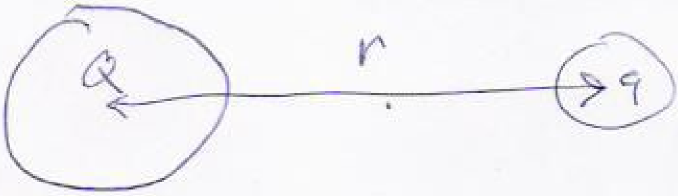
Ch. 21 - 26 : Questions?

Coulomb's Law:

$$F = \frac{kQq}{r^2} \iff E = \frac{kQ}{r^2} = \frac{Q}{4\pi\varepsilon_0 r^2}$$

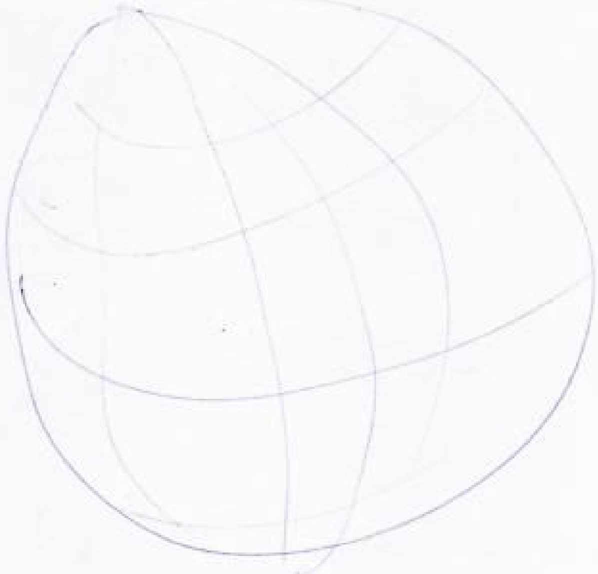
E ↑ field generated by Q



stationary

Gauss' Law

$$\oiint_{\text{closed surface}} \vec{E}\cdot\overrightarrow{dA} = \frac{Q_{enclosed}}{\varepsilon_0} = 4\pi k Q_{encl}$$

