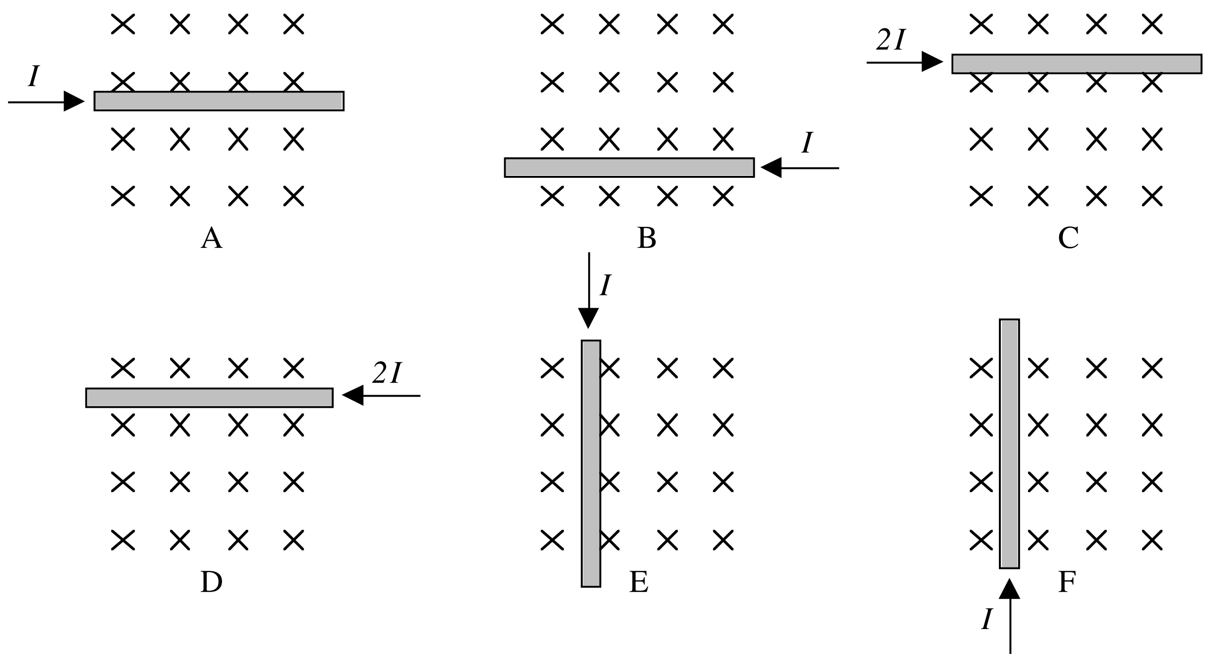
MFF 4A: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

MFF4a-RT1: Straight Current-Carrying Wire in a Uniform Magnetic Field

The figures below show current carrying long straight wire segments in identical uniform magnetic fields directed into the page. All the magnetic field regions are the same width and height.

Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic force on each wire.



Greatest 1 __*CD*____ 2 _______ 3 __*ABEF*____ 4 _______ 5 _______ 6 _______ Least

Or, the force is the same for all six situations. _______

Or, the ranking for the forces cannot be determined. _______

Please carefully explain your reasoning.

Based on $F_B = I\,\Delta l\,B\sin\theta$. All B's, θ's, and Δl's are equal. Thus, $F_B \propto I$.

