Problem Set #14 Electrostatics and Voltage
Due on your class date the week of April 27th (B- Apr. 27th, A- Apr. 28th, D- Apr. 29th, C- Apr. 30th)

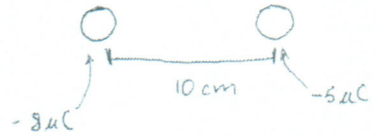
Name: Key

I worked with:

Equations:

Coulomb's Force	$F_c = \frac{kq_1q_2}{r^2}$
Coulomb's Constant	$k = 9 * 10^9 Nm^2$
Electric Field Strength	$E = \frac{F_c}{q_2}$
Work	$W = F * d$
Voltage Difference	$\Delta V = \frac{W}{q_2}$

1. Two charged objects are 10 cm apart. One object has a charge of -5μC and the other has a charge of -8μC.
   a. What is the force experienced by the two charges?
   b. What is the electric field strength of the -8μC object?
   c. Draw field lines on the objects below. What will the objects if nothing is holding them in place?



a. $F = \frac{k q_1 q_2}{r^2} = \frac{9\times10^9 \times -5\times10^{-6} \times -8\times10^{-6}}{(10\times10^{-2})^2}$

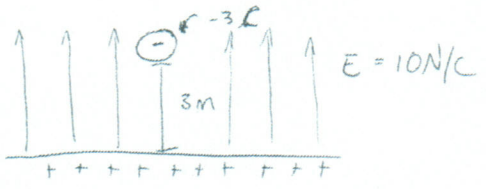
$k = 9\times10^9$
$q_1 = -8\times10^{-6}$
$q_2 = -5\times10^{-6}$
$r = 10\times10^{-2}$

$= 36\,N$

b. $E = \frac{F}{q} \rightarrow \frac{36}{-5\times10^{-6}} = -7.2\times10^6 \ \frac{N}{C}$

c. They will push each other apart

2. An object with a charge of -3C is held in a uniform electric field due to a positively charged infinite plate. The strength of the electric field is 10 N/C. What is the force experienced by the object? In what direction does the force act?
    a. Assume that the charge is initially held 3m away from the infinite plate. What is the work required to move the object 4m farther away from the plate?
    b. What is the voltage difference that this charged object experiences?



a. $W = F \times d$ $F = E \times q = -10 \times -3 = +30$, $+30 \times 4 = +120\,J = W$

b. $\Delta V = E \Delta r$ $\Delta V = 10 \cdot 4 = 40$ Volts

3. Show that units of V/m and N/C for electric field strength are indeed equivalent.

$$\frac{V}{m} = \frac{J/C}{m} = \frac{Nm/C}{m} = N/C$$

$V = J/C$

$J = Nm$

4. Membrane walls of living cells have surprisingly large electric fields across them due to separation of ions. What is the voltage across an 8.00 nm–thick membrane if the electric field strength across it is 5.50 MN/C? You may assume a uniform electric field. (M - "Mega" means x10^6)

$E = 5.5 \times 10^6$ N/C

$\Delta r = 8 \times 10^{-9}$ m

$\Delta V = E \Delta r$

$\Delta V = 5.5 \times 10^6 \times 8 \times 10^{-9} = 0.044$ Volts