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

5 pts each

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

$$F = \frac{kq_1q_2}{r^2} = \frac{8.99 \times 10^9 \text{ N m}^2/\text{C}^2 (1.602 \times 10^{-19} \text{ C})^2}{(2 \times 10^{-10} \text{ m})^2} = 5.77 \times 10^{-9} \text{ N}$$

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

$$E = \frac{k(q_1)}{r^2} = \frac{8.99 \times 10^9 \text{ N m}^2/\text{C}^2 (2 \times 1.602 \times 10^{-19} \text{ C})}{(4.32 \times 10^{-12} \text{ m})^2} = 1.55 \times 10^4 \text{ N/C}$$

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

$$\text{we want } \frac{kq_1}{x} - \frac{kq_2}{a-x} = 0 \Rightarrow 2a - 2x - 3x = 0 \Rightarrow x = \frac{2a}{5}$$

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

$$K = \frac{1}{2}mv_f^2 = 5320 \text{ eV} = 8.5226 \times 10^{-16} \text{ J} \Rightarrow v_f = 1.01 \times 10^6 \text{ m/s}$$

(e) A very long wire has a linear charge density $\lambda$, of $275 \times 10^{-12} \text{ C/m}$. 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.)

$$\phi = \frac{q_{tot}}{\varepsilon_0} = E (2\pi r l) \Rightarrow E = \frac{\lambda l}{2\pi \varepsilon_0 r} = 132 \text{ N/C}$$