b.) (10 pts.) The law of physics that explains the voltage difference is named after (circle one)

Coulomb Ampere [✓ Faraday] Maxwell Gauss Biot-Savart

3.) A proton is moving with speed equal to 0.8 times the speed of light.

a.) (10 pts.) Determine its total energy in MeV (1 MeV = 10^6eV).

$$E = \frac{mc^2}{\sqrt{1-u^2/c^2}} = \frac{(1.67\times10^{-27}\,kg)(9\times10^{16}\,m^2/s^2)}{\sqrt{1-.64}\quad 1.6\times10^{-13}\,J/MeV} = \underline{\underline{1566\ MeV}}$$

b.) (10 pts.) Determine its kinetic energy in MeV.

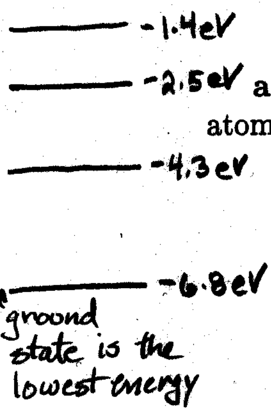
$$K = E - mc^2 = 1566 - 939 = \underline{\underline{627\ MeV}}$$

c.) (15 pts.) A neutron is slightly more massive that a proton, by the amount 1.95×10^{-30} kg. Because of this the neutron can decay into a proton plus other forms of energy. Determine how much other energy can be released.

$m_n c^2 = m_p c^2 + E$ where E is the other energy

$$\text{so } E = (m_n - m_p)c^2 = \frac{(1.95\times10^{-30}\,kg)(9\times10^{16}\,m^2/s^2)}{1.6\times10^{-13}\,J/MeV} = \underline{\underline{1.1\ MeV}}$$

4.) An atom has four bound states with energies equal to -6.8 eV, -4.3 eV, -2.5 eV and -1.4 eV. It may be helpful to make an energy-ladder diagram for the following.



a.) (15 pts.) What is the longest wave length of a photon that can be absorbed by the atom?

$\lambda = \frac{hc}{E_{photon}}$, $E_{photon} + E_i(atom) = E_f(atom)$ smallest E_{ph} gives longest λ

so $E_f = -4.3eV$

$E_i = -6.8eV$ (atom is in ground state)

$E_{ph} = 2.5eV$ $\lambda = \frac{1240\,eV\,nm}{2.5} = \underline{\underline{496\ nm}}$

b.) (15 pts.) If the atom is in its second excited state above the ground state, it will decay quickly by emitting photons. Determine all the possible photon wave lengths.

$E_i = -2.5eV$ is 2nd excited state

$E_{ph} =$ 1.8eV or 4.3eV, $\lambda = \frac{1240}{1.8} = \underline{\underline{689\ nm}}$

or 2.5eV $\lambda = \frac{1240}{4.3} = \underline{\underline{289\ nm}}$

(from 1st excited state to ground state) $\lambda = \frac{1240}{2.5} = \underline{\underline{496\ nm}}$