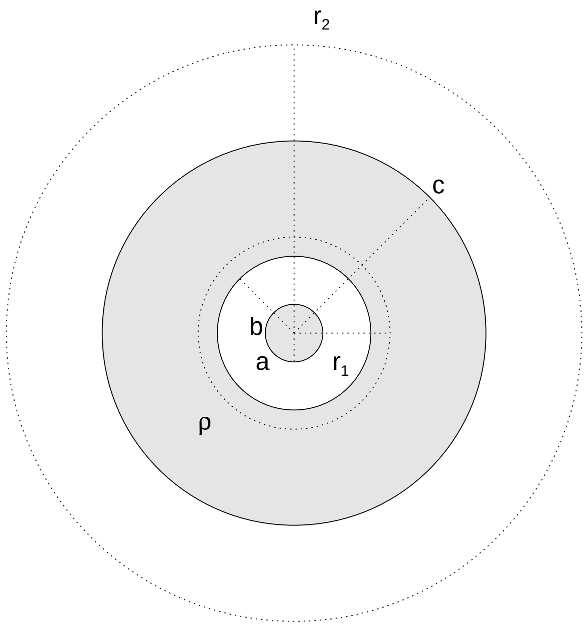
$\lvert E(r)\rvert = \frac{q}{4\pi\epsilon_0 r^2}$	$\lvert E(r)\rvert = \frac{\lambda}{2\pi\epsilon_0 r}$	$\lvert E\rvert = \frac{\sigma}{2\epsilon_0}$
$V(r) = \frac{q}{4\pi\epsilon_0 r}$	$V(r) = -\frac{\lambda}{2\pi\epsilon_0}\ln r$	$V(x) = C - \frac{\sigma}{2\epsilon_0}\,x$
$\oint_S \mathbf{E}\cdot\hat{n}dA = \frac{Q_{inS}}{\epsilon_0}$	$\Delta V = \frac{Q}{C}$	$\mathbf{E} = \rho\mathbf{J}$
$\lvert J\rvert = \frac{I}{A}$	$U = \frac{Q^2}{2C}$	$RC = \epsilon_0\rho$
$\mathbf{F} = q\mathbf{v}\times\mathbf{B}$	$R = \frac{mv}{qB}$	$d\mathbf{B} = \frac{\mu_0}{4\pi}Id\ell\frac{\mathbf{t}\times\mathbf{r}}{r^3}$
$V(b) - V(a) = -\int_a^b \mathbf{E}\cdot\mathbf{d}r$	$R = \frac{\rho L}{A}$	$C = \frac{\kappa\epsilon_0 A}{d}$
$\frac{d\mathbf{F}}{d\ell} = I\mathbf{t}\times\mathbf{B}$	$\oint_C \mathbf{B}\cdot d\mathbf{r} = \mu_0 I_C$	$\mathbf{B} = \frac{\mu_0 q}{4\pi}\frac{\mathbf{v}\times\mathbf{r}}{r^3}$
$C_{parallel} = C_1 + C_2$	$\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2}$	$\tan\theta = \frac{\sin\theta}{\cos\theta}$
$\mathbf{B} = \nabla\times\mathbf{A}$	$\mathbf{A}(r) = \frac{\mu_0}{4\pi}\int\frac{Id\ell\mathbf{t}}{r}$	$U = -\mathbf{m}\cdot\mathbf{B}$
$(x-x_c)^2 + (y-y_c)^2 = R^2$	$E_x = -\frac{\partial V}{\partial x}$	$E_y = -\frac{\partial V}{\partial y}$
$Q = \rho\cdot Vol$	$Q = \sigma A$	$\sigma(x) = \epsilon_0\mathbf{E}(x)\cdot\mathbf{n}$
$F_x = -\frac{\partial U}{\partial x}$	$\mathbf{N} = \mathbf{p}\times\mathbf{E}$	$\mathbf{p} = \sum_{i=1}^{2} q_i\mathbf{r}_i$
$\frac{d}{du}\tan^{-1}u = \frac{1}{1+u^2},$	$\frac{d}{dx}\frac{u}{v} = \frac{u'v-v'u}{v^2}$	$\frac{d}{dx}\ln x = \frac{1}{x}$
$\int_a^b\frac{dr}{r^2} = \frac{1}{a} - \frac{1}{b}$	$\int_a^b\frac{dr}{r} = \ln\frac{b}{a}$	$\tan(\tan^{-1}(x)) = x = \tan^{-1}(\tan(x))$
$\Delta W = \Delta(qV)$	$\frac{dW}{dVol} = \frac{1}{2}\epsilon_0\kappa E^2$	$W = \frac{Q^2}{2C} = \frac{CV^2}{2}$
$\ln(e^x) = -\ln(e^{-x}) = x$	$V = IR$	$ma = -kx$
$Vol = \pi r^2 h$	$Vol = \frac{4\pi}{3}r^3$	$Vol = LWH$
$Area = 2\pi rh$	$Area = 4\pi r^2$	$Area = L^2$
$C = \frac{4\pi\epsilon_0 ab}{b-a}$	$C = \frac{2\pi\epsilon_0\ell}{\ln\frac{b}{a}}$	$C = \frac{\epsilon_0 A}{d}$
$\lvert E_{total}\rvert = \frac{\lvert E_{ext}\rvert}{\kappa}$	$\mathbf{J} = \frac{I}{A}\hat{n}$	$\frac{dy}{dx} = \frac{E_y}{E_x}$
$\frac{d}{dx}\tan^{-1}f(x) = \frac{f'(x)}{1+f^2(x)}$	$\tan(a-b) = \frac{\tan a - \tan b}{1+\tan a\,\tan b}$	$\lvert\mathbf{B}\rvert = \frac{\mu_0 I}{2\pi R},\ \frac{\mu_0 I}{2R},\ \mu_0 nI,$
$\int_a^b\frac{dx}{(c-x)^2} = \frac{a-b}{(c-a)(c-b)}$	$U = \frac{1}{2}CV^2$	$Q = \lambda\ell$
$\frac{1}{4\pi\epsilon_0} = 9.0\times 10^9\frac{Nm^2}{C^2}$	$\mu_0 = 4\pi\times 10^{-7}\frac{T\,m}{A}$	$c = 3.0\times 10^8\frac{m}{s}$

