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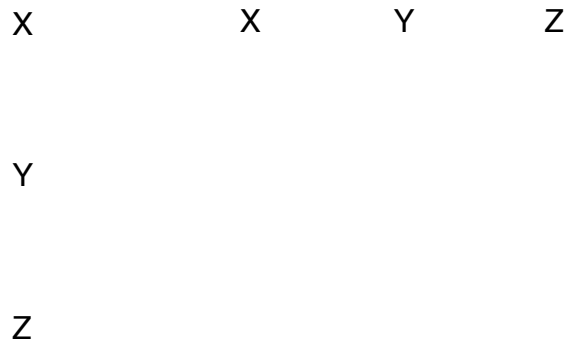
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MFF 8c: Three Parallel Current-Carrying Wires II

MFF8c—RT1: THREE PARALLEL CURRENT-CARRYING WIRES II

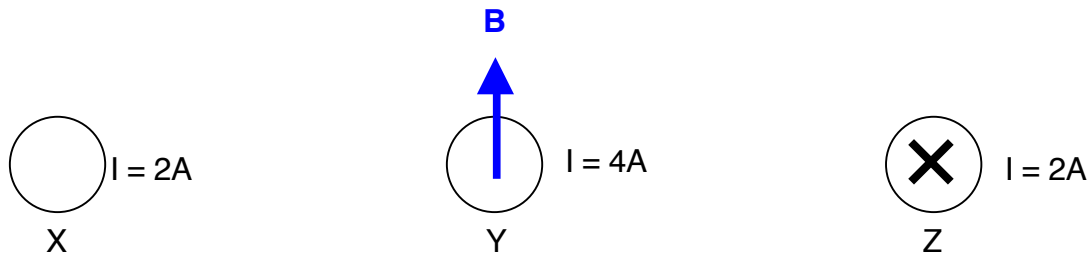
Shown below are six situations where three long straight wires are parallel to each other carrying currents either into, or out of, the page. The distance between wires X and Y is the same as the distance between wires Y and Z. The magnitudes of the currents in each wire are all the same. The directions of the current are shown as either a dot indicating out of the page, or an X indicating into the page.

Rank these situations, from greatest to least, on the strength of the total magnetic field at the location of wire Y.



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.

MFF8c—CCT1: THREE PARALLEL CURRENT-CARRYING WIRES II

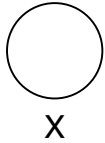
Given below are statements made by three students about the situation shown underneath the statements. **With which, if any, of the following students do you agree and why?**

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."

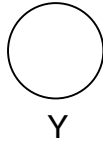
Student B: "For this configuration, the total field at the location of wire Y will be zero only if the center current is opposite the other two."

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."

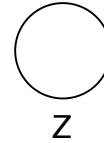
$I = 2A$



$I = 2A$



$I = 2A$



I agree with: Student A _____
None of them _____

Student B _____

Student C _____

Carefully explain your reasoning.

MFF8c—WWT1: THREE PARALLEL CURRENT-CARRYING WIRES II

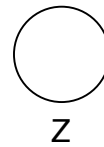
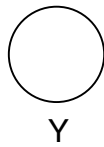
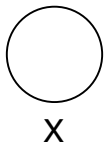
What, if anything, is wrong with the following situation? If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the situation works as it does.

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.

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.

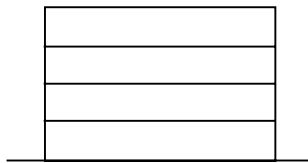
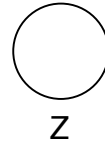
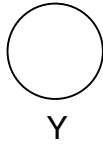
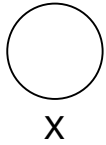


MFF8c—PET1: THREE PARALLEL CURRENT-CARRYING WIRES II

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?**

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.**



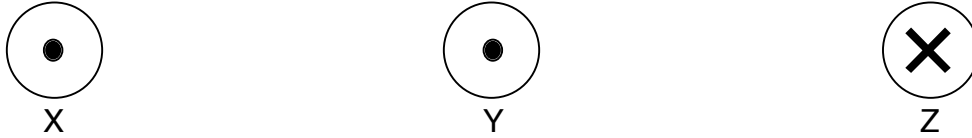
B_{initial} (at Y)



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

Please carefully explain how you determined your answer.

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 equal.

