MFF 7A: CURRENT-CARRYING CIRCULAR LOOP

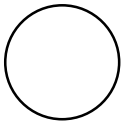
MFF7A-RT1: CURRENT-CARRYING CIRCULAR LOOP

The figures below show current carrying, circular loops. The current in the loop is given and is in the clockwise direction. Also given is the radius of the loop.

Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic field at the center of the circular loop.

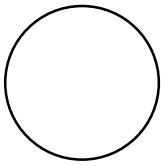
$I = 3$ A, r = 2 *cm*

A



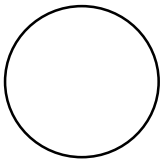
$I = 2$ A, r = 3 *cm*

B



$I = 1$ A, r = 4 *cm*

C

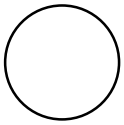


$I = 3$ A, r = 4 *cm*

D

$I = 2$ A, r = 2 *cm*

E



$I = 1$ A, r = 3 *cm*

F

Greatest 1 ___*A*___ 2 ___*E*___ 3 ___*D*___ 4 ___*B*___ 5 ___*F*___ 6 ___*C*___ Least

Or, the field is the same for all six situations. _____

Or, the ranking for the fields cannot be determined. _____

Please carefully explain your reasoning.

Based on $B = \mu_o I / 2r$. Thus, $B \propto I / r$.

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

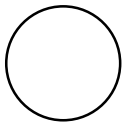
Basically Guessed				Sure					Very Sure
1	2	3	4	5	6	7	8	9	**10**

MFF7A-RT2: CURRENT-CARRYING CIRCULAR COIL

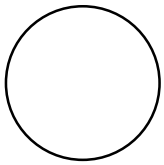
The figures below show current carrying, circular coil. The current in the coil is given and is in the clockwise direction. Also given is the radius of the coil and the number of turns of wire making up the circular coil.

Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic field at the center of the circular coil.

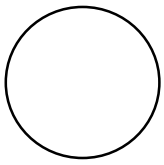
$N = 10$
$I = 3$ A, r = 2 *cm*
A



$N = 15$
$I = 2$ A, r = 3 *cm*
B

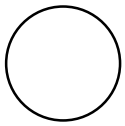


$N = 10$
$I = 1$ A, r = 4 *cm*
C



$N = 15$
$I = 1$ A, r = 4 *cm*
D

$N = 20$
$I = 2$ A, r = 2 *cm*
E



$N = 15$
$I = 3$ A, r = 3 *cm*
F

Greatest 1 __*E*____ 2 ___*AF*___ 3 _____ 4 ___*B*___ 5 __*D*___ 6 ___*C*___ Least

Or, the field is the same for all six situations. _____

Or, the ranking for the fields cannot be determined. _____

Please carefully explain your reasoning.

Based on $B = N \mu_o I / 2 r$. Thus, $B \propto N I / r$.

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

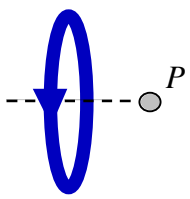
Basically Guessed				Sure					Very Sure
1	2	3	4	5	6	7	8	9	**10**

MFF7A-RT3: CURRENT-CARRYING CIRCULAR LOOP

The figures below show current carrying, circular loops, all with the same radius. In each figure, the current flows as shown by the arrow. Also given is a point in space, P, and its distance along the axis from center of loop.

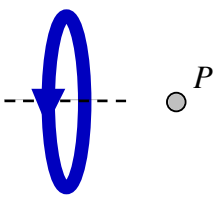
Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic field at point P.

A



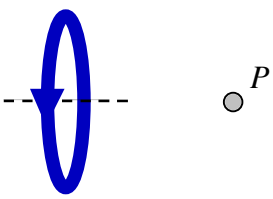
I = 3A d= 1cm

B



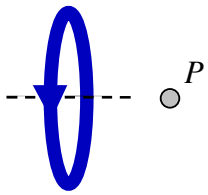
I = 2A d= 2cm

C



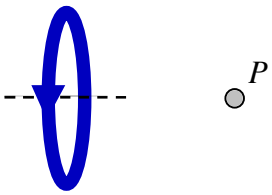
I = 1A d= 3cm

D



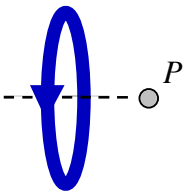
I = 1A d= 2cm

E



I = 3A d= 3cm

F



I = 2A d= 1cm

Greatest 1 __*A*___ 2 ___*F*___ 3 ___*B*___ 4 ___*E*___ 5 ___*D*___ 6 ___*C*___ Least

Or, the field is the same for all six situations. _____

Or, the ranking for the fields cannot be determined. _____

Please carefully explain your reasoning.

