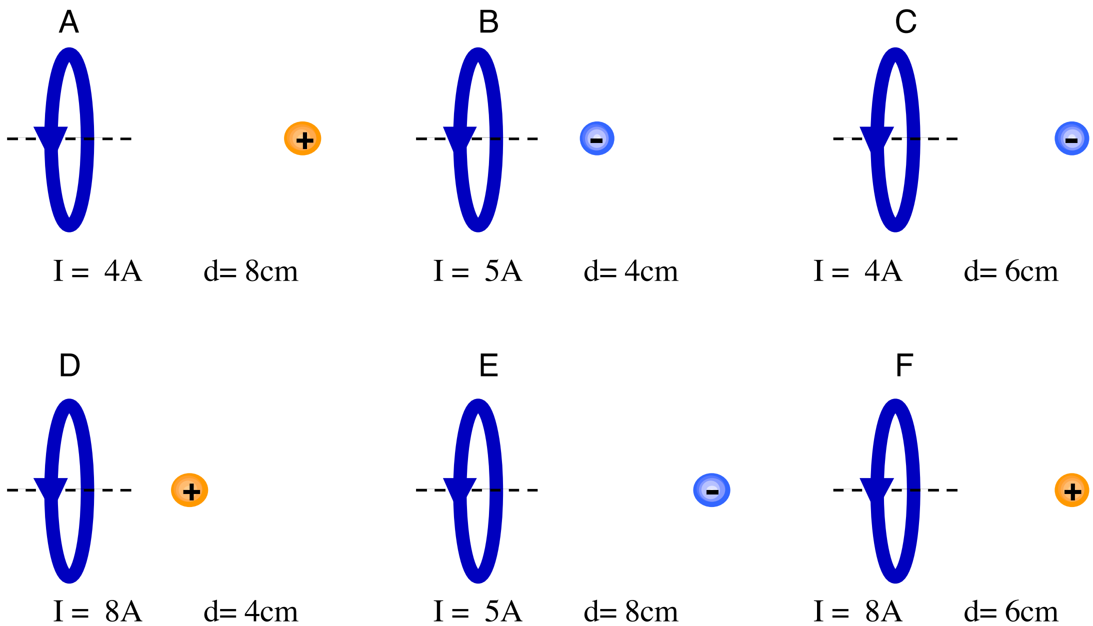
MMF 1B: CHARGE AND A CIRCULAR CURRENT LOOP

MFF1B—RT1: CHARGE AND A CIRCULAR CURRENT LOOP

Shown below are six situations where an electrically charged particle is placed at rest near a circular current carrying loop of wire, along the center line of the loop. Each figure gives the sign of the charge, the magnitude of the current in the loop and how far the charge is from the loop. All of the charges have the same magnitude and the currents in all the loops are flowing in the same direction, i.e. counter clockwise when looking from the charge toward the loop.

Rank these situations, from greatest to least, on the basis of the force exerted on the charged particle by the magnetic field due to the current in the wire.



Greatest 1 _______ 2 _______ 3 _______ 4 _______ 5 _______ 6 ________ Least

OR, All six charged particles will experience the same force. _______

OR, All six charged particle will experience no force. ___*X*____

Carefully explain your reasoning.

Although the current loop will generate a magnetic field pointing to the right at the charged particle, the field strength is constant and the particle is not moving. Hence, there is no magnetic force in any of the six cases.

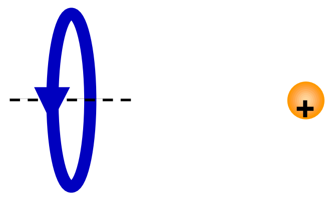
How sure were you of your ranking? (circle one)

Basically Guessed Sure Very Sure

1 2 3 4 5 6 7 8 9 10

MFF1b—CCT1: Charge and a Circular Current Loop

Consider the following statements. (The figure below shows the situation they are talking about.)