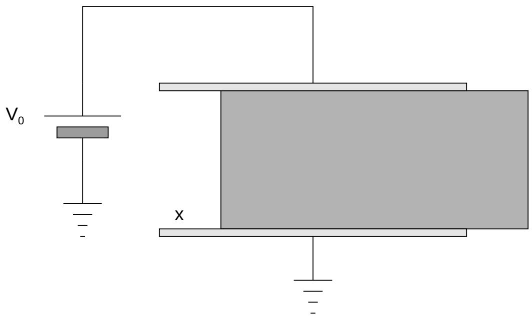


1 (p-73) (5+5+5 points)

A hollow ball of inner radius $b = 2\,cm$ and outer radius $c = 3\,cm$ is made of charged dust of density $\rho = 1.0 \times 10^3 \frac{C}{m^3}$ contains an inner solid ball of the same matter of radius $a = 1\,cm$. Compute the electric field strength for $r_0 = 0.75\,cm$, $r_1 = 2.25\,cm$, and for the exterior region, $r_2 = 3.5\,cm$

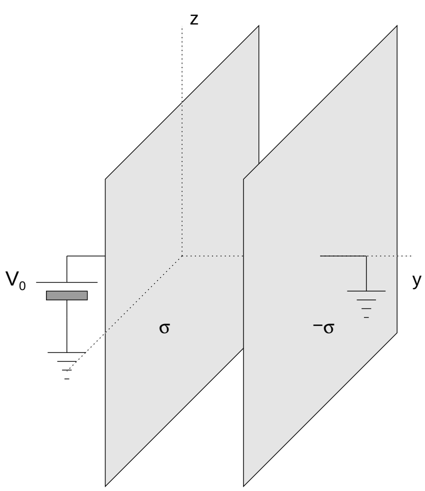
2 (p-76) (10 points)

A region of space around the origin contains an electric field $\mathbf{E} = 4.0\frac{N}{m \cdot C} x\mathbf{i} + 3.0\frac{N}{C}\mathbf{j}$. Such a field cannot exist in empty space. Find the total charge within a cube of side $a = 0.5\,m$ centered on the origin, with its six faces possessing normals in the six cardinal directions $\pm\mathbf{i}, \pm\mathbf{j}, \pm\mathbf{k}$.



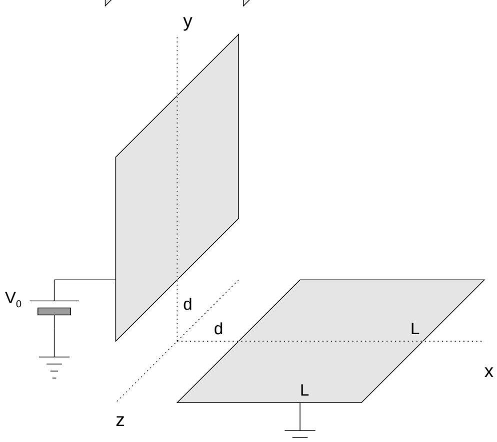
3A. (p-109) (5+3 points)

Consider a capacitor of plate area $A = \ell^2 = 0.01\,m^2 = (0.1\,m \times 0.1\,m$, separation $d = 0.005\,m$, connected to battery $V_0 = 100\,V$. A dielectric slab $\kappa = 3.0$ fills the device. If the slab is now withdrawn by $x = \frac{1}{3}\ell$ **compute the charge** that flows out of/into the battery. **Specify which (into/out of)**. **Find** $|\mathbf{E}|$ (total) within the dielectric.



