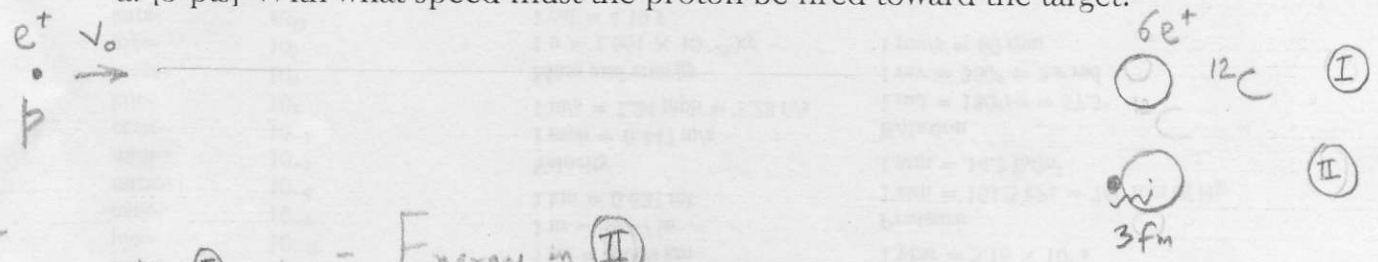
NAME:	Quiz #9b: Phys270

1. [10 pts] To initiate a nuclear reaction, an experimental nuclear physicist wants to shoot a proton into a ^{12}C nucleus. The proton must impact the nucleus with a kinetic energy of 3.00 MeV. The nuclear radius is 3.00 fm. You can assume the nucleus remains at rest and the proton's velocity is non-relativistic. [Note: 1 eV = 1.6×10^{-19} J]

a. [5 pts] With what speed must the proton be fired toward the target?



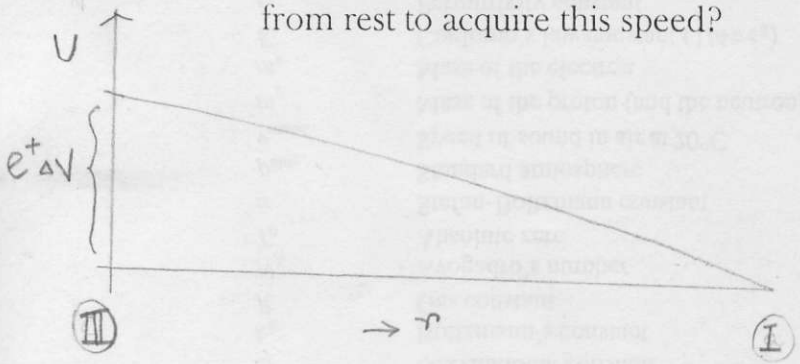
Energy in (I) = Energy in (II)

or, (*) $\frac{1}{2} m_p v_0^2 = 3.00\ MeV + \frac{6e^+ \cdot e^+}{4\pi\epsilon_0 (3fm)}$, The 2nd one being electro static potential energy.

or, $\frac{1}{2} \times 1.67 \times 10^{-27}\ Kg \cdot v_0^2 = 4.8 \times 10^{-13}\ J + 4.6 \times 10^{-13}\ J$

or, $v_0 \cong 3.35 \times 10^7\ m/c \approx .11c$

b. [5 pts] Through what potential difference must the proton be accelerated from rest to acquire this speed?



Again Energy in (III) = energy in (I)

or, $e^+ \Delta V = 9.4 \times 10^{-13} J \approx 5.88 MeV$

or, $\Delta V \cong 5.88 MV$ or $5.88 \times 10^6 V$

(*) Rest mass energy of proton = $m_p c^2 = 1.67 \times 10^{-27} kg \times (3 \times 10^8 m/s)^2 \cong 1.50 \times 10^{-10} J$

$\cong 1.50 \times 10^{-10} J * 10^{19}/1.6\ eV/J \cong 938 MeV$

which is much larger than 3.00 MeV & 4.6×10^{-13} J. Hence, can use non-Relativistic formula.