Based on $B = \mu_o I r^2 / 2 (r^2 + d^2)^{3/2}$. If we let r = 1, then $B \propto I / 2(1 + d^2)^{3/2}$.

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

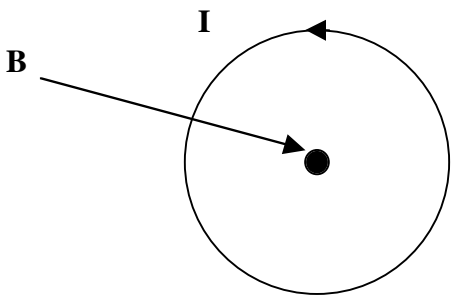
Basically Guessed				Sure					Very Sure
1	2	3	4	5	6	7	8	9	**10**

MFF7A-WBT1: CURRENT-CARRYING CIRCULAR LOOP

Draw and describe a physical situation to which the equation below could apply.

$$3.14 \bullet 10^{-5}\,\mathrm{T} = \frac{\left(4\pi \bullet 10^{-7} T \bullet m/A\right)\left(2.50 A\right)}{2\left(.05 m\right)}$$

The equation describes the magnitude of the magnetic field at the center of a circular loop of radius .05 m with a current of 2.50 A.

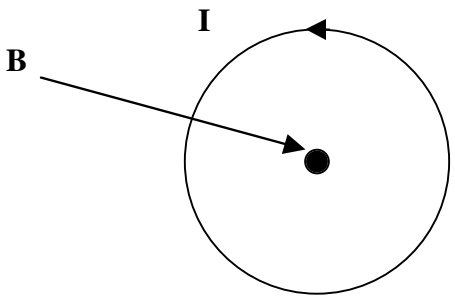


MFF7A-WBT2: CURRENT-CARRYING CIRCULAR LOOP

Draw and describe a physical arrangement to which the equation below could apply.

$$6.37\text{A} = \frac{\left(1.60 \bullet 10^{-5} T\right)\left(.025 m\right)}{10\left(4\pi \bullet 10^{-7} T \bullet m/A\right)}$$

The equation describes the magnitude of the magnetic field at the center of a circular loop of radius .025 m with a current of 6.37 A and 10 turns of wire. The equation is solved for the current in the circular loop.

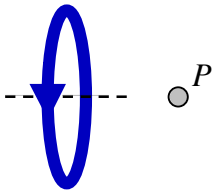


MFF7A-WBT3: CURRENT-CARRYING CIRCULAR LOOP

Draw and describe a physical arrangement to which the equation below could apply.

$$4.83\times10^{-2}T=\frac{(4\pi\times10^{-7}T\bullet m/A)(1.50A)(0.10m)^2}{2[(.05m)^2+(.10m)^2]^{3/2}}$$

The equation describes the magnitude of the magnetic field at a distance of .05 m on the perpendicular axis going through the center of a circular loop of radius .10 m with a current of 1.50 A.



MFF7A-WWT1: CURRENT-CARRYING CIRCULAR LOOP

"A circular loop lying flat in a plane is conducting current counter-clockwise around the loop as viewed from above. The magnetic field at the center of the loop points into the plane."

What, if anything, is wrong with the above statement about this situation? If something is wrong, explain the error and how to correct it. If the statement is legitimate as it stands explain why it is valid.

The direction of the magnetic field at the center of the circular loop would be out of the plane.

MFF7A-WWT2: CURRENT-CARRYING CIRCULAR COIL

"A circular coil is conducting current in the clockwise direction as viewed from above. Since the coil is made of several turns of wire, the magnetic field is larger than for a single loop. If the coil is lying flat in a plane, the direction of the magnetic field through the center of the loop is out of the plane."

What, if anything, is wrong with the above statement about this situation? If something is wrong, explain the error and how to correct it. If the statement is legitimate as it stands explain why it is valid.

The statement would be correct if the direction of the magnetic field was down into the plane.

MFF7A-WWT3: CURRENT-CARRYING CIRCULAR LOOP

What, if anything, is wrong with the following statement? If something is wrong, explain the error and how to correct it. If the statement is legitimate as it stands, explain why it is valid.

