Seminar 8: Resistors and Magnetism

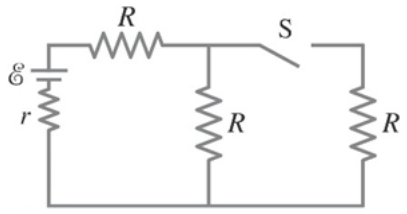
Emf and Terminal Voltage:

1. Four 1.50 V cells are connected in series to a 12 Ω lightbulb. If the resulting current is 0.45 A, what is the internal resistance of each cell, assuming they are identical and neglecting the resistance of the wires?

Resistors in Series and Parallel:

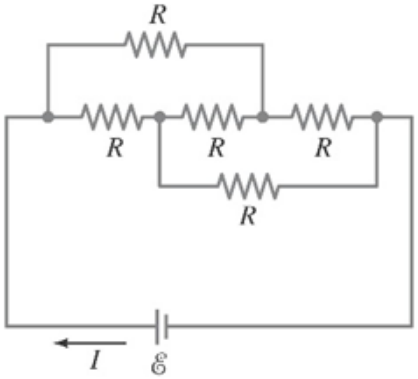
2. Three 1.70 kΩ resistors can be connected together in four different ways, making combinations of series and/or parallel circuits. What are these four ways, and what is the net resistance in each case?

3. Three equal resistors (*R*) are connected to a battery as shown in the figure below. Qualitatively, what happens to (*a*) the voltage drop across each of these resistors, (*b*) the current flow through each, and (*c*) the terminal voltage of the battery, when the switch S is opened, after having been closed for a long time? (d) If the emf of the battery is 9.0 V, what is its terminal voltage when the switch is closed if the internal resistance *r* is 0.50 Ω and R = 5.50 Ω? (*e*) What is the terminal voltage when the switch is open?

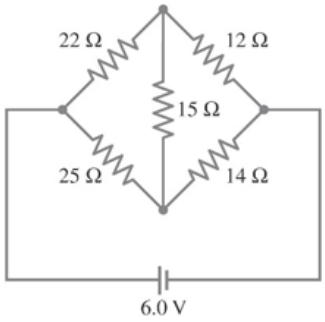


Kirchoff's Rules:

4. (*a*) A network of five equal resistors *R* is connected to a battery ξ as shown in the figure below. Determine the current I that flows out of the battery. (*b*) Use the value determined for I to find the single resistor R_{eq} that is equivalent to the five-resistor network.

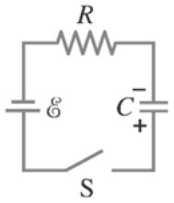


5. Determine the current through each of the resistors in the figure below.



RC Circuits:

6. In the figure below, the total resistance is 15.0 kΩ, and the battery's emf is 24.0 V. If the time constant is measured to be 24.0 μs, calculate (*a*) the total capacitance of the circuit and (*b*) the time it takes for the voltage across the resistor to reach 16.0 V after the switch is closed.



7. How long does it take for the energy stored in a capacitor in a series *RC* circuit (shown in the figure above) to reach 75% of its maximum value? Express your answer in terms of the time constant $\tau = RC$?

Force on Electric Current in a Magnetic Field:

8. Calculate the magnitude of the magnetic force on a 240 m length of wire stretched between two towers and carrying a 150 A current. The Earth's magnetic field of 5.0×10^{-5} T makes an angle of 68° with the wire.

9. Suppose a straight 1.00 mm diameter copper wire could just 'float' horizontally in air because of the force due to the Earth's magnetic field $\vec{\mathbf{B}}$, which is horizontal, perpendicular to the wire, and of magnitude 5.0×10^{-5} T. What current would the wire carry? Does the answer seem feasible? Explain briefly.

Force on Charge Moving in a Magnetic Field:

10. An electron is projected vertically upward with a speed of 1.70×10^{6} m/s into a uniform magnetic field of 0.480 T that is directed horizontally away from the observer. Describe the electron's path in this field.

11. A 3.40 g bullet moves with a speed of 155 m/s perpendicular to the Earth's magnetic field of 5.00×10^{-5} T. If the bullet possesses a net charge of 18.5×10^{-9} C, by what distance will it be deflected from its path due to the Earth's magnetic field after it has traveled 1.00 km?