1. Consider Fig. 1 below. A ring of charge with radius R is situated in the xy-plane. The charge is positive, and it is distributed evenly across the ring. We write $\Delta q = \lambda R \Delta\theta$, to mean that there is λ Coulombs per unit length. If $\Delta\theta$ were to extend to 2π (all the way around the circle), then the total charge is $Q = \lambda(2\pi R)$. (a) By symmetry, where should the electric field be zero?

a.) At the center of the ring where $\phi = 0$

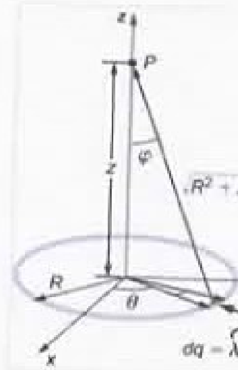

Figure 1: A ring of charge situated in the xy-plane.

2. As $z \to \infty$ in Fig. 1, what happens to the field?

- A: The field-strength increases.
- B: The field-strength remains constant.
- C: The field-strength decreases.
- D: The field-strength is exactly zero.

3. Suppose the actual function for the E-field $\vec{E}(z)$ is

$$\vec{E}(z) = \frac{1}{4\pi\epsilon_0}\frac{qz}{(z^2+\cancel{R^2})^{3/2}}\hat{z} \quad (1)$$

To see what happens when z is much larger than R, try setting $R = 0$. What is the result in Eq. 1 if $R = 0$?

$\frac{1}{4\pi\varepsilon_0}\frac{qz}{z^3} \rightarrow \frac{1}{4\pi\varepsilon_0}\frac{q}{z^2}$ It becomes the point charge formula

4. To what charge distribution does this expression correspond (the limit that $R \to 0$)?

$\frac{1}{4\pi\varepsilon_0}\frac{q}{z^2}$

5. (a) What is the final kinetic energy of a proton accelerated through 1 kV? (b) Suppose protons are placed into a linear accelerator with 100 voltages that each provide 10 kV potential. What is the final kinetic energy in eV? (c) What is the final speed of the proton?

a) $KE = q * V \rightarrow 1kV = 1000V$ $\rightarrow \boxed{1000\,eV}$

$KE = 1.602\times10^{-19}C * 1000V = 1.602\times10^{-16}J$

b.) $KE = q * V$

$1.602\times10^{-19}C\ 1\times10^{6}V$

$\boxed{1\times10^{6}\,eV}$

c.) $KE = \frac{mv^2}{2}$ $m = 1.672\times10^{-27}$ $k = 1.602\times10^{-13}J$

$\sqrt{\frac{2\cdot1.602\times10^{-13}}{1.672\times10^{-27}}}$ $= \frac{1.672\times10^{-27}(v^2)}{2}$

$\boxed{V = 1.38\times10^{7}\frac{m}{s}}$

6. Suppose two parallel plate capacitors are added in parallel. One has an area of 1.0 mm², and a plate separation of 0.1 mm, and the other has area 0.5 mm² and separation 0.2 mm. What is the total capacitance of the system?

$1\times10^{-4}m$

$C = \frac{Q}{V} = \frac{Q_1+Q_2}{V}$

$0.5mm^2\left(\frac{1m}{1000mm}\right)\left(\frac{1m}{1000mm}\right) \rightarrow 5\times10^{-7}m$

$0.2mm\left(\frac{1m}{1000mm}\right) = 2\times10^{-4}m$

$\frac{Q_1}{V} = C_1 = \frac{\varepsilon_0 A_1}{d_1} = \frac{8.85\times10^{-12}\frac{C^2}{Nm^2}(1\times10^{-6}m)}{1\times10^{-4}m} = 8.85\times10^{-14}F$

$\frac{Q_2}{V} = C_2 = \frac{\varepsilon_0 A_2}{d_2} = \frac{8.85\times10^{-12}(5\times10^{-7}m)}{2\times10^{-4}} = 2.21\times10^{-14}F$

$C = 8.85\times10^{-14} + 2.21\times10^{-14} = \boxed{1.11\times10^{-14}F}$