Name: Key Period: _____ Date:_____

Electrostatics: Electric charges and Coulomb's Law problems I

$$E = \frac{F_E}{q} = \frac{kq}{r^2}$$

Where:

E: Electric Filed [N/C]

F_E: Electrostatic force (N)

q: Test Charge [C]

r=distance between charges [m]

k=Coulomb's constant [$9x10^9 Nm^2/C^2$]

I. Answer the following problems.

1) What is the electric field strength 0.750 m from an 8.00 μC charged object? _____

2) Calculate the gravitational field strength on the surface of Mars. Mars has a radius of $3.43x10^6$ m and a mass of $6.37x10^{23}$ kg. _____

3) At a point a short distance from a $4.60x10^{-6}$ C charged object, there is an electric field strength of 2.75x105 N/C. What is the distance to the charged object producing this field? _____

4) If an alpha particle* experiences an electric force of 0.250 N at a point in space, what electric force would a proton experience at the same point? _____

5) What is the electric field strength at a point in space where a $5.20x10^{-6}$ C charged object experiences an electric force of $7.11x10^{-3}$ N? _____

6) What is the initial acceleration of an alpha particle when it is placed at a point in space where the electric field strength is $7.60x10^4$ N/C? _____

*An Alpha particle consists of 2 protons and 2 neutrons.

7) Calculate the electric field strength midway between a 4.50 μC charged object and a - 4.50 μC charged object if the two charges are 50 cm apart. _____

8) Calculate the electric field strength midway between a 3.0 μC charged object and a 6.0 μC object if they are 0.80 m apart. _____

9) Calculate the electric field strength midway between two 3.0 μC objects if they are 90 cm apart. _____

10) What is the electric field strength at a point in space where an electron experiences an initial acceleration of 7.50×10^{12} m/s^2? _____

11) The electric field strength at a distance of 3.00×10^{-1} m from a charged object is 3.60×10^{5} N/C. What is the electric field strength at a distance of 45 cm from the same object? _____

*An Alpha particle consists of 2 protons and 2 neutrons.

Electrostatics I

①

$r = 0.75\,m$

$q = 8\times10^{-6}\,C$

$E = \frac{F_E}{q} = \frac{Kq}{r^2}$

$E = \frac{Kq}{r^2} = \frac{(9\times10^9)(8\times10^{-6})}{(.75)^2} = 128{,}000\,N/C$

or

$1.28\times10^5\,N/C$

②

$g = \frac{Gm}{r^2} = \frac{(6.67\times10^{-11})(6.37\times10^{23}\,kg)}{(3.43\times10^6\,m)^2} = 3.61\times10^{0}\,N/kg$

or

$3.61\,N/kg$

③

$q = 4.6\times10^{-6}\,C$

$E = 2.75\times10^5\,N/C$

$r = ?$

$E = \frac{Kq}{r^2}$

$r = \sqrt{\frac{Kq}{E}} = \sqrt{\frac{(9\times10^9)(4.6\times10^{-6})}{2.75\times10^5}}$

$r = 0.39\,m$

or

$3.9\times10^{-1}\,m$

⑤

$E = ?$

$q = 5.2\times10^{-6}\,C$

$F_E = 7.11\times10^{-3}\,N$

$E = \frac{F_E}{q} = \frac{7.11\times10^{-3}\,N}{5.2\times10^{-6}\,C} = 1.37\times10^{3}\,N/C$

⑥ $a = ?$

$m_\alpha = 6.68 \times 10^{-27}\ kg$

$q_\alpha = 3.2 \times 10^{-19}\ C$

$E = 7.6 \times 10^{4}\ N/C$

STEP 1: Find F_E

$$E = \frac{F_E}{q_\alpha}$$

$$F_E = E q_\alpha = (7.6 \times 10^{4})(3.2 \times 10^{-19})$$

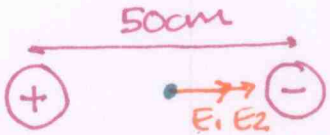
$$F_E = 2.43 \times 10^{-14}\ N$$

STEP 2: find acceleration

$$F_E = m_\alpha \cdot a$$

$$a = \frac{F_E}{m_\alpha} = \frac{2.43 \times 10^{-14}}{6.68 \times 10^{-27}} = 3.64 \times 10^{12}\ m/s^2$$

⑦



$q_1 = 4.5\mu C$ $\quad q_2 = -4.5\mu C$

Remember...

