PH2223 Test 2 : Practice Problems

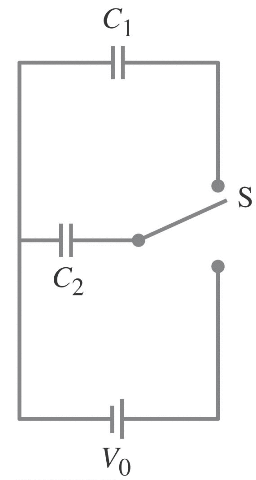
Updated 07 March, 2023

Chapter 24 : Capacitance, Dielectrics, Electric Energy Storage

1. It takes 15 J of energy to move a 0.20 mC charge from one plate of a 15 μF capacitor to the other. How much charge is on each plate?

2. The capacitance of a portion of a circuit is to be reduced from 2900 pF to 1600 pF. What capacitance can be added to the circuit to produce this effect without removing existing circuit elements? Must any connections be broken to accomplish this?

3. The switch S in figure 24-24 is connected downward to that capacitor C_2 becomes fully charged by the battery of voltage V_o. If the switch is then connected upward, determine the charge on each capacitor after the switching.



4. A 175 pF capacitor is connected in series with an unknown capacitor, and as a series combination they are connected to a 25 V battery. If the 175 pF capacitor stores 125 pC of charge on it's plates, what is the unknown capacitance?

Chapter 25 : Electric Current and Resistance

1. A 100 W lightbulb has a resistance of about 12 Ω when cold (20^o C) and 140 Ω when hot. Estimate the temperature of the filament when hot assuming an average temperature coefficient of resistivity of $\alpha = 0.0045$ (in units of deg C inverse).

2. A length of aluminum wire is connected to a precision 10.00 V power supply, and a current of 0.4212 A is precisely measured at 20^oC. The wire is placed in a new environment of unknown temperature where the measured current is 0.3818 A. What is this unknown temperature?

3. A 10 m length of wire consists of 5.0 m of copper followed by 5.0 m of aluminum, both of diameter 1.4 mm. A voltage difference of 85 mV is placed across the composite wire. (Assume $T = 20^o\ C$.) (a) What is the total resistance of the two wires? (b) What is the current through the wires? (c) What are the voltages across the aluminum part and the copper part separately?

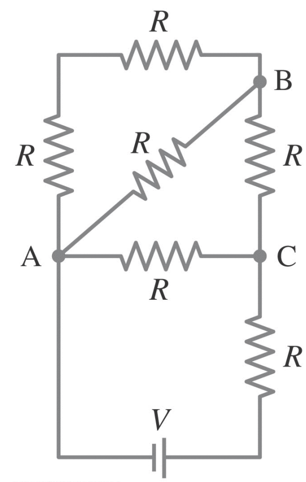
4. HW 25-45 : A power station delivers 750 kW of power at $12,000\ V$ to a factory through wires with total resistance 3 Ω. How much less power is wasted if the electricity is delivered at $50,000\ V$ rather than $12,000\ V$?

Chapter 26 : DC Circuits

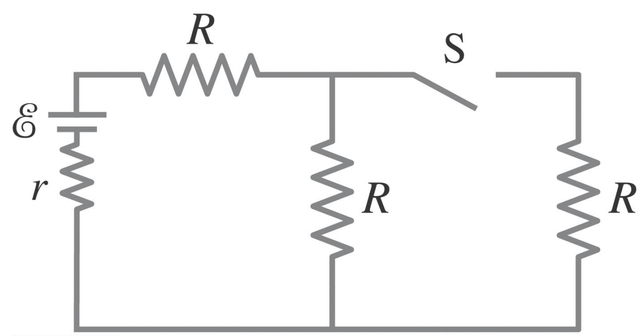
1. What is the internal resistance of a 12 V car battery whose terminal voltage drops to 8.4 V when the starter motor draws 95 A? What is the resistance of the starter?

2. A close inspection of an electric circuit reveals that a 480 Ω resistor was inadvertently soldered in the place where a 370 Ω resistor is needed. How can this be fixed without removing anything from the existing circuit?

