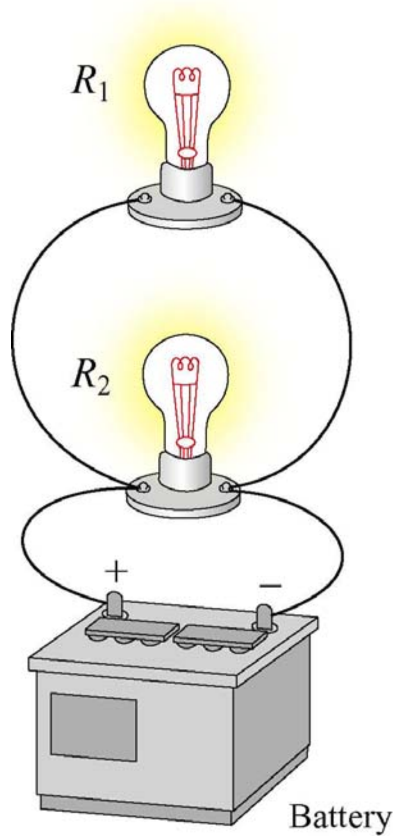
Bulbs and Batteries

An ideal battery is hooked to a light bulb with wires. A second identical light bulb is ;connected in parallel to the first light bulb. After the second light bulb is connected, the current from the battery compared to when only one bulb was connected.



1. Is Higher
2. Is Lower
3. Is The Same
4. Don’t know

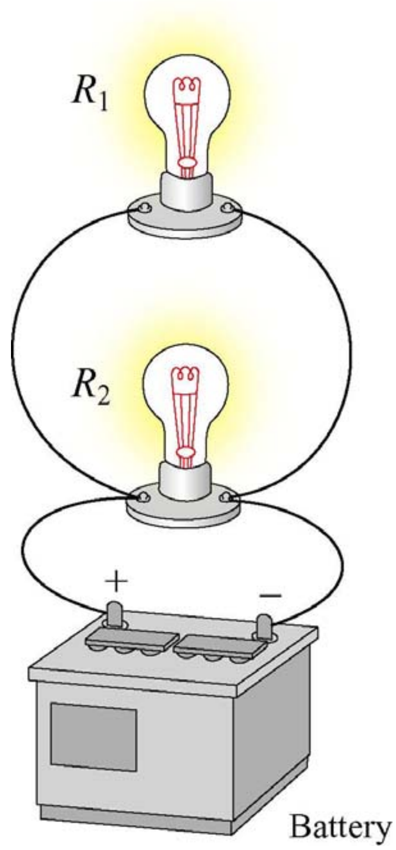
Bulbs and Batteries

(1) More current flows from the battery

There are several ways to see this:

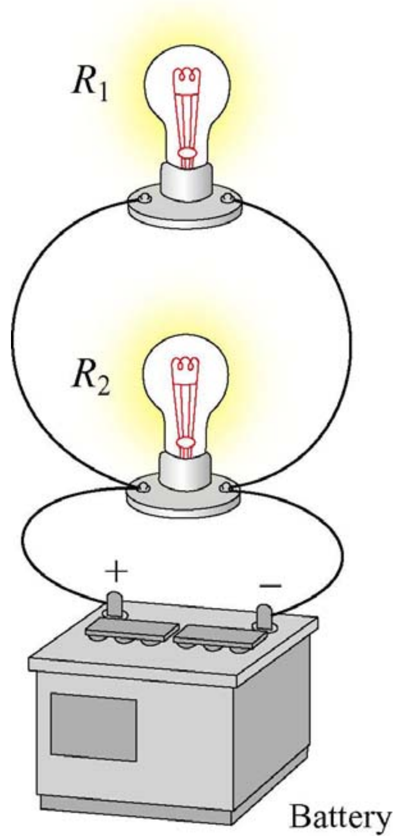
(A) The equivalent resistance of the two light bulbs in parallel is half that of one of the bulbs, and since the resistance is lower the current is higher, for a given voltage.

(B) The battery must keep two resistances at the same potential → I doubles.



