

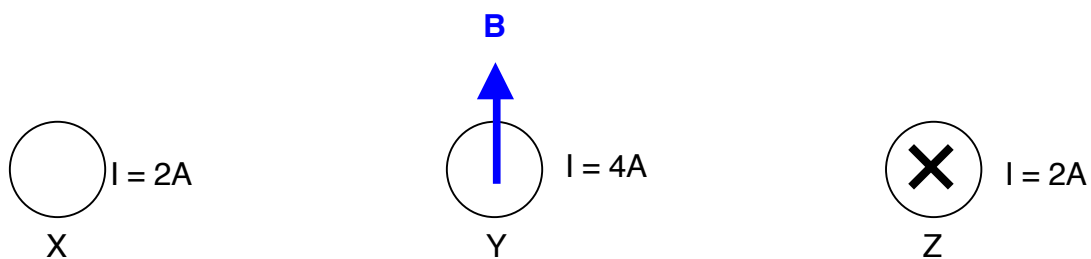
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**MFF 8c: THREE PARALLEL CURRENT-CARRYING WIRES II**



## MFF8c—WBT1: THREE PARALLEL CURRENT-CARRYING WIRES II

For the situation shown below, what can we determine about the direction(s) of the currents in wires X and Y?



The arrow shows the total magnetic field at the location of wire Y. Wire Z at the far right is carrying a current down into the page.

**Carefully explain your reasoning.**

*The current in X must be out of the page in order to add to the magnetic field contributed by the current in Z. We cannot determine anything about the current in Y.*

**MFF8c—CCT1: THREE PARALLEL CURRENT-CARRYING WIRES II**

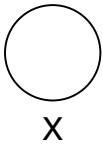
Given below are statements made by three students about the situation shown underneath the statements. **With which, if any, of the following students do you agree and why?**

*Student A: "For this configuration, the total field at the location of wire Y will be zero only if all 3 currents are in the same direction."*

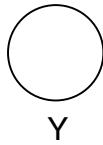
*Student B: "For this configuration, the total field at the location of wire Y will be zero only if the center current is opposite the other two."*

*Student C: "For this configuration, the total field at the location of wire Y will be zero only if the currents in the other two wires are in the same direction."*

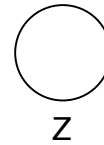
$I = 2A$



$I = 2A$



$I = 2A$



I agree with: Student A \_\_\_\_\_  
None of them \_\_\_\_\_

Student B \_\_\_\_\_

Student C X

**Carefully explain your reasoning.**

*The current in wire Y does not produce a field at Y so the field will be due to the other two currents. The currents in X and Z have to be in the same direction if we want them to cancel at wire Y.*

## MFF8c—WWT1: THREE PARALLEL CURRENT-CARRYING WIRES II

**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.**

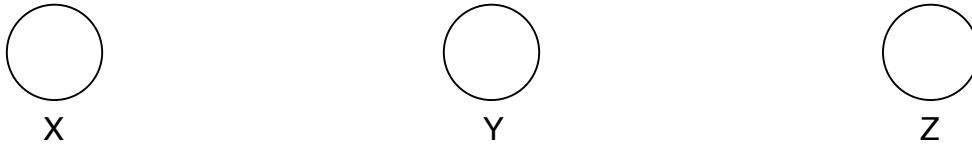
For three long straight parallel wires carrying equal magnitude electric currents, it is not possible to have the total magnetic field at the location of the center wire be zero under any circumstances.

*This is incorrect. The magnetic field at wire Y will be zero anytime the two outside wires carry equal magnitude currents in the same direction.*

## MFF8c—TT1: THREE PARALLEL CURRENT-CARRYING WIRES II

There is something wrong with the following situation. **Identify the problem and explain how to correct it.**

The three long straight parallel wires, whose ends we see in the figure below, all carry the same current. The total magnetic field at the location of wire Y will depend on the magnitude and direction of all three currents.



