Physics 2220
Spring 2006
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FIRST MIDTERM

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Name: Solution Student ID #:

Discussion Instructor (circle): Barcikowski El-Gendy Johnson Rodriguez

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES! 5 pts each
Use the conversion constants and data given on the front page.

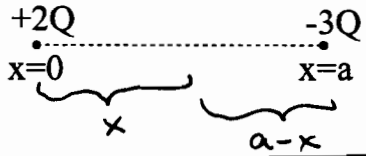
(a) Calculate the magnitude of the electric force between two electrons that are 2.00×10^{-10} m apart.

$$F = \frac{ke^2}{r^2} = \frac{8.99\times10^9\ \mathrm{N\frac{m^2}{C^2}}\,(1.602\times10^{-19}\mathrm{C})^2}{(2\times10^{-10}\mathrm{m})^2} = \boxed{5.77\times10^{-9}\mathrm{N}}$$

(b) Calculate the electric field a distance 4.32×10^{-12} m away from the nucleus of a helium atom. The helium atom nucleus has 2 protons and 2 neutrons.

$$E = \frac{k(2e)}{r^2}\hat{r} = \frac{8.99\times10^9\ \mathrm{N\frac{m^2}{C^2}}\,(2\times1.602\times10^{-19}\mathrm{C})}{(4.32\times10^{-12}\mathrm{m})^2}\hat{r} = \boxed{1.55\times10^{14}\ \mathrm{\frac{N}{C}}\,\hat{r}}$$

(c) Find the point on the x-axis, between the two charges, where the electric potential is zero.

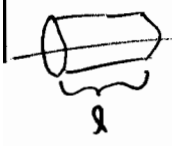


we want $\frac{k(2Q)}{x} - \frac{k(3Q)}{a-x} = 0 \Rightarrow 2a - 2x - 3x = 0 \Rightarrow \boxed{x = \frac{2}{5}a}$

(d) A proton is accelerated from rest through an electric potential difference of 5320 volts. Find its final velocity.

$$K = \frac{1}{2}m_p v_f^2 = 5320\,\mathrm{eV} = 8.5226\times10^{-16}\mathrm{J} \Rightarrow \boxed{v_f = 1.01\times10^6\ \mathrm{m/s}}$$

(e) A very long wire has a linear charge density λ, of 275×10^{-12} C/m. Calculate the magnitude of the electric field a distance of 3.75 cm from the center of the wire. (This is outside of the wire.)



$$\Phi = \frac{Q_{enc}}{\varepsilon_0} = E\overbrace{(2\pi r\ell)}^{A} \Rightarrow E = \frac{\lambda\ell}{2\pi\varepsilon_0 r\ell} = \boxed{132\ \mathrm{\frac{N}{C}}}$$