus because of its thermal motion. Its kinetic energy cannot be much higher than about 10 kT, where k is Boltzmann's constant ($k = 1.38 \times 10^{-23}$ J/K) and $T \approx 10^7$ K is the temperature near the center of the sun. Estimate this kinetic energy and compare it with the height of the Coulomb barrier.

6. (10 points) Calculate the probability that the proton of kinetic energy 10 kT (as in problem 5) can penetrate the Coulomb barrier $V_{\text{Coul}}(r)$. Assume for simplicity that the barrier is of constant height $V = V_{\text{Coul}}(r_0)$ and extends from r_0 to r_1, where r_1 is the radius where the Coulomb potential drops to $V/2$ – that is, $V_{\text{Coul}}(r_1) = V/2$.

7. (10 points) Is the penetration through the actual Coulomb barrier potential greater or less than through the rectangular barrier that we considered for simplicity in problem 6? Explain your reasoning with a diagram or a calculation.