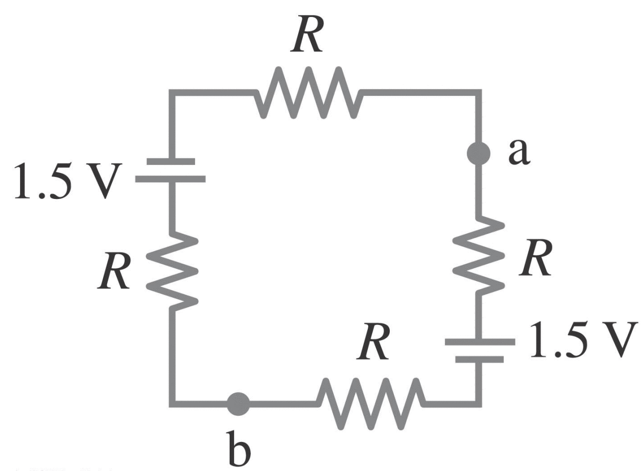
3. What is the net resistance of the circuit connected to the battery here?



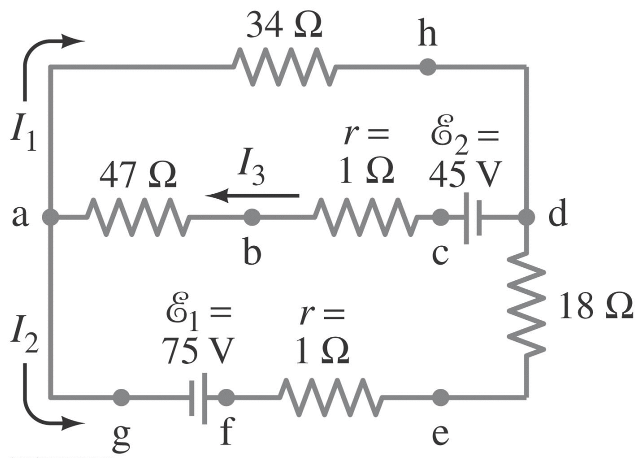
4. Three equal resistors R are connected to a battery as shown in the figure. Qualitatively, what happens to (a) the voltage across across each of the resistors, (b) the current flow through each, and (c) the terminal voltage of the battery, when switch S is opened, after having been closed for a long time?
(d) If the emf of the battery is 9 V, what is it's terminal voltage when the switch is closed if the internal resistance is $r = 0.5\ \Omega$ and $R = 5.5\ \Omega$?
(e) What is the terminal voltage when the switch is open?



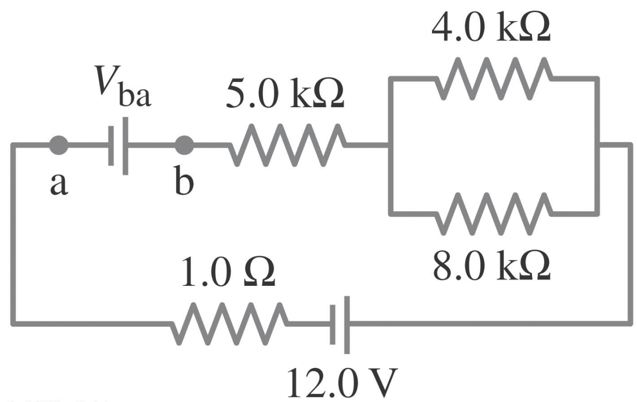
5. For the circuit shown, find the potential difference between points (a) and (b). Each resistor has $R = 130\ \Omega$ and each battery is 1.5 V.



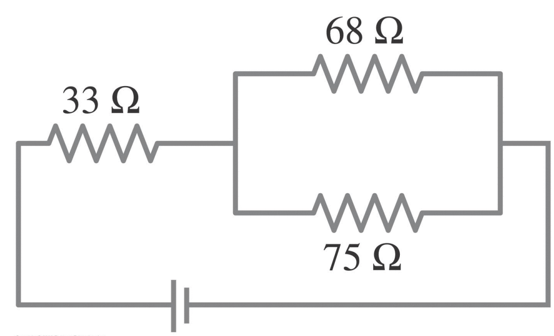
6. What is the potential difference between points (a) and (d) in the figure, and what is the terminal voltage of each battery?
(Actually, on a test this question would just ask you to apply Kirchoff's rules to generate the equations you'd need to solve to find the currents, but not actually grind through the linear algebra to actually find those currents. So here, just apply Kirchoff's rules and generate the two node and three loop rule equations.



