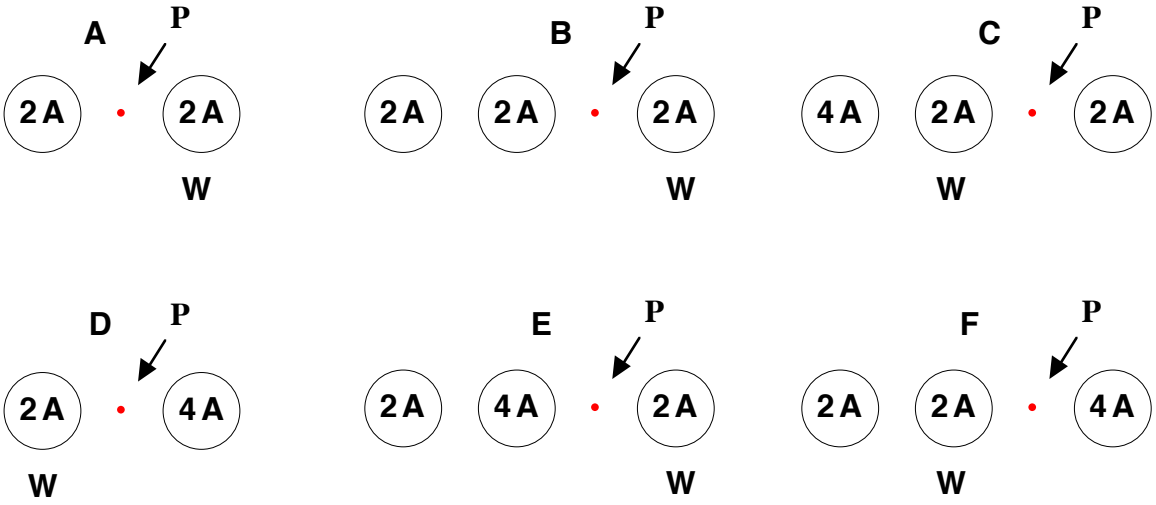
MFF 8A: CURRENT-CARRYING STRAIGHT WIRES

MFF8A—RT1: CURRENT-CARRYING STRAIGHT WIRES

The figures show long straight wires that are oriented perpendicular to the page. The wires are carrying electric currents into the page. The amount of current in each wire is identified in the figures. The figures also show the arrangements of the wires and indicate a point of interest marked P. All of the distances between adjacent items, either wires or a wire and the point of interest, are the same.

Rank these arrangements, from greatest to least, on the basis of the strength (magnitude) of the magnetic field at P due to the wire marked W.



Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Least

OR, Wire W produces the same strength magnetic field at P in ALL six cases. _____

Carefully explain your reasoning.

How sure were you of your ranking? (circle one)

Basically Guessed					Sure				Very Sure
1	2	3	4	5	6	7	8	9	10

MFF8A—WBT: CURRENT-CARRYING STRAIGHT WIRES

Construct a physical situation to which the following could apply.

$$\left|\vec{B}\right| = \frac{\mu_0 \cdot (2\ \text{A})}{2\pi \cdot (4\ \text{cm})} + \frac{\mu_0 \cdot (4\ \text{A})}{2\pi \cdot (8\ \text{cm})} - \frac{\mu_0 \cdot (2\ \text{A})}{2\pi \cdot (4\ \text{cm})}$$

Please diagram or sketch your proposed physical situation and carefully explain your reasoning.

MFF8A—CCT1: CURRENT-CARRYING STRAIGHT WIRES

Given below are statements by three students who are talking about the magnetic fields due to electric currents passing through long straight wires. **Consider the statements and then decide which, if any, of the students you agree with.**

Student A: "The direction of the magnetic field a current produces at a certain point is changed if there is another current in the region with which current 1 interacts."

Student B: "The magnitude of the magnetic field a current produces at a certain point is changed if there is another current in the region with which current 1 interacts."

