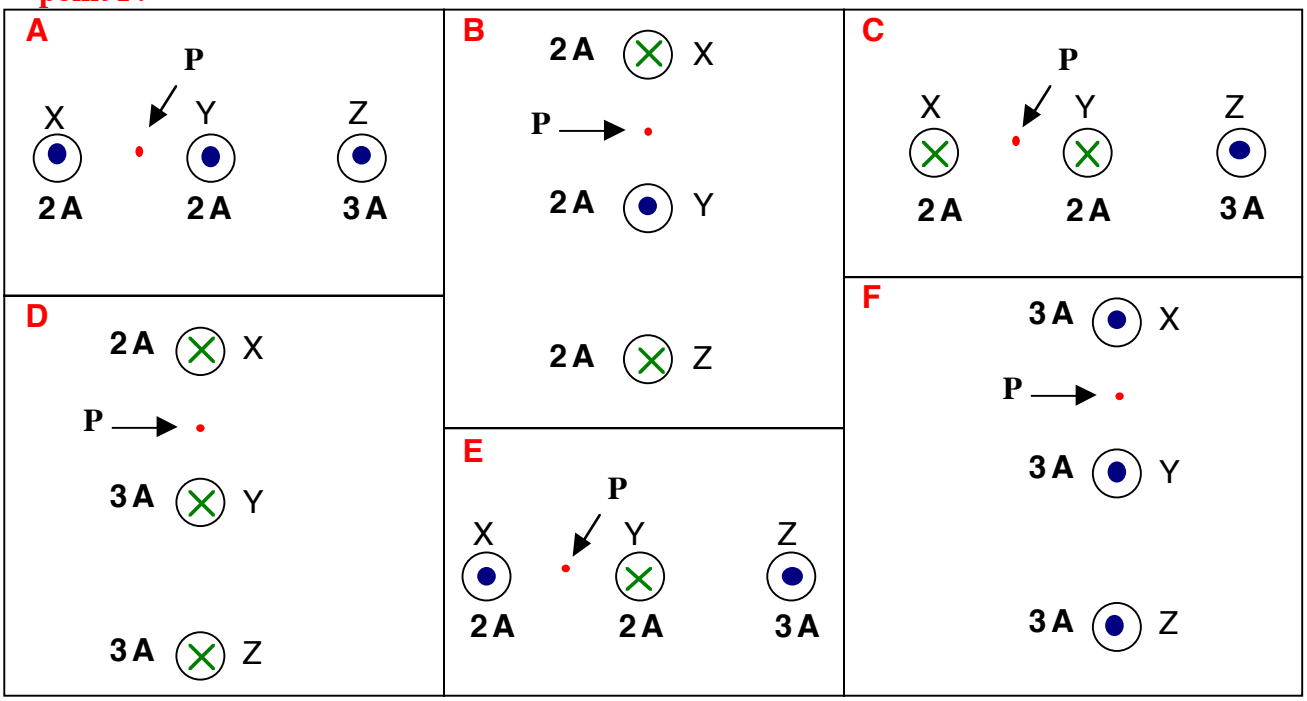
## MFF 8b: Three Parallel Current-Carrying Wires I

## MFF8b—RT1: Three Parallel Current-Carrying Wires I

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, as well as their directions, are given in each figure. In each situation, a point P is identified, and is halfway between the two wires adjacent to it.

**Rank these situations, from greatest to least, on the strength of the total magnetic field at point P.**




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

OR, The total magnetic field at P has the same strength for ALL 6 of these situations. _____

OR, the total magnetic field is zero at P for all 6 of these situations. _____

**Carefully explain your reasoning.**

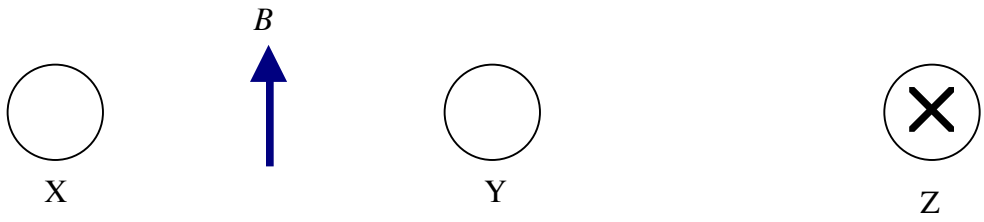
**How sure were you of your ranking? (circle one)**