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

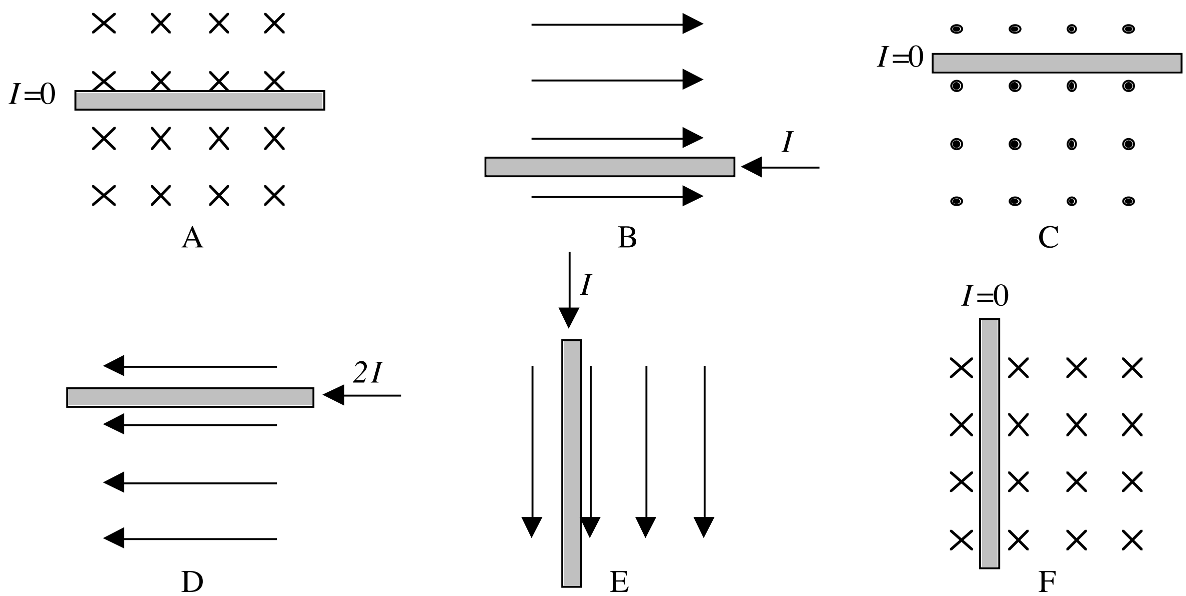
Basically Guessed — Sure — Very Sure

1 2 3 4 5 6 7 8 9 10

MFF4a-RT2: Straight Current-Carrying Wire in a Uniform Magnetic Field

The figures below show current carrying long straight wire segments in uniform magnetic fields. The magnetic fields all have the same strength. Magnetic fields whose directions are into the paper are represented by **x** and those that come out of the paper are represented by •. All the magnetic field regions are the same width, length, and height.

Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic force on each wire.



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

Or, the force is the same for all six situations. __*X*____

Or, the ranking for the forces cannot be determined. ______

Please carefully explain your reasoning.

Based on $F_B = I\,\Delta l\,B\sin\theta$. All F's are 0 either because $I = 0$ or $\theta = 0^\circ$ or 180°.

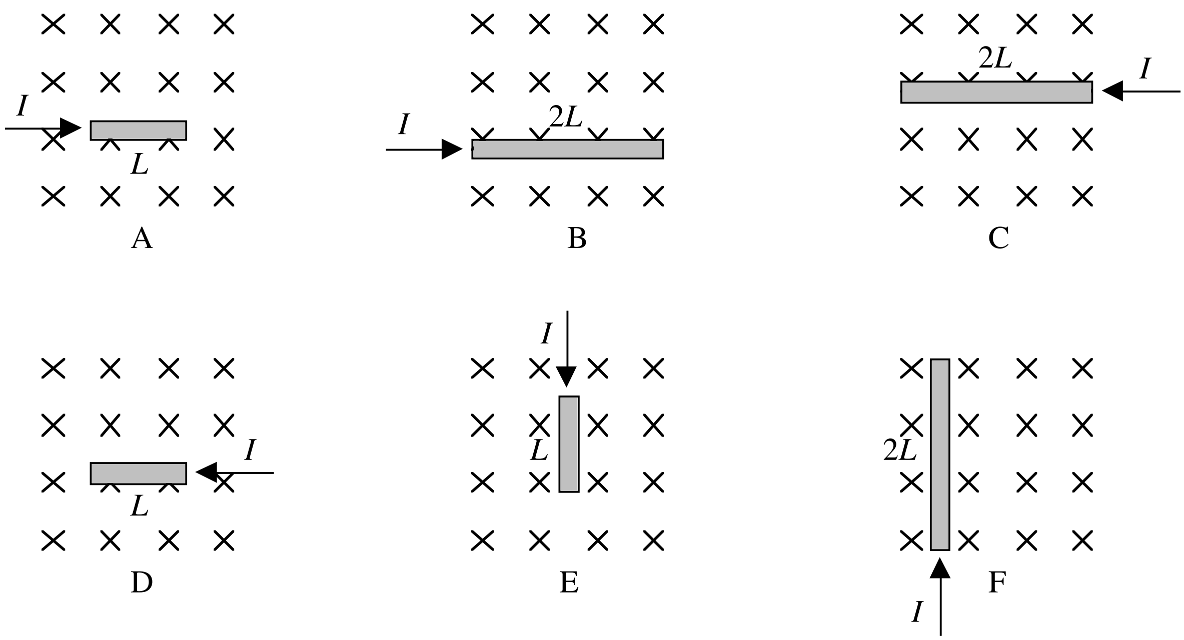
How sure were you of your ranking? (circle one)

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

MFF4A-RT3: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

The figures below show current carrying long straight wire segments in an identical uniform magnetic field directed into the paper. All the magnetic field regions are the same width, length, and height. All the currents are the same magnitude.

Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic force on each wire.



Greatest 1 ___*BCF*___ 2 ______ 3 ______ 4 ___*ADE*___ 5 ______ 6 ______ Least

Or, the force is the same for all six situations. ______

Or, the ranking for the forces cannot be determined. ______

Please carefully explain your reasoning.

Based on $F_B = I\,\Delta l\,B \sin\theta$. All B's, θ's, and I's are equal. Thus, $F_B \propto \Delta l$.

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

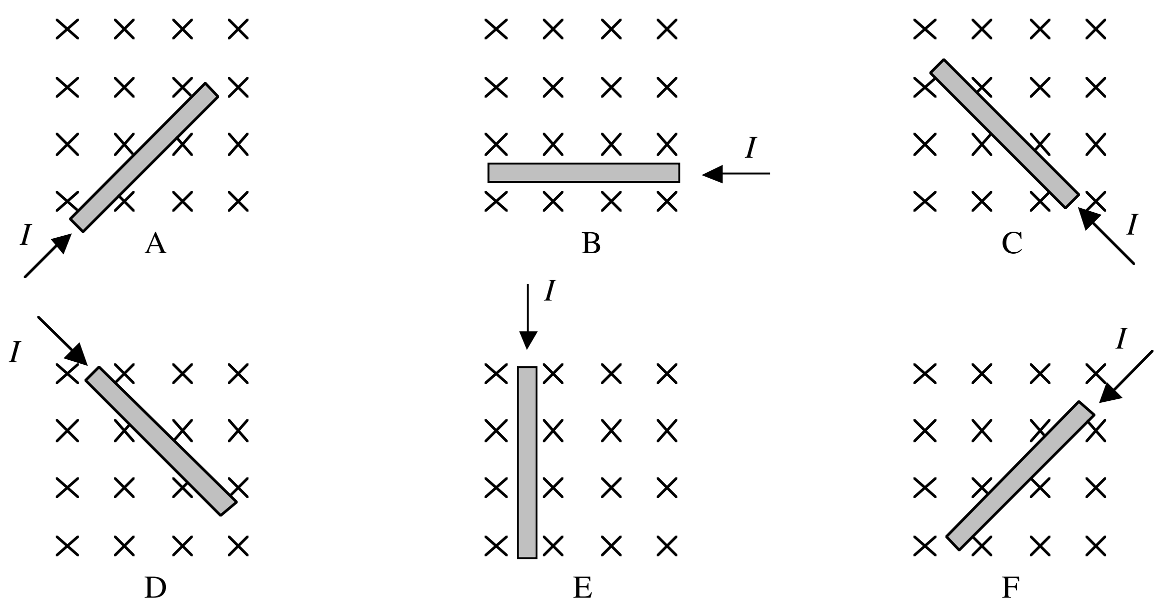
Basically Guessed | Sure | Very Sure

1 2 3 4 5 6 7 8 9 10

MFF4a-RT4: Straight Current-Carrying Wire in a Uniform Magnetic Field

The figures below show current carrying identically long straight wire segment in an identical uniform magnetic field directed into the page. All the magnetic field regions are the same width and height.

Rank these situations from greatest to least on the basis of the strength (magnitude) of the magnetic force on each wire.



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

Or, the force is the same for all six situations. __*X*____

Or, the ranking for the forces cannot be determined. ______

Please carefully explain your reasoning.

Based on $F_B = I\,\Delta l\,B \sin\theta$. All B's, θ's, I's, and Δl's are equal. Thus, F_B is the same for all.

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

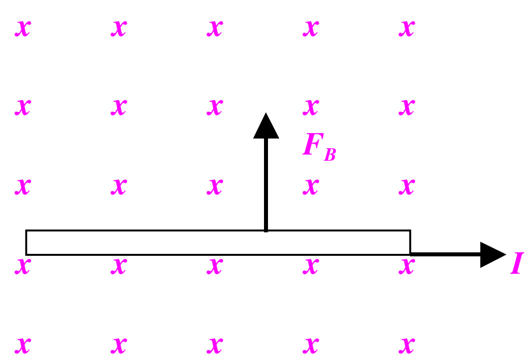
Basically Guessed				Sure					Very Sure
1	2	3	4	5	6	7	8	9	10

MFF4a-WBT1: Straight Current-Carrying Wire in a Uniform Magnetic Field

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

$$6.48\text{N} = (1.60\text{A})(2.50\text{m})(1.62\text{T})$$

A long, straight wire of length 2.50 m, is conducting current (I=1.60 A) in a magnetic field, B = 1.62 T. The wire is conducting current toward the right (east) and the magnetic field is into the page. The wire feels a magnetic force of 6.48 N pointing toward the top of the page.