B. (p-100) (5 points)

Consider this parallel (conducting) plate capacitor of plate area $A = 100\,cm^2$ and plate separation $d = 1.0\,mm$, fringing is negligible. How much work is needed to increase the plate separation to $3.0\,mm$?

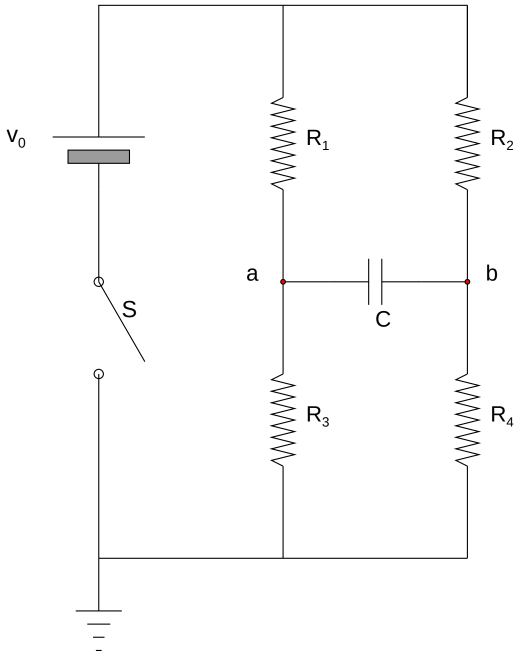


C. (e-49) (6 points)

Two semi-infinite conducting planes would meet along the z-axis except for a small gap. The right horizontal plane is grounded and the left vertical is maintained at voltage V_0 by a battery. The voltage function is

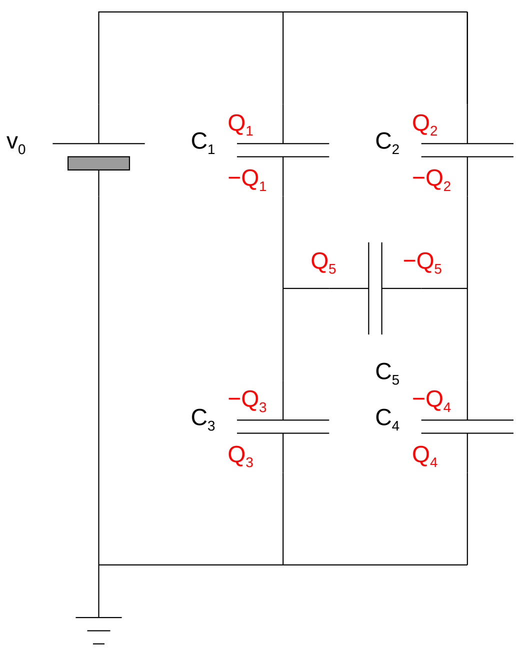
$$V(x, y) = \frac{2V_0}{\pi} \tan^{-1}(\frac{y}{x})$$

Find the surface charge density $\sigma(y)$ at a point on the left high-voltage vertical plate at a distance $y > d$ from the z-axis.



4 A. (p-131) (2+2+2+2+2 points)

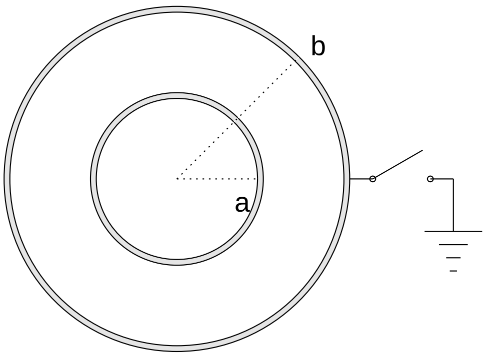
A. Very long after closing the switch S at $t = 0$, the currents will have reached steady (constant) values, as will the charge on the capacitor. Find these steady values. $V_0 = 100\,V$, $R_1 = 100\Omega$, $R_2 = 200\,\Omega$, $R_3 = 300\,\Omega$, $R_4 = 400\,\Omega$ and $C = 1.0\times10^{-6}F$. **Label your currents I_1, I_2, I_3, I_4 pointing down**.



