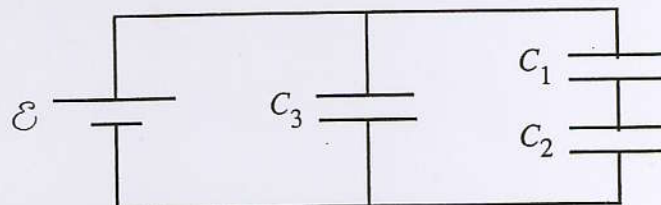


Problem 1.

Three capacitors, $C_1 = 2 \mu F$, $C_2 = 2 \mu F$, and $C_3 = 4 \mu F$, are connected to a battery with voltage $\mathcal{E} = 10V$ as shown.



- What is the equivalent capacitance of this network of capacitors?
- What are the charges stored on each of the capacitors?
- How much electrical energy is stored in C_3 ?
- If C_3 is a parallel-plate capacitor with plates of area 0.5 mm^2 , which is filled with a dielectric material with a dielectric constant of 5, how far apart are these plates?

Problem 2.

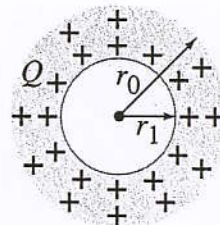
An electron (mass = 9.11×10^{-31} kg) is located in a region of space where the electric potential is given by $V(x) = (3.0 \frac{\text{V}}{\text{m}^3})x^3 - (4.0 \frac{\text{V}}{\text{m}})x$.

- a) When the electron is located at $x = 2$ m, what is its acceleration vector?
- b) How much work must be done by an external force to move the electron from $x = 2$ m to $x = 0$ m?

Problem 3.

Consider a nonconducting sphere of radius r_0 , which has a spherical cavity of radius r_1 , centered at the sphere's center. An electric charge Q is distributed uniformly throughout the "shell" (*i.e.* between $r = r_1$ and $r = r_0$). Determine the electric field (magnitude and direction) as a function of r for:

- a) $0 < r < r_1$
- b) $r_1 < r < r_0$
- c) $r > r_0$



Problem 4.

You toast your morning bagel at the Cafeteria. Being a physics nerd, you calculate that 26.4 kJ of heat were produced by the toaster in one minute. The toaster is supplied by AC electricity at 110 V (rms) and 60 Hz, and it consists of, in essence, a single cylindrical nichrome ($\rho = 1 \times 10^{-6} \Omega \cdot \text{m}$) wire of total length 3.0 m (the wire is coiled up). Ignore any change of resistivity with temperature.

- a) What rms current runs through the wire when the toaster is on?
- b) What is the peak current?
- c) What is the resistance of the wire?
- d) What is the diameter of the wire?
- e) What is the drift velocity of the electrons in the wire, given that there are roughly 10^{28} free electrons/ m^3 in nichrome?