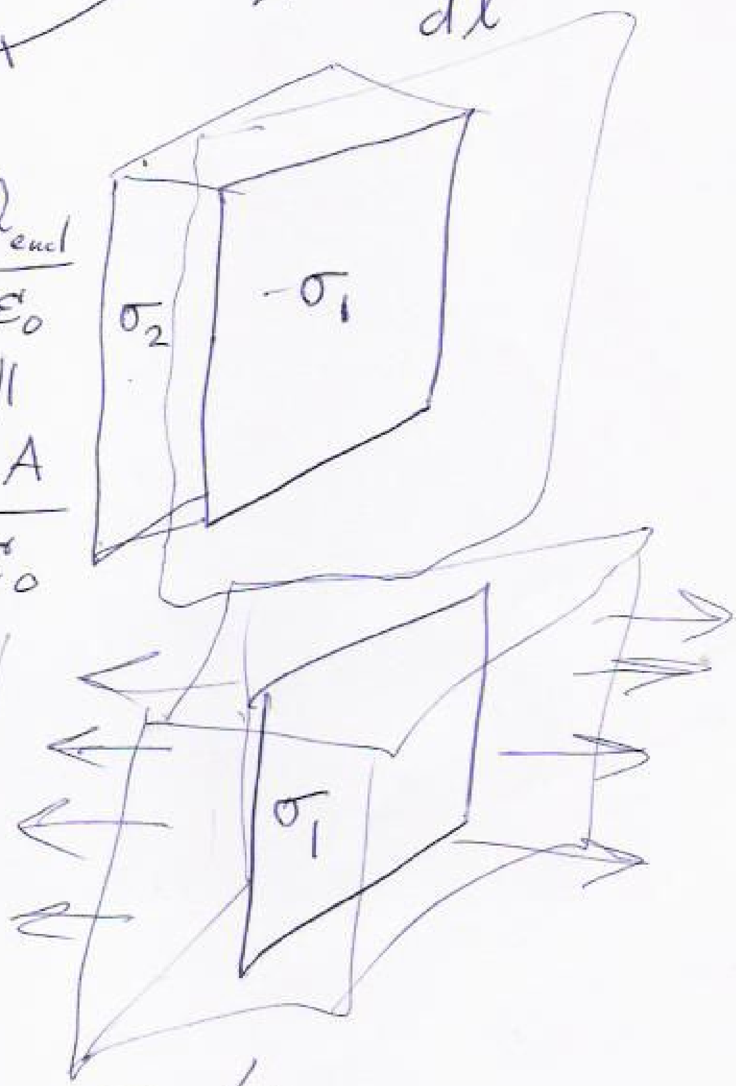


Convenient for distributions of charge with symmetry

$$\sigma = \frac{dQ}{dA}$$

$$\lambda = \frac{dQ}{dl}$$

$$\Phi_E = \oiint \vec{E} \cdot \vec{dA} = \frac{Q_{encl}}{\varepsilon_0} = \frac{\sigma_1 A}{\varepsilon_0}$$



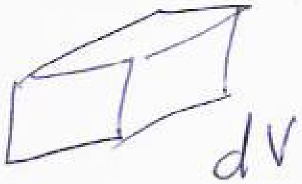
If σ_1 is <u>uniform,</u> then

$$\sigma = \frac{Q}{A}$$

$$\rightarrow E_{left} A + E_{right} A$$

$$\Downarrow$$

$$E_{left} + E_{right} = \sigma_1 / \varepsilon_0$$



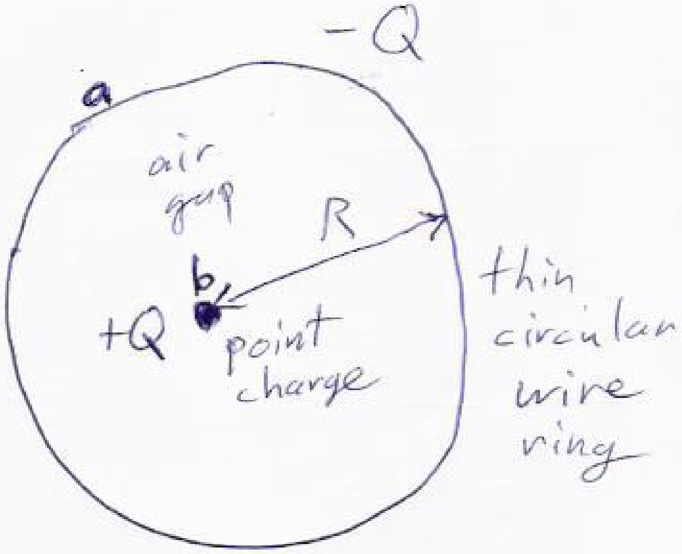
$$\rho = \frac{dQ}{dV} = \frac{\text{charge}}{\text{volume}}$$

surface = boundary of $l \times l \times l$ cube

$$\frac{Q_{encl}}{\varepsilon_0} = \Phi_E = \oiint \vec{E} \cdot \vec{dA} \underset{\text{rough}}{\approx} \underbrace{6l^2}_{\text{surface area}} E$$

If ρ uniform, then $\frac{Q_{encl}}{\varepsilon_0} = \frac{\rho l^3}{\varepsilon_0}$

$$\Rightarrow E \underset{\text{rough}}{\approx} E \rho l / 6$$



Capacitance = ?

