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AP Physics C
Resistance HO36

Resistivities (ρ) Silver $1.47 \times 10^{-8}\ \Omega\cdot m$ Copper $1.72 \times 10^{-8}\ \Omega\cdot m$ Gold $2.44 \times 10^{-8}\ \Omega\cdot m$ Aluminum $2.75 \times 10^{-8}\ \Omega\cdot m$

1.) A current of 4.8 A flows through an automobile headlight. How many coulombs of charge flow through it in 2.0 hours? (UP 26-1)

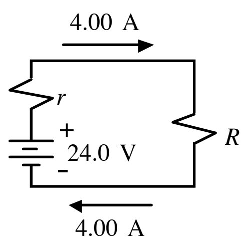
2.) A silver wire 1.3 mm in diameter transfers a charge of 72 C in 1 hour. Silver contains 5.8×10^{28} free electrons per cubic meter.
a.) What is the current in the wire? b.) What is the magnitude of the drift velocity of the electrons in the wire? (UP 26-4)

3.) Find the resistance of a 35.0 m length of copper wire that is 2.05 mm in diameter. Repeat for gold and silver wires with the same dimensions. (UP 26-9)

4.) What diameter must an aluminum wire have is its resistance is to be the same as that of an equal length of copper wire with diameter 2.2 mm? (UP 26-12)

5.) What length of copper wire 0.750 mm in diameter has a resistance of 1.00 Ω? (UP 26-10)

6.)

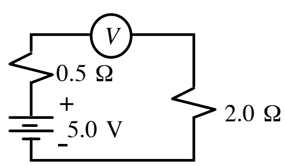


Consider the circuit shown in the figure to the left. The terminal voltage of the 24.0 V battery is 20.2 V, and the current in the circuit is 4.0 A. (UP 26-24)

a.) What is the internal resistance *r* of the battery?

b.) What is the resistance *R* of the circuit resistor?

7.)



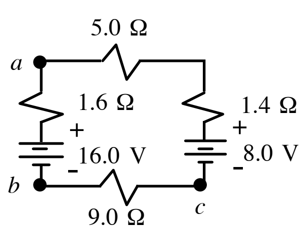
An ideal voltmeter *V* is connected to a 2.0 Ω resistor and a battery with *emf* 5.0 V and internal resistance 0.5 Ω as shown in the figure to the left. (UP 26-25)

a.) What is the current in the 2.0 Ω resistor?

b.) What is the terminal voltage of the battery?

c.) What is the reading on the voltmeter?

8.)



The circuit to the left contains two batteries, each with an *emf* and an internal resistance, and two resistors. (UP 26-26)

a.) Find the current in the circuit (magnitude *and* direction).

b.) Find the terminal voltage V_{ab} of the 16.0 V battery.

c.) Find the potential V_{ac} of point *a* with respect to point *c*.

9.) In the circuit in Problem 8, the 16.0 V battery is removed and reinserted with the opposite polarity, so that its negative terminal is next to *a*. Repeat Problem 8 with this new configuration. (UP 26-27)

10.) A resistor develops thermal energy at the rate of 369 W when the potential difference across its ends is 18.0 V. What is its resistance? (UP 26-32)

11.) A car radio operating on 12.0 V draws a current of 0.29 A. How much electrical energy does it consume in 4.5 hours? (UP 26-34)

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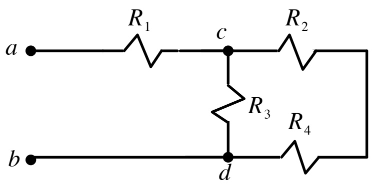
AP Physics C
Resistance HO37

1.)



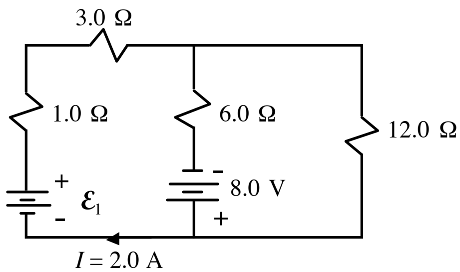
In the figure to the left $R_1 = 12\ \Omega$, $R_2 = 20.0\ \Omega$, $R_3 = 30.0\ \Omega$, and $R_4 = 40.0\ \Omega$. The potential difference between a and b is 96 V.

a.) Find the equivalent resistance of the network.

b.) Find the current through and voltage across each resistor.

c.) Find the total energy dissipated in the network.

2.)



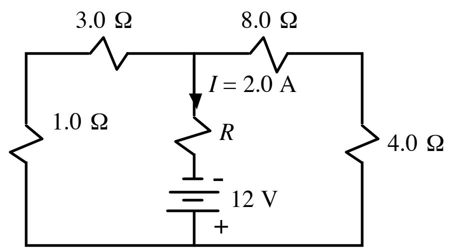
a.) What is the emf $\mathcal{E}$ of the battery in the circuit in the figure to the left?

b.) What is the current through the 12.0 Ω resistor?

c.) Find the power dissipated in each resistor.

d.) Compare the power in part (c.) to the power provided by each battery.