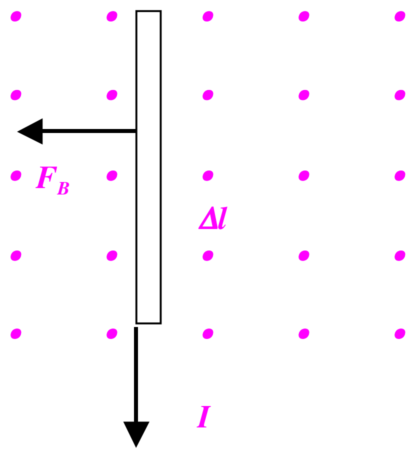


MFF4a-WBT2: Straight Current-Carrying Wire in a Uniform Magnetic Field

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

$$-6.48\hat{\mathbf{i}}\text{N} = (-1.60\text{A})(2.50\hat{\mathbf{j}}\text{m})\mathbf{x}(1.62\hat{\mathbf{k}}\text{T})$$

A long, straight wire of length 2.50 m, is conducting current (I=1.60 A) in a magnetic field, B = 1.62 T. The wire is conducting current toward the bottom of the page and the magnetic field is out of the page. The wire feels a magnetic force of 6.48 N pointing toward the left (west).

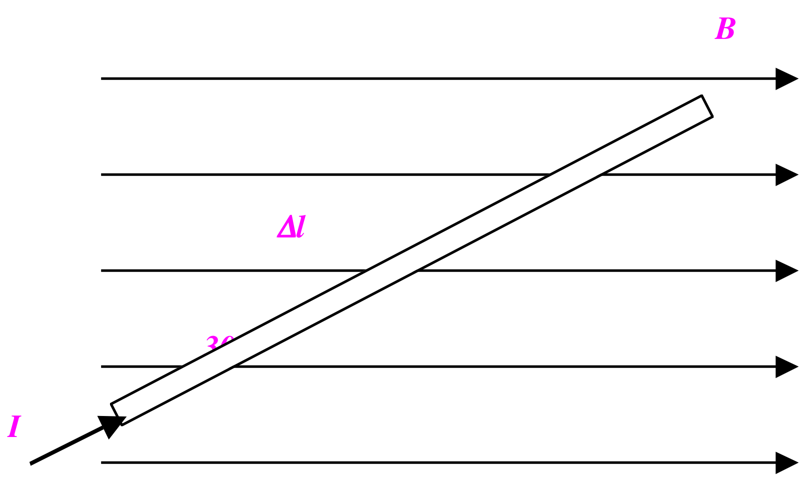


MFF4A-WBT3: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

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

$$7.20\text{N} = (3.20\text{A})(1.50\text{m})(3.00\text{T})\sin 30°$$

A long, straight wire of length 1.50 m, is conducting current (I=3.20 A) in a magnetic field, B = 3.00 T. The wire is conducting current toward the right and up 30˚ to the horizontal. The magnetic field is toward the right. The wire feels a magnetic force of 7.20 N pointing into the page.

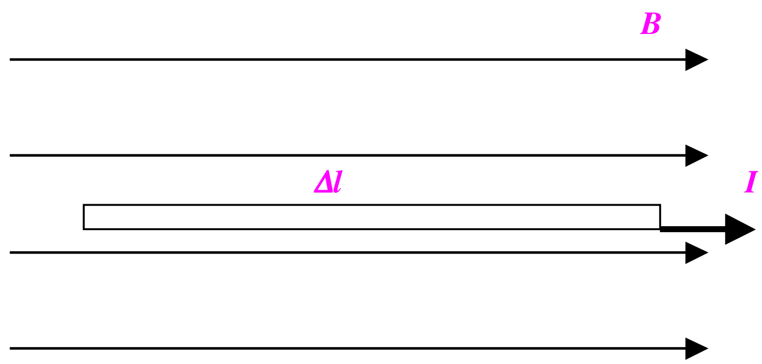


MFF4a-WBT4: Straight Current-Carrying Wire in a Uniform Magnetic Field

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

$$0\text{N} = (1.60\text{A})(2.50\text{m})(1.62\text{T})\sin 0°$$

A long, straight wire of length 2.50 m, is conducting current (I=1.60 A) in a magnetic field, B = 1.62 T. The wire is conducting current toward the right. The magnetic field is also toward the right. The wire feels no magnetic force.



