1. A particular bolt of lightning lasts for 75 μs, during which there is a transfer of 14 C of charge between Earth and sky. (a) Determine the average current. (b) A typical lightbulb carries a current of 0.30 A – in how much time does 14 C pass through it?

2. A certain fuse is rated at 3.0 A. Determine the most charge that can pass through it in one minute without "blowing it".

3. A battery rated 6.0 volts and 3100 mAh is used in a flashlight with power 11 W. (a) Determine the current. (b) How long can the light stay on if the battery is fully charged? (c) Determine the total energy storage of the battery.

4. A certain electric motor draws 2.0 A current and runs on 240 V. What is the maximum work it can do in 5.0 minutes time? How many horsepower is it?

5. A 75 W bulb is connected to 120 V and it is switched on for 1.0 hour. Determine the amount of charge that passes through it and the total energy given off by it.

6. A light bulb is connected to a 6.00 V battery. A current of 175 mA flows through the bulb. (a) Find the resistance of the bulb. (b) Find the power of the battery. (c) What total amount of energy is given off by the bulb in 2.00 minutes?

7. A rechargeable battery with ratings 1.4 V and 2700 mAh is used to power a device with a certain resistance. (a) If the resistance is 33 Ω, how long will the battery last before needing a charge. (b) If it is desired that a single charge lasts 96 hours what is the resistance? Is this a max or min to last that long?

8. A home stereo speaker is rated 8.0 Ω and maximum power 100 W. Determine the maximum current that can pass through the speaker before it "blows".

9. (a) Given the resistivity of copper is 1.68×10^{-8} Ωm find the resistance of a copper wire with diameter 0.645 mm and length 10.0 m. (b) What length of the same wire would have resistance 1.00 Ω? (c) Using a 1.00 m length of this wire what current through it would cause a potential drop of 0.01 volt? (d) What is the electric field in such a wire?

10. A copper rod of length 6.0 feet and diameter 3/8 inch is used as a lightning rod. (a) If the current in a bolt of lightning can reach 30 kA, what voltage and power would this generate in the rod? (b) If the transfer of charge is 15 C how much energy is released?

11. How can a bird sit on a 50 kV wire carrying 100 A?! Suppose it is aluminum, $\rho = 2.7 \times 10^{-8}\ \Omega\text{m}$, 2.0 cm in diameter – what is the potential difference from one foot to the other – gripping the bare wire 3.0 cm apart?

12. Resistance of wires is a significant problem when "delivering" a certain amount of electric power over a long distance. Derive an expression for the rate at which energy is wasted in terms of the properties of the wire, the distance d, and the power and voltage, P and V, at the receiving end of the transmission lines.

13. A resistor of 150.0 Ω is connected to a battery of emf 3.00 V and internal resistance 1.50 Ω. (a) Determine the voltage and power of the resistor. (b) Compare to the power found using the emf – why the difference? (c) Show numerically and also explain how energy is conserved.

14. A second resistor is connected into the circuit from the previous problem. Find the terminal voltage of the battery depending on how the second resistor is connected with the first, being either (a) series, or (b) parallel. (c) In which case is energy extracted from the battery most efficiently?

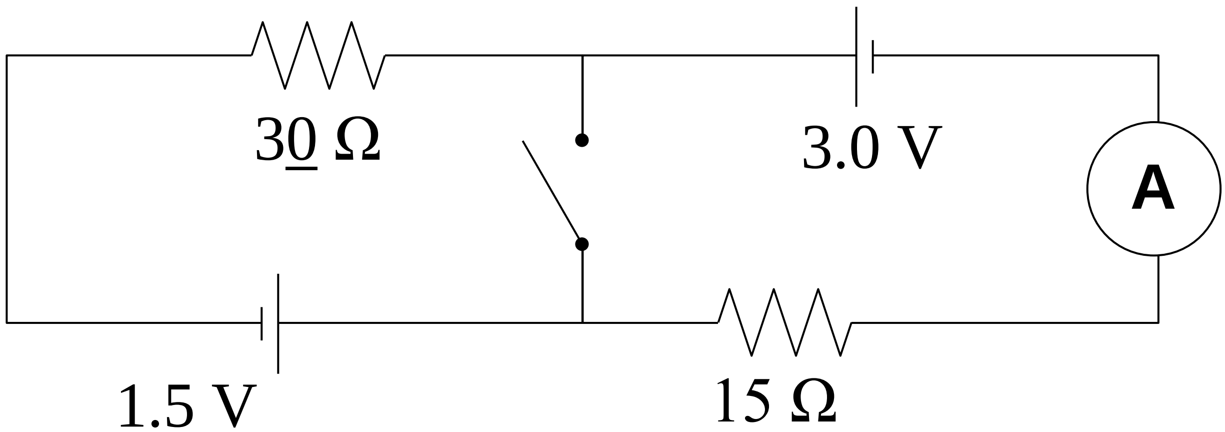
15. Three resistors 10.0 Ω, 20.0 Ω, and 30.0 Ω are connected end to end forming a triangular circuit. A cell with emf 9.00 V and internal resistance 2.00 Ω is then connected at two points to supply power to all three. What is the maximum power that can be dissipated by the three resistors? Find voltage and current for each resistor in this case.

