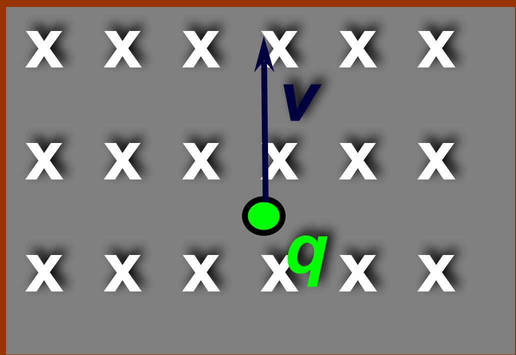
1) Magnetic Force I

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) downwards
4) to the right
5) to the left

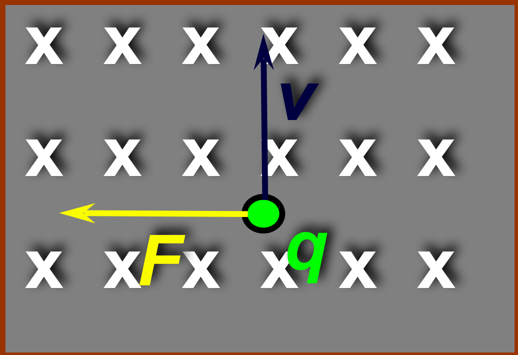


1) Magnetic Force I

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) downwards
4) to the right
5) to the left

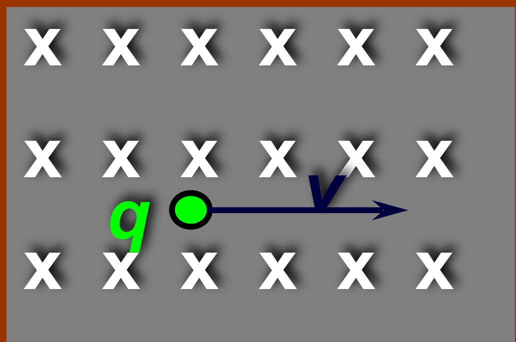
Using the right-hand rule, you can see that the magnetic force is directed to the left. Remember that the magnetic force must be perpendicular to BOTH the *B* field and the velocity.



2) Magnetic Force II

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) downwards
4) upwards
5) to the left

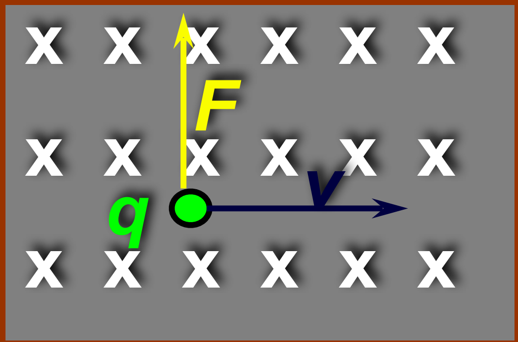


2) Magnetic Force II

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) downwards
4) upwards
5) to the left

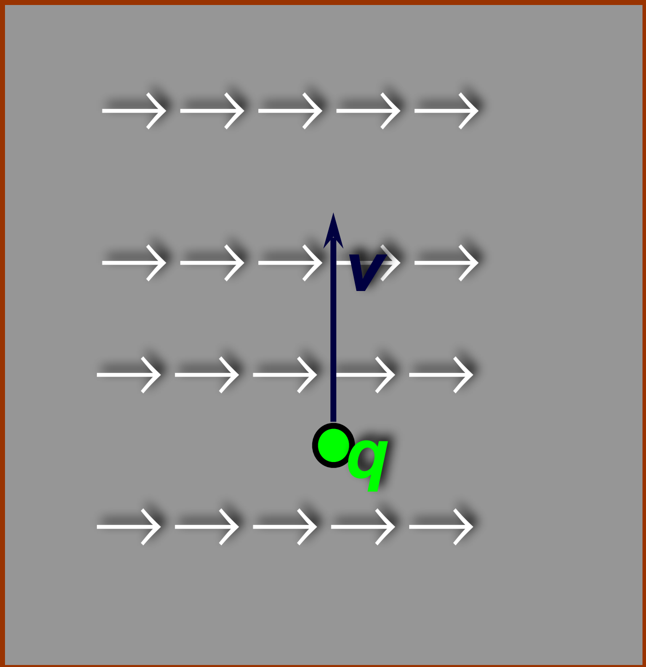
Using the right-hand rule, you can see that the magnetic force is directed upwards. Remember that the magnetic force must be perpendicular to BOTH the *B* field and the velocity.



3) Magnetic Force III

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) zero
4) to the right
5) to the left

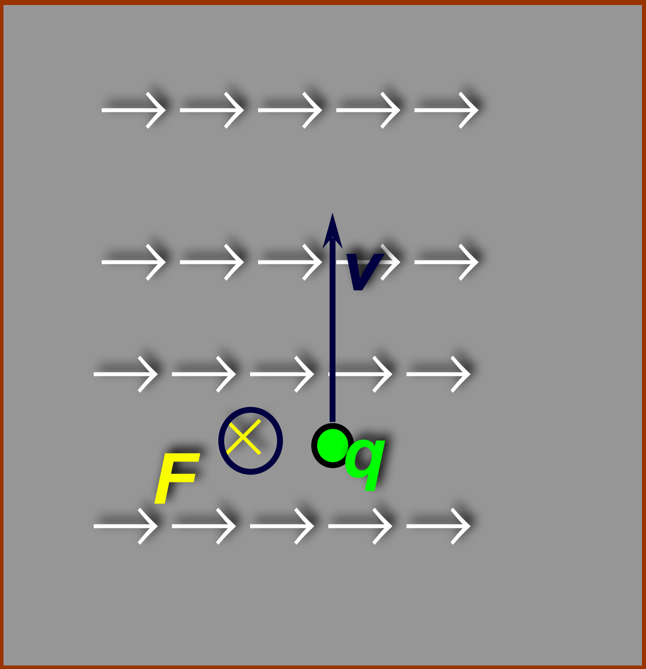


3) Magnetic Force III

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) zero
4) to the right
5) to the left

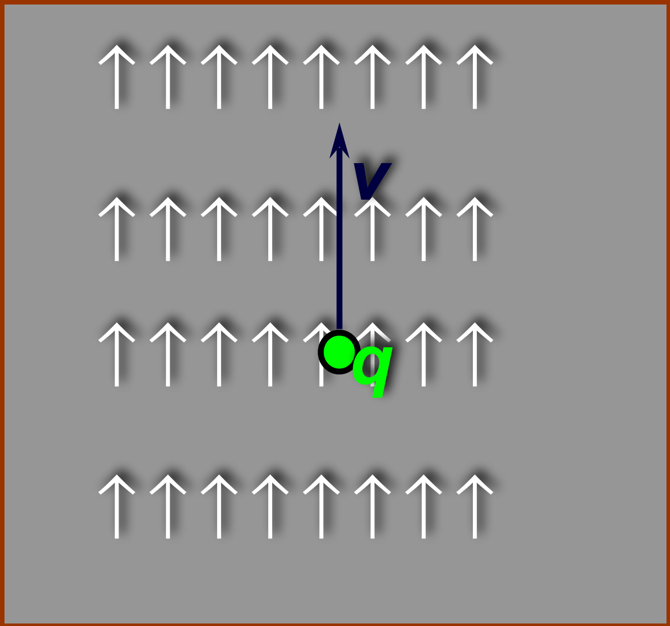
Using the right-hand rule, you can see that the magnetic force is directed into the page. Remember that the magnetic force must be perpendicular to BOTH the *B* field and the velocity.



4) Magnetic Force IV

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

1) out of the page
2) into the page
3) zero
4) to the right
5) to the left

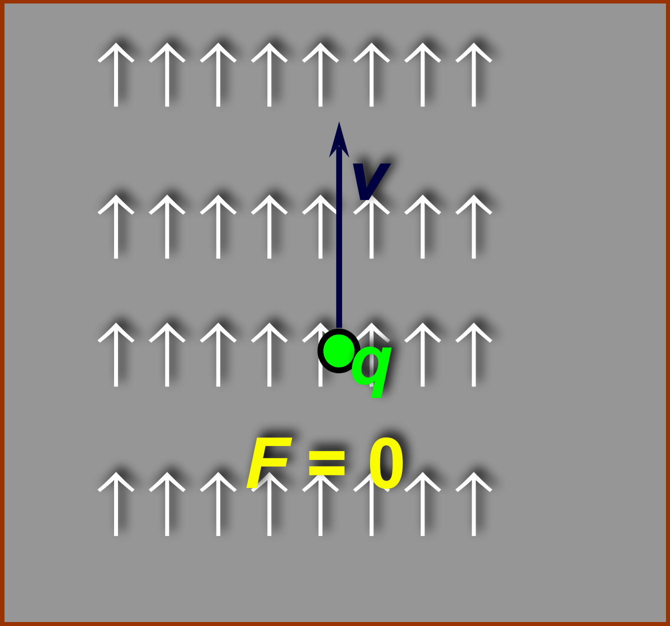


4) Magnetic Force IV

A positive charge enters a uniform magnetic field as shown. What is the direction of the magnetic force?