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

## MFF8B—WBT1: THREE PARALLEL CURRENT-CARRYING WIRES I

The arrow in the figure below represents the magnitude and direction of the total magnetic field at that point. Wire Z at the far right is carrying a current into the page. All three wires are carrying the same magnitude of current.

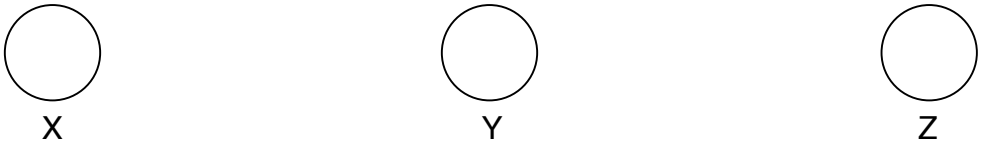
**For the situation shown below, what can you determine about the direction(s) of the currents in wires X and Y?**




**Carefully explain your reasoning.**

## MFF8b—CCT1: Three Parallel Current-Carrying Wires I

Given below are statements made by three students about the situation shown. All three wires have the same non-zero magnitude of current.




**With which, if any, of the following students do you agree and why?**

***Student A: "For this configuration, the total field midway between wires X and Y will be zero only if all 3 currents are in the same direction."***

***Student B: "For this configuration, the total field midway between wires X and Y will be zero only if the center current is opposite the other two."***

***Student C: "For this configuration, the total magnetic field midway between wires X and Y will never be zero."***

**With which, if any, student do you agree?**

Student A _____ Student B _____ Student C _____ None of them _____

**Carefully explain your reasoning.**

## MFF8B—WWT1: THREE PARALLEL CURRENT-CARRYING WIRES I

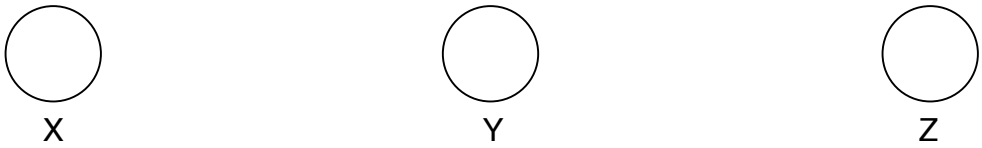
**What, if anything, is wrong with the following situation? If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the situation works as it does.**

For three long straight parallel wires lying on a table and carrying equal magnitude electric currents, it is not possible for the total magnetic field between the wires to be zero at any point.

## MFF8B—TT1: THREE PARALLEL CURRENT-CARRYING WIRES I

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

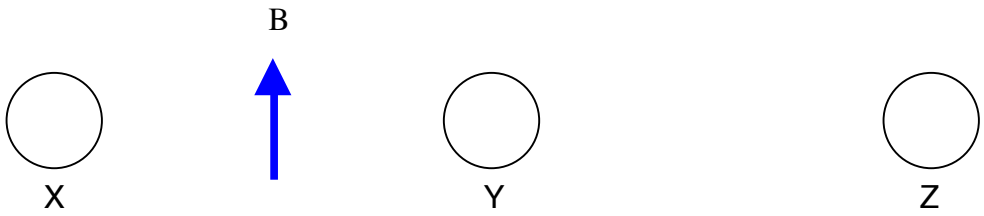
The three long straight parallel wires, whose ends we see in the figure below, all carry the same magnitude of current. The total magnetic field midway between wires X and Y has the same magnitude and direction as the total magnetic field midway between wires Y and Z.