$$C = \frac{Q}{V}$$

$$V = V_{ba} = V_b - V_a$$

$$V = \frac{U_b - U_a}{q}$$

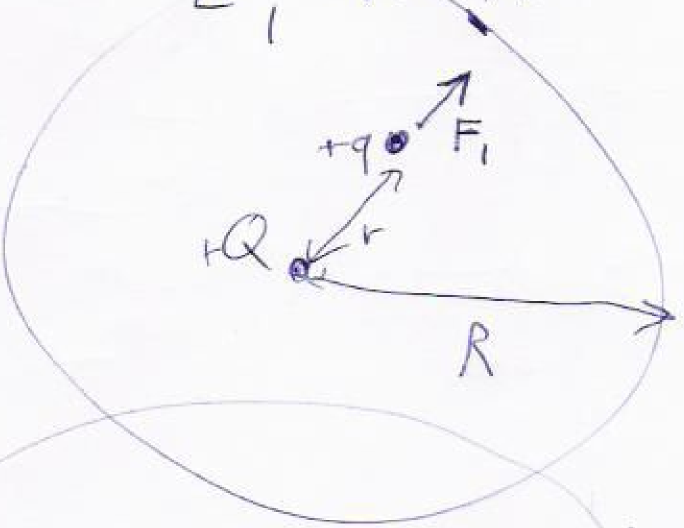
$$F_1 = kqQ/r^2$$

$$E_1 = kQ/r^2$$

$$V = \int_a^b -dW/q$$

$$V = -\int_a^b \vec{F}\cdot dl/q$$

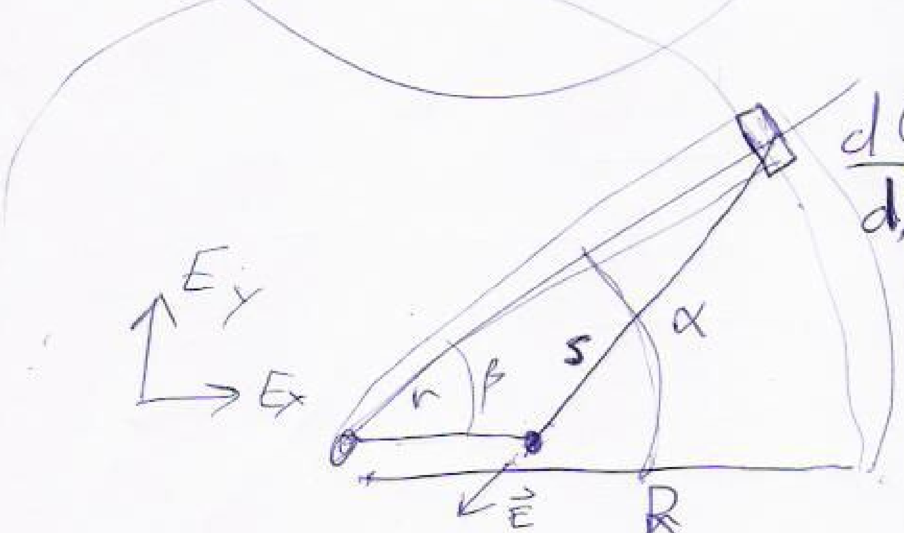
$$V = -\int_a^b \vec{E}\cdot dl$$



$$\frac{dQ}{dl} = \frac{Q}{l} = \boxed{\frac{Q}{2\pi R}}$$

$$\boxed{dl = R\,d\alpha}$$

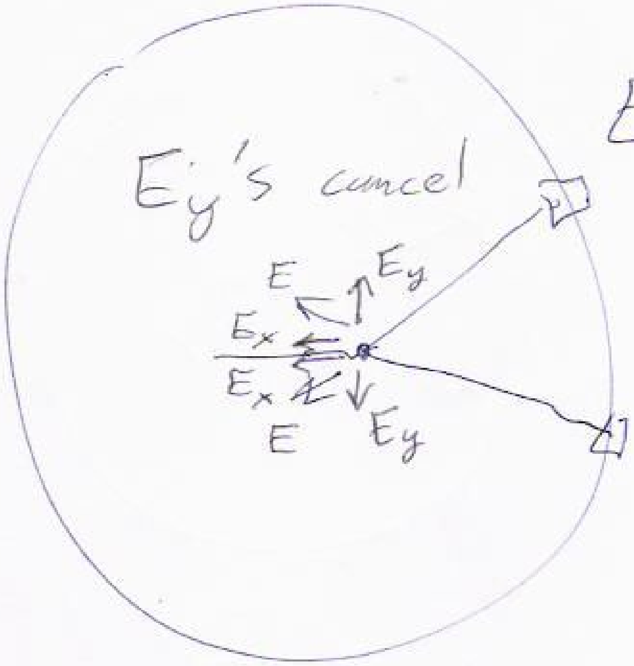
$$dQ = \frac{Q}{l}dl = \frac{Q\,d\alpha}{2\pi}$$