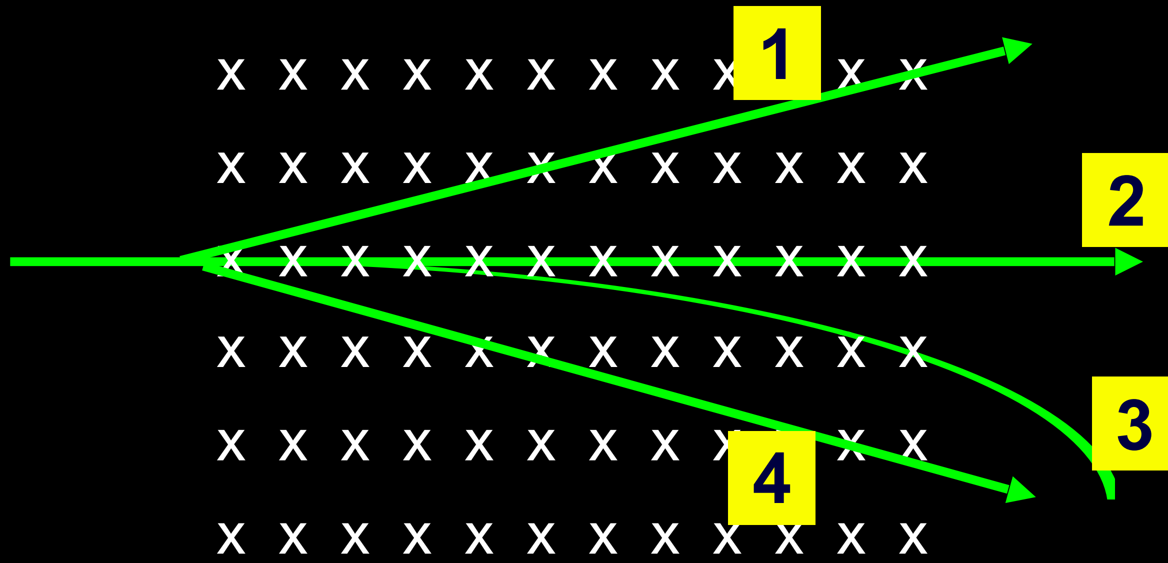
1) out of the page
2) into the page
3) zero
4) to the right
5) to the left

The charge is moving **parallel to the magnetic field**, so **it does not experience any magnetic force**. Remember that the magnetic force is given by: $F = v B \sin(\theta)$.



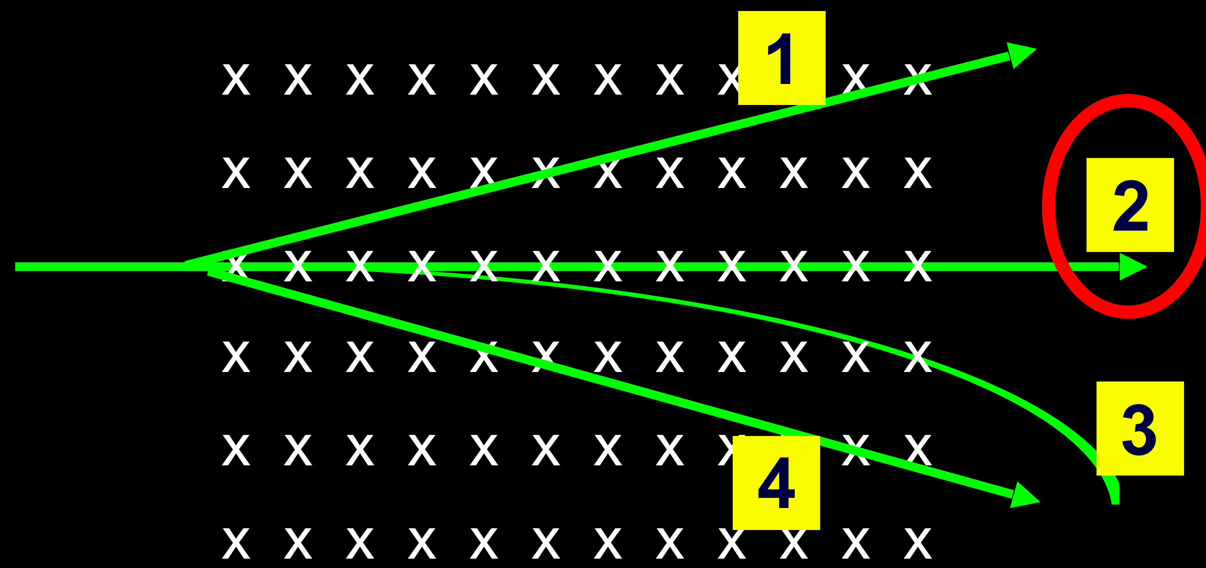
5) Atomic Beams

A beam of atoms enters a magnetic field region. What path will the atoms follow?



5) Atomic Beams

A beam of atoms enters a magnetic field region. What path will the atoms follow?



Atoms are neutral objects whose net charge is zero.

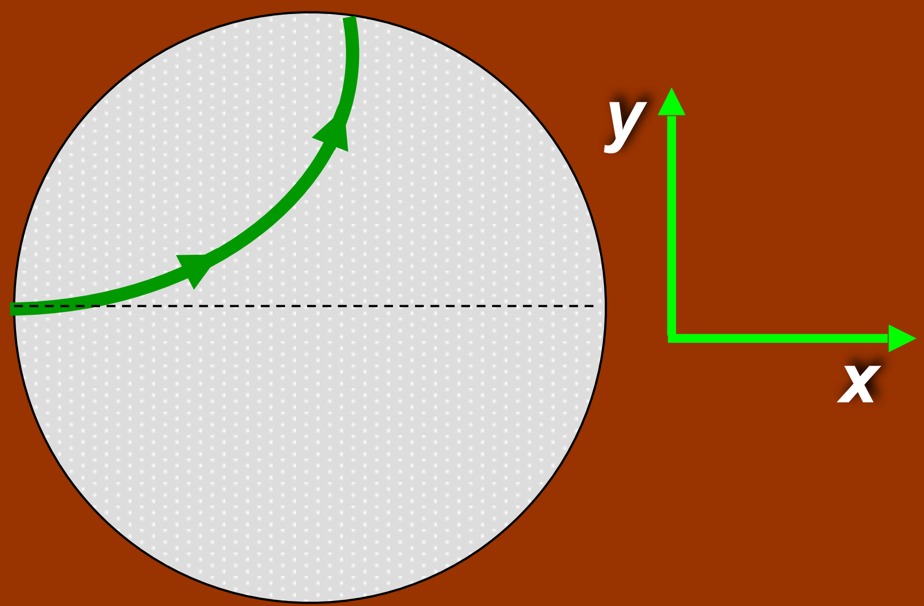
Thus they do not experience a magnetic force.

Follow-up: What charge would follow path #3? What about path #1?

6) Magnetic Field

A proton beam enters into a magnetic field region as shown below. What is the direction of the magnetic field *B*?

1) + *y*
2) – *y*
3) + *x*
4) + *z* (out of page)
5) – *z* (into page)

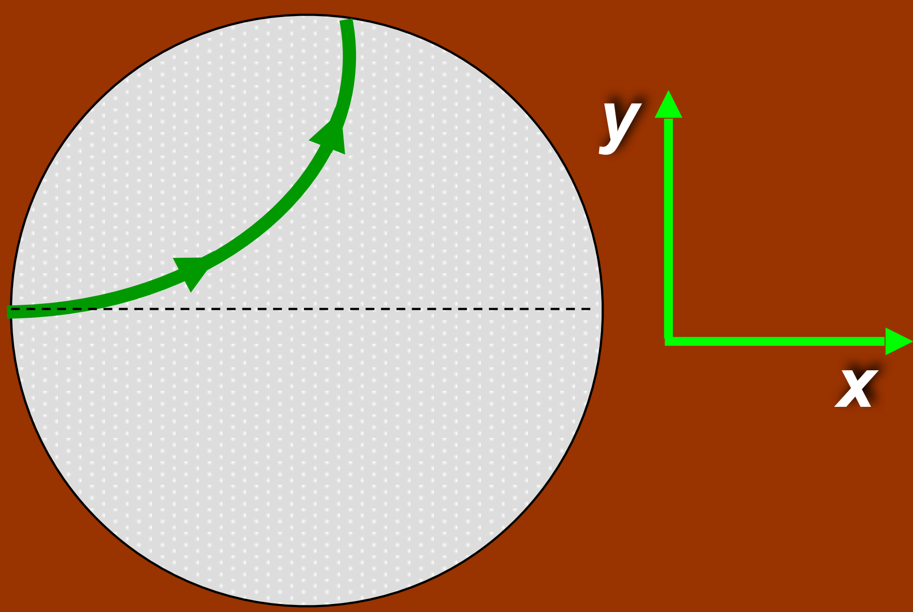


6) Magnetic Field

A proton beam enters into a magnetic field region as shown below. What is the direction of the magnetic field *B*?