16. Suppose you have multiple devices that require the same voltage. Sketch a circuit connecting the devices to a single voltage source with an on/off switch for each. (a) Ideally the voltage across one of these devices stays the same when another is switched on – why? (b) In reality the voltage will change. Does it go up or down and why? (c) Does the amount of change depend on the resistance of the device that is switched on? Explain.

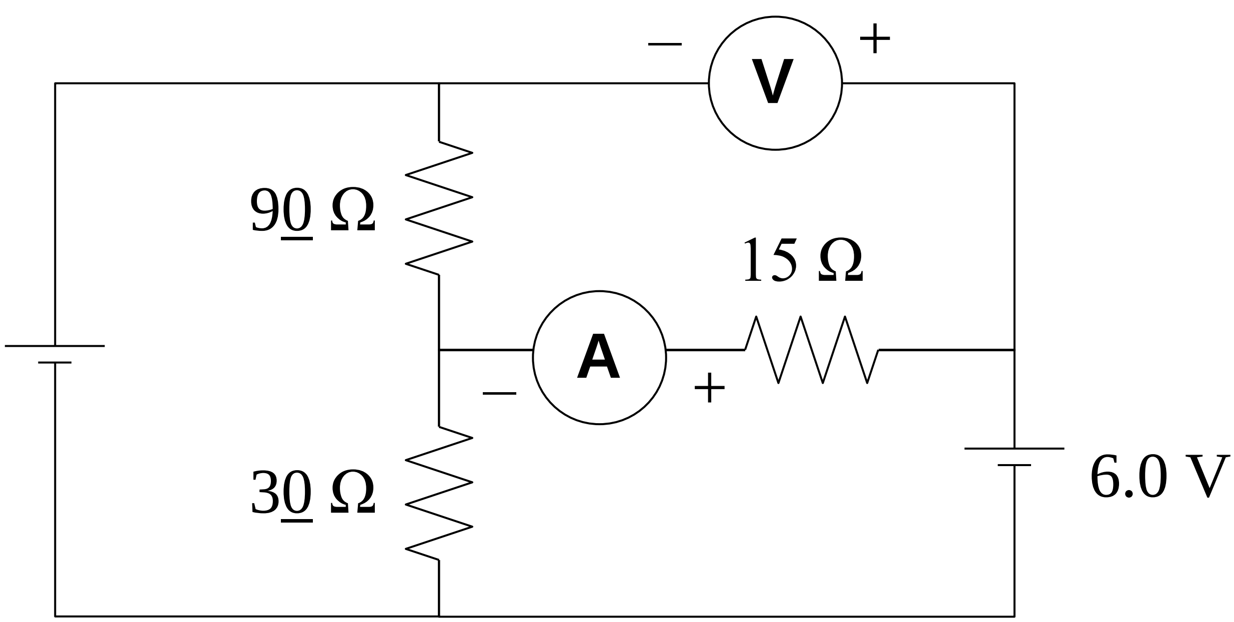
17. Two identical D cells of emf 1.50 V and internal resistance 0.40 Ω are used to power a bulb of 30.0 Ω. Determine current, voltage, and power for the bulb with cells connected either in (a) series or (b) parallel. Suppose the number of cells is increased… (c) Find the maximum voltage and power of the bulb for each type of connection.

18. The rechargeable battery pack in a certain toy is rated 6.0 V 600 mAh and the charger is labeled 9.0 V 300 mA. (a) What internal resistance is implied by these ratings? (b) How much heat energy is generated by charging the battery?