"A circular loop is conducting current clockwise around the loop. The strength of the magnetic field varies inversely with the distance from the loop on the central axis perpendicular to the plane of the loop."

Not exactly. The student would be correct if the statement was "the strength of the magnetic field varies inversely with the $(r^2 + d^2)^{3/2}$ ***…"***

MFF7A-TT1: CURRENT-CARRYING CIRCULAR LOOP

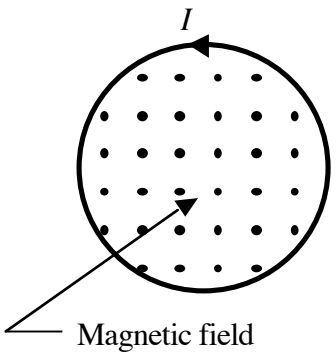
There is at least one error in the statement below, identify the error(s) and explain how to correct it (them.)

"A circular loop is lying on a table. The direction of the magnetic field at the center of the loop is into the table. The current must be in the counter-clockwise direction around the loop when viewed from above table."

The current must be in the clockwise direction around the loop.

MFF7A-TT2: CURRENT-CARRYING CIRCULAR LOOP

As shown in the figure below, a current carrying, circular loop is conducting current in the counter-clockwise direction. The magnetic field generated by the current is uniform inside the loop and directed out of the paper as shown.

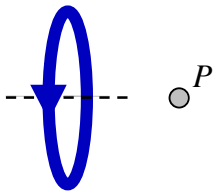


There is at least one error in the diagram and statement above, identify the error(s) and explain how to correct it (them.)

The magnetic field generated is not uniform inside the circular loop. It would be correct if we said that the magnetic field at the center of the loop is directed out of the paper.

MFF7A-TT3: CURRENT-CARRYING CIRCULAR LOOP

As shown in the figure below, a circular loop is conducting current in the direction indicated by the arrow. The direction of the magnetic field at point P is to the left. Point P is on the central axis to the plane of the circular loop.

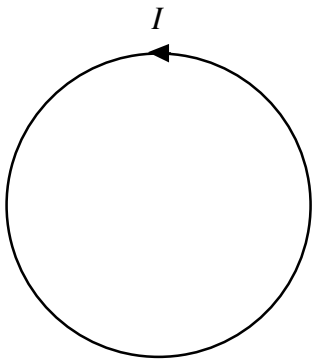


There is at least one error in the diagram and statement above, identify the error(s) and explain how to correct it (them).

The direction of the magnetic field at point P is to the right.

MFF7A-LMCT1: CURRENT-CARRYING CIRCULAR LOOP

As shown in the figure below, a circular loop is conducting current counter-clockwise around the loop. The magnetic field at the center of the loop is directed out of the paper.



A number of changes in this situation will be described below. For each change, you are to identify how the change will affect, if it will, the magnetic field generated by the current-carrying circular loop at its center.

The possible answers are:

A. this change will alter the direction of the magnetic field at the center of the loop.
B. this change will increase the magnitude of the magnetic field generated by the loop.
C. this change will decrease the magnitude of the magnetic field generated by the loop.
D. this change will alter both the magnitude and direction of the magnetic field generated by the loop.
E. this change will not affect the magnetic field generated by the loop.

Each change below refers to the original situation stated above:

The current in the loop is replaced by a larger current. ___*B*____

The direction of the current in the loop is reversed. ___*A*____

The current in the loop is reduced to zero. ___*C*____

The current in the loop is replaced by a smaller current. ___*C*____

The radius of the loop is increased. ___*C*____

The radius of the loop is decreased. ___*B*____

The loop is replaced by a coil with several turns that has the same size and current. ___*B*____

MFF7A-PET1: CURRENT-CARRYING CIRCULAR LOOP

A circular loop is initially conducting current in a counter-clockwise direction. The current is reversed.

What will happen to the magnetic field generated by the current carrying circular loop? Explain fully.

The direction of the magnetic field at the center of the loop will also reverse in direction. The magnitude of the magnetic field will remain the same if the current is the same value as before.

MFF7A-PET2: CURRENT-CARRYING CIRCULAR LOOP

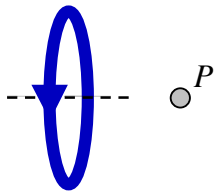
A current-carrying, circular loop lying in the plane of this page produces magnetic field at the center of the loop that is out of the page. The magnetic field is made larger than before.

What could have occurred to the circular coil to cause the magnetic field to increase? Explain fully.