1) + *y*
2) – *y*
3) + *x*
4) + *z* (out of page)
5) – *z* (into page)

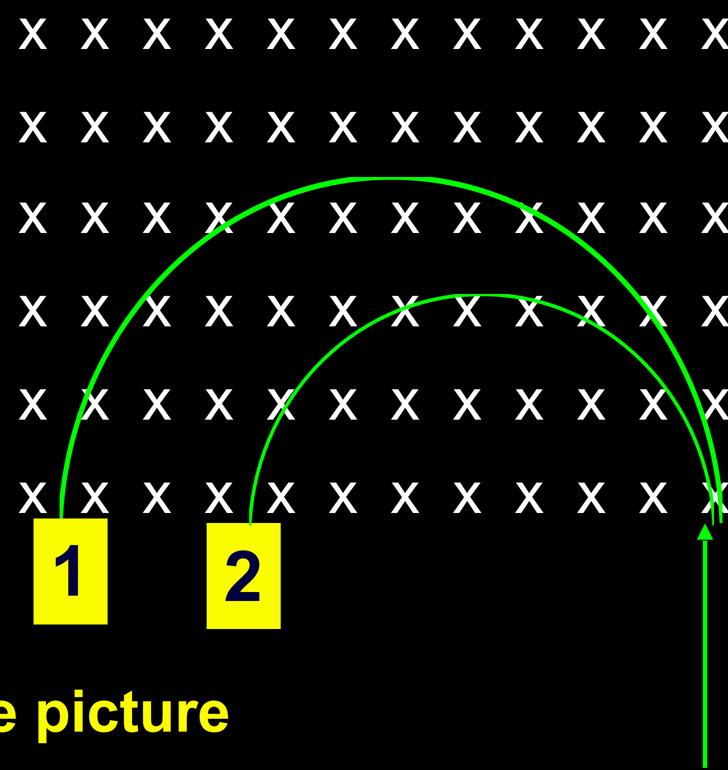
The picture shows the force acting in the +*y* direction. Applying the right-hand rule leads to a B field that points into the page. The B field must be out of the plane because ***B*** ⊥ ***v*** and ***B*** ⊥ ***F***.



Follow-up: What would happen to a beam of atoms?

7) Mass Spectrometer I

Two particles of the ***same mass*** enter a magnetic field with the ***same speed*** and follow the paths shown. Which particle has the ***bigger charge***?

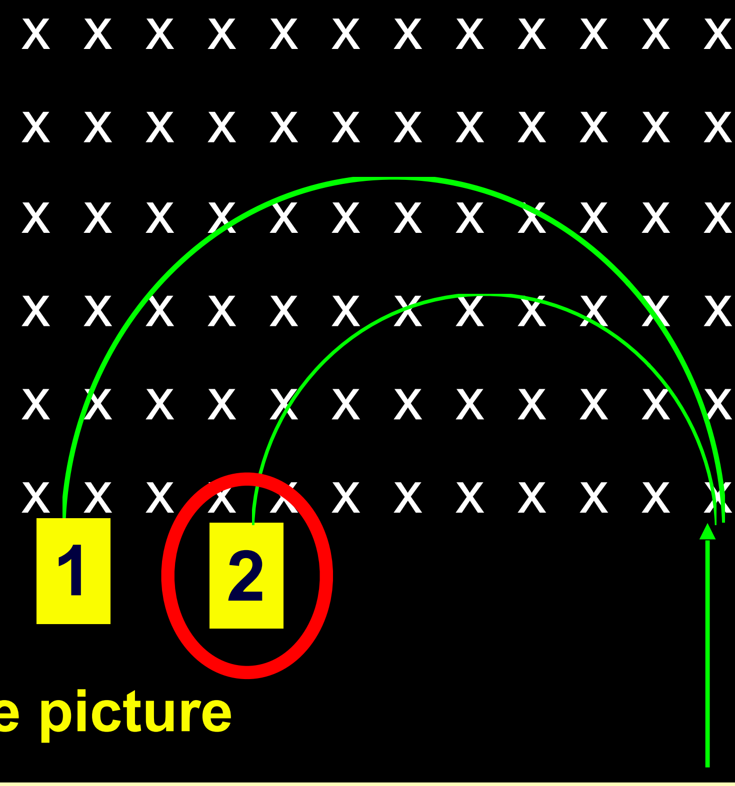


3) both charges are equal

4) impossible to tell from the picture

7) Mass Spectrometer I

Two particles of the *same mass* enter a magnetic field with the *same speed* and follow the paths shown. Which particle has the *bigger charge*?



3) both charges are equal

4) impossible to tell from the picture

The relevant equation for us is: $R = \frac{mv}{qB}$

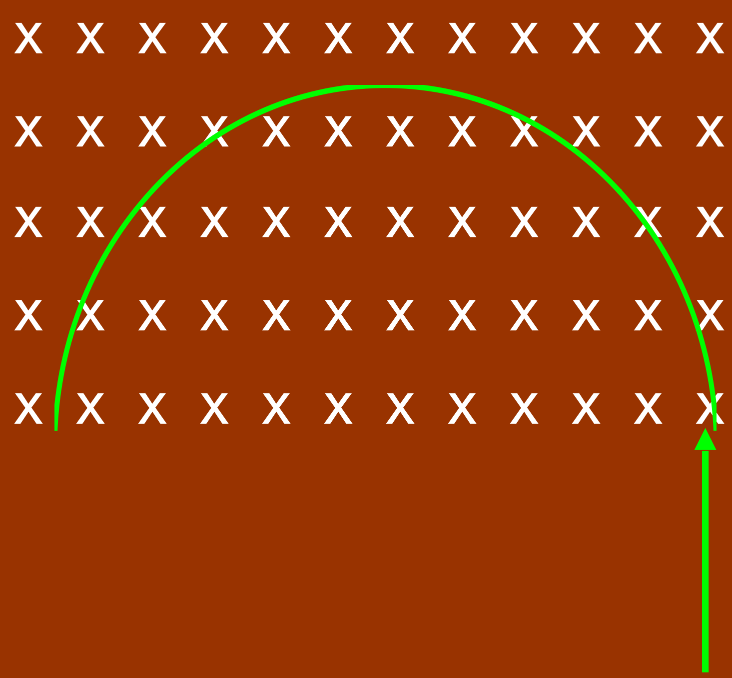
According to this equation, the bigger the charge, the smaller the radius.

Follow-up: What is the sign of the charges in the picture?

8) Mass Spectrometer II

A proton enters a uniform magnetic field that is perpendicular to the proton's velocity. What happens to the **kinetic energy** of the proton?

1) it increases
2) it decreases
3) it stays the same
4) depends on the velocity direction
5) depends on the *B* field direction

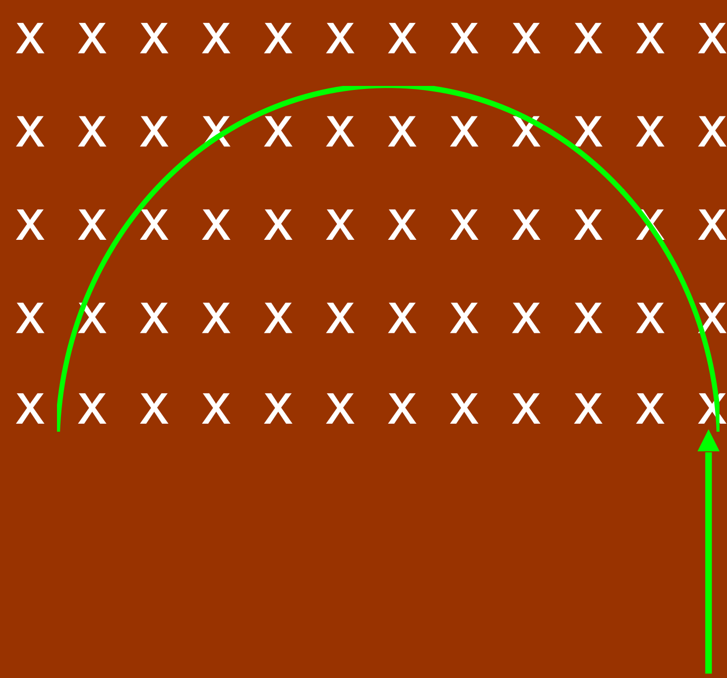


8) Mass Spectrometer II

A proton enters a uniform magnetic field that is perpendicular to the proton's velocity. What happens to the kinetic energy of the proton?