Bulbs and Batteries

An ideal battery is hooked to a light bulb with wires. A second identical light bulb is connected in parallel to the first light bulb. After the second light bulb is connected, the power output from the battery (compared to when only one bulb was connected)



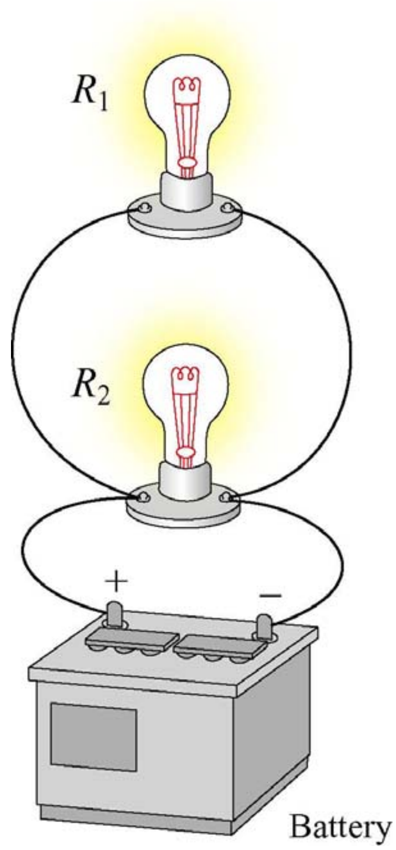
1. Is four times higher
2. Is twice as high
3. Is the same
4. Is half as much
5. Is one quarter as much
6. Don’t know

Bulbs and Batteries

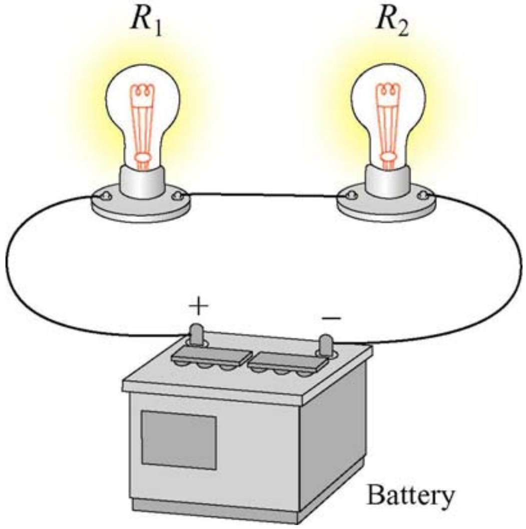
(2) Twice as much

The current from the battery must double (it must raise two light bulbs to the same voltage difference) and

$$P=IV$$



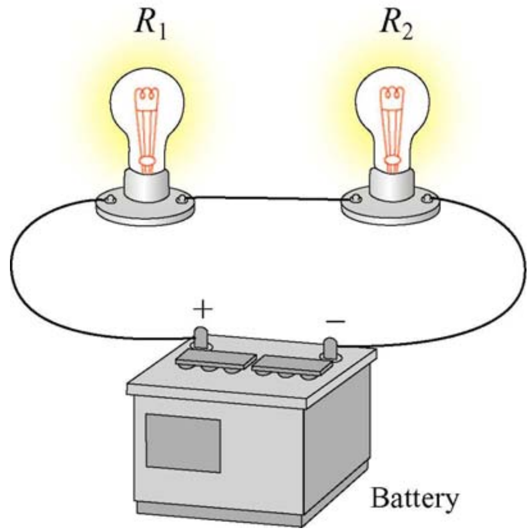
Bulbs and Batteries



An ideal battery is hooked to a light bulb with wires. A second identical light bulb is connected in series with the first light bulb. After the second light bulb is connected, the light from the first bulb (compared to when only one bulb was connected)

1. is four times as bright
2. is twice as bright
3. is the same
4. is half as bright
5. is one quarter as bright

Bulbs and Batteries



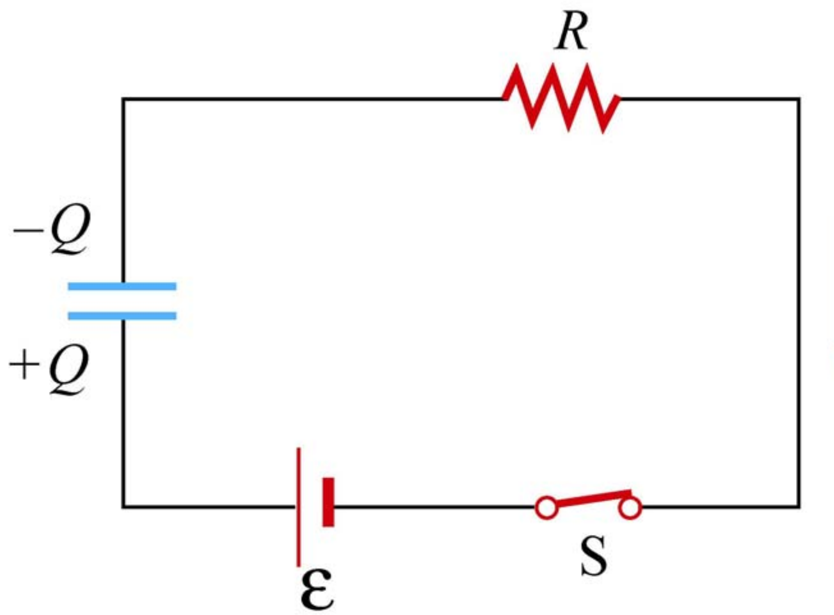
(5) The light is ¼ as bright

The resistance in the circuit doubled so the current is cut in half. This means that the power delivered by the battery is half what it was. But that power is further divided between two bulbs now.