On positive charges, the electric field heads away!

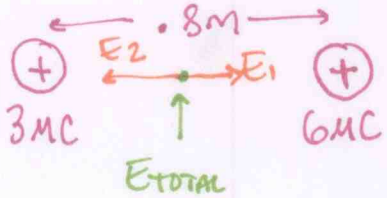
On negative charges, electric field heads toward the charge!

$$E_1 = \frac{Kq_1}{r_1^2} = \frac{(9 \times 10^{9})(4.5 \times 10^{-6})}{(.25)^2} = 6.48 \times 10^{5}\ N/C$$

$$E_2 = \frac{Kq_2}{r_2^2} = \frac{(9 \times 10^{9})(4.5 \times 10^{-6})}{(.25)^2} = 6.48 \times 10^{5}\ N/C$$

$$E_{TOTAL} = 6.48 \times 10^{5}(2) = 1.29 \times 10^{6}\ N/C \rightarrow$$

⑧



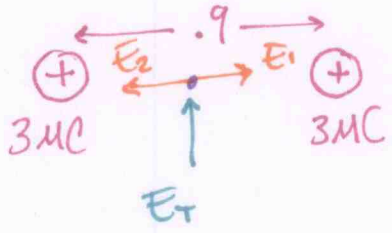
$$E_1 = \frac{(9 \times 10^{9})(3 \times 10^{-6})}{(.4)^2} = 1.68 \times 10^{5}\ N/C$$

$$E_2 = \frac{(9 \times 10^{9})(6 \times 10^{-6})}{(.4)^2} = 3.38 \times 10^{5}\ N/C$$

$$E_{TOTAL} = E_2 - E_1 = 3.38 \times 10^{5} - 1.68 \times 10^{5}$$

$$E_T = 1.7 \times 10^{5}\ N/C$$

(9)



$E_1 = \frac{Kq_1}{r_1^2} = \frac{(9\times10^9)(3\times10^{-6})}{(.45)^2} = 1.33\times10^5 \frac{N}{C}$

$E_2 = \frac{Kq_2}{r_2^2} = \frac{(9\times10^9)(3\times10^{-6})}{(.45)^2} = 1.33\times10^5 \frac{N}{C}$

$E_T = E_1 - E_2$

$E_T = 1.33\times10^5 - 1.33\times10^5$

$E_T = 0\ N/C$

(10)

$E = ?$

$q_e = 1.6\times10^{-19}\ C$

$a = 7.5\times10^{12}\ m/s^2$

$m_e = 9.11\times10^{-31}\ kg$

STEP 1: Find electric force

$F_E = m_e \cdot a$

$F_E = (9.11\times10^{-31})(7.5\times10^{12})$

$F_E = 6.83\times10^{-18}\ N$

STEP 2: Find electric field

$E = \frac{F_E}{q} = \frac{6.83\times10^{-18}\ N}{1.6\times10^{-19}} = 42.69\ N/C$

(11)

$r = 3\times10^{-1}\ m$

$E = 3.6\times10^5\ N/C$

$r = 45cm$

STEP 1: Find value of charge

$E = \frac{Kq}{r^2}$

$q = \frac{Er^2}{K} = \frac{(3.6\times10^5)(3\times10^{-1})^2}{9\times10^9}$

$q = 3.6\times10^{-6}\ C$

STEP 2: Now find Electric field with new distance

$E = \frac{Kq}{r^2} = \frac{(9\times10^9)(3.6\times10^{-6})}{(.45)^2} = 1.6\times10^5\ N/C$