1) it increases
2) it decreases
3) it stays the same
4) depends on the velocity direction
5) depends on the *B* field direction

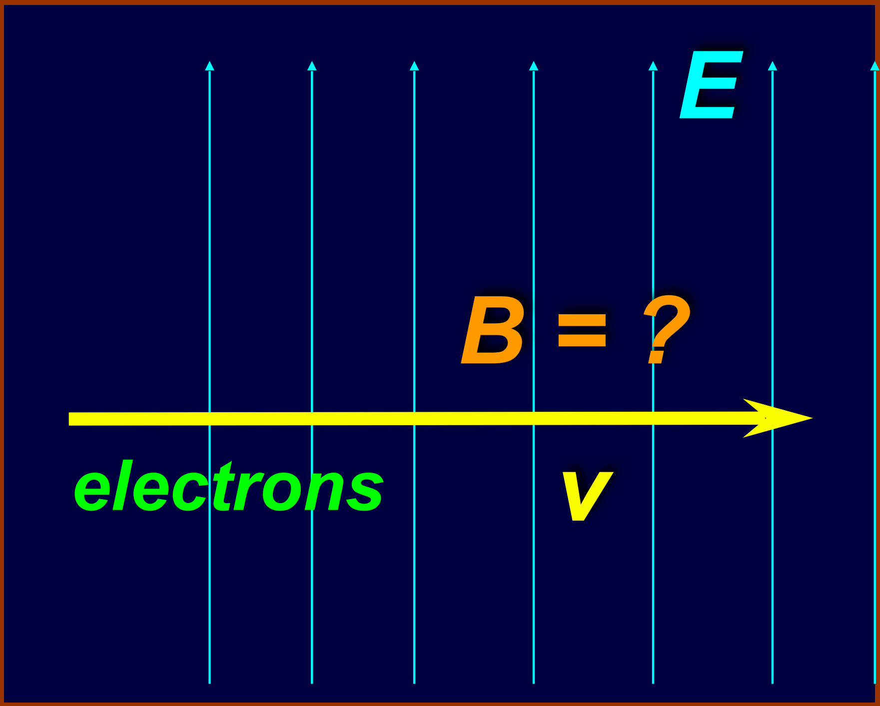
The velocity of the proton changes **direction** but the **magnitude** (speed) doesn't change. Thus the **kinetic energy stays the same**.



9) Velocity Selector

What direction would a *B* field have to point for a beam of *electrons* moving to the right to go *undeflected* through a region where there is a uniform *electric field* pointing vertically upward?

1) up (parallel to *E*)
2) down (antiparallel to *E*)
3) into the page
4) out of the page
5) impossible to accomplish

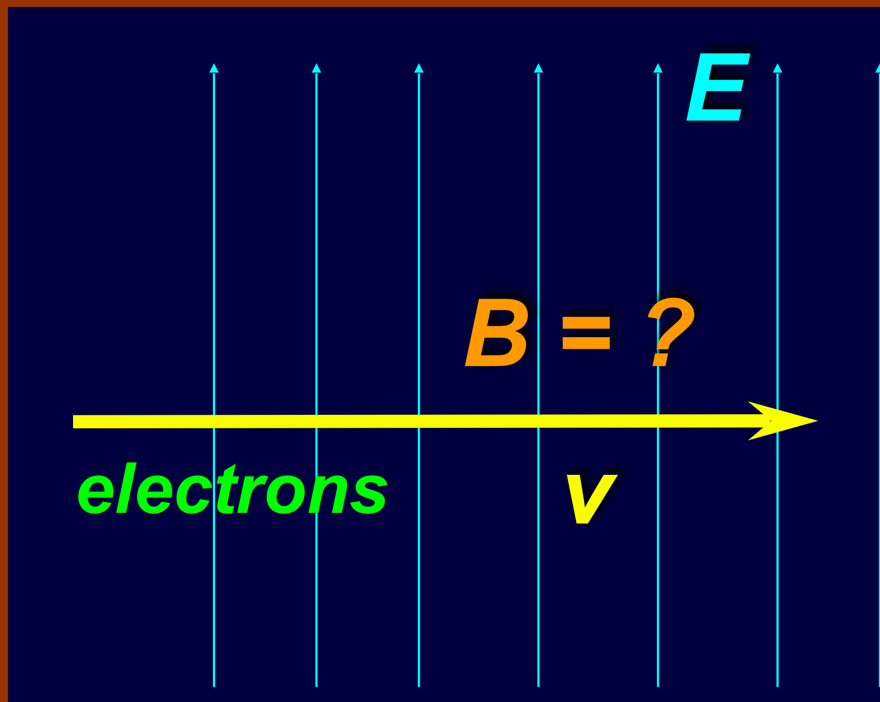


9) Velocity Selector

What direction would a *B* field have to point for a beam of *electrons* moving to the right to go *undeflected* through a region where there is a uniform *electric field* pointing vertically upward?

1) up (parallel to *E*)
2) down (antiparallel to *E*)
3) into the page
4) out of the page
5) impossible to accomplish

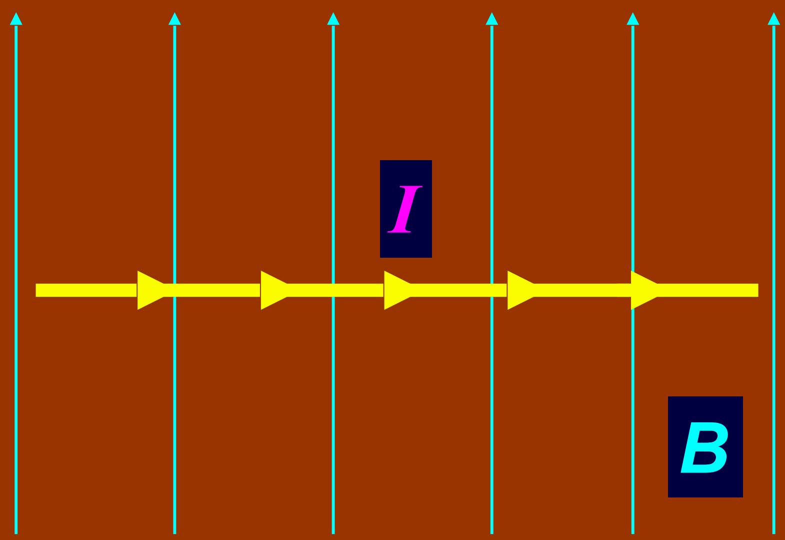
Without a *B* field, the electrons feel an electric force ***downwards***. In order to compensate, the magnetic force has to point ***upwards***. Using the right-hand rule and the fact that the electrons are ***negatively charged*** leads to a **B field pointing *out of the page***.



10) Magnetic Force on a Wire I

A horizontal wire carries a current and is in a vertical magnetic field. What is the direction of the force on the wire?

1) left
2) right
3) zero
4) into the page
5) out of the page

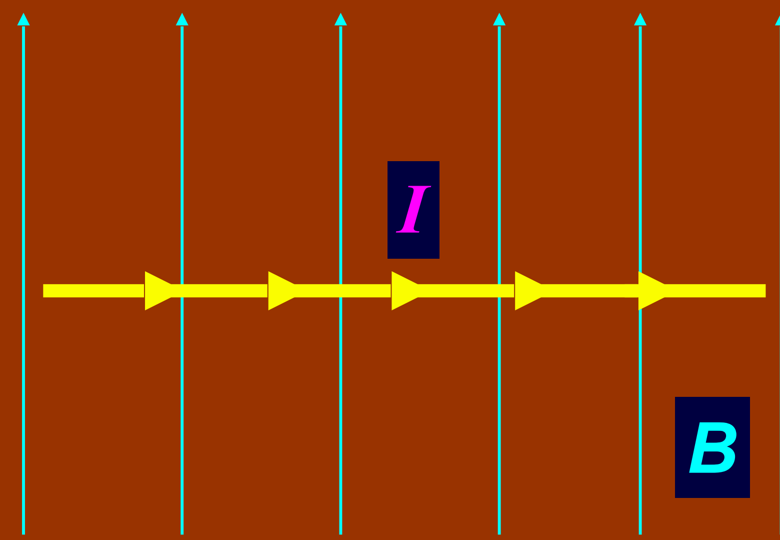


10) Magnetic Force on a Wire I

A horizontal wire carries a current and is in a vertical magnetic field. What is the direction of the force on the wire?

