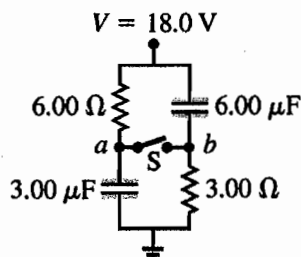
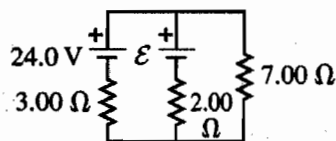


1. The magnetic poles of a cyclotron produce a magnetic field with magnitude 1.42 T. The poles have a diameter of 88 inches, which is the maximum diameter of the orbits of the accelerated particles. (a) What is the maximum energy to which protons ($q=1.60 \times 10^{-19}$ C, $m=1.67 \times 10^{-27}$ kg) can be accelerated by this cyclotron? Give your answer in Joules and in electron volts. (b) What is the time for one revolution of a proton? (c) If the cyclotron has 2 Dee's like the one I described in class, how many orbits must the proton make to obtain it's maximum energy if the accelerating voltage each time it passes the dee gap is 100 kV?

2. (a) As a new electrical technician, you are designing a large solenoid to produce a uniform 0.150 T magnetic field near the center of the solenoid. You have enough wire for 4400 circular turns. This solenoid must have a length of 1.10 m and a diameter of 23.0 cm. What current will you need to produce the necessary field?

(b) What must the emf \mathcal{E} in the figure on the left below be in order for the current through the 7.00Ω resistor to be 1.40 A? Each emf source has negligible internal resistance.



(c) In the figure on the right above, what is the charge on the $6 \mu\text{F}$ capacitor a long time after switch S is closed?

3. A thin disk of dielectric material with radius a has a total charge $+Q$ distributed uniformly over its surface. It rotates n times per second about an axis perpendicular to the surface of the disk and passing through its center. Find the magnetic field at the center of the disk.

4. A 12V car battery with an internal resistance of $.004 \Omega$ is hooked to the starter by 2m long cables (each is 2 m long!) having 1 cm diameter copper.

(a) What is the resistance of the battery cables at 20°C ?

(b) If the starter motor has a resistance R_m of $.008 \Omega$ and a back EMF of 8 V when the starter is turning at 800 RPM, how much current does the starter draw from the battery?

(c) Calculate the acceleration of the electrons from the electric field in the wire and use this to calculate their velocity (assuming they are "free to move") after 5 seconds.

(d) Assuming the atomic weight of copper is 63 and that there is 1 free electron per atom, what is the drift velocity of the electrons for the current calculated in part (b). $\rho_{\text{Cu}} = 9.00 \text{ gm/cm}^3$