Since $B = m_o I / 2 r$, you would need to increase I, decrease r, a combination of the two, or increase the number of loops.

MFF7A-M/MCT1: CURRENT-CARRYING CIRCULAR LOOP

The figure below shows a circular loop, of radius 10cm, with current flowing in the direction indicated by the arrow. The current is 1.5 A and point P is located 5 cm along the central axis perpendicular to the plane of the loop from the center of the loop.



Given below is a student's calculation for the magnetic field generated by the current carrying loop.

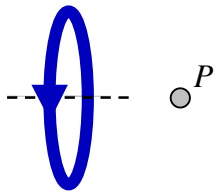
$$6.74\times10^{-6}\,\mathrm{T} = \frac{(4\pi\times10^{-7}\,\mathrm{T\bullet m/A})(1.50\mathrm{A})(.10\mathrm{m})^2}{2\left[(.05\mathrm{m})^2+(.10\mathrm{m})^2\right]^{3/2}}$$

Is this calculation meaningful (i.e., it tells us something legitimate about this situation) or is it meaningless (i.e., the value calculated is either nonsense, or it tells us nothing legitimate about this situation)?

meaningful

MFF7A-M/MCT2: CURRENT-CARRYING CIRCULAR LOOP

The figure below shows a circular loop, of radius 10cm, with current flowing in the direction indicated by the arrow. The current is 1.5 A and point P is located 5 cm along the central axis perpendicular to the plane of the loop from the center of the loop.



Given below is a student's calculation for the magnetic field generated by the current carrying loop.

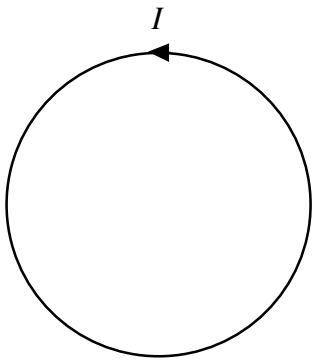
$$B = \frac{\mu_0 I}{2r} = \frac{(4\pi \times 10^{-7}\,\mathrm{T \bullet m/A})(1.50\,\mathrm{A})}{2[.10\mathrm{m}]}$$

Is this calculation meaningful (i.e., it tells us something legitimate about this situation) or is it meaningless (i.e., the value calculated is either nonsense, or it tells us nothing legitimate about this situation)?

Meaningless-this is the equation for the magnetic field at the center of the loop.

MFF7A-QRT1: CURRENT-CARRYING CIRCULAR LOOP

The figure below shows a current carrying circular loop.



What is the direction of the magnetic field at the center of the loop due to the current carrying loop?

The direction of the magnetic field is out of the plane.

What would happen to the direction of the magnetic field at the center of the loop if the current is reversed?

The direction would reverse. It would be into the plane.

What would happen to the magnitude of the magnetic field at the center of the loop if the current in the loop is increased?

The magnitude would increase.

What would happen to the magnitude of the magnetic field at the center of the loop if the current in the loop is decreased?

The magnitude would decrease.

What would happen to the magnitude of the magnetic field at the center of the loop if the radius of the loop is increased?

The magnitude would decrease.

What would happen to the magnitude of the magnetic field at the center of the loop if the radius of the loop is decreased?

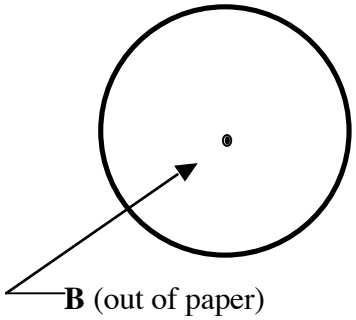
The magnitude would increase.

What would happen to the magnitude of the magnetic field at the center of the loop if the number of turns of wire making up the loop is increased?

The magnitude would increase.

MFF7A-QRT2: CURRENT-CARRYING CIRCULAR LOOP

The figure below shows the magnetic field due to a current carrying, circular loop at the center of the loop.



What is the direction of the current in the loop?

The current is in the counter-clockwise direction in the circular loop.

If we reversed the direction of the current, what would be the direction of the magnetic field generated by the loop at the center of the loop?

The direction of the magnetic field would be into the paper.

If we increase the current flowing in the loop, what will happen to the strength of the generated magnetic field?