1) left
2) right
3) zero
4) into the page
5) out of the page

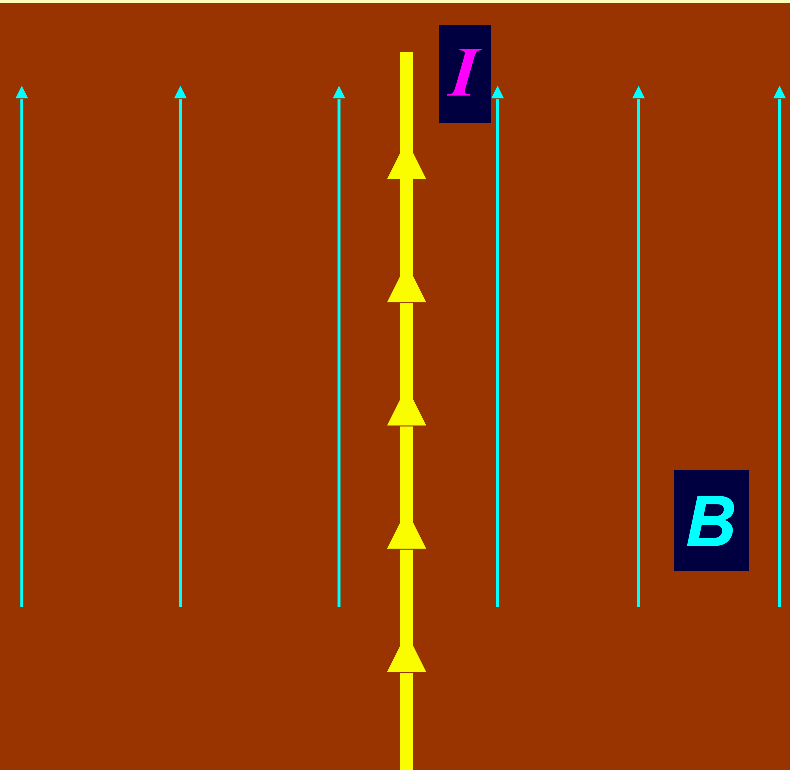
Using the right-hand rule, we see that the magnetic force must point out of the page. Since *F* must be perpendicular to both *I* and *B*, you should realize that *F* cannot be in the plane of the page at all.



11) Magnetic Force on a Wire II

A horizontal wire carries a current and is in a vertical magnetic field. What is the direction of the force on the wire?

1) left
2) right
3) zero
4) into the page
5) out of the page

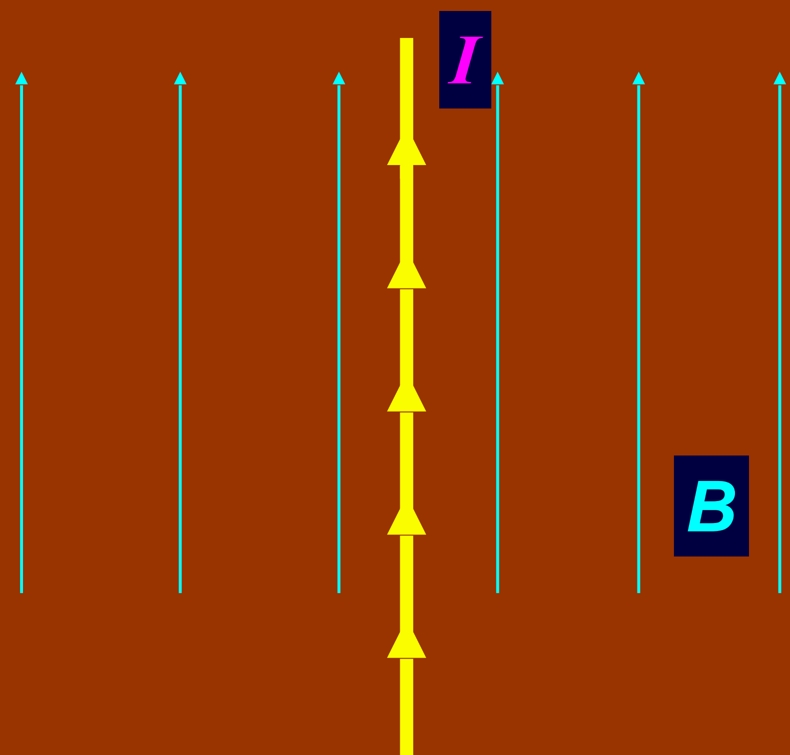


11) Magnetic Force on a Wire II

A horizontal wire carries a current and is in a vertical magnetic field. What is the direction of the force on the wire?

1) left
2) right
3) zero
4) into the page
5) out of the page

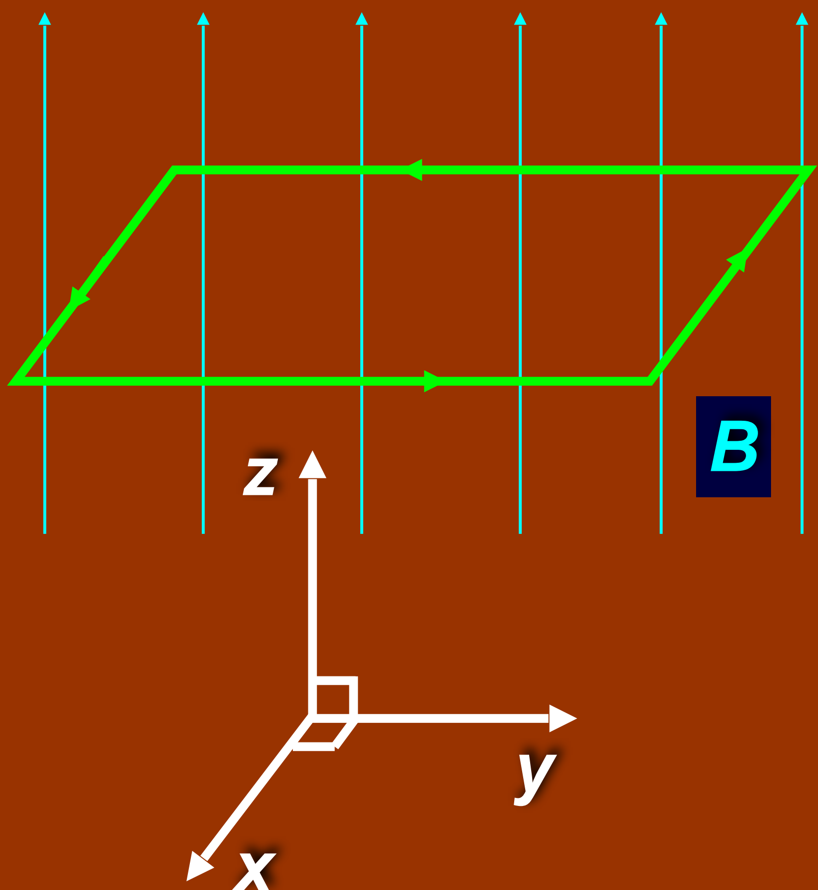
When the current is **parallel** to the magnetic field lines, the force on the wire is ***zero***.



12) Magnetic Force on a Loop I

A rectangular current loop is in a uniform magnetic field. What is the direction of the net force on the loop?

1) + *x*
2) + *y*
3) zero
4) - *x*
5) - *y*

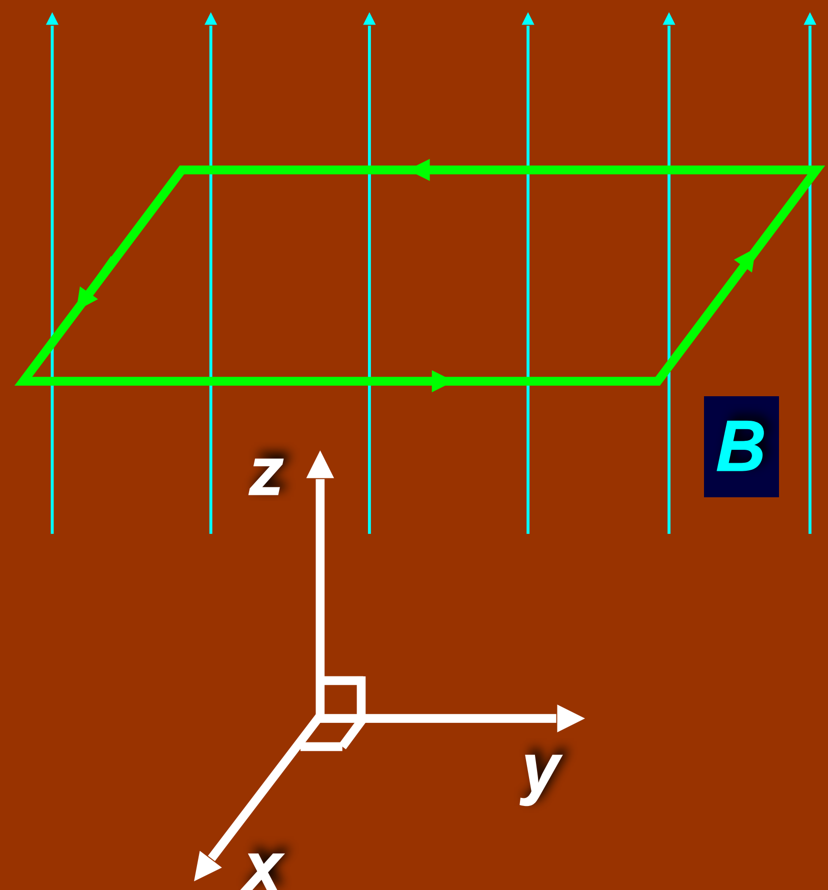


12) Magnetic Force on a Loop I

A rectangular current loop is in a uniform magnetic field. What is the direction of the net force on the loop?