19. Determine the reading of the ammeter with switch open and with switch closed.



20. Determine the value indicated by the voltmeter if the ammeter in the circuit indicates: (a) 0.10 A, or (b) –0.10 A. (c) At what voltage for the unknown emf would the ammeter read zero and what would voltmeter show? (d) Repeat if voltmeter reads zero.



21. A capacitor of 100 mF, initially uncharged, is connected in series with an ideal battery of 6.0 V and a resistor of 50 Ω in a single loop circuit. (a) Determine the initial current. (b) Determine the eventual charge and energy for the capacitor. (c) Find the charge and current when the capacitor is at 2.0 V. (d) Find the charge and voltage when the current is 20.0 mA.

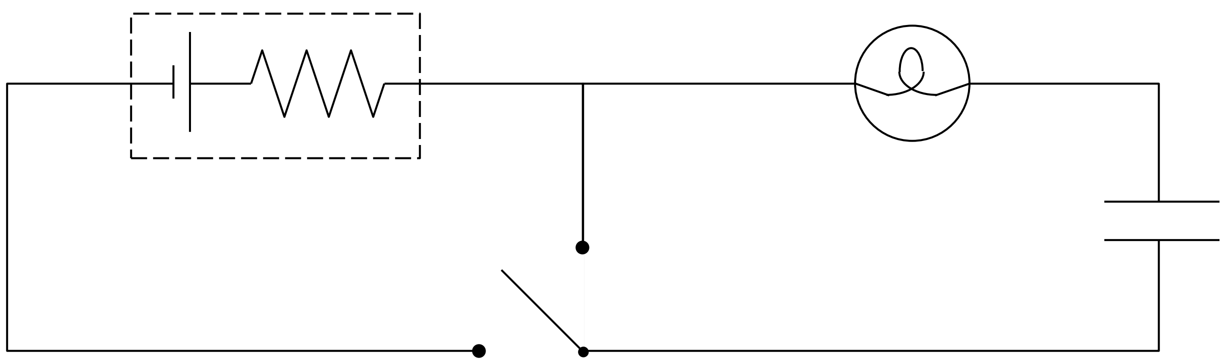
22. A "super capacitor" of 0.75 F is charged to 5.0 V. It is then connected to a resistance of 100 Ω. (a) Determine the amount of charge "pulled" from the capacitor as it drops to 4.0 V. (b) Estimate the time for this to happen by using the "average" current. (c) Find the total heat dissipated by the resistor in the time it takes to discharge the capacitor.

23. Do an experiment measuring the voltage and of a capacitor charging through a known resistance by a battery with a known emf. Measure the time interval between two voltages approaching the emf. (a) Find the initial and final currents. (b) Estimate the charge added to the capacitor during this interval. (c) Determine the apparent capacitance.

24. A defibrillator utilizes a capacitor to deliver a shock with energy equivalent to 15<u>0</u> J and sends 0.165 C of charge through the 75.0 Ω chest of the patient. Determine the required capacitance and initial current.

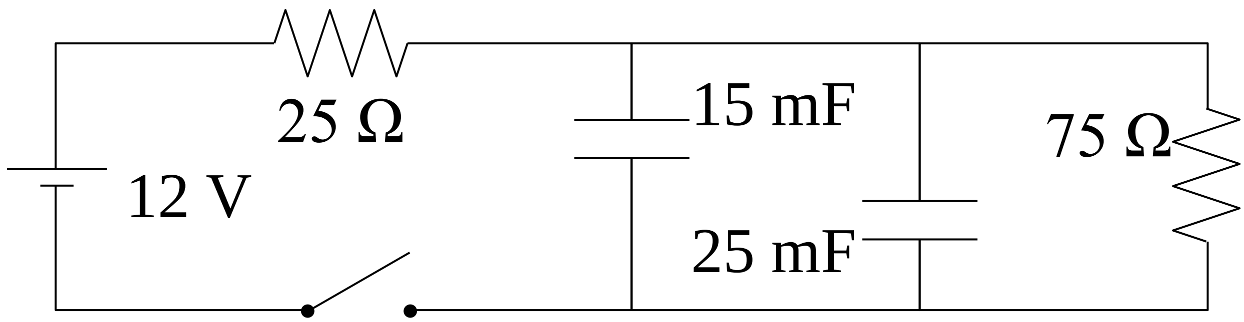
25. Estimate the "half-life" of a charged capacitor connected to a resistance *R*. Derive an expression for current in terms of *Q* and *C*. Make a graph of current versus time and estimate charge as area under the curve using a trapezoid. Solve for time required for the charge to drop to half its original value. How many half-lives would be enough to drop the charge to less than one half one percent its original value?

