WebAssign
CH19-HW04-FALL2010 (Homework)

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PHYS 272-FALL 2012, Fall 2012
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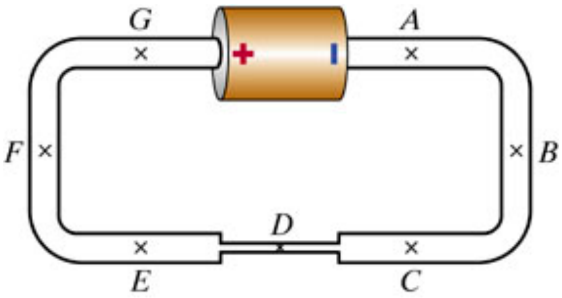
Current Score : 45 / 45 **Due :** Friday, October 19 2012 11:59 PM EDT

1. 10/10 points | Previous Answers MI3 19.9.P.065



The circuit shown above consists of a single battery, whose emf is 1.8 V, and three wires made of the same material, but having different cross-sectional areas. Each thick wire has cross-sectional area 1.1e-6 m^2, and is 25 cm long. The thin wire has cross-sectional area 6.1e-8 m^2, and is 5.9 cm long. In this metal, the electron mobility is 3e-4 (m/s)/(V/m), and there are 5e+28 mobile electrons/m^3.

Which of the following statements about the circuit in the steady state are true?

- [x] At location *B* the electric field points toward the top of the page.
- [ ] The magnitude of the electric field at locations *D* and *G* is the same.
- [x] The magnitude of the electric field at locations *G* and *C* is the same.
- [x] The electron current at location *D* is the same as the electron current at location *G*.

The symbol E_F represents the magnitude of the electric field at location *F*, and the symbol E_D represents the magnitude of the electric field at location *D*. Which of the following equations is a correct energy conservation (loop) equation for this circuit, following a path that starts at the positive end of the battery and goes clockwise?

- ○ $0 = +1.8\text{V} - \boldsymbol{E}_F{*}0.25\text{m} - \boldsymbol{E}_D{*}0.059\text{m} - \boldsymbol{E}_F{*}0.25\text{m}$
- ◉ $0 = -1.8\text{V} + \boldsymbol{E}_F{*}0.25\text{m} + \boldsymbol{E}_D{*}0.059\text{m} + \boldsymbol{E}_F{*}0.25\text{m}$
- ○ $0 = -1.8\text{V} - \boldsymbol{E}_F{*}0.25\text{m} - \boldsymbol{E}_D{*}0.059\text{m} - \boldsymbol{E}_F{*}0.25\text{m}$
- ○ $0 = 1.8\text{V} + \boldsymbol{E}_F{*}0.25\text{m} + \boldsymbol{E}_D{*}0.059\text{m} + \boldsymbol{E}_F{*}0.25\text{m}$
- ○ $1.8\text{V} = \boldsymbol{E}_F{*}0.25\text{m}$
- ○ $1.8\text{V} = \boldsymbol{E}_D{*}0.059\text{m}$

✔

The symbol $\mathbf{i}_F$ represents the electron current at location *F*, etc. Which of the following equations is a correct charge conservation (node) equation for this circuit?

- ○ $\mathbf{i}_F + \mathbf{i}_D = 0$
- ○ $\mathbf{i}_F = 2{*}\mathbf{i}_D$
- ◉ $\mathbf{i}_F = \mathbf{i}_D$
- ○ $2{*}\mathbf{i}_F = \mathbf{i}_D$

✔

Use the appropriate equation(s), plus the equation relating electron current to electric field, to solve for the factor that goes in the blank below:

$\boldsymbol{E}_F$ = [5.545e-2] ✔ * $\boldsymbol{E}_D$

Use the appropriate equation(s) to calculate the magnitude of $\boldsymbol{E}_D$

$\boldsymbol{E}_D$ = [20.755] ✔ V/m

Use the appropriate equation(s) to calculate the electron current at location *D* in the steady state:

$\mathbf{i}_D$ = [1.9e19] ✔ [electrons/s] ✔

- *Read the eBook*
- Section 19.9

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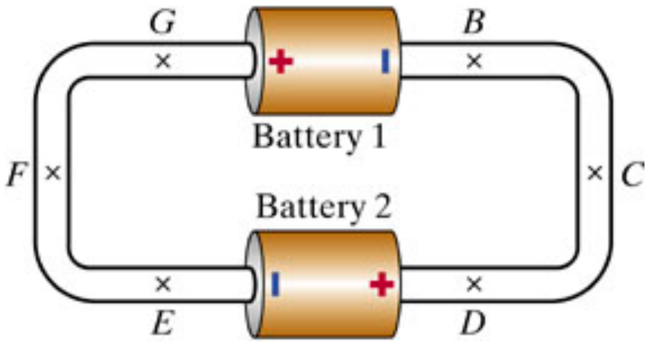
2. 10/10 points | Previous Answers MI3 19.9.P.063

A circuit is constructed from two batteries and two wires, as shown in the diagram below.