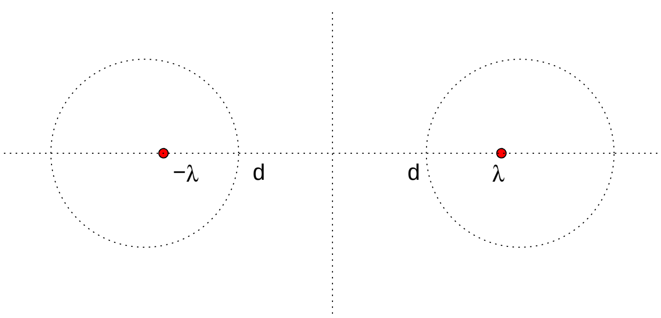
B. (p-127) (2+2+2+2+2 points)

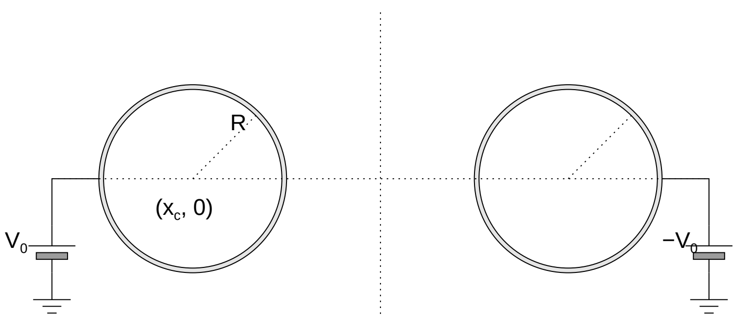
In this bridge problem we have $V_0 = 100\,V$, $C_1 = C_2 = 1000\,pF$, $C_3 = C_4 = 5000\,pF$ and $C_5 = 3.0\,\mu F$. Find all five charges on the capacitors.

5 A. (e-58) (5+5 points)



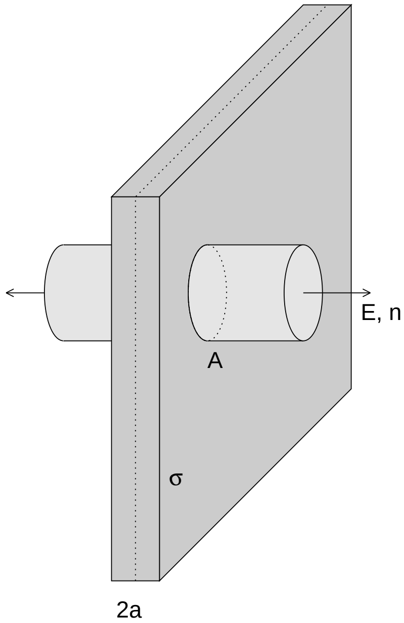
Find the capacitance of a coaxial cylindrical capacitor of length $\ell = 2.0\,m$. Assume that the inner cylinder at $r = a$ is connected to a battery of voltage $V_0 = 10\,V$. Let $a = 5\,cm$, $b = 6\,cm$ and **compute the total charge** Q stored by the device.





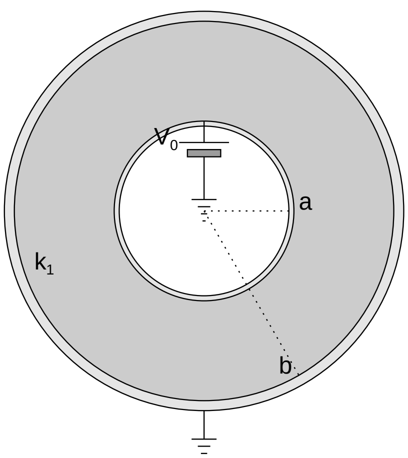
B. (p-104) (6 points)

Run the axis of a conducting cylinder of **approximately uniform** charge density λ and radius R parallel to the z axis through $x = -d$, $y = 0$ and run the axis of a second conducting cylinder of radius R, charge density $-\lambda$ through $x = d$, $y = 0$ with $d >> R$. **The electric field between them is well approximated by replacing them with parallel line charges along their axes**. Use this fact to estimate the capacitance per unit length of the two non-coaxial cylinders.



6A. (p-84) (5+5 points)

Compute the electric field strength at a point a distance x (measured perpendicularly) from the median plane (dotted) of an infinite planar slab of charged dust of density ρ and thickness $2a$, **for both cases** $x < a$ and $x > a$.



B. (p-118) (3+3+4 points

A cylindrical shell capacitor (length ℓ seen in cross-section) has a layer of dielectric material with radii indicated in the figure. Find the **total electric field strength** in the dielectric as functions of r, the **molecular electric field strength** in the dielectric as functions of r, and the net **free charge** that it will pull from the battery. Answer in terms of $a, b, \kappa_1, V_0, \ell, \epsilon_0, r$ and numbers.