*This is incorrect. The magnetic field at wire Y will depend on the currents (and direction of currents) in wires X & Z, not Y.*

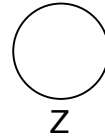
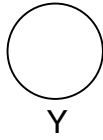
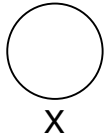
## MFF8c—PET1: THREE PARALLEL CURRENT-CARRYING WIRES II

For a situation where we have three long straight parallel wires arranged along a line carrying equal magnitude electric currents, **how will the magnitude and direction of the total magnetic field at the location of the center wire depend on the current in the center wire and why?**

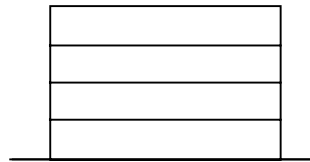
*It will not depend on the current in the center wire because there is no distance.*

### MFF8c—BCT1: THREE PARALLEL CURRENT-CARRYING WIRES II

The bar chart below shows the initial magnitude of the total magnetic field at the location of wire Y in the figure when all three wires are carrying the same current. **Complete the bar chart below to show the final magnitude of the total magnetic field at the same location if the current in wire Y is tripled.**



$B_{\text{initial}}$  (at Y)

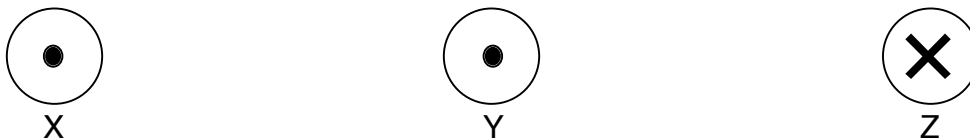


$B_{\text{Final}}$  (at Y when current in Y is tripled)

**Please carefully explain how you determined your answer.**

*The magnetic field at Y is independent of the current in wire Y.*

## MFF8c—QRT1: THREE PARALLEL CURRENT-CARRYING WIRES II



**For the situation shown above, describe how each of the following changes will affect the total magnetic field at the location of wire Y. All currents are the same magnitude.**

(a) When the current in wire Y is reversed.

*No change.*

(b) When the directions of the currents in Y and Z are both reversed.

*Magnetic field will be zero since the two equal strength fields have opposite directions.*

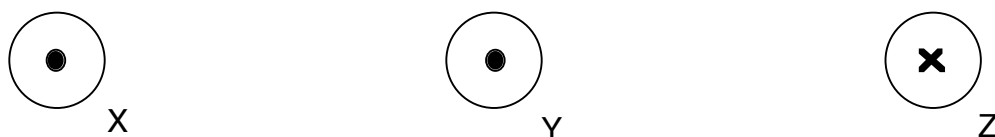
(c) When the currents in wires X and Z are doubled.

*The magnetic field magnitude will quadruple.*

(d) When the current in wire Y is reduced to 1/3 of original.

*No change.*

## MFF8c—LMCT1: THREE PARALLEL CURRENT-CARRYING WIRES II



The situation above shows the ends of three long straight wires that are parallel to each other. All three wires in the situation above carry the same current directed out of the page for X and Y and into the page for Z. Described below are possible changes to this situation.

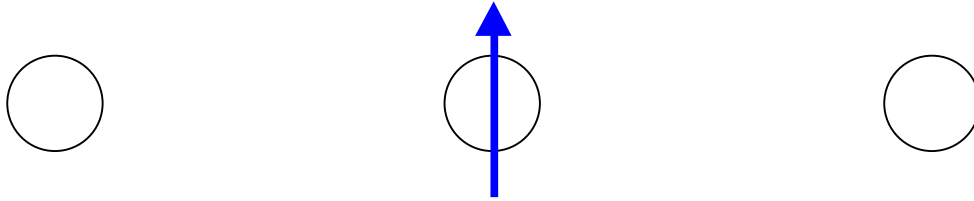
**For each change, choose the effect on the total magnetic field at the location of the center wire from the following choices:**

- a) Direction of the magnetic field at location of Y remains the same, but the magnitude increases.
- b) Direction of the magnetic field at location of Y remains the same, but the magnitude decreases.
- c) Magnitude of the magnetic field at location of Y remains the same, but the direction of the field reverses.
- d) Magnitude changes and direction reverses for the magnetic field at location of Y.
- e) Both magnitude and direction of the magnetic field at location of Y will be unaffected.