Each battery has an emf of 1.3 volts. Each wire is 21 cm long, and has a diameter of 0.0007 meters. The wires are made of a metal which has 7e+28 mobile electrons per cubic meter; the electron mobility is 4e-05 (m/s)/(V/m). A steady current runs through the circuit. The locations marked by "x" and labeled by a letter are in the interior of the wire.

Which of these statements about the electric field in the interior of the wires, at the locations marked by "x"s, are true? Check all that apply.

- [ ] The magnitude of the electric field at location D is larger than the magnitude of the electric field at location C.
- [x] At location B the electric field points to the left.
- [x] At every marked location the magnitude of the electric field is the same.

Which of the following equations is a correct energy conservation (round-trip potential difference) equation for this circuit, along a round trip path starting at the negative end of battery #1 and traveling counterclockwise through the circuit (that is, traveling to the left through the battery, and continuing on around the circuit in the same direction)?

- ○ -1.3 V + **E***(0.21 m) = 0
- ○ -1.3 V + **E***(0.21 m) - 1.3 V + **E***(0.21 m) = 0
- ○ -1.3 V + **E***(0.21 m) + 1.3 V - **E***(0.21 m) = 0
- ○ +1.3 V - **E***(0.21 m) = 0
- ○ +1.3 V - 1.3 V = 0
- ○ +1.3 V - **E***(0.21 m) - 1.3 V + **E***(0.21 m) = 0
- ● +1.3V - **E***(0.21 m) + 1.3V - **E***(0.21 m) = 0

What is the magnitude of the electric field at location B?

$\boldsymbol{E}_B$ = 6.19 V/m

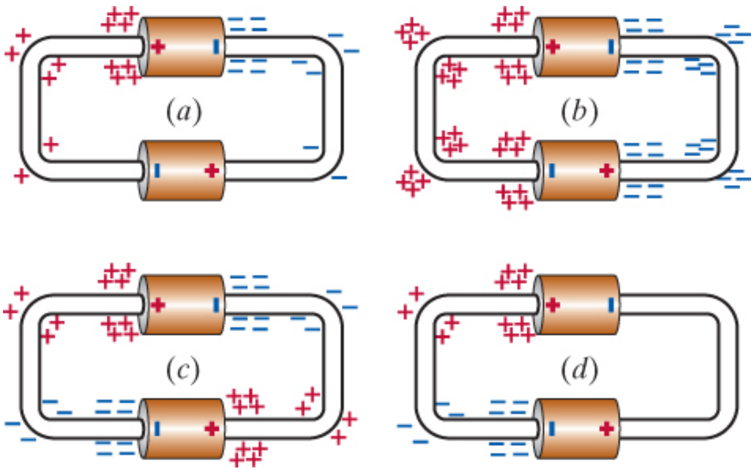
How many electrons per second enter the positive end of battery #2?

6.67e18 electrons/s

If the cross-sectional area of both wires were increased by a factor of 2, what would the be magnitude of the electric field at location B?

new value of $\boldsymbol{E}_B$ = 6.19 V/m

Which of the diagrams below best shows the approximate distribution of excess charge on the surface of the circuit? C

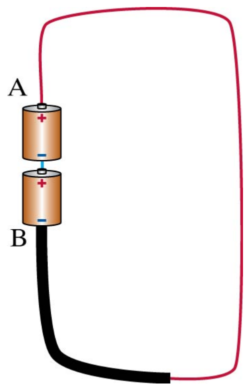


- *Read the eBook*
- Section 19.9

3. 14/14 points | Previous Answers MI3 19.9.P.070

Two Nichrome wires

The following questions refer to the circuit shown in the figure, consisting of two flashlight batteries and two Nichrome wires of different lengths and different thicknesses as shown (corresponding roughly to your own thick and thin Nichrome wires). The thin wire is 53 cm long, and its diameter is 0.25 mm. The thick wire is 15 cm long, and its diameter is 0.36 mm.