MFF4A-CCT1: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

Consider the following statements made by three students.

***Student I:** "For a straight wire to feel a magnetic force, it only needs to be within a magnetic field."*

***Student II:** "For a straight wire to feel a magnetic force, it only needs to be conducting current and within a magnetic field."*

***Student III:** "For a straight wire to feel a magnetic force, the wire must be conducting current, within a magnetic field and cutting across the magnetic field.*

Which, if any, of these three students do you believe is correct? Explain fully why you chose as you did.

Student III is correct.

MFF4a-CCT2: Straight Current-Carrying Wire in a Uniform Magnetic Field

Consider the following statements made by three students.

Student I: "For a straight wire to feel a magnetic force, it only needs to be within a magnetic field."

Student II: "For a straight wire to feel a magnetic force, the wire must be conducting current, within a magnetic field and cutting across that magnetic field.

Student III: "For a current-carrying wire to feel a magnetic force, the wire must be within a magnetic field and has to be perpendicular to the magnetic field."

Which, if any, of these three students do you believe is correct? Explain fully why you chose as you did.

Student II is correct.

MFF4a-WWT1: Straight Current-Carrying Wire in a Uniform Magnetic Field

"A straight wire is conducting current whose direction is pointed out of the paper towards you. If this current carrying wire encounters a magnetic field pointing toward the left, then it feels a magnetic force towards the top of the page."

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 is incorrect. The magnetic force is towards the bottom of the page.

MFF4A-WWT2: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

"A current carrying straight wire has current going to the right. It encounters a magnetic field that is into the paper. The direction of the magnetic force felt by the wire must be into the paper."

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 is incorrect. The magnetic force should be towards the top of the page*.**

MFF4a-WWT3: Straight Current-Carrying Wire in a Uniform Magnetic Field

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 current carrying straight wire in a magnetic field always feels a magnetic force."

The statement is incorrect. The current, carrying straight wire has to be cutting across magnetic field lines to feel a magnetic force.

MFF4a-TT1: Straight Current-Carrying Wire in a Uniform Magnetic Field

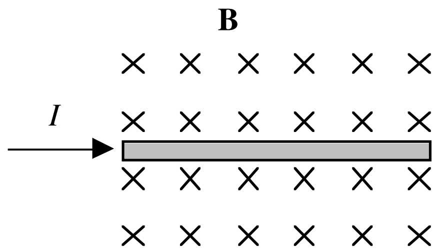
There is at least one error in the statement below, identify the error(s) and explain how to correct it (them.)

"A current carrying straight wire is conducting current in the + x-direction. Since the wire feels a magnetic force whose direction is in the + y direction, the direction of the magnetic field is in the + z direction."

The statement is incorrect and can be made correct by changing the magnetic field to the –z direction, or changing the magnetic force direction to –y direction.

MFF4a-TT2: Straight Current-Carrying Wire in a Uniform Magnetic Field

As shown in the figure below, a current carrying, straight wire is conducting current to the right through a magnetic field. The magnetic field is uniform and into the paper. The current carrying wire feels no magnetic force due to the magnetic field.

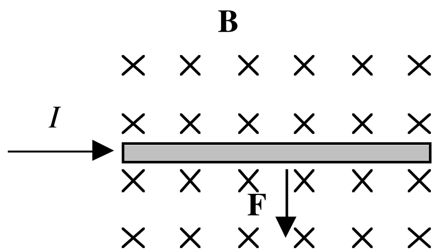


There is at least one error in the diagram and/ or statement above, identify the error(s) and explain how to correct it (them.)

This is an incorrect statement, but can be corrected by stating that it does feel a magnetic force towards the top of the page.

MFF4A-TT3: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

As shown in the figure below, a current carrying, straight wire is conducting current to the right through a magnetic field. The magnetic field is uniform and into the paper. The current carrying wire feels a magnetic force due to the magnetic field as shown.

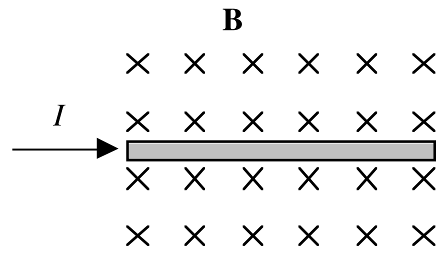


There is at least one error in the diagram and/or statement above, identify the error(s) and explain how to correct it (them.)

