Name: Key   Period: _______ Date: _________

Electrostatics: Electric charges and Coulomb's Law problems 2

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

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. A charge q=+3.0nC is placed at a placed at a location at which the electric field strength is 400 N/C. Find the force felt by the charge q. 1.2×10^{-6} N

2. A dipole is formed by two point charges, each of magnitude 4.0 nC, separated by a distance of 6.0 cm. What is the strength of the electric field at the point midway between them? 8×10^{4} N/C

3. If a charge q= -5.0pC were placed at the midway point described in the previous problem, calculate the force it would feel. 4×10^{-7} N

4. What can you say about the electric force that a charge would feel if it were placed at a location at which the electric field was zero? Zero!

5. Positive charge is distributed uniformly over a large, horizontal plate, which then acts as the source of a vertical electric field. An object of mass 5 g is placed at a distance of 2 cm above the plate. If the strength of the electric field at this location is 10^6 N/C, how much charge would the object need to have in order for the electrical repulsion to balance the gravitational pull? 5×10^{-8} C

6. A proton, neutron, and electron are in a uniform electric field of 20 N/C that is caused by two large charged plated that are 30 cm apart. The particles are far enough apart so that they don't interact with each other. They are released from rest equidistant from each plate.

(a) What is the magnitude of the net force acting on each particle?

$F_{E\text{-proton}}=$

$F_{E\text{-neutron}}=$

$F_{E\text{-electron}}=$

(b) What is the magnitude of the acceleration of each particle?

$a_{\text{-proton}}=$

$a_{\text{-neutron}}=$

$F_{E\text{-electron}}=$

(c) How much work is done on each particle?

$W_{\text{-proton}}=$

$W^{-}_{\text{neutron}}=$

$W_{\text{-electron}}=$

(d) What is the speed of each particle when it strikes the plate?

$v_{\text{-proton}}=$

$v_{\text{-neutron}}=$

$v_{\text{-electron}}=$

(e) How long does it take to reach the plate?

$t_{E\text{-proton}}=$

$t_{E\text{-neutron}}=$

$t_{E\text{-electron}}=$

①

$q = 3nC = 3\times10^{-9}C$

$E = 400 N/C$

$F_E = E \cdot q$

$F_E = 400 N/\cancel{C}\,(3\times10^{-9}\cancel{C})$

$F_E = 1.2\times10^{-6} N$

②

Dipole → $q_1 = 4nC = 4\times10^{-9}C$ $r = 6cm = .06m$

$q_2 = -4nC = 4\times10^{-9}C$

$$E_1 = \frac{(9\times10^{9})(4\times10^{-9})}{(.03)^2} = 4\times10^{4} N/C$$

$$E_2 = \frac{(9\times10^{9})(4\times10^{-9})}{(.03)^2} = 4\times10^{4} N/C$$

$E_{TOTAL} = E_1 + E_2 = 4\times10^{4} N/C + 4\times10^{4} N/C$

$E_{TOTAL} = 8\times10^{4} N/C$

③

$q = -5pC = -5\times10^{-12}C$

$E = 8\times10^{4} N/C$

$F_E = Eq = (8\times10^{4} N/C)(5\times10^{-12})$

$F_E = 4\times10^{-7} N$

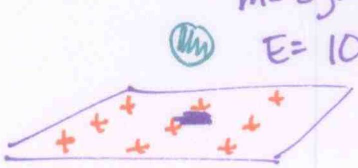
④ Electric force would be zero as

$F_E = E \cdot q = (\phi)(q) = \phi N$

⑤

$m = 5g = .005kg$

$E = 10^{6} N/C$



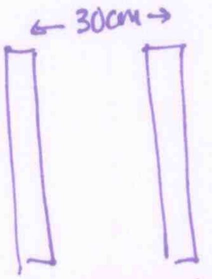
To balance the mass, a repulsive force has to be applied to the object.

$F_E = F_b$

$E \cdot q = mg$

$$q = \frac{mg}{E} = \frac{(.005)(10)}{10^{6}} = 5\times10^{-8} C$$

⑥



$E = 20 N/C$

a) F_{NET}

$F_E = E \cdot q$

$F_{E_p} = (20)(1.6\times10^{-19}) = 3.2\times10^{-18} N$

$F_{E_N} = (20)(0) = 0N$

$F_{E_e} = (20)(1.6\times10^{-19}) = 3.2\times10^{-18} N$

b) acceleration $a = \frac{F_E}{m}$

$a_p = \frac{F_{E_p}}{m_p} = \frac{3.2\times10^{-18} N}{1.67\times10^{-27} Kg} = 1.92\times10^{9} m/s^2$

$a_N = \frac{F_{E_N}}{m_N} = 0 m/s^2$

$a_e = \frac{F_{E_e}}{m_e} = \frac{3.2\times10^{-18} N}{9.11\times10^{-31} Kg} = 3.51\times10^{12} m/s^2$

c) WORK. $W = F_E \cdot d$

$W_p = F_{E_p} \cdot d = (3.2\times10^{-18} N)(.15m) = 4.8\times10^{-19} J$

$W_N = F_{E_N} \cdot d = 0 J$

$W_e = F_{E_e} \cdot d = (3.2\times10^{-18} N)(.15m) = 4.8\times10^{-19} J$

d) velocity $v^2 = v_0^2 + 2aX$ ($v_0 = 0$)

$V = \sqrt{2aX}$

$V_p = \sqrt{2(1.92\times10^{9})(.15)} = 2.4\times10^{4} m/s$

$V_N = 0 m/s$

$V_e = \sqrt{2(3.51\times10^{12})(.15)} = 1.02\times10^{6} m/s$

e) time $v = v_0^{\,0} + at$

$t = \frac{v}{a}$

$t_P = \frac{V_p}{a_p} = \frac{2.4\times10^4 m/s}{1.92\times10^9 m/s^2} = 1.25\times10^{-5} s$

$t_N = 0 s$

$t_e = \frac{V_e}{a_e} = \frac{1.02\times10^6 m/s}{3.51\times10^{12} m/s^2} = 2.9\times10^{-7} s$