

PHYSICS 112 - SUMMER 2005 - EXAM 2

Name _____ Section _____

NO CALCULATORS. SHOW YOUR WORK! Full credit will be given only if you explain how you arrived at your answer. Either show your work (especially in a calculation) or give a short explanation. Nothing elaborate is required.

1. [7 points] A current of 3.0 A is being drawn from a 24-volt battery. Draw the circuit, showing the value (in ohms) of each resistance, assuming:

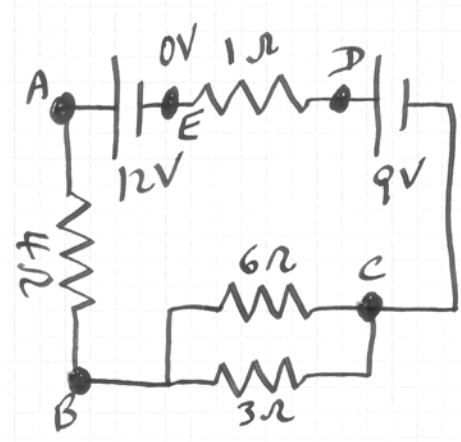
- (a) There is a single resistor in series with the battery.

- (b) There are two resistors in series with the battery, one three times as large as the other.

- (c) The battery is connected to a two-branch parallel circuit, each branch containing a single resistor, the two resistors having the same resistance.

- (d) If the current drawn had been 6.0 A instead of 3.0 A, how would your answers to parts (a), (b), and (c) have changed?
 - The resistors would all have been the same.
 - The resistors would all have been twice as large.
 - The resistors would all have been half as large.
 - The resistors in (a) and (b) would have been twice as large and those in (c) half as large.
 - The resistors in (a) and (b) would have been half as large and those in (c) twice as large.
 - None of the above.

2. [16 points] For the circuit shown, determine the four quantities requested, showing your work. Then fill out the $R - I - \Delta V - P$ table for the circuit, entering the battery voltage as negative if the current passes through it from + to -. Determine the electric potential at points A, B, C, and D, given that point E has $V = 0$ V, and show them on the circuit. Determine the total power delivered by the batteries and the total power dissipated in the resistors.



The equivalent voltage of the batteries:

The equivalent resistance of the parallel part of the circuit with the 3-Ω and 6-Ω resistors:

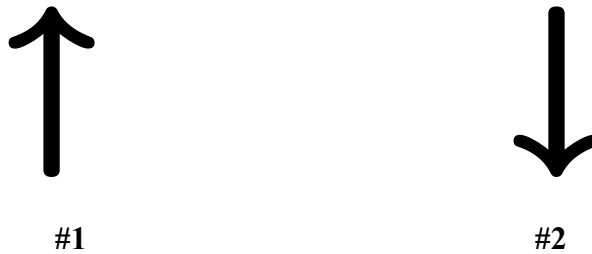
The equivalent resistance of the whole circuit:

The current passing through the batteries:

R	I	ΔV	P
1 Ω			
4 Ω			
3 Ω			
6 Ω			
leave blank		9 V	
leave blank		12 V	

Bonus question: [1 point] If a 2-Ω resistor were connected between points E and B, what current would flow through it, and why?

3. [10 points] The diagram below shows two wires, #1 and #2, carrying currents in opposite directions. Determine and show (using symbols like \rightarrow , \leftarrow , \uparrow , \downarrow , \otimes , or \odot) the directions of \vec{B}_1 , the magnetic field due to wire #1 at the location of wire #2, and \vec{B}_2 , the magnetic field due to wire #2 at the location of wire #1, and then determine and show the directions of the forces that each wire is exerting (through its magnetic field) due to the other.



Determine (and explain why) what would happen:

to the magnitude of \vec{B}_1 if the separation of the wires were doubled:

to the magnitude of the force on wire #2 if current #1 were tripled:

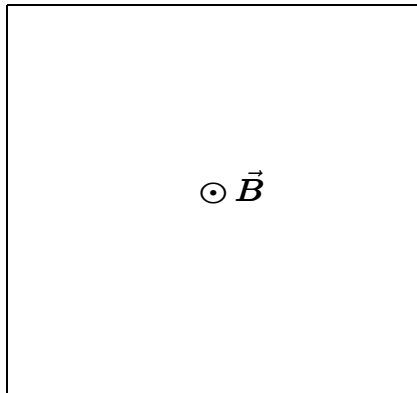
to the magnitude of the force on wire #1 if current #1 were tripled:

4. [3 points] A negative charge ($q = -2.0 \mu\text{C}$) moving at $v = 5000 \text{ m/s}$ enters a region in which there is a magnetic field, and is observed to begin deviating to the right.

