EvaluAIde 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:** 2.0×10^{-6} C ↑ -3×10^{-6} C ↑

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

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

   $F = k\cdot\frac{|q_1 \times q_2|}{r^2}$

   $= \left(8.99\times10^9\ \frac{N\cdot m^2}{C^2}\right)\times\frac{|(+2.0\times10^{-6}\,C)\times(-3.0\times10^{-6}\,C)|}{(0.5m)^2}$

   $= \left(8.99\times10^9\ \frac{N\,m^2}{C^2}\right)\left(2.4\times10^{-11}\ \frac{C^2}{m^2}\right) = 0.21576\ N$

   0.21576 N
   The force on q_1 is directed towards q_2.
   The force on q_2 is directed towards q_1.

   b) Is the force attractive or repulsive?

   The force is attractive.

2. **Electric Field of a Point Charge:** $+5.0\times10^{-6}$ C ↑

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

   $\vec{E} = k\cdot\frac{|q|}{r^2}$

   $= \left(8.99\times10^9\ \frac{N\cdot m^2}{C^2}\right)\times\frac{|5.0\times10^{-6}\,C|}{(0.3m)^2}$

   $= 499444.44\ \frac{N}{C}$

   $\approx 5.0\times10^5\ \frac{N}{C}$, which points radially outwards from the charge.

3. **Electric Field from Multiple Charges:**

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

1.0×10^{-6}C $\quad -2.0\times10^{-6}$ C

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

$\vec{E} = k\cdot\frac{|q|}{r^2}$

$E_+ = \left(8.99\times10^9\ \frac{N\cdot m^2}{C^2}\right)\times\frac{(1.0\times10^{-6}\,C)}{(.20m)^2}$

$= 224750\ \frac{N}{C} = 2.2475\times10^5\ \frac{N}{C}$, to the right

$E_- = \left(8.99\times10^9\ \frac{N\cdot m^2}{C^2}\right)\times\frac{|-2.0\times10^{-6}\,C|}{(0.20m)^2}$

$= 449500\ \frac{N}{C} = 4.495\times10^5\ \frac{N}{C}$, to the right

$E_{total} = E_+ + E_-$

$= 2.2475\times10^5\ \frac{N}{C} + 4.495\times10^5\ \frac{N}{C}$

$\boxed{= 6.7425\times10^5\ \frac{N}{C}\text{, to the right.}}$

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

$\vec{F} = q\cdot\vec{E}$

$= (1.0\times10^{-9}\,C)\times\left(6.7425\times10^5\ \frac{N}{C}\right)$

$\boxed{= 6.7425\times10^{-4}\ N\text{, to the right.}}$

4. **Electric Potential (Point Charges):**

-4.0×10^{-6}C

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

$V = k\cdot\frac{q}{r}$

$= \left(8.99\times10^9\ \frac{N\cdot m^2}{C^2}\right)\times\frac{(-4.0\times10^{-6}\,C)}{0.25m}$

$= \boxed{-143840\ V}$

5. **Potential Difference and Work:**

An electron moves from point A (potential = +100 V) to point B (potential = −50 V).

a) What is the potential difference $V_B - V_A$?

$\Delta V = V_B - V_A$

$= -50V - 100V$

$= \boxed{-150\ V}$

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

$W = q\times\Delta V$

$= (-1.6\times10^{-19}\,C)(-150\ V)$

$= \boxed{2.4\times10^{-17}\ J}$