

EvaluAlde Beta Bonus Assignment – College Physics II: Electrostatics

Instructions:

- ❓ Answer all questions in detail. Show your work and reasoning for each part.
- ❓ Your submission must be a single PDF file. You may type your solutions or handwrite and scan them.
- ❓ This assignment is for bonus credit and will help improve our grading tools—thank you for participating!
- ❓ Submit your PDF via the usual course submission portal by the posted deadline.

Questions

1. Coulomb's Law: $F = \frac{k q_1 q_2}{r^2}$

Two point charges, $q_1 = +2.0 \mu\text{C}$ and $q_2 = -3.0 \mu\text{C}$, are placed 0.50 m apart in vacuum.

a) Calculate the magnitude and direction of the electrostatic force on each charge.

b) Is the force attractive or repulsive? $+ \text{ } -$ (attract = opposite signs)

2. Electric Field of a Point Charge: $E = \frac{F}{q}$

What is the magnitude and direction of the electric field at a point 0.30 m away from a $+5.0 \mu\text{C}$ point charge?

3. Electric Field from Multiple Charges:

Two charges, $+1.0 \mu\text{C}$ and $-2.0 \mu\text{C}$, are fixed 0.40 m apart.

a) Find the electric field at the midpoint between them (magnitude and direction).

b) If a $+1.0 \text{ nC}$ test charge is placed at the midpoint, what force does it experience (magnitude and direction)?

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2} \quad 1 \mu\text{C} = 1 \times 10^{-6} \text{ C}$$

$$(+2 \times 10^{-6} \text{ C})$$

$$(-3 \times 10^{-6} \text{ C})$$

distance
(r)²

$$F = \frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(2.0 \times 10^{-6} \text{ C})(3.0 \times 10^{-6} \text{ C})}{(0.50 \text{ m})^2}$$

$$F = \frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(6.0 \times 10^{-12} \text{ C}^2)}{0.25 \text{ m}^2} = 0.22 \text{ N}$$

"opposite charges attract whereas similar charges repel"

$$E = \frac{F}{q}$$

$$E = \frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(5.0 \times 10^{-6} \text{ C})}{(0.30 \text{ m})^2}$$

(1)²

$$= 5.0 \times 10^5 \text{ N/C}$$

$$\frac{-0.054}{0.25} = -0.216$$

$$+5.0 \mu\text{C}$$

$$\times 1 \times 10^{-6}$$

$$\frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(5.0 \times 10^{-6} \text{ C})}{0.09 \text{ m}^2}$$

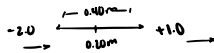
$$\frac{45000}{0.09}$$

$$= 5 \times 10^5 \text{ N/C}$$

$+ \text{ } -$ = opposite direction (repel / away)

$$(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(1 \times 10^{-6} \text{ C})$$

$$\frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(1 \times 10^{-6} \text{ C})}{(0.20 \text{ m})^2}$$



$$(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(2 \times 10^{-6} \text{ C})$$

$$\frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2})(2 \times 10^{-6} \text{ C})}{(0.20 \text{ m})^2}$$

$$\frac{18000}{0.04} = 450000 \text{ N/C}$$

$$\frac{9000}{0.04} =$$

$$225000 \text{ N/C}$$

$$450000 + 225000 = 675000 \text{ N/C}$$

Amount of energy per unit charge

4. **Electric Potential (Point Charges):** $V_P = \frac{kQ}{R}$

What is the electric potential at a point 0.25 m from a $-4.0 \mu\text{C}$ point charge? (Assume zero potential at infinity.)

$$\frac{(9 \times 10^9 \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}) (-4.0 \times 10^{-6} \text{ C})}{0.25 \text{ m}} = \frac{-36000}{0.25} = -144000 \text{ V}$$

5. **Potential Difference and Work:**

An electron moves from point A (potential = $+100 \text{ V}$) to point B (potential = -50 V).

a) What is the potential difference $V_B - V_A$? $-50 \text{ V} - 100 \text{ V} = -150 \text{ V}$

b) How much work is done by the electric field on the electron during this move?

$$W_{AB} = q(V_B - V_A)$$

$$= (-1.6 \times 10^{-19} \text{ C})(-150 \text{ V})$$

$$= 2.4 \times 10^{-17} \text{ J}$$