## MFF8B—PET1: THREE PARALLEL CURRENT-CARRYING WIRES I

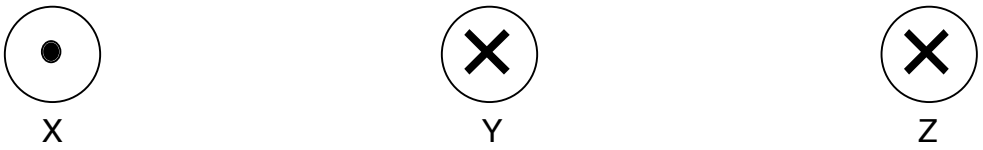
The total magnetic field is shown below at a point that is midway between wires X and Y and directed toward the top of the page. All wires have the same magnitude of current.

**How could a single current be changed to produce a total field at this point directed toward the bottom of the page?**



## MFF8B—BCT1: THREE PARALLEL CURRENT-CARRYING WIRES I

The bar chart below (left) shows the magnitude of the total magnetic field midway between wires X and Y in the figure. The currents in the three wires have the same magnitude. **Complete the bar chart below (right) to show the magnitude of the total magnetic field midway between wires Y and Z.**

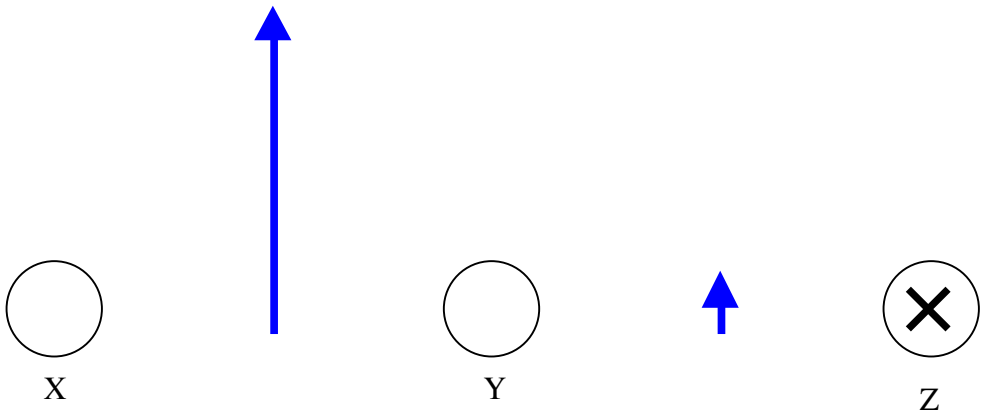




**Please carefully explain how you determined your answer.**

## MFF8B—QRT1: THREE PARALLEL CURRENT-CARRYING WIRES I

In the figure below, all currents in the three wires have the same magnitude and the arrows represent the magnetic fields at the midway points between the two adjacent wires.




What is the direction of the current in wire X?

What is the direction of the current in wire Y?

**For the situation shown above, describe how each of the following changes will affect the total magnetic field at the point midway between wires X and Y.**

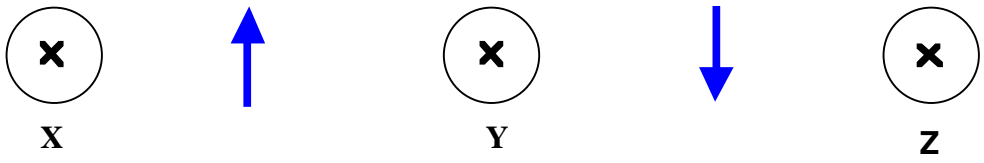
a) The current in wire Y is reversed.

b) The currents in wires X and Z are doubled.

c) The current in Y goes to zero.

d) The currents in all three wires are reversed.

## MFF8B—LMCT1: THREE PARALLEL CURRENT-CARRYING WIRES I




The arrows in the figure above represent the total magnetic field at points midway between wires X and Y and wires Y and Z. All three wires have the same magnitude of current in them directed into the page. Described below are possible changes to this situation.