1) + *x*
2) + *y*
3) zero
4) - *x*
5) - *y*

Using the right-hand rule, we find that each of the four wire segments will experience a force *outwards* from the center of the loop. Thus, the forces of the opposing segments cancel, so the net force is zero.

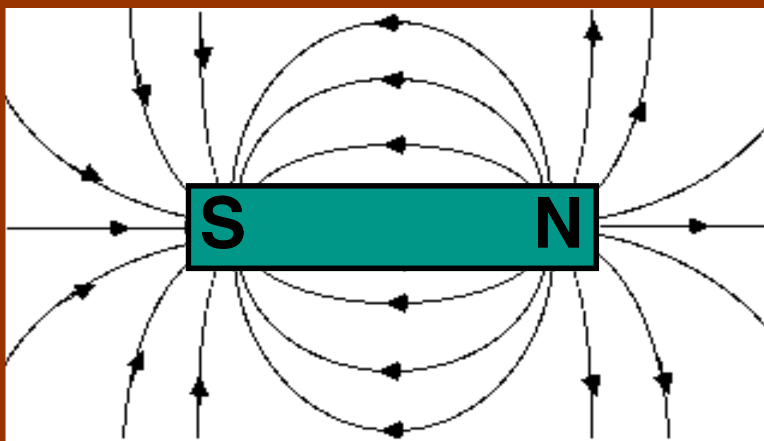


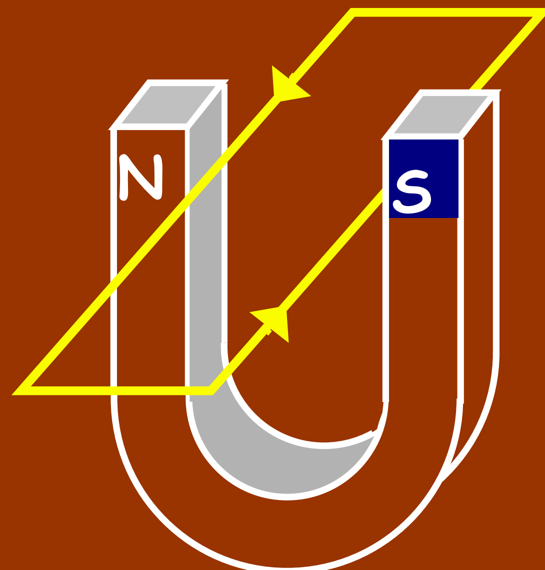
13) Magnetic Force on a Loop II

If there is a current in the loop in the direction shown, the loop will:

1) move up
2) move down
3) rotate clockwise
4) rotate counterclockwise
5) both rotate and move

B field out of North
B field into South



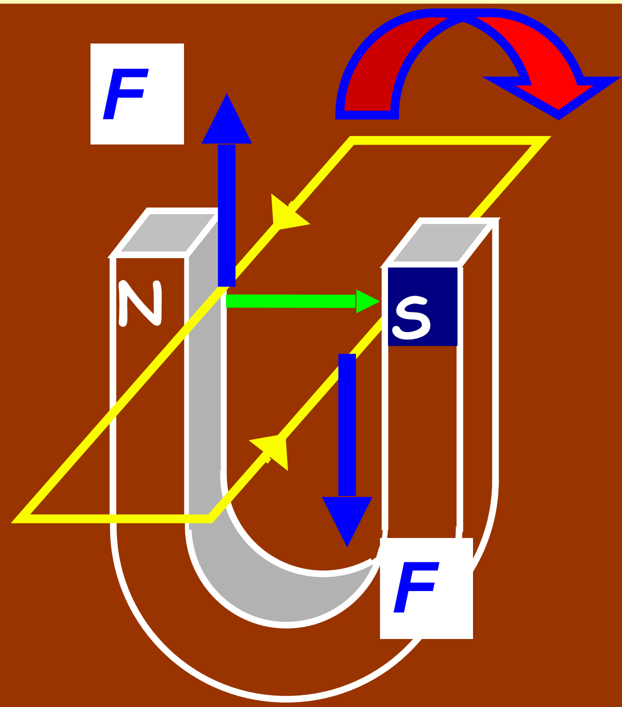


13) Magnetic Force on a Loop II

If there is a current in the loop in the direction shown, the loop will:

1) move up
2) move down
3) rotate clockwise
4) rotate counterclockwise
5) both rotate and move

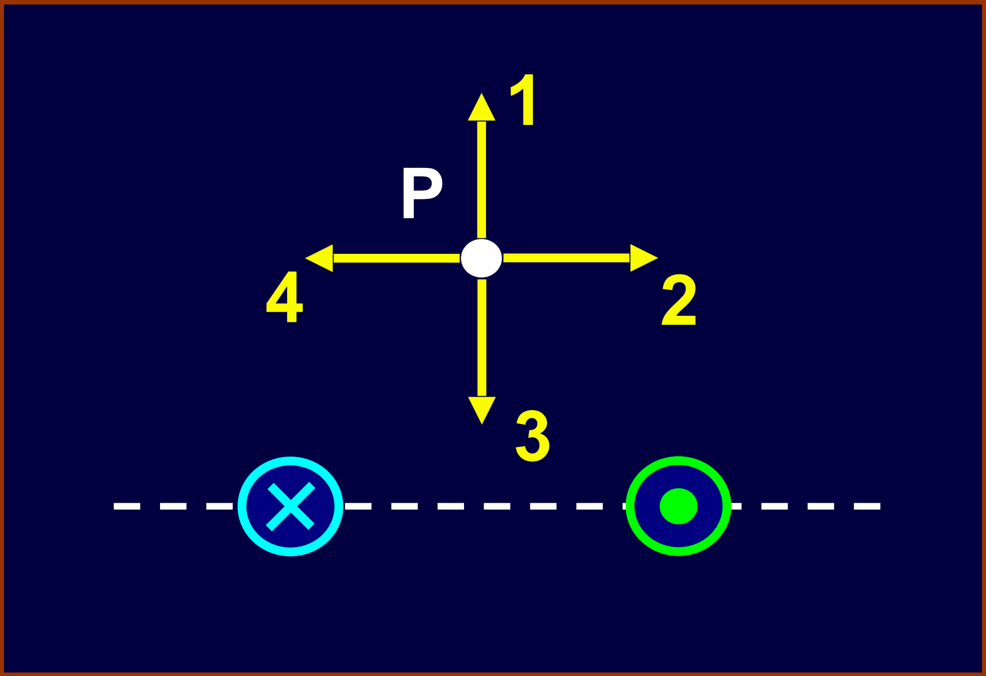
Look at the North Pole: here the magnetic field points to the *right* and the current points *out of the page*. The right-hand rule says that the force must point *up*. At the south pole, the same logic leads to a *downward* force. Thus the loop rotates *clockwise*.



14) Magnetic Field of a Wire I

If the currents in these wires have the same magnitude, but opposite directions, what is the direction of the magnetic field at point P?

1) direction 1
2) direction 2
3) direction 3
4) direction 4
5) the *B* field is zero

