ergs → $1\,erg = g\cdot cm^2/s^2 = (10^{-3}kg)(10^{-2}m)^2/s^2 = 10^{-7}kg\cdot m^2/s^2 = 10^{-7}J$.

4. A parallel plate capacitor has electrical energy 2.4×10^{-5} ergs when connected to a 3 V battery. It is now disconnected from the battery. A slab of dielectric constant $\kappa = 4$ and nearly the same thickness as the capacitor is slid into the capacitor.

Key yellow

   a. (3 pts) What was the initial charge on the plates?

$U = \frac{1}{2}C(\Delta V)^2 = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}Q(\Delta V) \Rightarrow Q = \frac{2U}{\Delta V} = \frac{4.8\times10^{-12}J}{3V} = 1.6\times10^{-12}C$

   b. (3 pts) What is the final charge on the plates?

$Q_{final} = Q_{initial} = 1.6\times10^{-12}C$.

   c. (3 pts) What is the final voltage difference?

$\Delta V_f = \frac{\Delta V_{initial}}{K} = \frac{3V}{4} = 0.75V$.

   d. (3 pts) What is the final electrical energy?

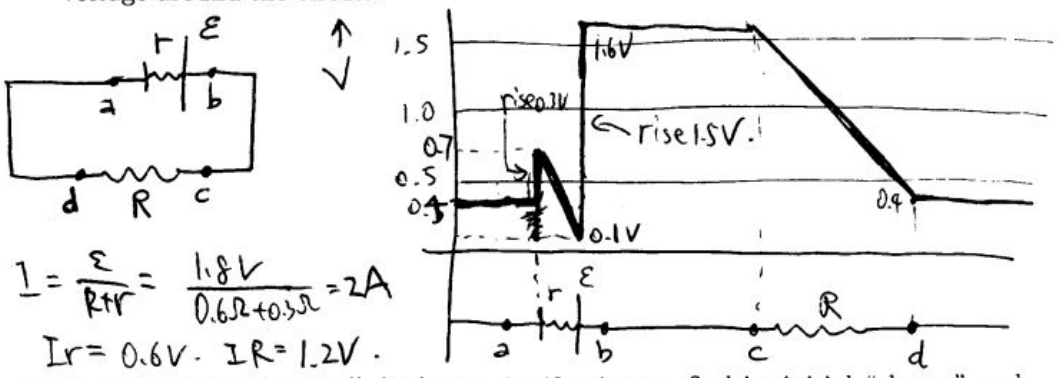
$U_f = \frac{1}{2}Q_f\cdot\Delta V_f = \frac{1}{2}\cdot 1.6\times10^{-12}C\cdot 0.75V = 0.6\times10^{-12}C$.

   e. (3 pts) Was the dielectric attracted, repelled, or did it feel no force when it was part way in the capacitor? No reason, no credit.

Attracted. by the amber effect the dielectric is polarized by the charge on the plates · and then is drawn in.

5. A voltaic cell has internal resistance $r = 0.3\ \Omega$ and open circuit voltages across the left and right electrodes of 0.3 V and 1.5 V, for a net emf of $\mathcal{E} = 1.8$ V. It is in series with a resistor $R = 0.6\ \Omega$. Let $V_a = 0.4$ V. The connecting wires have zero resistance.

   a. (10 pts) Find the current, the voltage drops across the resistances, and sketch the voltage around the circuit.



$I = \frac{\mathcal{E}}{R+r} = \frac{1.8V}{0.6\Omega+0.3\Omega} = 2A$

$I_r = 0.6V$. $I_R = 1.2V$.

   b. (5 pts) If the voltaic cell discharges in 40 minutes, find its initial "charge" and its initial energy.

$Q = It = 2A\cdot(40\times60s) = 4800\,C$.

$U_0 = \mathcal{E}Q_0 = (1.8V)(4800C) = 8640J$.