Student A: ***"A positively charged particle placed at rest near a circular current carrying loop of wire will experience a repulsive force from the magnetic field of the current."***

Student B: ***"A positively charged particle placed at rest near a circular current carrying loop of wire will experience an attractive force from the magnetic field of the current."***

Student C: ***"A positively charged particle placed at rest near a circular current carrying loop of wire will experience no force from the magnetic field of the current."***

With which, if any, student do you agree?

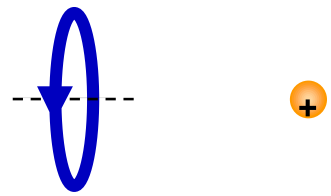
Student A _____ Student B _____ Student C __*X*___ None of them _____

Carefully explain your reasoning.

The generated magnetic field by the current carrying loop will be toward the right (for the direction of the current indicated in the figure) where the particle is located. However, the field is constant and the particle is not moving. Thus, there is *no magnetic force* ***felt by the particle.***

MFF1b—WWT1: Charge and a Circular Current Loop

What, if anything, is wrong with the statement presented below. If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the statement is correct.

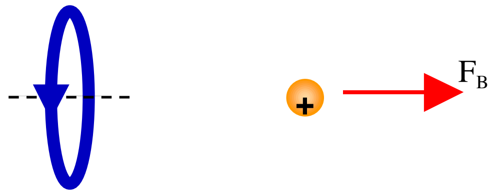


A positively charged particle placed at rest along the axis of a circular loop of current-carrying wire (see figure above) will start moving away from the loop because it will be repelled by the magnetic field produced by the constant current in the loop.

The generated magnetic field by the current-carrying loop will be toward the right where the particle is located. However, the field is constant and the particle is not moving. Thus, there is no magnetic force felt by the particle.

MFF1b—TT1: Charge and a Circular Current Loop

Something is wrong with the situation described below. Identify what is wrong and explain how to correct it.



\

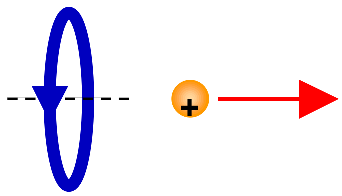
A positively charged particle placed at rest along the center line of a circular loop of wire (see figure above) that is carrying a constant current of 4 A will move away from the loop due to the magnetic force acting on the particle.

The generated magnetic field by the current carrying loop will be toward the right where the particle is located. However, the field is constant and the particle is not moving. Thus, there is *no magnetic force* ***felt by the particle.***

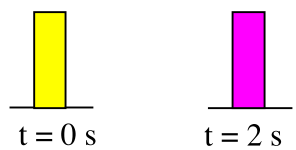
MFF1b—BCT1: Charge and a Circular Current Loop

The figure below shows a positively charged particle at a certain position relative to a circular loop of wire carrying a current of 4 A, and a bar chart (a histogram) showing the particle's speed at that point. The particle is released at t = 0 s moving with a velocity of 3 m/s and allowed to move freely.

Complete the bar chart below showing the particle's speed 2 seconds after being released.



Speed Bar Chart



Explain your answer fully.

The speed of the particle is not affected by the magnetic field since the direction of the magnetic field is in the same direction as the motion of the particle. Hence, there is no magnetic force on the particle and no "reason" for it to change it speed.

MFF1b—PET1: Charge and a Circular Current Loop

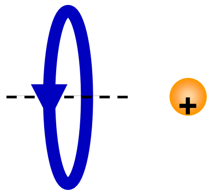
A positively charged Styrofoam packing "peanut" is suspended from a thread and hangs freely. A circular loop of wire carrying a constant current of 4 A is brought up near the peanut. The peanut swings toward the wire loop indicating that it is attracted to the wire loop.