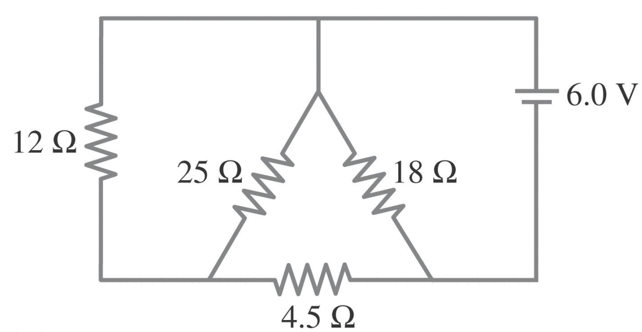
7. The current through the 4.0 $k\Omega$ resistor is 3.10 mA. What is the terminal voltage V_{ba} of the unknown battery? (There are two answers. Why?)
(Hint: we have the current magnitude here, but not it's direction, so it might be going left or right through that resistor. Also - you don't need Kirchoff here.)



8. In the circuit shown, the 33 Ω resistor dissipates 0.80 W. What is the battery voltage?

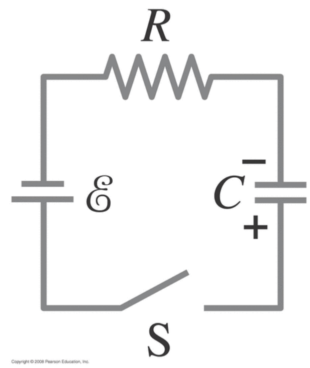


9. (a) What is the equivalent resistance of the circuit shown? (b) What is the current in the 18 Ω resistor? (c) What in the current in the 12 Ω resistor? (d) What is the power dissipation in the 4.5 Ω resistor?
(Note: we need actual numerical values here, not just Kirchoff equations.)



There are a lot of nodes here, representing 4 or 5 different current variables, so applying Kirchoff would generate a lot of linear equations to deal with. See if you can find resistors in series and parallel first to simplify the circuit. Remember: resistors are in parallel if they have the same voltage across them; resistors are in series if the same current is flowing through them. Try coloring the wire segments to represent pieces that are at the same voltage. As a test problem, only part (a) would likely be included.)

10. In the figure, we have a 12 V battery, a 15 $k\Omega$ resistor, and a 4 μF capacitor connected as shown. The instant after the switch is thrown:



 (a) How much current is flowing?

 (b) How much power is the resistor receiving?

Once the circuit has reached equilibrium:

 (c) How much energy is being stored in the capacitor?

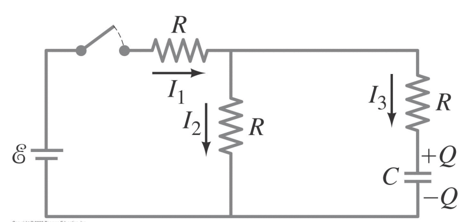
At what times will the following conditions occur:

 (d) The current reaches half it's maximum value.

 (e) The energy stored in the capacitor reaches 90% of it's maximum value.

11. Two 3.8 μF capacitors, two 2.2 $k\Omega$ resistors, and a 12.0 V source are connected in series. Starting from the uncharged state, how long does it take the current to drop from its initial value to 1.35 mA?

12. A 12 V battery is connected to three $R = 10\ \Omega$ resistors and a $C = 1\ mF$ capacitor as shown in the figure.



 (a) How much current is flowing initially?

 (b) After a very long time has gone by, what is the voltage across just the capacitor?

Remember how RC circuits behave in the 'charging' scenario. At the start, the capacitor has no charge on it, so at $t = 0$ we can apply Kirchoff's rules ignoring the capacitors. As $t \to \infty$ and the capacitor fully 'charges up', **no current** will flow through the capacitor (meaning I_3 becomes 0 after a 'long time'). What does that imply about the two other currents at that point?

13. A heart pacemaker is designed to operate at 72 beats/minute using a 5.2 μF capacitor in a simple RC circuit. What value of R is needed if the pacemaker is to fire (capacitor discharge) when the voltage across the capacitor reaches 75% of maximum (dropping to 0 right after)? (It has to do this 72 times each minute, or 1.2 times each second, meaning the time to reach the firing point happens in 0.8333.. *sec.*)