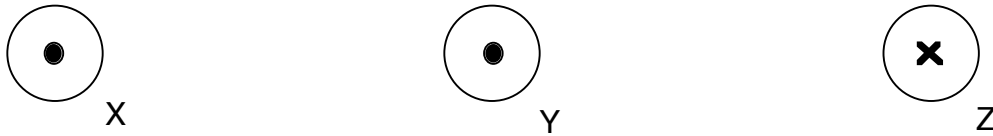
- (a) When the current in wire Y is reversed.

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

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

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

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.

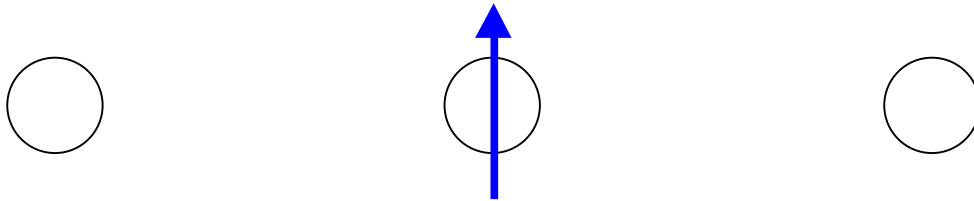
For each change, choose the effect on the total magnetic field at the location of the center wire from the following choices:

- 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.

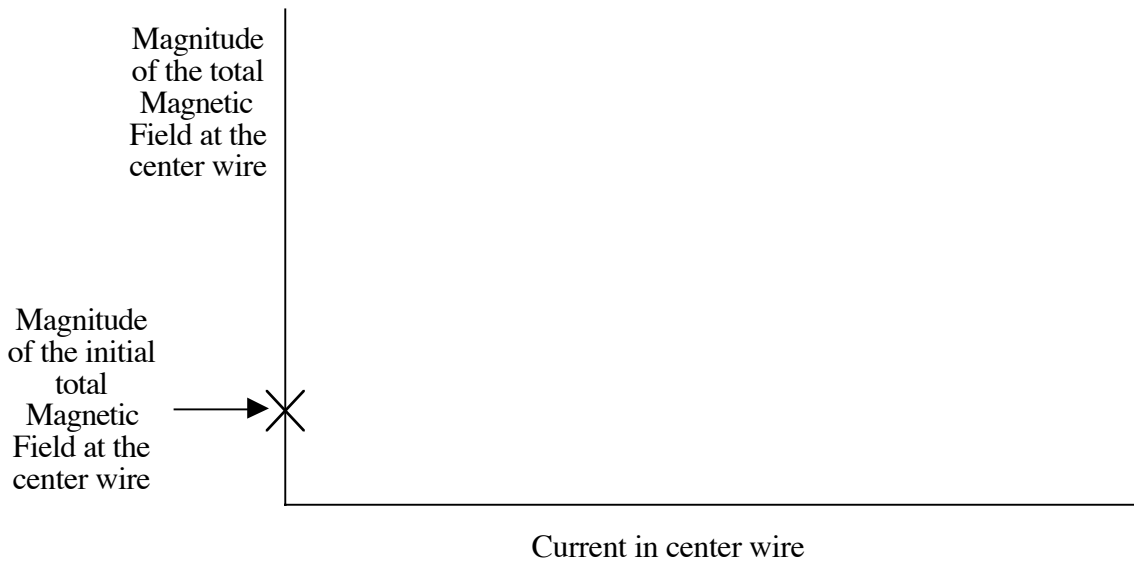
- 1) The current in wire Y is reversed. _____
- 2) The currents in all three wires are doubled. _____
- 3) The currents in the wires X and Z are reversed and cut in half. _____
- 4) The current in wire Y is reduced to one-fourth of the initial value. _____
- 5) The currents in the wires X and Z are both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

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.



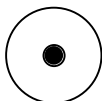
On the axes below, draw the graph of the total magnetic field versus the magnitude of the current in the center wire. (The initial value is marked with an x on the vertical axis.)



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

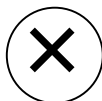
For the situation below, a student calculates the magnitude of the total magnetic field at the location of the center wire in the manner shown under the figure. The distances between the wires is 6 cm.

I = 4A (out of page)



X

I = 5A (into page)



Y

I = 2A (into page)



Z

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

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.