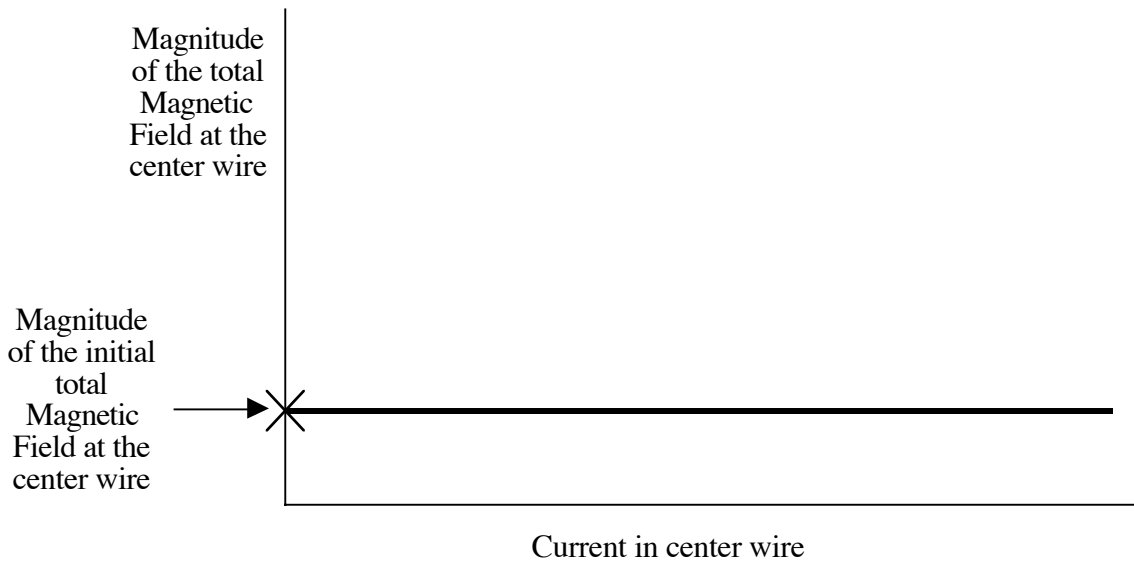
- 1) The current in wire Y is reversed. \_\_\_ *E* \_\_\_
- 2) The currents in all three wires are doubled. \_\_\_ *A* \_\_\_
- 3) The currents in the wires X and Z are reversed and cut in half. \_\_\_ *D* \_\_\_
- 4) The current in wire Y is reduced to one-fourth of the initial value. \_\_\_ *E* \_\_\_
- 5) The currents in the wires X and Z are both reversed. \_\_\_ *C* \_\_\_
- 6) The current in wire Y is reduced to zero. \_\_\_ *E* \_\_\_

### MFF8c—CRT1: THREE PARALLEL CURRENT-CARRYING WIRES II

The figure below shows a situation with three long, straight parallel current-carrying wires. We are looking at the wires end on. The arrow represents the total magnetic field at the location of the center wire when the current in that wire is zero.



**On the axes below, draw the graph of the total magnetic field versus the magnitude of the current in the center wire.** (The initial value is marked with an x on the vertical axis.)

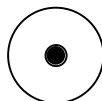


*The magnetic field at the center wire is independent of the current in the center wire.*

## MFF8c—M/MCT1: THREE PARALLEL CURRENT-CARRYING WIRES II

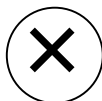
For the situation below, a student calculates the magnitude of the total magnetic field at the location of the center wire in the manner shown under the figure. The distances between the wires is 6 cm.

$I = 4\text{A}$  (out of page)



X

$I = 5\text{A}$  (into page)



Y

$I = 2\text{A}$  (into page)



Z

$$|\vec{B}| = \frac{(\mu_0)(2\text{A})}{(2\pi)(6\text{ cm})} + \frac{(\mu_0)(4\text{A})}{(2\pi)(6\text{ cm})} - \frac{(\mu_0)(5\text{A})}{(2\pi)(6\text{ cm})}$$

**Is this calculation meaningful, supplies useful information about the situation, or meaningless, makes no sense either in general or for this specific situation? Carefully explain your answer.**

*The calculation is meaningless since there cannot be an contribution to the field due to the current in the center wire.*