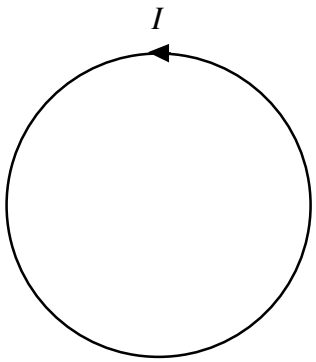
The strength of the magnetic field would increase.

If we increase the loops of wire that make up the circular coil, what will happen to the strength of the generated magnetic field?

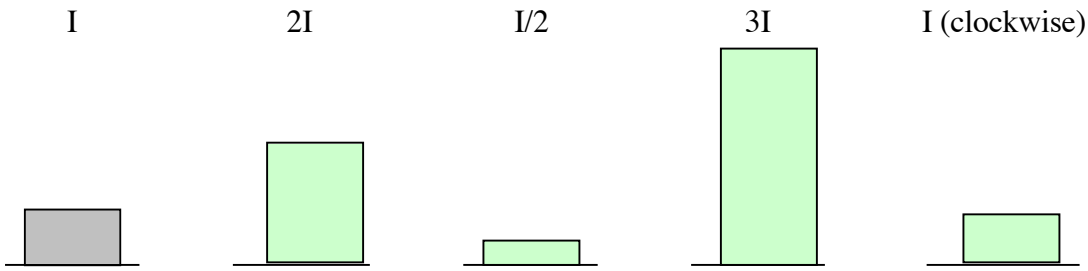
The strength of the magnetic field would increase.

MFF7A-BCT1: CURRENT-CARRYING CIRCULAR LOOP

The figure below shows a current carrying circular loop conducting current in a counter-clockwise direction.



Represent this situation with a bar chart of the magnitude of the magnetic field at the center of the loop if the current can change. The amount of current is indicated on the bar chart.

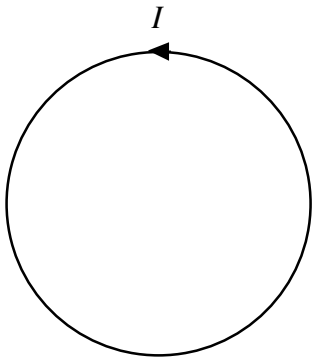


Explain the reasoning behind your bar chart:

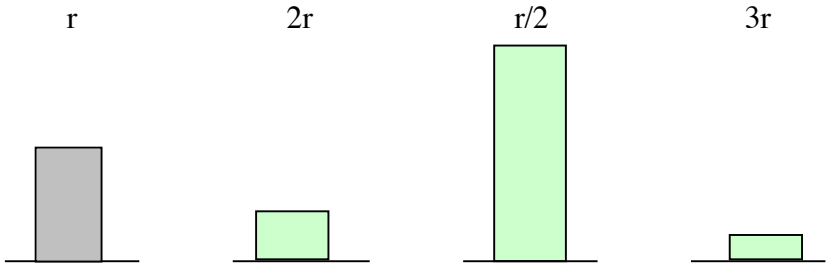
Based on $B = \mu_o I / 2 r$.

MFF7A-BCT2: CURRENT-CARRYING CIRCULAR LOOP

The figure below shows a current carrying circular loop conducting current in a counter-clockwise direction.



Represent this situation with a bar chart of the magnitude of the magnetic field at the center of the loop if the radius can change. The radius value is indicated on the bar chart.



Explain the reasoning behind your bar chart:

Based on $B = \mu_0 I / 2 r$.

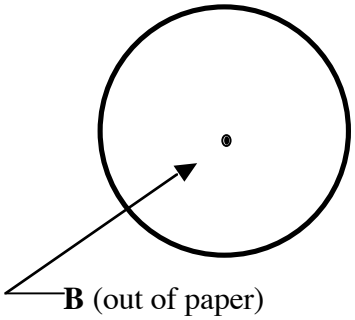
MFF7A-CRT1: CURRENT-CARRYING CIRCULAR LOOP

The equation below represents the magnetic field due to a current carrying circular loop.