$$dE = \frac{k\,dQ}{s^2} = \frac{kQ\,d\alpha}{2\pi s^2}$$

$$\vec{E} = \int_{\alpha=0}^{\alpha=2\pi}$$

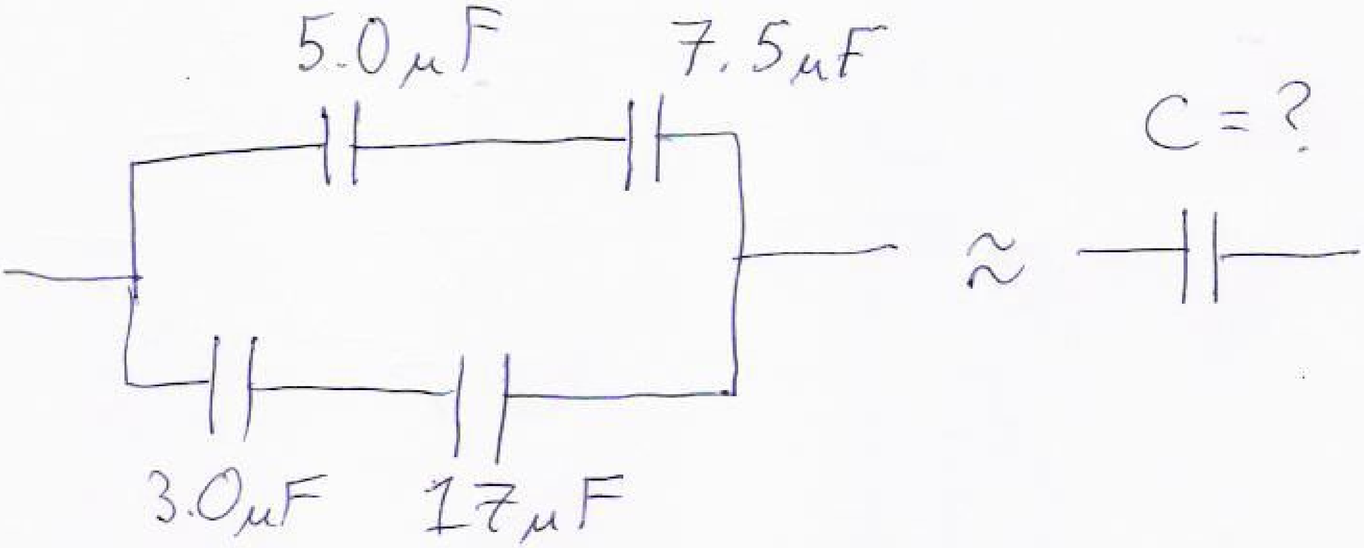
direction



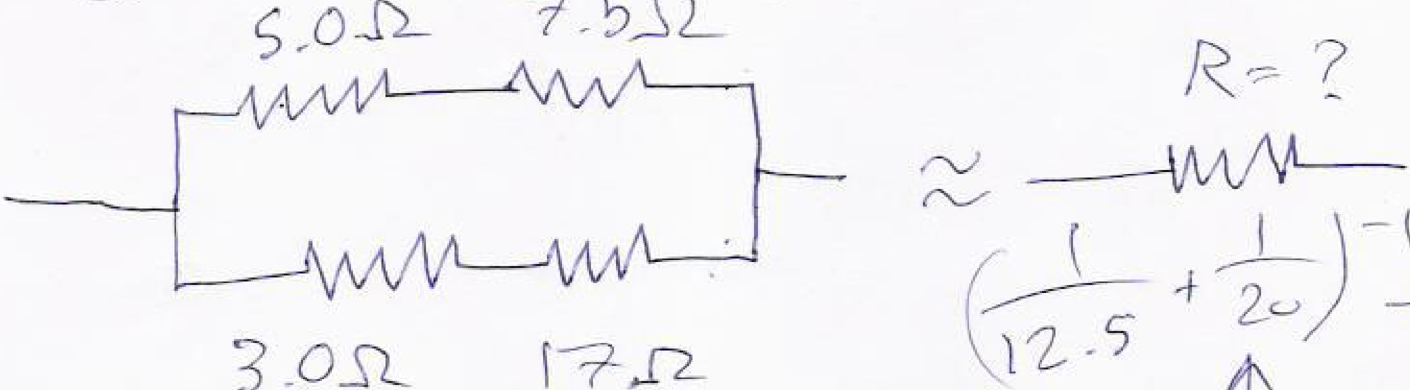
$$E_y = \int dE_y = 0$$

$$E_x = \underbrace{-\int_0^{2\pi} \frac{kQ\,d\alpha}{2\pi s^2}(\cos\beta)}_{\text{depend on } r}$$