Student C: "The magnetic field a current produces at a certain point is not affected in any way by the presence of other currents, or their fields, in the region."

I agree with:

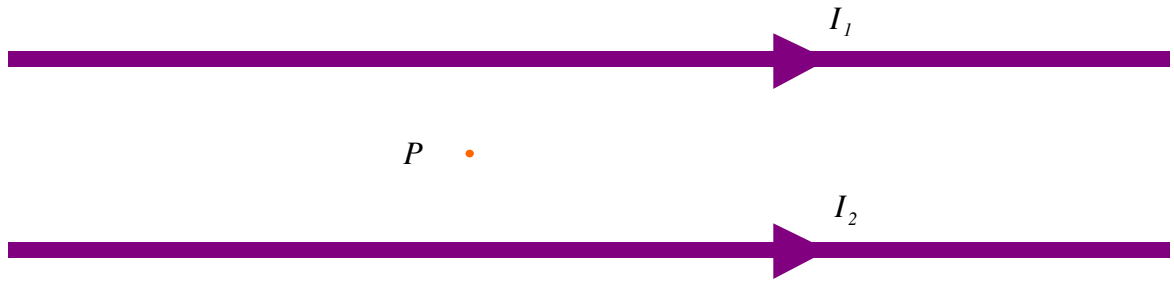
Student A _____ Student B _____ Student C _____ None of them_____

Please carefully explain your reasoning.

MFF8A—WWT1: CURRENT-CARRYING STRAIGHT WIRES

What, if anything, is wrong with the following situation? If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the situation works as it does.

"A current in a long straight wire produces a magnetic field at a point P. A second long straight wire with a current is placed beside and parallel to the first wire. The two wires are fixed in place. Point P is between the two wires. The magnetic field at P due to the current in wire 1 will be modified because of the magnetic interaction between the two current-carrying wires".



MFF8A—TT1: CURRENT-CARRYING STRAIGHT WIRES

There is something wrong in the situation described below. Identify the problem and explain fully how to correct it.

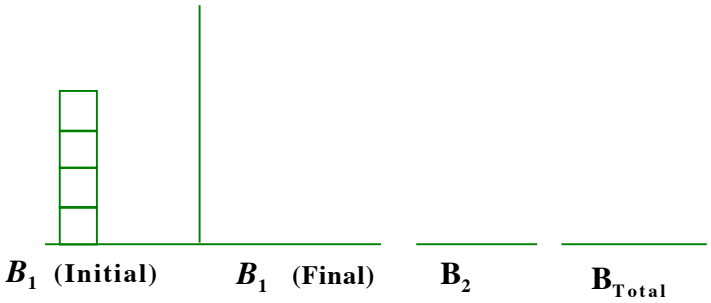
"A long straight wire with a current I_1 produces a magnetic field B_1 at a point P. A second long straight current-carrying wire, which has three times the current of the first wire, is placed parallel to wire 1. The two wires are fixed in place. Point P is between the two wires. When the second wire is placed parallel to wire 1, the field produced by the first current at P, B_1, will change direction."

What is wrong and how could it be corrected?

MFF8A—BCT1: CURRENT-CARRYING STRAIGHT WIRES

The bar chart below left shows the magnitude of the magnetic field (B_1) at a point P produced exclusively by a current (I_1) in a single long straight wire.

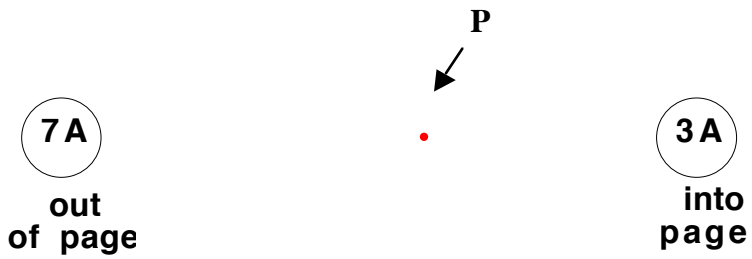
On the bar chart below, draw the appropriate number of bars for the magnitude of the magnetic field (B_1 due to I_1) at P if another long straight wire carrying a current (I_2) with twice the value of I_1 is placed parallel to the original wire so that point P is midway between the two wires. Also draw the bar charts for the field B_2 due to I_2, and B_{total} at P when the two wires are present.