**For each change, choose the effect on the field midway between X and Y from the following choices:**

a) The direction of the magnetic field remains the same, but the magnitude increases.
b) The direction of the magnetic field remains the same, but the magnitude decreases.
c) The magnitude of the magnetic field remains the same, but the direction reverses.
d) Both magnitude and direction change.
e) Both magnitude and direction will be unaffected.

1) The current in wire Z is reversed. _____

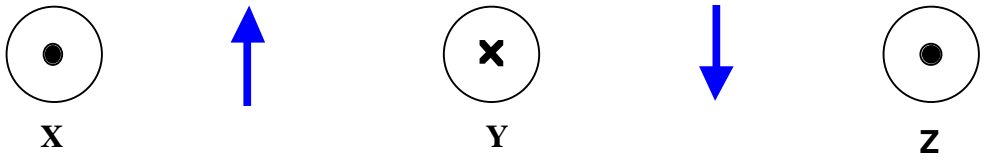
2) The currents in all three wires are doubled. _____

3) The currents in wires X and Z are reversed and cut in half. _____

4) The current in wire Y is reduced to zero. _____

5) The currents in both X and Y are both reversed. _____

## MFF8B—LMCT2: THREE PARALLEL CURRENT-CARRYING WIRES I




The arrows in the figure above represent the total magnetic field at the midway points between wires X and Y and wires Y and Z. All three wires have the same magnitude of current in them directed out of the page for X and Z and into the page for Y. Described below are possible changes to this situation.

**For each change, choose the effect on the field midway between X and Y from the following choices:**

a) The direction of the magnetic field remains the same, but the magnitude increases.
b) The direction of the magnetic field remains the same, but the magnitude decreases.
c) The magnitude of the magnetic field remains the same, but the direction reverses.
d) Both magnitude and direction change.
e) Both magnitude and direction will be unaffected.

1) The current in wire Z is reversed. _____

2) The currents in all three wires are doubled. _____

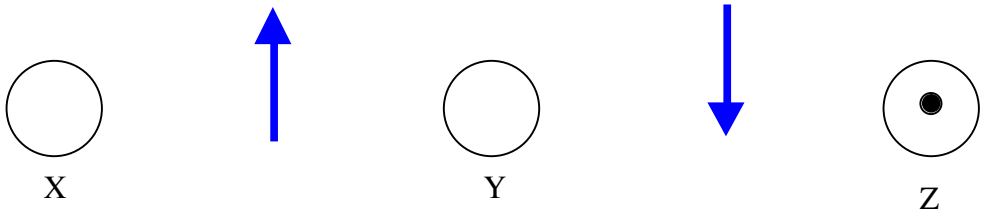
3) The currents in wires X and Z are reversed and cut in half. _____

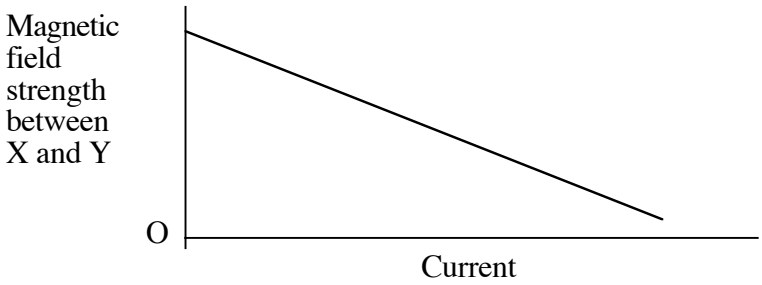
4) The current in wire Y is reduced to zero. _____

5) The currents in both X and Y are both reversed. _____

## MFF8B—CRT1: THREE PARALLEL CURRENT-CARRYING WIRES I

The arrows in the figure below represents the total magnetic fields at the midway points between wires X and Y and wires Y and Z. The graph shows how the magnitude of the total magnetic field at the point midway between wires X and Y changes as the current in only one of the wires increases. The currents in the other two wires remain constant and are the same magnitude.




**In which wire is the current increasing and how do you know?**