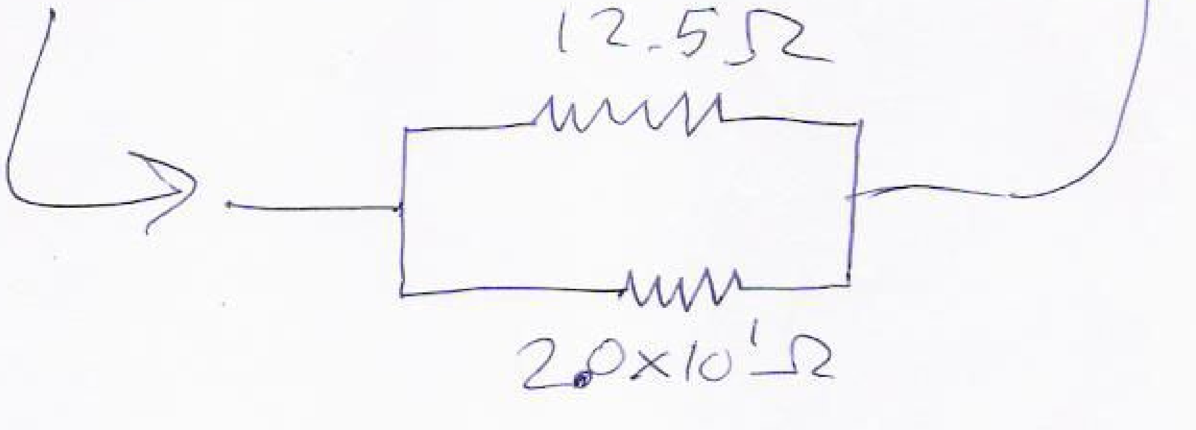
$$V = \int_{r=0}^{r=R} -E_x\,dr$$

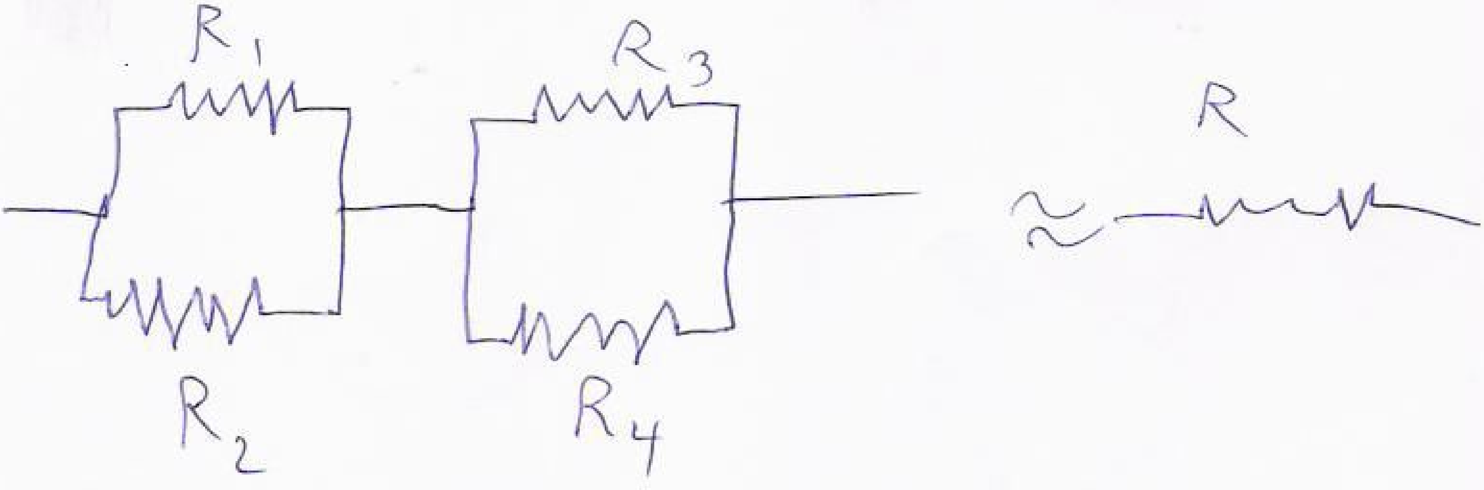


$$C = \left[\left(\frac{1}{5.0} + \frac{1}{7.5} \right)^{-1} + \left(\frac{1}{3.0} + \frac{1}{17} \right)^{-1} \right] \mu F$$



$$\left(\frac{1}{12.5} + \frac{1}{20} \right)^{-1} \Omega$$



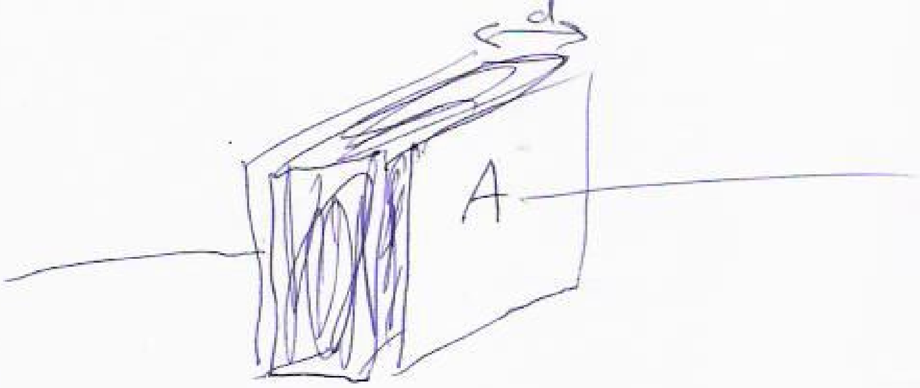


$$R = \left(R_1^{-1} + R_2^{-1}\right)^{-1} + \left(R_3^{-1} + R_4^{-1}\right)^{-1}$$

$$\text{constant } R = \frac{V(t)}{I(t)} \quad \begin{matrix}\text{variable}\\ \text{variable}\end{matrix} \quad \underset{ac}{=} \frac{V_{rms}}{I_{rms}}$$

$$\underset{dc}{P = IV} \qquad \underset{ac}{P = I_{rms} V_{rms}}$$

What is the energy density between a parallel plate capacitor with a dielectric $K = 3.6$ between the plates & $V = 15.0\,V$ between the plates & distance $4.0\,mm$ between the plates?