Please carefully explain your answer.

MFF8A—M/MCT1: CURRENT-CARRYING STRAIGHT WIRES

The figure below shows the end of a long straight wire carrying a current of 7 A out of the page. The figure also shows a point labeled P and the end of a second long straight wire carrying a current of 3 A into the page. The wire on the left is 0.08m from point P, and the wire on the right is 0.06m from P.



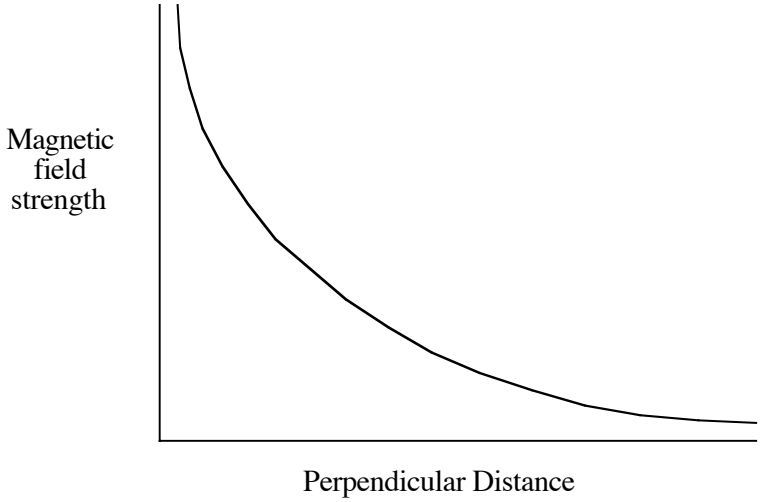
Given below is a student's calculation for the magnetic field at point P produced by the current on the left in the presence of the second current. **Is this calculation meaningful, i.e., tells us something realistic about the situation, or meaningless, i.e., is nonsense or totally irrelevant to the calculation of the field due to the left current.**

$$\left|\vec{B}\right| = \frac{\mu_0 \cdot (7\ \text{A})}{2\pi \cdot (0.08\ \text{m})}$$

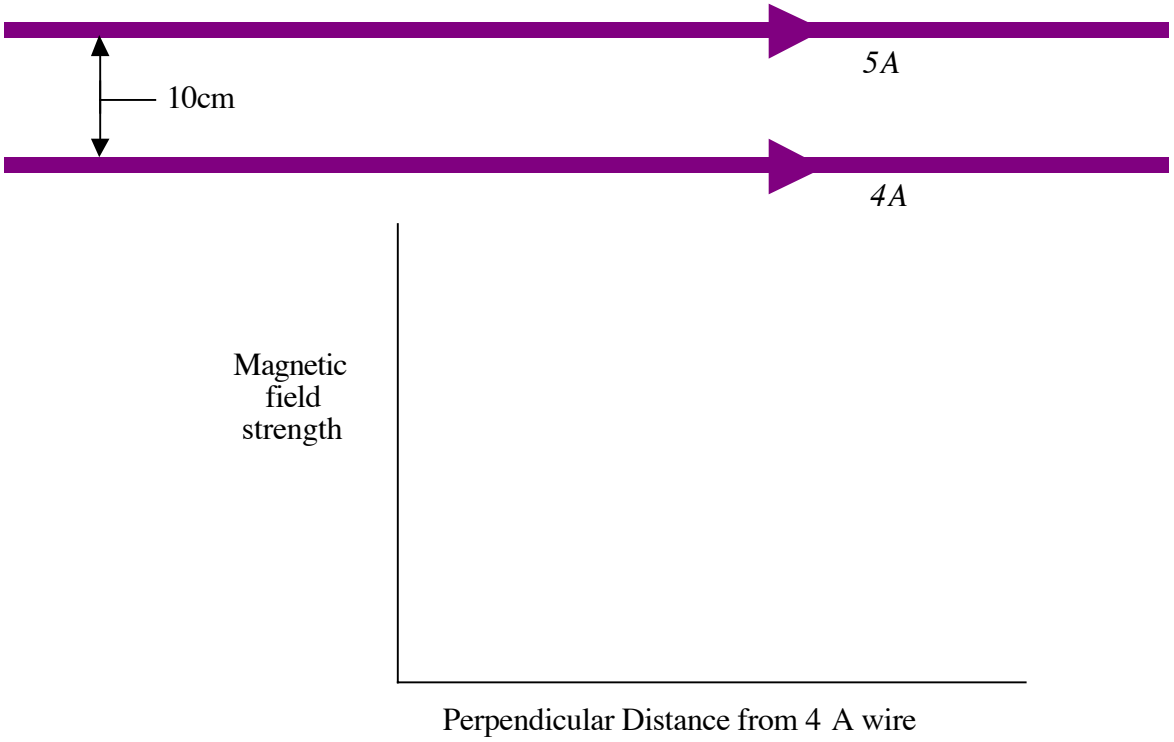
Explain.