This is an incorrect statement, but can be fixed by stating that the direction of the magnetic force is towards the top of the page.

MFF4A-LMCT1: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

As shown in the figure below, a current carrying, straight wire is conducting current to the right through a magnetic field. The magnetic field is uniform and into the paper. The current carrying wire feels a magnetic force due to the magnetic field.



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 force felt by the wire.

The possible answers are:

A. this change will only alter the direction of the magnetic force felt by the wire.
B. this change will only increase the magnitude of the magnetic force felt by the wire.
C. this change will only decrease the magnitude of the magnetic force felt by the wire.
D. this change will alter both the magnitude and direction of the magnetic force felt by the wire.
E. this change will not affect the magnetic force felt by the wire.

Each change below refers to the original situation stated above:

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

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

The current in the wire is zero. ___*C*____

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

The length of the wire in the magnetic field is greater. ___*B*____

The magnetic field is twice its original strength. ___*B*____

The magnetic field is one-third its original strength. ___*C*____

The direction of the magnetic field is parallel to the wire. ___*C*____

The direction of the magnetic field is 45° to the wire. ___*C*____

MFF4a-PET1 : Straight Current-Carrying Wire in a Uniform Magnetic Field

A current carrying, straight wire is conducting current towards the right. The wire is in a region in which the magnetic field is uniform and is directed towards the top of the page.

What will happen to the current carrying wire? Explain fully.

The wire will feel a magnetic force out of the page towards you, according to the right hand rule.

MFF4a-PET2: Straight Current-Carrying Wire in a Uniform Magnetic Field

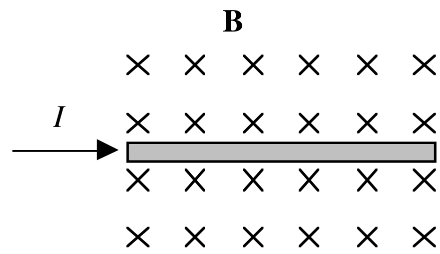
A current carrying, straight wire is conducting current towards the right. The wire is in a region in which the magnetic field is uniform and is also directed towards the right.

What will happen to the current carrying wire? Explain fully.

Nothing will happen. The wire will not feel a magnetic force because the wire is parallel to the field. $F = IlB \sin \theta$, and $\theta = 0$ so $F = 0$

MFF4a-M/MCT1: Straight Current-Carrying Wire in a Uniform Magnetic Field

The figure below shows a straight wire conducting a 10 A current in a uniform magnetic field of 200 mT. The wire is 5 m long.



Given below is a student's calculation for the magnetic force on the current carrying wire due to the magnetic field

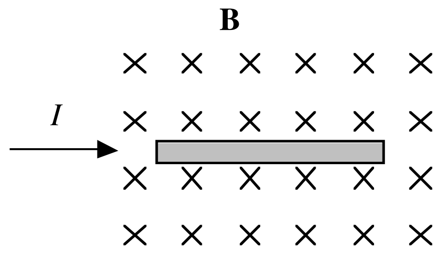
$$F_B = (10A)(5.00m)(.200T)$$

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)?

This is a meaningful calculation.

MFF4A-QRT1: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

The figure below shows a current-carrying straight wire segment (with connecting wires up out of the paper that are not shown) in a uniform magnetic field directed into the paper.



What is the direction of the magnetic force acting on the wire segment due to the magnetic field?

The magnetic force direction is towards the top of the page.

What would the direction of the magnetic force be if the direction of the magnetic field was out of the paper?

The magnetic force direction is towards the bottom of the page.

What would happen to the magnitude of the magnetic force acting on the wire segment if the wire segment was longer but still completely within the magnetic field?

The magnitude of the magnetic force would increase.

What would happen to the direction of the magnetic force if we reverse the direction of current in the wire segment?

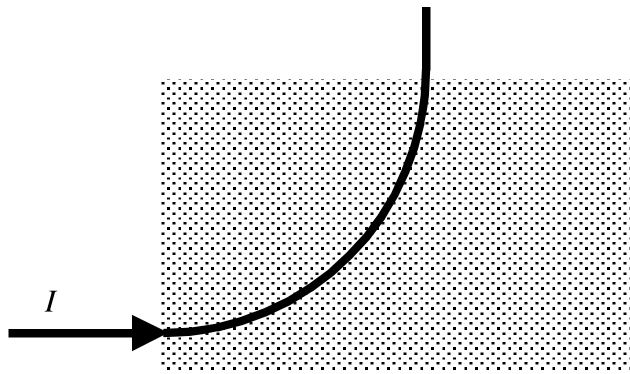
The direction of the magnetic force would also change (to opposite the direction it had before).