What is the direction of this magnetic field (\rightarrow , \leftarrow , \uparrow , \downarrow , \otimes , or \odot)?

If the magnetic field has a magnitude of 0.50 T , what is magnitude of the magnetic force acting on the charge?

5. [4 points] The plane circuit shown below is located in a uniform magnetic field in the direction showed. If the current is flowing counterclockwise around the circuit, indicate the direction of the force on each side of the circuit (using the symbols \rightarrow , \leftarrow , \uparrow , \downarrow , \otimes , or \odot).



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1. [7 points] A current of 3.0 A is being drawn from a 24-volt battery. Draw the circuit, showing the value (in ohms) of each resistance, assuming:

(a) There is a single resistor in series with the battery.

The equivalent resistance of the circuit is $R_{\text{eq}} = \Delta V_{\text{bat}}/I = (24 \text{ V})/(3.0 \text{ A}) = 8.0 \Omega$, so the single resistor would have to have this resistance.

(b) There are two resistors in series with the battery, one three times as large as the other.

The two resistors would have to add up to the equivalent resistance of 8.0Ω , so if one is three times as large as the other, they would have to be 6.0Ω and 2.0Ω .

(c) The battery is connected to a two-branch parallel circuit, each branch containing a single resistor, the two resistors having the same resistance.

The parallel branches would have to have an equivalent resistance of 8.0Ω . Calling the resistance of each resistor R , we then have $1/R_{\text{eq}} = 1/R + 1/R = 2/R$ so $R = 2R_{\text{eq}} = 16 \Omega$.

(d) If the current drawn had been 6.0 A instead of 3.0 A, how would your answers to parts (a), (b), and (c) have changed?

resistors would all have been the same.

The resistors would all have been twice as large.

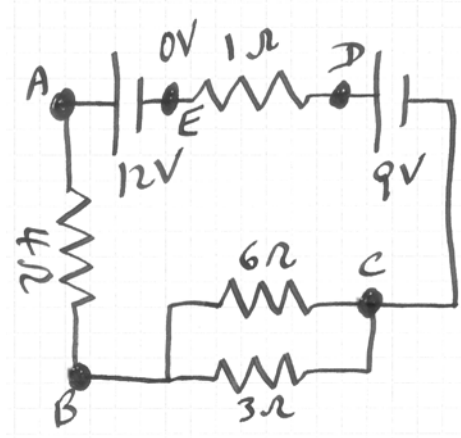
correct: The resistors would all have been half as large.

The resistors in (a) and (b) would have been twice as large and those in (c) half as large.

The resistors in (a) and (b) would have been half as large and those in (c) twice as large.

None of the above.

2. [16 points] For the circuit shown, determine the four quantities requested, showing your work. Then fill out the $R - I - \Delta V - P$ table for the circuit, entering the battery voltage as negative if the current passes through it from + to -. Determine the electric potential at points A, B, C, and D, given that point E has $V = 0$ V, and show them on the circuit. Determine the total power delivered by the batteries and the total power dissipated in the resistors.



The equivalent voltage of the batteries:

$$\Delta V = 12 \text{ V} + 9 \text{ V} = 21 \text{ V}$$

The equivalent resistance of the parallel part of the circuit with the 3- Ω and 6- Ω resistors:

$$R_{\text{eq}} = 1 / (1/3 \Omega + 1/6 \Omega) = (12 \Omega) / (4 + 2) = 2 \Omega$$

