Worksheet 4: **Connecting V and $\vec{E}$**

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Slightly fewer problems this week. The goal is to focus more on problem solving skills, trying to understand each step at a deep level when going through a solution.

1 Kirchhoff's Loop Law

Kirchhoff's Loop Law states the sum of all potential differences encountered while moving around a closed loop is zero.

$$\Delta V_{\text{loop}} = \sum_i (\Delta V)_i = 0$$

Prove that this is just a statement of conservation of energy.[1]

2 Parallel-Plate Capacitor

Earlier in the quarter, we learned that the electric field inside a parallel-plate capacitor is:

$$\vec{E} = \left(\frac{Q}{\epsilon_0 A}, + \to - \right)$$

Let $V = 0$ at the negative plate. Find the **electric potential** inside the capacitor.

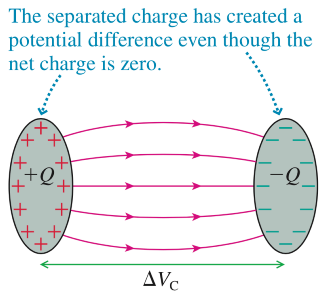
[1] In other words, this law doesn't tell us anything we didn't know from 40A.

3 Capacitance

The figure below shows two electrodes charged to $\pm Q$. Although net charge is equal to zero, there is a potential difference ΔV between the electrodes. We define **capacitance** C to be the proportionality constant that relates charge[2] to potential.

$$Q = C\Delta V_C \qquad \text{(charge on a capacitor)}$$

Prove that capacitance **depends only on the geometry of the electrodes**.



[2]Here, Q refers to the magnitude of the charge on *one* of the electrodes. The electrodes of a capacitor always have *equal but opposite* charges.