Last Time:

Equipotential lines \( \perp \) to \( E \).

\[ E_1 = \frac{\sigma}{2\varepsilon_0} \]

\[ 1E_1 = \frac{\sigma}{2\varepsilon_0} \]
\[ V = \frac{W}{q} \]

\[ W \sim KE = qVN \]

for \( e^- \)

\[ KE = \frac{(1.6 \times 10^{-19}) \text{Coul} \cdot 11}{\text{J}} \]

\[ KE = 1.6 \times 10^{-19} \text{ J} \]

\[ \Delta V = 1V \]

Define a unit of energy \( \equiv \) electron-Volt

1 eV = 1.6 x 10^{-19} J
\[ E = mc^2 \]

\[ m = \frac{E}{c^2} \]

\[ M_{\text{electron}} = 0.511 \text{ MeV}/c^2 \]

Often physicists leave the \( c^2 \) to be "understood".

\[ m_e = 0.511 \text{ MeV} \]
What is the Potential energy stored in a system of 2 Masses?

How does the PE depend on the position of Mass 2?

As masses get closer together the potential energy of the system is reduced.
Same thing in electrostatics

\[ \frac{kQ_1}{R_1} = \frac{kQ_2}{R_2} \quad \frac{Q_1}{Q} = \frac{R_1}{R_2} \]

Exam 1 Material ends here
\[ V_+ = \frac{1}{2} \frac{Q}{R} \sim V_+ \propto Q \]

Potential diff bet. spheres
\[ \Delta V = V_+ - V_- \sim 2 \frac{1}{R} \]
\[ \Delta V \propto Q \]

\[ V_- = -\frac{1}{2} \frac{Q}{R} \]

\[ V_- \propto Q \]
\[ V \propto Q \quad \text{constant of proportionality} \]

\[ Q = CV \]

\[ C = \frac{\text{Coulombs}}{\text{Volt}} = \text{Farad} \]

\[ Q_+ = C_+ V_+ \quad Q = C_+ V_+ - V_- \]

\[ Q_- = C_- V_- \]

\[ V_{+\text{ new}} < V_{+} \]
Capacitance is increased

Capacitance only depends on geometry

Capacitor acts as charge storage device
EMF = Electromotive force

maintenance constant potential difference between terminals
\[ \oint E \cdot dA = \frac{Q_{\text{enc}}}{\varepsilon_0} \]

\[ \bar{E} / A = \frac{Q}{\varepsilon_0} \]

\[ Q = CV \quad C = \frac{Q}{V} = \frac{\varepsilon_0 EA}{Ed} = \frac{\varepsilon_0 A}{d} \]
capacitance of // plate configuration

\[ \Rightarrow \text{depends only on geometry} \]

\[ \begin{align*}
Q &= CV \\
Q_1 &= C_1 V \\
Q_2 &= C_2 V \\
Q_3 &= C_3 V \\
Q &= Q_1 + Q_2 + Q_3 \\
cV &= C_1 V + C_2 V + C_3 V \\
C &= C_1 + C_2 + C_3
\end{align*} \]
Capacitors in parallel:

\[ C = \Sigma C_i \]

Capacitors in series:

\[ V = V_1 + V_2 + V_3 \]

\[ \frac{Q}{C} = \frac{Q_1}{C_1} + \frac{Q_2}{C_2} + \frac{Q_3}{C_3} \]
\[ \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \]

Capacitors in Series

\[ \frac{1}{C} \geq \frac{1}{C_i} \]