Lab: AP Review Sheets
E&M Chapter 7: Electric Potential
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Background / Summary

Electric potential is an electric field's ability to move a particle through space. When a field has substantial ability to move a particle, we say that it is at high potential. Likewise, if it would require a lot of energy to move a particle through space, that is a low potential point. Electric potential (V) can be defined as the potential energy (U) per unit charge (q).

Relevant Formulas (courtesy of the AP Equations sheet)

$$E_x = -\frac{dV}{dx} \qquad U_E = qV = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}$$

$$\Delta V = -\int \vec{E} \cdot d\vec{r} \qquad \Delta V = \frac{Q}{C}$$

$$V = \frac{1}{4\pi\varepsilon_0}\sum_i \frac{q_i}{r_i} \qquad \Delta E = W = \int \vec{F} \cdot d\vec{r}$$

Other Relevant Formulas (and alternative derivations)

$$V = \frac{U_E}{q} \qquad V = \frac{Q}{C} \qquad V = \frac{P}{I} \qquad V = IR$$

Other Key Points

- The units for electric potential are Volts, defined as Joules per Coulomb
- Charges will be inclined to move away from like charged ends of fields
    - A positive charge moves towards the negative end of a field
    - Likewise, negative charges naturally move towards the positive end of a field
- Equipotential lines are lines along a path of equal electric potential. These lines will always be perpendicular to electric field lines.

Review Problems

1. [Easy] Why are voltages always measured between two points? (Textbook 7.10)

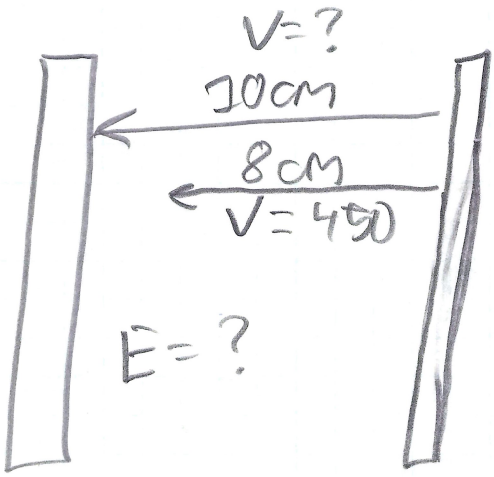
2. [Medium] Two parallel conducting plates are separated by 10.0 cm, and one of them is taken to be at zero volts. (Textbook 7.39)
    a. What is the electric field strength between them, if the potential 8.00 cm from the zero volt plate (and 2.00 cm from the other) is 450 V?
    b. What is the voltage between the plates?

3. [Hard] Two large charged plates of charge density $\pm 30 \mu C/m^2$ face each other at a separation of 5.0 mm. (Textbook 7.61)
    a. Find the electric potential everywhere.
    b. An electron is released from rest at the negative plate; with what speed will it strike the positive plate?

#1

Voltages are always measured between two points because we can only determine the <u>difference</u> in potential between points.

#2



a) $\Delta V = -\int E \cdot dr = -Ed$

$450 = -E(0.08)$

$|E| = 5.63e3 \text{ V/m} = \boxed{5.63 \text{ kV/m}}$

b) $\Delta V = -Ed$

$V = (5.63e3)(0.10) = \boxed{563 \text{ V}}$

#3

Recall that

$$E = \frac{\sigma}{\varepsilon_0}$$

a) $\Delta V = Ed$

$$\Delta V = \frac{\sigma}{\varepsilon_0} d$$

$$= \frac{30e{-}6}{8.85e{-}12}(0.005) = 1.69e4\ V$$

$$= 16.9k\ V$$

b) Converting U to K

$$U_E = qV = K = \frac{1}{2}mv^2$$

$$qV = \frac{1}{2}mv^2$$

Given on the eqn sheet

$$1.6e{-}19(16.9) = \frac{1}{2}(9.11e{-}31)v^2$$

$$v^2 = 5.94e12$$

$$v = 2.44e6\ m/s$$