3.)

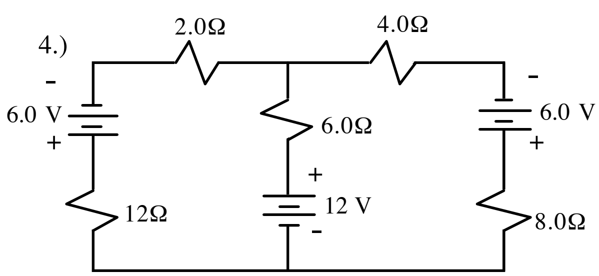


Consider the resistor circuit to the left.

a.) Find the value of R.

b.) Find the current through and voltage across each resistor.

4.)

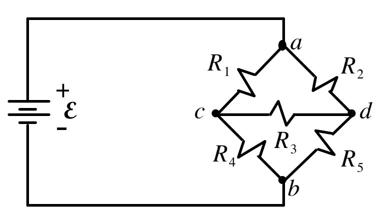


Consider the resistor circuit to the left.

a.) Find the current through and voltage across each resistor.

b.) What is power delivered to the circuit by each battery?

5.)

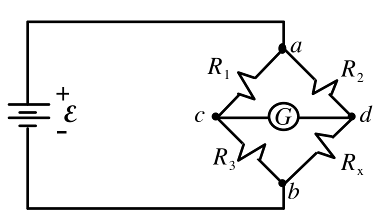


The figure to the left shows a "bridge" circuit. $R_1 = R_2 = R_3 = R_4 = 1.0\ \Omega$, and $R_5 = 2.0\ \Omega$. The voltage across the battery is 13 V and it has no internal resistance. (UP Ex 27-6)

a.) Find the current through and the voltage across each resistor.

b.) Find the equivalent resistance of the network.

6.)



The circuit to the left is called a *Wheatstone bridge* and is used to determine the value of an unknown resistor R_x by comparison with three resistors R_1, R_2, and R_3 whose resistance can be varied. These resistors are varied until the current in the galvanometer G is zero, and the bridge is then said to be *balanced*. Show that under this the condition the unknown resistance is given by (UP 27-61)

$$R_x = \frac{R_2 R_3}{R_1}$$

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AP Physics C
Circuits HO38

1.) The resistance of a galvanometer coil is 50.0 Ω, and the current required for full-scale deflection is 300 μA. (UP 27-22)

a.) Show in a diagram how to convert the galvanometer into an ammeter reading 10.0 A full scale, and compute the shunt resistance.
b.) Show how to convert the galvanometer to a voltmeter reading 500.0 V full scale, and compute the series resistance.

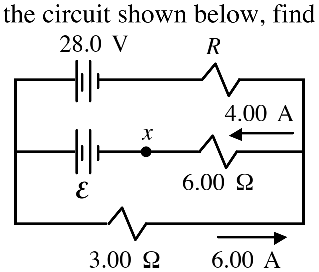
2.) A 582 Ω resistor and a 429 Ω resistor are connected in series across a 90 V line. A voltmeter connected across the 582 Ω resistor reads 44.6 V. (UP 27-57)

a.) Find the voltmeter resistance.
b.) Find the reading of the same voltmeter if it is connected across the 429 Ω resistor.

3.) Two 150-V voltmeters, one with a resistance of 15 kΩ and the other with a resistance of 150 kΩ, are connected in series across a 120-V dc line. Find the reading of each voltmeter. (A 150-V voltmeter deflects full scale when the potential difference between its terminals is 150 V.) (UP 27-28)

4.) A 100-V battery has an internal resistance of r = 5.83 Ω. What is the reading of a voltmeter having a resistance of R_v = 478 Ω when it is placed across the terminals of the battery? (UP 27-26)

5.) In the circuit shown below, find



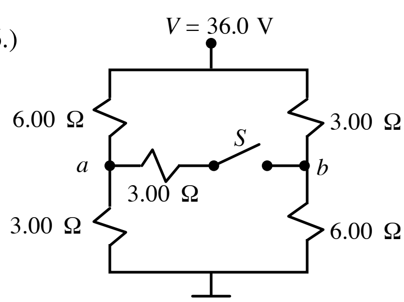
a.) the current in resistor R. (UP 27-17)

b.) the resistance R.

c.) the unknown *emf* $\mathcal{E}$.

d.) If the circuit is broken at point x, what is the current in the 28.0 V battery?

6.)



In the figure to the left it is understood that the point at the top, labeled "36.0 V", is connected to the positive terminal of a 36.0 V battery and that the "ground" symbol at the bottom is connected to the negative terminal of the battery. The circuit is completed through the battery, even it is not shown in the diagram. (UP 27-55)

a.) What is the potential difference V_{ab}, when the switch S is open?

b.) What is the current through the switch S when it is closed?

c.) What is the equivalent resistance when switch S is closed?