The equivalent resistance of the whole circuit:

$$R_{\text{eq}} = 2 \Omega + 1 \Omega + 4 \Omega = 7 \Omega$$

The current passing through the batteries:

$$I = \Delta V / R_{\text{eq}} = (21 \text{ V}) / (7 \Omega) = 3 \text{ A}$$

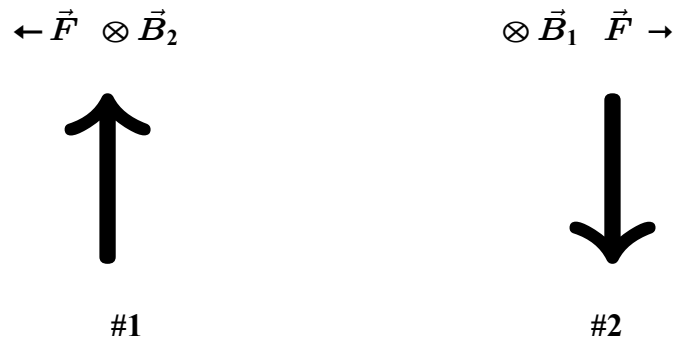
R	I	ΔV	P
1 Ω	3 A	3 V	9 W
4 Ω	3 A	12 V	36 W
3 Ω	2 A	6 V	12 W
6 Ω	1 A	6 V	6 W
leave blank	3 A	9 V	27 W
leave blank	3 A	12 V	36 W

The potentials at A, B, C, and D are 12 V, 0 V, -6 V, and 3 V.

One-bonus point question: If a 2- Ω resistor were connected between points E and B, what current would flow through it, and why?

The potential difference is 0 at both E and B, so there would be no current flowing through the resistor. This would not affect anything else in the problem.

3. [10 points] The diagram below shows two wires, #1 and #2, carrying currents in opposite directions. Determine and show (using symbols like \rightarrow , \leftarrow , \uparrow , \downarrow , \otimes , or \odot) the directions of \vec{B}_1 , the magnetic field due to wire #1 at the location of wire #2, and \vec{B}_2 , the magnetic field due to wire #2 at the location of wire #1, and then determine and show the directions of the forces that each wire is exerting (through its magnetic field) due to the other.



Determine (and explain why) what would happen:

to the magnitude of \vec{B}_1 if the separation of the wires were doubled:

This would halve the magnitude of \vec{B}_1 , which is proportional to I/r .

to the magnitude of the force on wire #2 if current #1 were tripled:

The magnitude of \vec{B}_1 would triple, so the force would triple.

to the magnitude of the force on wire #1 if current #1 were tripled:

The magnitude the force is proportional to the current, so it would triple.

4. [3 points] A negative charge ($q = -2.0 \mu\text{C}$) moving at $v = 5000 \text{ m/s}$ enters a region in which there is a magnetic field, and is observed to begin deviating to the right.

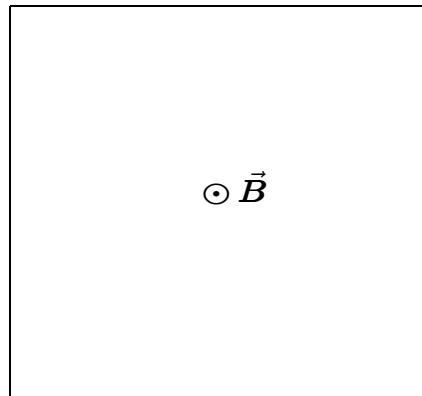
What is the direction of this magnetic field (\rightarrow , \leftarrow , \uparrow , \downarrow , \otimes , or \odot)?

Down (\otimes), by the right-hand rule. Point the thumb (\vec{v}) to the right, first finger (I) back towards you (because it is a negative charge), and your middle finger (\vec{B}) points down.

If the magnetic field has a magnitude of 0.50 T , what is magnitude of the magnetic force acting on the charge?

$$F = |q|vB = (2.0 \times 10^{-6} \text{ C})(5000 \text{ m/s})(0.50 \text{ T}) = 5.0 \times 10^{-3} \text{ N} = 5.0 \text{ mN}.$$

5. [4 points] The plane circuit shown below is located in a uniform magnetic field in the direction showed. If the current is flowing counterclockwise around the circuit, indicate the direction of the force on each side of the circuit (using the symbols \rightarrow , \leftarrow , \uparrow , \downarrow , \otimes , or \odot).



The magnetic force on each side is towards the interior: on the top, right, bottom, and left sides they are \downarrow , \leftarrow , \uparrow , and \rightarrow .