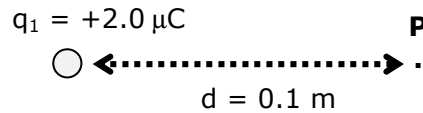


Electric Fields:

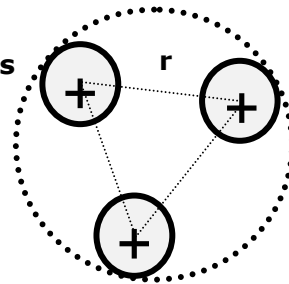
1. Consider a fixed point charge of $+2.0 \mu\text{C}$ (q_1).



- a. What is the magnitude and direction of the electric field at a point P, a distance of 0.1 m?
- b. A 2nd charge ($q_2 = -2.0 \mu\text{C}$) is placed at point P. What is the magnitude and direction of the electric force exerted on q_3 ?

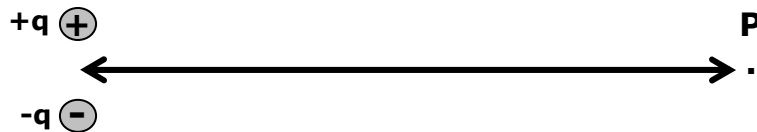
2. Three protons are present in the nucleus of a lithium atom, forming an equilateral triangle. The distance, r , between each pair of protons is $1.5 \times 10^{-15} \text{ m}$.

Lithium Nucleus



- a. What is the magnitude of the electric field vector due to the lithium nucleus at point P, a distance of $2.5 \times 10^{-10} \text{ m}$ from the center of the nucleus?
- b. What is the magnitude and direction of the total electric force exerted on an electron positioned at point P.

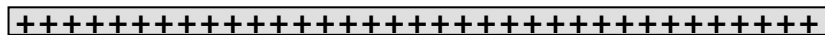
3. Consider an electric dipole, $q = 0.1 \mu\text{C}$, separated by a distance of $5 \times 10^{-6} \text{ m}$.



- Sketch the electric field lines for the electric field vector due to the dipole.
- What is the magnitude and direction of the electric field vector due to the dipole at point P, a distance of 0.5 m to the right of the dipole?
- What is the magnitude and direction of the electric field due to the dipole at a distance of 0.5 m directly above the dipole?

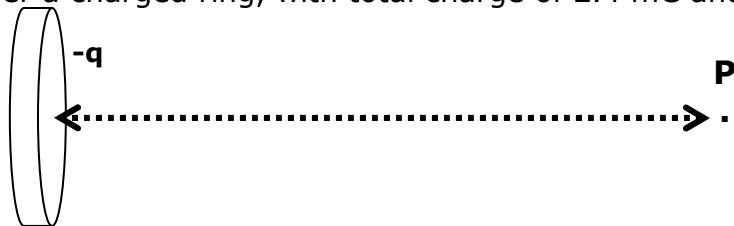
4. Consider a uniform line of charge with a total charge of 5 pC and a total length of 0.5 m.

P
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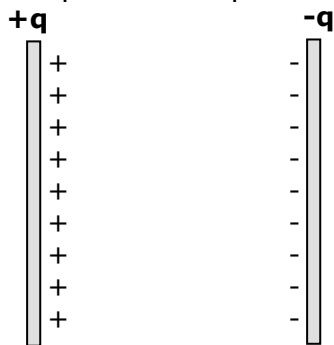
- What is the magnitude of the linear charge density?
- Sketch the field lines for the line of charge in the diagram above.
- Derive an equation for the electric field vector at point P, located 0.3 m above the line and centered between the ends
- What is the magnitude of the electric field vector at point P?
- Determine the electric force vector exerted on an electron placed at point P.
- What is the acceleration of the electron located at point P?

5. Consider a charged ring, with total charge of 2.4 mC and radius of 0.3 m.



- What is the magnitude of the surface charge density?
- Derive an equation for the electric field vector at point P , located 1.5 m to the right of the center of the disc.
-
- What is the magnitude and direction of the electric field vector at point P ?

5. The plates of a parallel plate capacitor have a uniform charge of +1.0 C and -1.0 C, respectively. Each plate is a square with sides of length of 0.5 m.

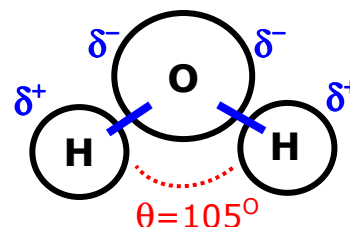


- What is the magnitude of the surface charge density on each plate?
- What is the magnitude of the electric field vector inside the plates of the capacitor?
- What is the electric force exerted on an electron placed inside the plates of the capacitor?
- What is the acceleration of the electron while it is in between the capacitor plates?
- For a 0.2 m plate separation, calculate the final speed of an electron (initially at rest), that is placed at the negative charged plate and just reaches the positive plate.

Dipole Moment of Water:

6. Water is a polar molecule that consists of 2 H atoms attached to a central oxygen atom. The H atoms are oriented at an angle of approximately 105° . Each of the H-O bonds has a dipole moment (p_{OH}) associated with it and together the 2 dipole moments have a resulting net dipole moment ($p_{\text{H}_2\text{O}}$) of $6.2 \times 10^{-30} \text{ C}\cdot\text{m}$. The effective separation distance between the respective positive (δ^+) and negative (δ^-) charges in each O-H bond is $3.9 \times 10^{-12} \text{ m}$.

- a. What is the magnitude of the effective dipole moment of the individual O-H bond for water?



- b. Determine the magnitude of the charge (δ) for the individual O-H dipole.
- c. Calculate the torque on a water molecule due to the electric field of a charged sphere ($q_{\text{sphere}} = -1.5 \times 10^{-6} \text{ C}$) at a separation distance of 0.05 m , where the direction of the electric field is oriented at an angle of 30° to $p_{\text{H}_2\text{O}}$.
- d. What is the potential energy of the water molecule in this electric field?