7.) Verify that the product RC has dimensions of time. (UP 27-31)

8.) A capacitor that is initially uncharged is connected in series with a resistor and an *emf* source with $\mathcal{E}$ = 200 V and negligible internal resistance. Just after the circuit is completed, the current through the resistor is 8.6 x 10^{-4} A. The time constant for the circuit is 5.7 s. What are the resistance of the resistor and the capacitance of the capacitor? (UP 27-63)

9.) A 3.40 μF capacitor that is initially uncharged is connected in series with a 7.25 kΩ resistor and an *emf* source with $\mathcal{E}$ = 180 V and negligible internal resistance. At the instant when the current through the resistor is 0.0185 A, what is the magnitude of the charge on each plate of the capacitor? (UP 27-65)

10.) A capacitor is charged to a potential of 15.0 V and is then connected to a voltmeter having an internal resistance of 2.25 MΩ. After a time of 5.00 s the voltmeter reads 5.0 V. What is the capacitance? (UP 27-34)

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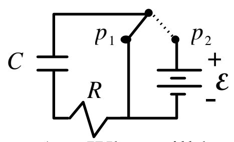
AP Physics C
RC Circuits HO39

1.) A 6.74 μF capacitor that is initially uncharged is connected in series with a 6.03 kΩ resistor and an emf source with $\mathcal{E}$ = 273 V and negligible internal resistance. Just after the circuit is completed, what is (UP 27-32)

a.) the voltage drop across the capacitor?
b.) the voltage drop across the resistor?
c.) the charge on the capacitor?
d.) the current through the resistor?

e.) A long time after the circuit is completed (after many time constants), what are the values of the preceding quantities?

2.)


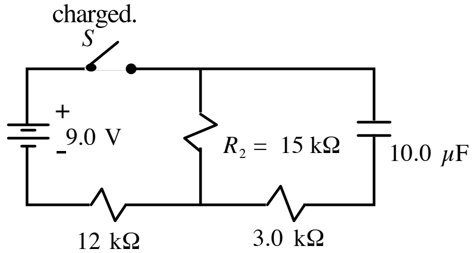
In the circuit shown to the left, C = 7.50 μF, $\mathcal{E}$ = 36.0 V, and the *emf* has negligible resistance. Initially, the capacitor is uncharged, and the switch and the switch is in position p_1. The switch is then moved to position p_2, so that the capacitor begins to charge. (UP 27-36)

a.) What will be the charge on the capacitor a long time after the switch has been moved to position p_2?
b.) After the switch has been in position p_2 for 3.00 ms, the charge on the capacitor is measured to be 225 μC. What is the value of the resistance R?
c.) How long after the switch is moved to position p_2 will the charge on the capacitor be equal to 99.0% of the final value found in part (a.)?

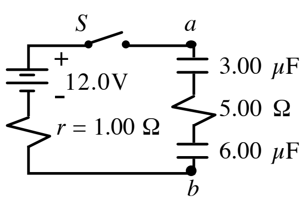
3.) A capacitor with C = 40.0 μF is connected as shown in the figure for Problem 2 with a resistor R = 950 Ω and an *emf* source with $\mathcal{E}$ = 24.0 V and negligible internal resistance. Initially, the capacitor is uncharged, and the switch is in position p_1. The switch is then moved to position p_2, so that the capacitor begins to charge. After the switch has been in position p_2 for 0.050 s, the switch is moved back to position p_1 so that the position begins to discharge. (UP 27-37)

a.) Find the charge on the capacitor just *before* the switch is thrown from position p_2 back to position p_1.
b.) Find the voltage drops across the resistor and across the capacitor at the instant described in part (a.).
c.) Find the voltage drops across the resistor and across the capacitor just *after* the switch is thrown from position p_2 back to position p_1.
d.) Compute the charge on the capacitor 0.050 s after the switch is thrown from position p_2 back to position p_1.

4.) In the circuit below, suppose the switch S has been closed for length of time sufficiently long for the capacitor to become fully charged.

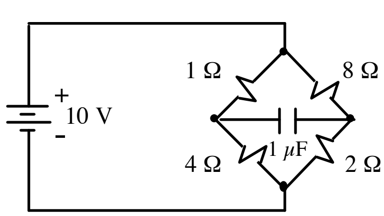


a.) Find the steady-state current in each resistor.
b.) Find the charge on the capacitor.
c.) The switch is opened at t = 0. Write an equation for the current in R_2.as a function of time and
d.) find the time that it takes for the charge on the capacitor to fall to one-fifth its initial value.

5.)


Two capacitors in series are charged by a 12.0 V battery that has an internal resistance of 1.00 Ω. There is a 5.00 Ω resistor in series between the capacitors as shown in the figure to the left. (UP 27-70)

a.) What is the time constant of the charging circuit?
b.) After the switch has been closed for the time determined in part (a.), what is the voltage across the 3.00 μF capacitor?

6.)


The circuit shown to the left has been connected for a long time.

a.) What is the voltage across the capacitor?
b.) If the battery is disconnected, how long does it take the capacitor to discharge to one-tenth its initial voltage?