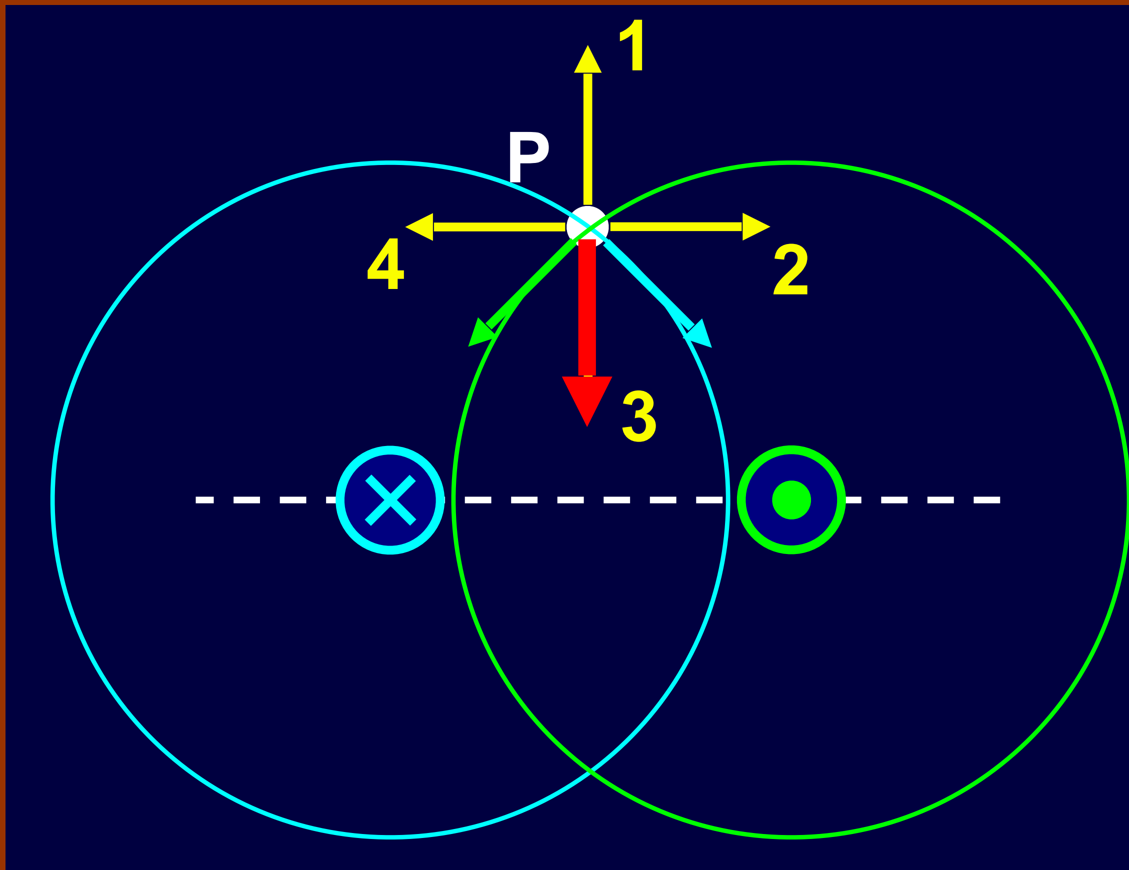


14) Magnetic Field of a Wire I

If the currents in these wires have the same magnitude, but opposite directions, what is the direction of the magnetic field at point P?

1) direction 1
2) direction 2
3) direction 3
4) direction 4
5) the *B* field is zero

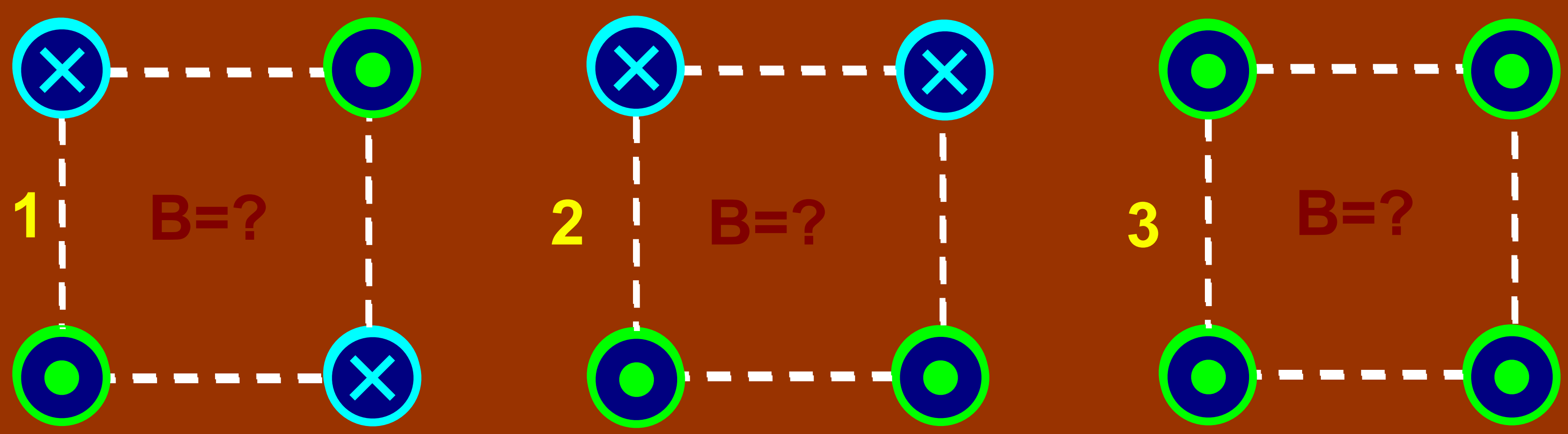
Using the right-hand rule, we can sketch the *B* fields due to the two currents. Adding them up as vectors gives a total magnetic field pointing downward.



15) Magnetic Field of a Wire II

Each of the wires in the figures below carry the same current, either into or out of the page. In which case is the magnetic field at the center of the square greatest?

1) arrangement 1
2) arrangement 2
3) arrangement 3
4) same for all



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Each of the wires in the figures below carry the same current, either into or out of the page. In which case is the magnetic field at the center of the square greatest?

1) arrangement 1
2) arrangement 2
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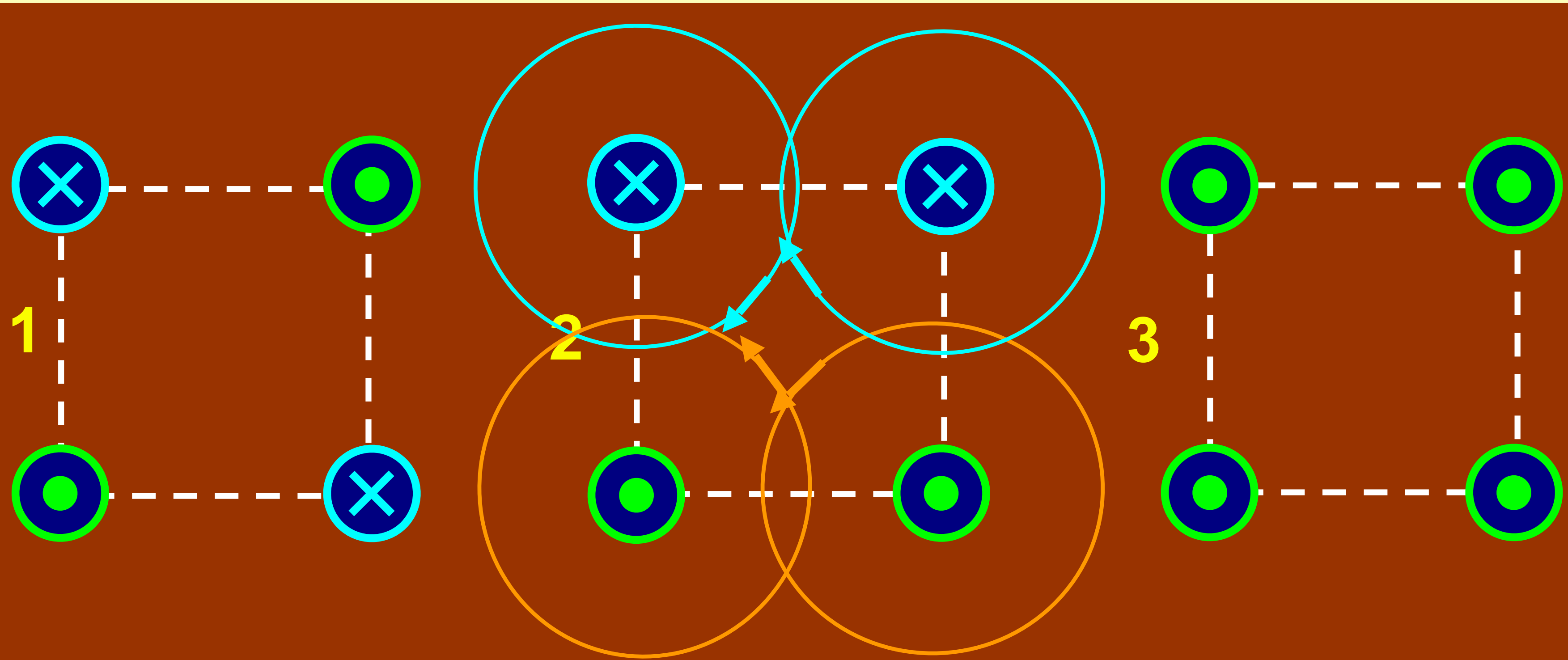
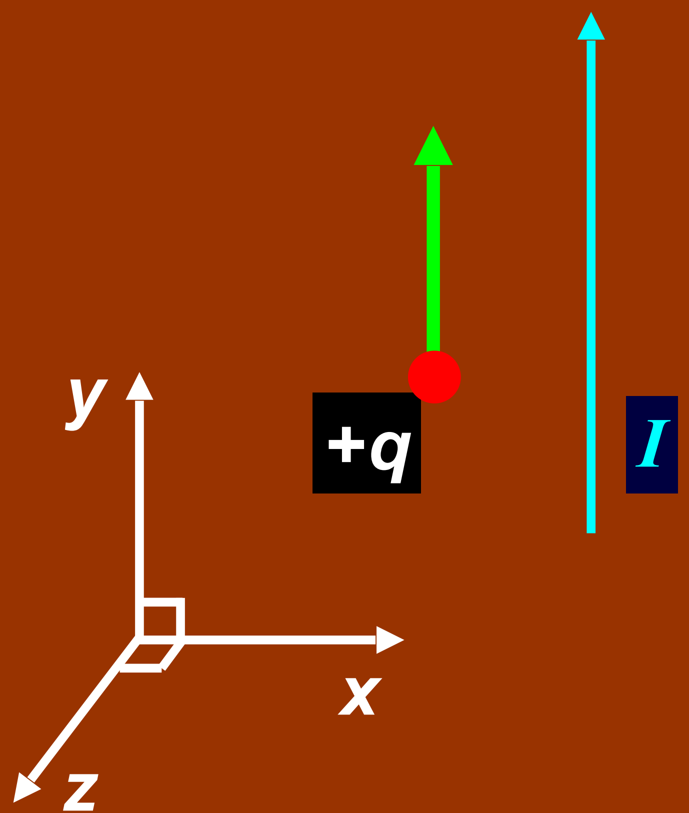
4) same for all



16) Field and Force I

A positive charge moves parallel to a wire. If a current is suddenly turned on, which direction will the force act?

