Exam 1 Tue 9/29
Practice test (last year's Exam) posted at tinyurl.com/gpikocz

Topics:
- Electrostatics Charge, E-Field
- Electric Potential (V), relation to E
- Batteries & Capacitors
- DC current & Ohm's Law
- Complex DC Circuits
  - Equivalent R
  - Kirchhoff's Laws
  - Meters for V, I, R
- RC Circuits
Current: \[ I_3 = I_2 + (3.2\ A) \]

Loops: Out: \[ \varepsilon - I_3 R + 24 - I_1 \cdot 6 = 0 \]

Left: \[ \varepsilon - I_3 R - I_2 \cdot 3 = 0 \]

\[
\begin{align*}
(\varepsilon - I_3 R) &= -24 + I_1 \cdot 6 = I_2 \cdot 3 \\
\end{align*}
\]

W/o Kirchhoff: \[ V_6 = 6 \cdot 3.2 = (19.2 \ V) \]

\[ a \rightarrow b \quad \Delta V = +24 \ V - 19.2 \ V = 4.8 \ V \]

\[ b \ is \ 4.8\ V \ higher \ than \ a \]

\[ I_2 = \frac{(4.8\ V)}{(3\ \Omega)} = 1.6 \ A \quad b \rightarrow a \]
\( Q = CV \quad V = \text{const} \quad I = 0 \)

\[
I_2 = \frac{10}{1 + R_2} \quad V_2 = I R_2
\]

\[
V_a = V_2 \quad V_b = 2I_1
\]

\[
V_c = V_a - V_b
\]

\( V = V_o e^{-t/2} \quad \frac{\dot{V}}{V_o} = e^{-t/2} \quad \frac{i}{\dot{i}} = e^{-\frac{t}{2}} \quad I_n(\frac{1}{2}) = \frac{-t}{2} \)
After 3 time constants, how much charge is left in a discharging cap?

\[ Q = Q_0 e^{-t/\tau} \]

\[ \frac{Q}{Q_0} = e^{-t/\tau} \]

Answer: as worded

\[ e^{-3 \times 3/2} = e^{-3} \]

\[ = 0.0498 \]

\[ = 5\% \]

\[ \tau = RC \]

Thunderstorm as a parallel plate cap:

\[ A = 9 \text{ km}^2 \]

\[ E_{\text{max}} = 10^6 \text{ N/C} \]

\[ d = 2400 \text{ m} \]

\[ E = \frac{4 \pi k \sigma}{\varepsilon_0} \]

\[ T \times 10^9 \frac{9}{\varepsilon_0} \text{ Nm}^2 \]

\[ \sigma = E/(4\pi k) = 8.84 \times 10^{-6} \text{ C/m}^2 \]

\[ Q = \sigma A = \sigma (9 \times 10^6 \text{ m}^2) = 80 \text{ C} \]

This is +80 C on ground, -80 C in cloud.
\[ V = \frac{kq}{r} = \frac{(9 \times 10^9)(1 \times 10^{-9})}{0.5} = 18 \text{ V} \]

1.0 nC spread out on a ring w/ radius 0.5 m. What is \( V \) @ center?

\[ V = \int \frac{kq}{r} \, d\theta = \frac{kq}{r} \int \, d\theta = \frac{kq}{r} = (18 \text{ V}) \]