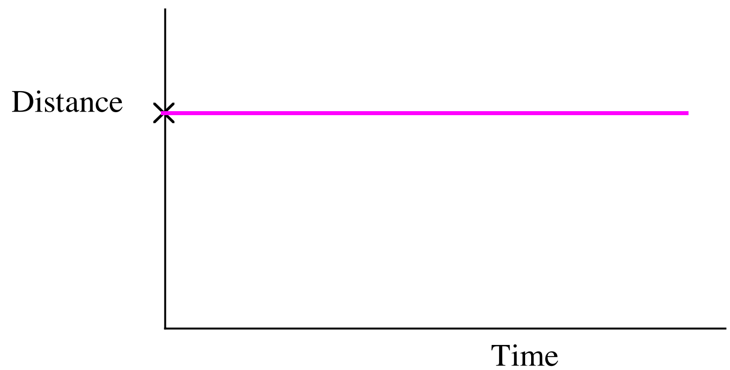
Suppose that the loop is brought up near the peanut with the opposite side of the loop near the peanut, **what will the peanut do and why?**

The Styrofoam peanut will still swing toward the wire loop. This is not a magnetic phenomena, but an electrostatic one. The "charge" in the wire loop induces a charge in the Styrofoam peanut of opposite sign. Therefore, the peanut is attracted to the circular loop.

MFF1b—CRT1: Charge and a Circular Current Loop

A positively charged particle is released from rest near a circular wire loop that is carrying a constant current of 4 A. The particle is placed on the line running through the center of the loop. **On the axes below, plot the distance of the particle from the wire loop versus time. (The particle's initial distance from the loop is marked with an X on the vertical axis.)**





Explain fully why the graph looks as you have drawn it.

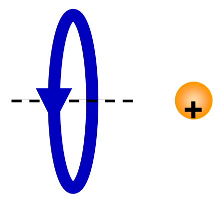
The distance does not change since the charged particle does not feel a magnetic force (since it is not moving) due to the circular loop.

MFF1B—LMCT1: CHARGE AND A CIRCULAR CURRENT LOOP

A positively charged particle is placed at rest 3 cm from a circular loop of wire carrying 4 A. The particle is on the line running through the center of the loop as shown below. Several modifications to this initial situation are going to be described below. For each, **identify how the magnetic force, if any, exerted on the particle will change, if it does.**

The same possible answers are available for all changes. They are:

(a) this modifications will increase the force.
(b) this modifications will decrease the force.
(c) this modifications will reverse the direction of the force.
(d) this modifications will reverse the direction of the force and alter the strength.
(e) there was no force and this change will not alter that.



All the modifications are of the original situation.

(1) The current in the wire loop is doubled ___*E*__

(2) The particle is placed 7 cm from the wire loop. ___*E*__

(3) The current in the loop is reversed. ___*E*__

(4) The diameter of the loop is increased. ___*E*__

(5) The charge polarity is reversed to negative. ___*E*__

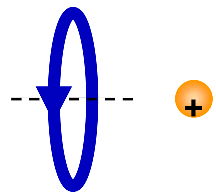
(6) The loop is moved toward the charge keeping the charge on the centerline. ___*E*__

(7) The diameter of the loop is decreased. ____*E*__

.

MFF1B—QRT1: CHARGE AND A CIRCULAR CURRENT LOOP

The figure below shows a positively charged particle placed along the axis at rest at a certain position relative to a circular loop of wire that is carrying a constant current of 4 A. A number of modifications are going to be made to this situation. **In each case, explain how the modification will affect, if it does, the magnetic force exerted on the particle.**



(a) The charge on the particle is tripled.

No effect since the magnetic force is zero since the velocity is zero

(b) The current in the loop is decreased.

No effect since the magnetic force is zero since the velocity is zero

(c) The charge is placed closer to the loop.

No effect since the magnetic force is zero since the velocity is zero

(d) The loop is reversed so the particle is sitting near the other side.

No effect since the magnetic force is zero since the velocity is zero

(e) The particle's charge is reversed.

No effect since the magnetic force is zero since the velocity is zero

(f) The diameter of the loop is doubled.

No effect since the magnetic force is zero since the velocity is zero