What would happen to the magnitude of the magnetic force acting on the wire segment if the wire segment is moved without changing it's orientation so that its length is half-in and half-out of the magnetic field region?

The magnitude of the magnetic force would be half of the initial value.

MFF4a-QRT2: Current-Carrying Wire in a Uniform Magnetic Field

The figure below shows the effect on a thin, flexible current-carrying wire with one end fixed, in a region of uniform magnetic field strength.



What is the direction of the magnetic field acting on the wire?

The magnetic field is into the page.

If we reversed the direction of the magnetic field, what would happen to the "bend" of the wire in the uniform magnetic field?

The wire would bend downwards toward the bottom of the page (instead of upwards towards the top of the page).

If we increase the current flowing in the wire, what will happen to the "bend" of the wire in the uniform magnetic field?

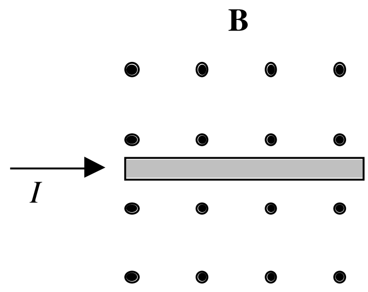
The bend in the wire would be "greater"(smaller radius).

If we double the magnitude of the uniform magnetic field, what will happen to the "bend" of the wire in the uniform magnetic field?

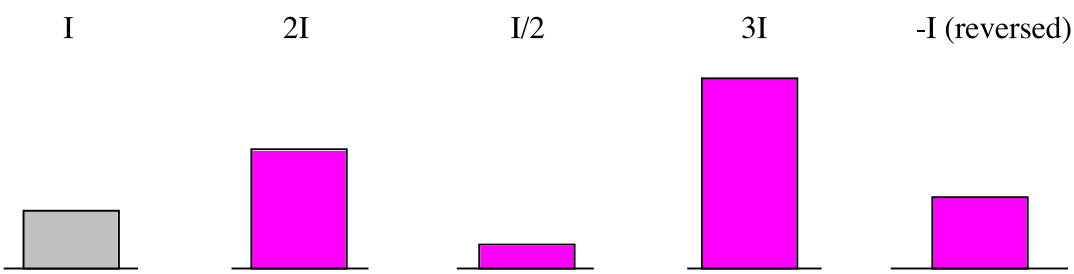
The bend in the wire would be "greater" (smaller radius).

MFF4A-BCT1: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

The figure below shows a current carrying straight wire segment conducting a current in a region where there is a uniform magnetic field directed out of the plane of the paper.



Represent this situation with a bar chart of the magnitude of the magnetic force that the wire feels due to the magnetic field if the current can change. The amount of current is indicated on the bar chart.

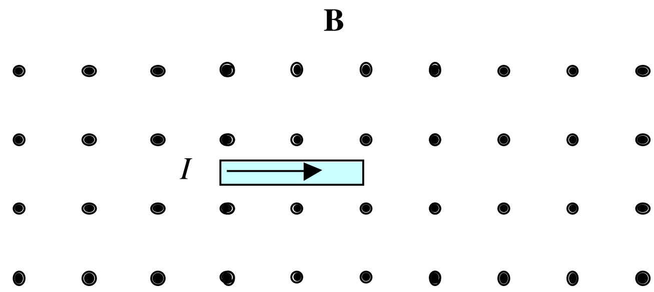


Explain the reasoning behind your bar chart:

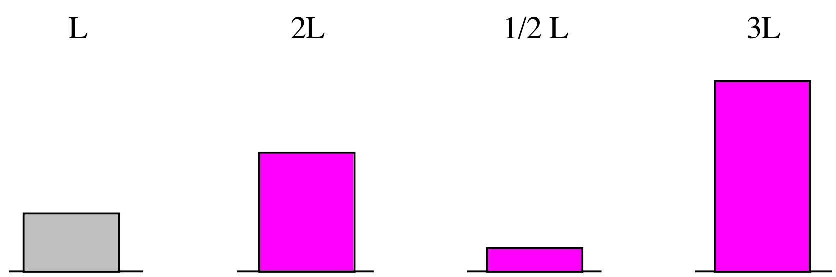
The magnitude of the magnetic force is directly proportional to the absolute value of the current.