(a) The emf of each flashlight battery is 1.5 volts. Determine the steady-state electric field inside each Nichrome wire. Remember that in the steady state you must satisfy both the current node rule and energy conservation. These two principles give you two equations for the two unknown fields.

E inside thin wire = 4.98 V/m

E inside thick wire = 2.402 V/m

(b) The electron mobility in room-temperature Nichrome is about 7×10^{-5} (m/s)/(N/C). How long (in minutes) does it take an electron to drift through the two Nichrome wires from location B to location A?

40.208 min

(c) On the other hand, about how long did it take to establish the steady state when the circuit was first assembled? Give an approximate, not precise numerical answer.

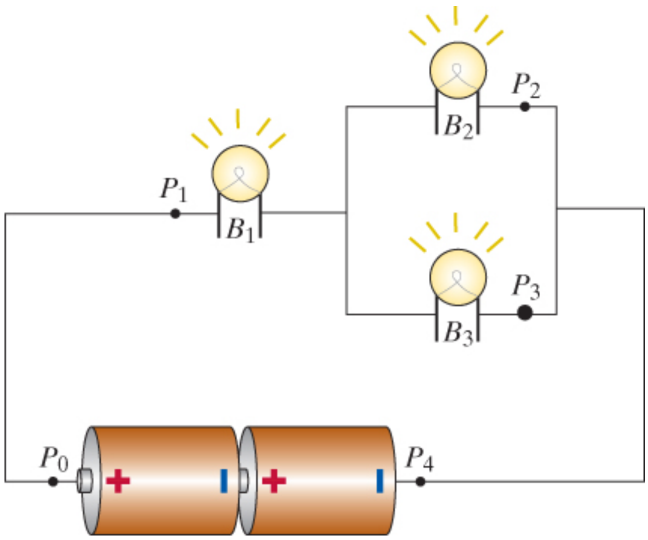
1e-9 s

(d) There are about 9×10^{28} mobile electrons per cubic meter in Nichrome. How many electrons cross the junction between the two wires every second?

1.54e18 electrons/s

- *Read the eBook*
- Section 19.9

4. 11/11 points | Previous Answers MI3 19.9.P.064



Three identical light bulbs are connected to two batteries as shown in the diagram above.

To start the analysis of this circuit you must write energy conservation (loop) equations. Each equation must involve a round-trip path that begins and ends at the same location. Each segment of the path should go through a wire, a bulb, or a battery (not through the air). How many valid energy conservation (loop) equations is it possible to write for this circuit? 3 ✓

Which of the following equations are valid energy conservation (loop) equations for this circuit? E_1 refers to the electric field in bulb #1, L refers to the length of a bulb filament , etc. Assume that the electric field in the connecting wires is small enough to neglect.

- [x] $+2*\text{emf} - E_1L - E_2L = 0$
- [x] $+E_2L - E_3L = 0$
- [ ] $+2*\text{emf} - E_1L - E_2L - E_3L = 0$
- [ ] $E_1L - E_2L = 0$
- [x] $+2*\text{emf} - E_1L - E_3L = 0$
- [ ] $E_1L - E_3L = 0$
- [ ] $+2*\text{emf} - E_2L - E_3L = 0$

✓

It is also necessary to write charge conservation equations (node) equations. Each such equation must relate electron current flowing into a node to electron current flowing out of a node. Which of the following are valid charge conservation equations for this circuit?

- [x] $i_1 = i_2 + i_3$
- [ ] $i_1 = i_3$
- [ ] $i_1 = i_2$

Each battery has an emf of 1.3 volts. The length of the tungsten filament in each bulb is 0.01 m. The radius of the filament is 5e-6 m (it is very thin!). The electron mobility of tungsten is 1.8e-3 (m/s)/(V/m). Tungsten has 6e+28 mobile electrons per cubic meter.

Since there are three unknown quantities, we need three equations relating these quantities. Use any two valid energy conservation equations and one valid charge conservation equation to solve for the following electric field magnitudes:

What is the magnitude of the electric field inside bulb #1?

E_1 = 173.33 V/m

What is the magnitude of the electric field inside bulb #2?

E_2 = 86.66 V/m

How many electrons per second enter bulb #1?

i_1 = 1.47e18 electrons/s

How many electrons per second enter bulb #2?

i_2 = 7.35e17 electrons/s

- *Read the eBook*
- Section 19.9