1) + *z* (out of page)
2) - *z* (into page)
3) + *x*
4) - *x*
5) - *y*

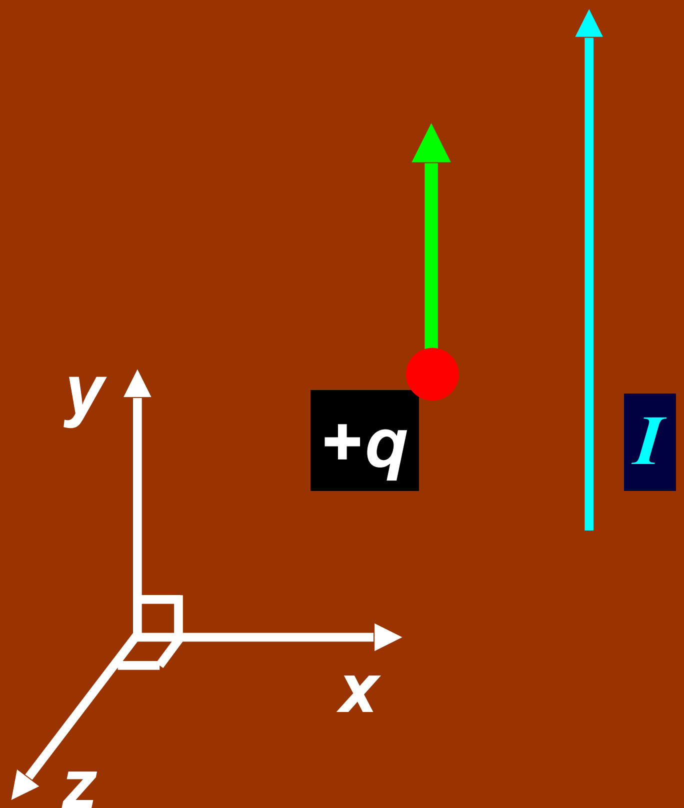


16) Field and Force I

A positive charge moves parallel to a wire. If a current is suddenly turned on, which direction will the force act?

1) + *z* (out of page)
2) - *z* (into page)
3) + *x*
4) - *x*
5) - *y*

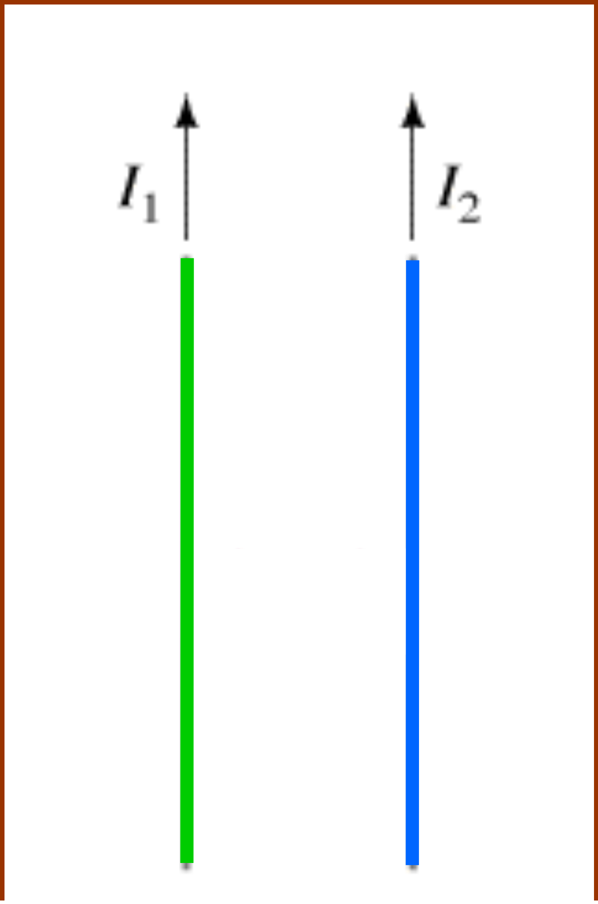
Using the right-hand rule to determine the magnetic field produced by the wire, we find that at the position of the charge +*q* (to the left of the wire) the *B* field ***points out of the page***. Applying the right-hand rule again for the magnetic force on the charge, we find that +*q* experiences a force in the ***+x direction***.



17) Field and Force II

Two straight wires run parallel to each other, each carrying a current in the direction shown below. The two wires experience a force in which direction?

1) toward each other
2) away from each other
3) there is no force

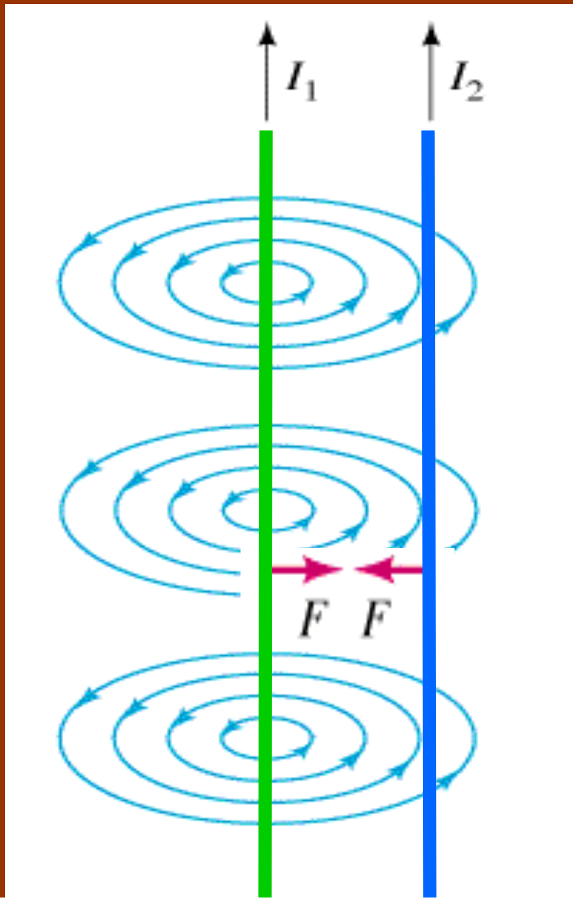


17) Field and Force II

Two straight wires run parallel to each other, each carrying a current in the direction shown below. The two wires experience a force in which direction?

1) toward each other
2) away from each other
3) there is no force

The current in each wire produces a magnetic field that is felt by the current of the other wire. Using the right-hand rule, we find that each wire experiences a force toward the other wire (i.e., an attractive force) when the currents are parallel (as shown).

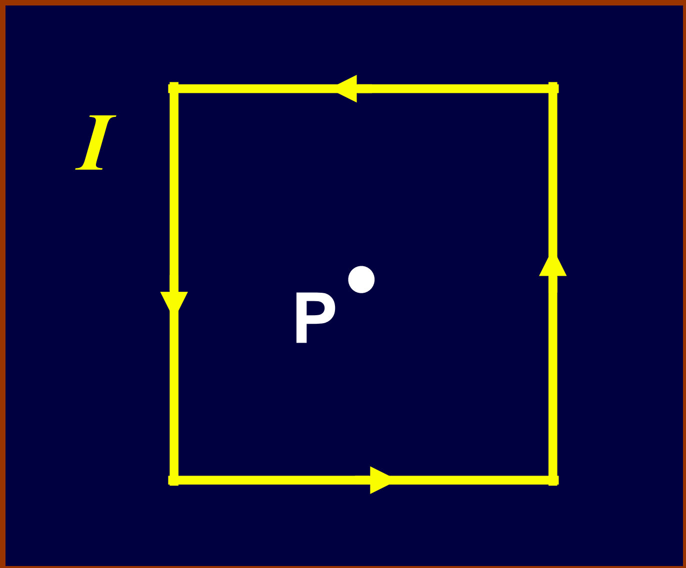


Follow-up: What happens when one of the currents is turned off?

18) Current Loop

What is the direction of the magnetic field at the center (point P) of the square loop of current?

1) left
2) right
3) zero
4) into the page
5) out of the page



18) Current Loop

What is the direction of the magnetic field at the center (point P) of the square loop of current?

1) left
2) right
3) zero
4) into the page
5) out of the page

Use the right-hand rule for each wire segment to find that each segment has its *B* field pointing out of the page at point P.