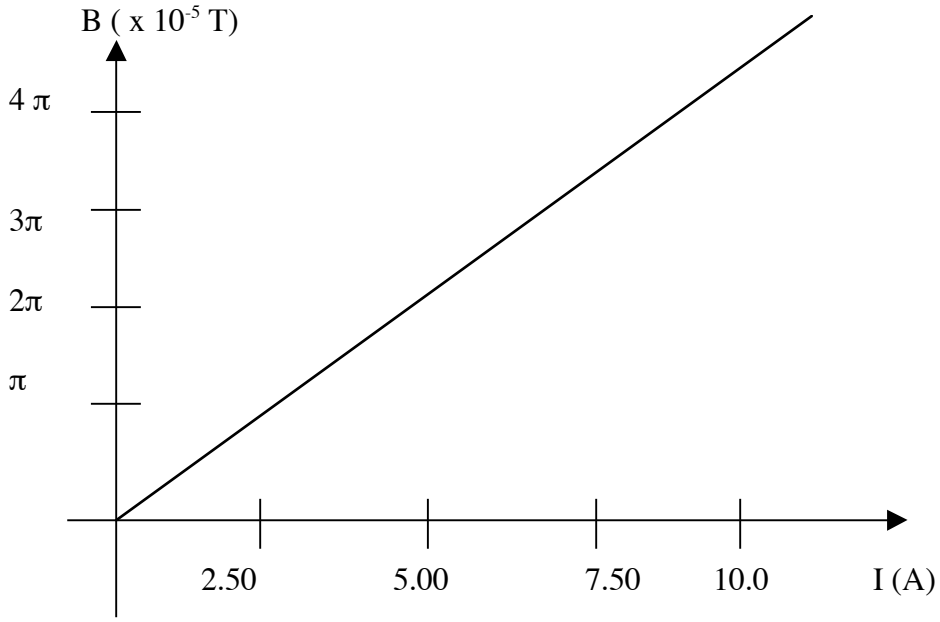
$$3.14\times10^{-5}T=\frac{\left(4\pi\times10^{-7}T\cdot m/A\right)\left(2.50A\right)}{2\left(.05m\right)}$$

Draw an appropriate diagram of the current carrying loop and magnetic field represented by this equation.

r = .05 m, I = 2.50 A

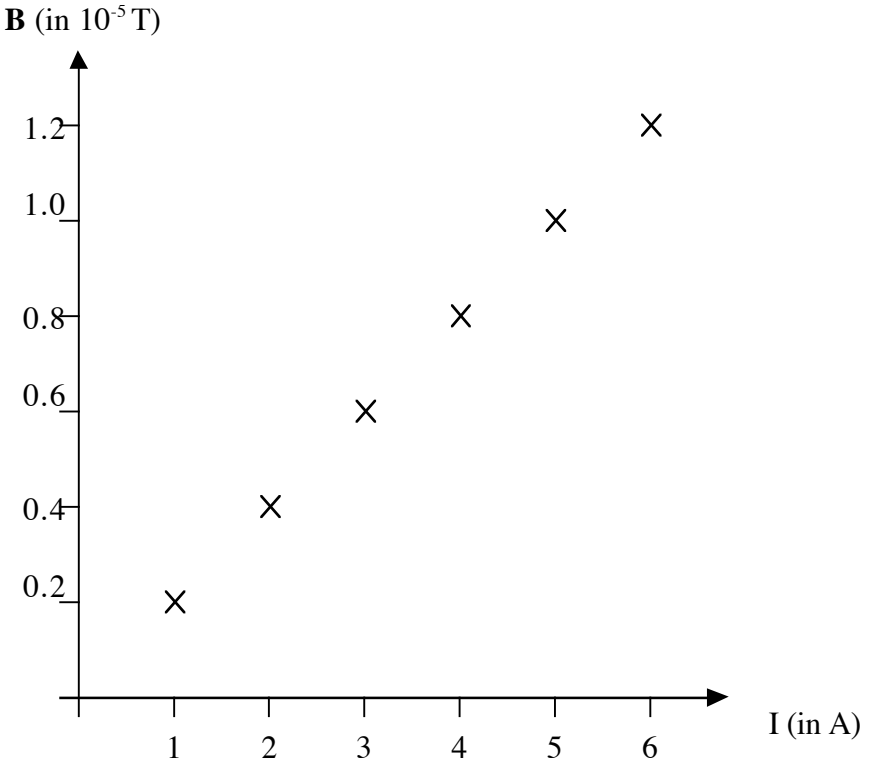


If the current in this circular loop varies, draw an appropriate graph to represent the magnetic field strength versus current for the changing current.



MFF7A-CRT2: CURRENT-CARRYING CIRCULAR LOOP

Shown below is the graph of the magnetic field generated by a current in a circular loop. The magnetic field is measured at the center of the circular loop.



Setup (write) an appropriate equation that would give the radius r of the circular loop based on this graph.

Based on B $= \mu_o I / 2r$

$= (.2 \times 10^{-5}\ T)\ I \quad (T)$