MFF4A-BCT2: Straight Current-Carrying Wire in a Uniform Magnetic Field

The figure below shows a current carrying straight wire segment conducting a current in a region where there is a uniform magnetic field directed out of the plane of the paper.



Represent this situation with a bar chart of the magnitude of the magnetic force that the wire feels due to the magnetic field if the length of the wire can change. The length of the wire inside the magnetic field is indicated on the bar chart



Explain the reasoning behind your bar chart:

The magnitude of the magnetic force is directly proportional to the absolute value of the length of the wire.

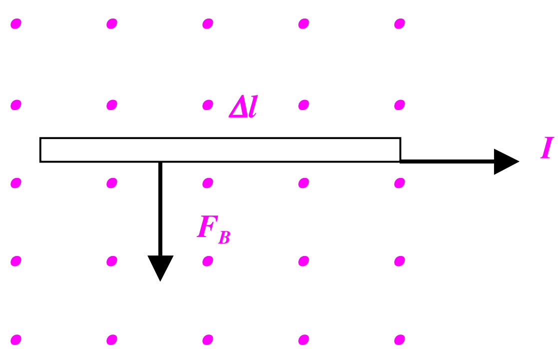
MFF4A-CRT1: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

The equation below represents the magnetic force on a current carrying straight wire segment in a uniform magnetic field.

$$-6.48\hat{\mathbf{j}}\text{N} = (1.60\hat{\mathbf{i}}\text{A})(2.50\text{m})\mathbf{x}(1.62\hat{\mathbf{k}}\text{T})$$

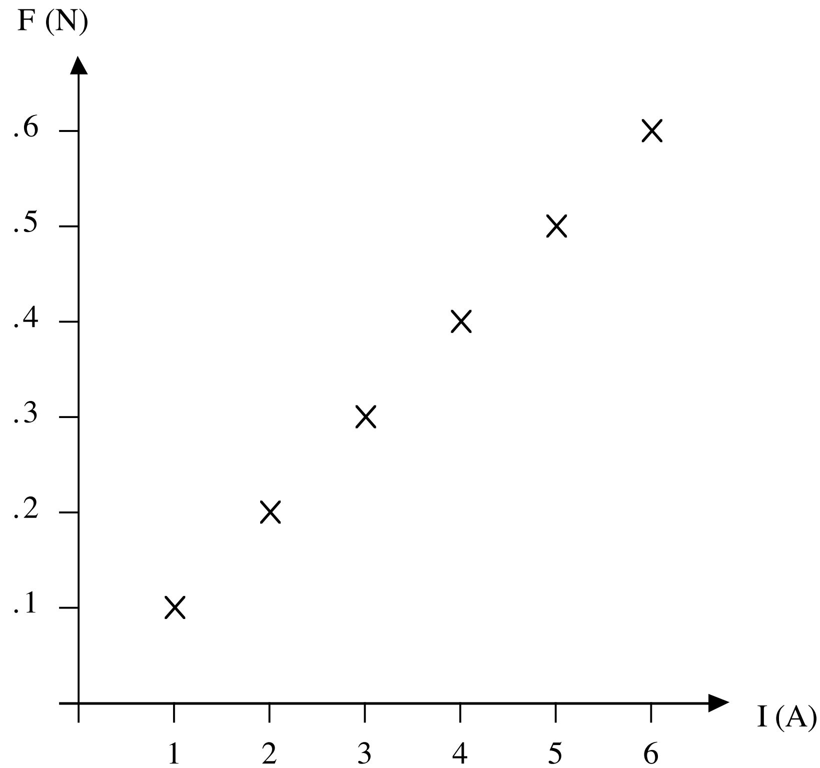
Draw an appropriate diagram of the current carrying wire and magnetic field represented by this equation.

A long, straight wire of length 2.50 m, is conducting current (I=1.60 A) in a magnetic field, B = 1.62 T. The wire is conducting current towards the right and the magnetic field is out of the page. The wire feels a magnetic force of 6.48 N pointing toward the bottom of the page.



MFF4A-CRT2: STRAIGHT CURRENT-CARRYING WIRE IN A UNIFORM MAGNETIC FIELD

Shown below is the graph of the magnetic force on a current carrying straight wire due to the current in the wire. The wire's length is 2 m and the magnetic field is 7 μT.



Setup (write) an appropriate equation that would give the strength of the magnetic force felt by the current carrying straight wire.

Using $F_B = I\,\Delta l\,B \sin 90^\circ$

$F_B = (.1\ N/A)\ I \quad (N)$