26. The switch allows the user to charge or discharge the capacitor, which has capacitance 680 μF. The cell has emf 3.70 V and internal resistance 1.50 Ω and the bulb is 30.0 Ω, assumed ohmic. (a) Find the initial current when switch if flipped down. (b) Determine the maximum energy and charge that can be stored in the capacitor. (c) Determine the maximum power output (brightness) of the bulb and the circumstances for it to occur.

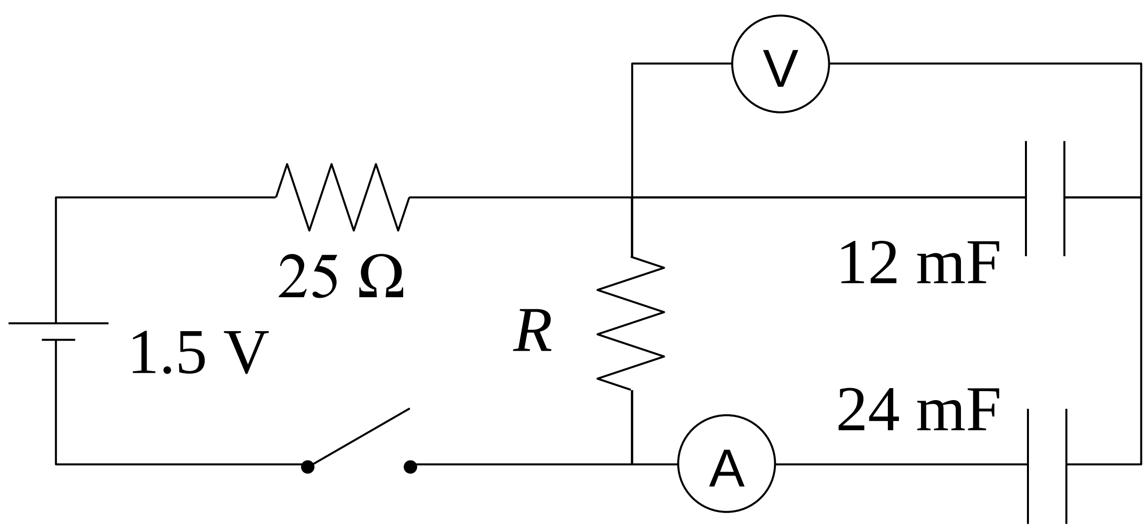


27. Two capacitors, 330 μF and 680 μF, are connected to a 3.0 V battery. Determine the charge and energy stored in each capacitor if the connection is (a) series or (b) parallel.

28. Determine the maximum current possible through the battery and the amount of charge that passes through the 75 Ω resistor if the switch opens after being closed for a long time.



29. With the switch closed the voltmeter reads 0.60 V when the ammeter reads zero. With switch open the voltmeter reads zero when the ammeter reads zero. (a) Determine the value of *R*. (b) Find min and max readings possible for the ammeter. (c) Find two possible readings of the voltmeter when the ammeter reads 30.0 mA (switch open or closed).



30. Parallel circular metal disks of radius 20.0 cm are used to form a parallel plate capacitor. (a) Determine the capacitance if separation of the disks is a gap of 2.00 mm. (b) If instead a piece of paper ($\kappa = 3.7$) of thickness 0.10 mm is sandwiched tightly between the plates find new value. (c) To increase the capacitance to 1.00 μF disks of what radius should be used with the paper?

31. In order to do the Millikan oil drop experiment a field of around 50.0 kN/C is desired in a vertical space of 0.80 cm. Metallic parallel plates at least ten times as wide as the gap are used. (a) Determine the minimum capacitance of the apparatus. (b) Find the amount of charge on each plate needed to produce the desired field. (c) Show that Coulomb's law does not apply to a charged oil drop and the charges of the plates.

32. A parallel plate capacitor has area 0.10 m^2 and separation 0.500 mm and is charged by a 9.0 V battery. The battery is disconnected and the plates are moved farther apart to a separation of 2.00 mm. Determine the change in voltage and energy.