MFF8A—CRT1: CURRENT-CARRYING STRAIGHT WIRES

Shown below is the graph of the strength of the magnetic field produced by a long straight wire carrying a current of 4 A to the right as a function of the perpendicular distance from the wire.



Draw the graph for the strength of the magnetic field due ONLY to the 4 A current as a function of distance when a second long straight wire carrying a current of 5 A is placed 10 cm from the first wire and parallel to it as shown.



MFF8A—QRT1: CURRENT-CARRYING STRAIGHT WIRES

A long, straight wire carrying a current of 7 A into the page is 3 cm from a point called P. A second long straight wire carrying a current of 9 A into the page is parallel to the first wire and 7 cm from the point P on the opposite side of P, i.e., it is 10 cm from the first wire.

Explain how each of the changes listed below will affect the magnetic field at P due ONLY to the 7 A current.

The direction of the 7 A current is reversed.

The 9 A current is increased.

The 9 A current is moved closer to P.

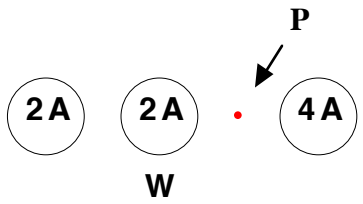
The 9A current is removed.

The 7A current is decreased.

The wire carrying the 7A current is rotated 90°, so it lies in the plane of the page.

MFF8A—LMCT1: CURRENT-CARRYING STRAIGHT WIRES

The situation below shows three long straight wires carrying various currents out of the page. Also shown is a dot identifying a point P. The same distance separates all four items. A number of changes to this situation will be described below. For each change, **you are to identify how the change will affect, if it will, the magnetic field produced at P by ONLY the wire marked W.**



Use the following choices for the effects due to the changes listed below:
(a) This change will alter the direction of the field at P produced by the current in W.
(b) This change will increase the magnitude of the field at P produced by the current in W.
(c) This change will decrease the magnitude of the field at P produced by the current in W.
(d) This change will alter both the direction and the magnitude of the field at P produced by the current in W.
(e) This change will not affect the field at P produced by the current in W.

Change:

1) The current in the left most wire is doubled. ___

2) The right hand wire is moved closer to point P. ___

3) The current in wire W is doubled. ___

4) The current in the right hand wire is reversed. ___

5) Wire W and the wire at the left end are interchanged. ___

6) Wire W is moved 90° clockwise around a circle centered at P so that it is directly above P at the same distance away. ___

7) The leftmost and rightmost wires are moved the same distance farther away from P. ___