$$C = K\varepsilon_0 \frac{A}{d}$$

$$U = \frac{1}{2} Q V = \frac{CV^2}{2}$$

$$C = \frac{Q}{V} \Rightarrow Q = CV$$

$$U = \frac{K\varepsilon_0 A V^2}{2d}$$ volume = Ad

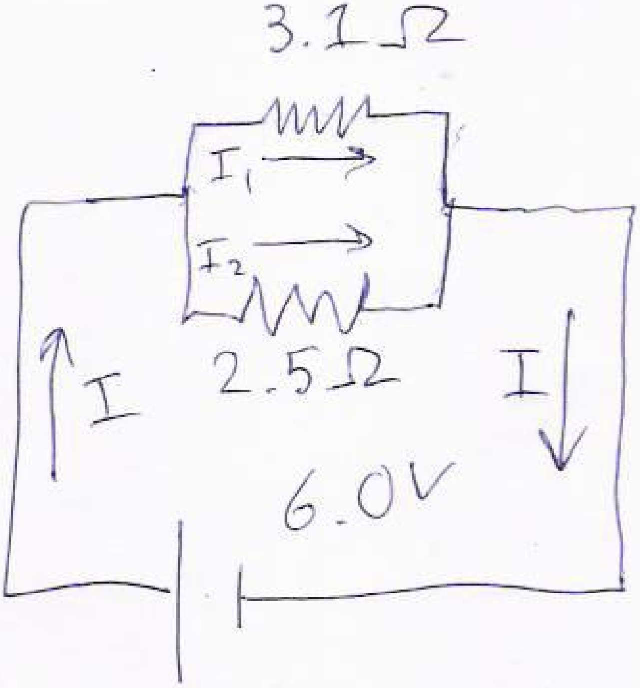
$$u = \frac{U}{Ad} = \frac{K\varepsilon_0 \cancel{A} V^2}{2\cancel{A}d^2} = \frac{K\varepsilon_0 V^2}{2d^2}$$

$V = 15.0\,V = 15.0\,J/C$ $\quad d = 4.0\,mm = 4.0\times10^{-3}\,m$

$\varepsilon_0 = 8.85\times10^{-12}\,C^2/(N\cdot m^2)$ $\quad K = 3.6$

$$\frac{3.6(8.85\times10^{-12})\,C^2 N^{-1} m^{-2} (15.0)^2 J^2/C^2}{2(4.0\times10^{-3})^2 m^2}$$

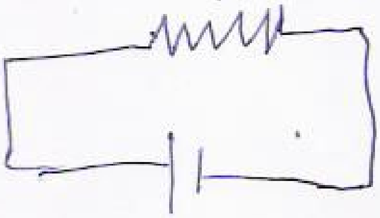
$$[\quad\quad] \frac{J^2}{N\cdot m^2\, m^2} = \frac{\cancel{(N\cdot m)}\, J}{\cancel{(N\cdot m)}\, m^3} [\quad]$$



What percentage of the power goes through the 3.1 Ω resistor?

$$R = (3.1^{-1} + 2.5^{-1})^{-1}\ \Omega$$

$\approx$



$V_0 = 6.0\,V$

$$I = \frac{V_0}{R}$$

$$P = IV_0 = \frac{V_0^2}{R}$$

$$\cancel{I = I_1 + I_2 \ \& \ (I_1)3.1\,\Omega = (I_2)2.5\,\Omega}$$

Solve for I_1. $P_1 = I_1 V_0$

Simpler: $V_0 = I_1(3.1\,\Omega)$

$(P_1/P) \times 100\% =$ answer