Alternatively,

$$P = I^2R$$

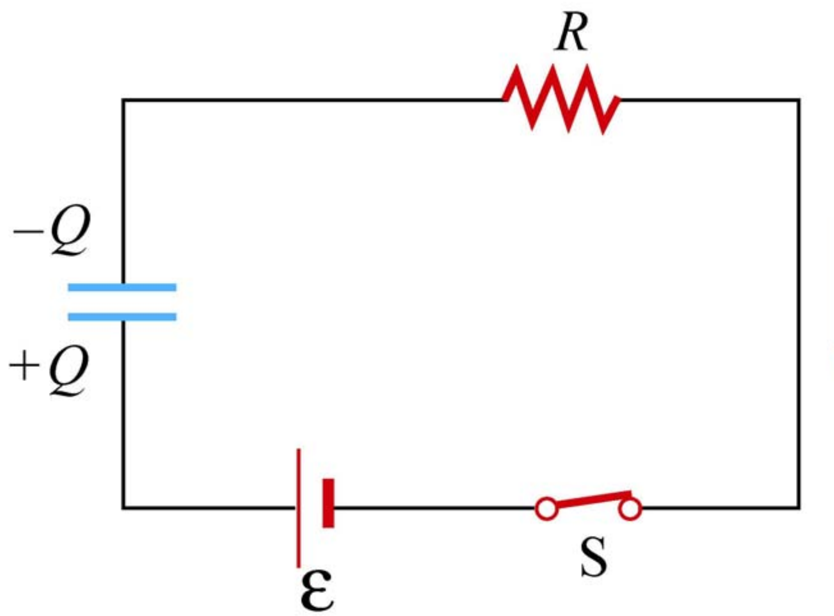
RC Circuit



An uncharged capacitor is connected to a dc voltage source via a switch. A resistor is placed in series with the capacitor. The switch is initially open. At t = 0, the switch is closed. A very long time after the switch is closed, the current in the circuit is

1. nearly zero
2. at a maximum and decreasing
3. nearly constant but non-zero

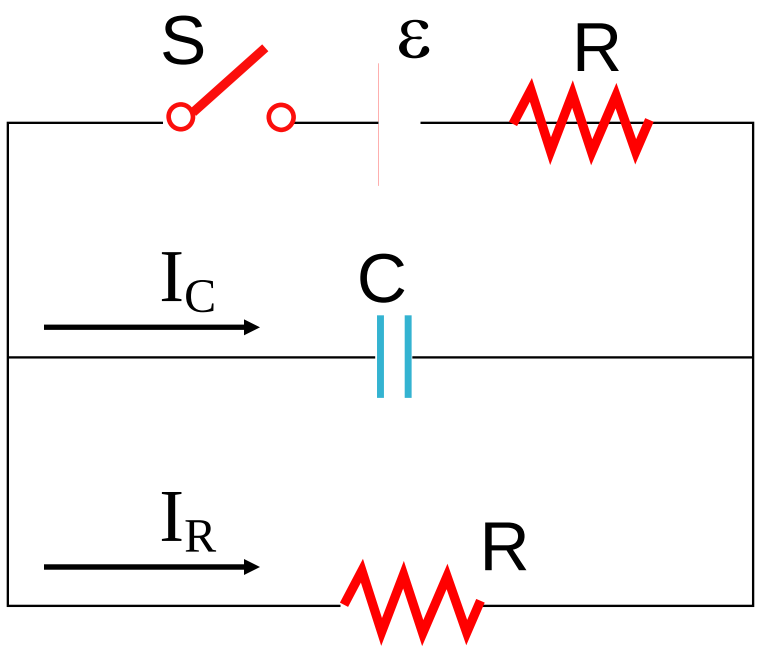
RC Circuit



(1) After a long time the current is 0

Eventually the capacitor gets “full” – the voltage increase provided by the battery is equal to the voltage drop across the capacitor. The voltage drop across the resistor at this point is 0 – no current is flowing.

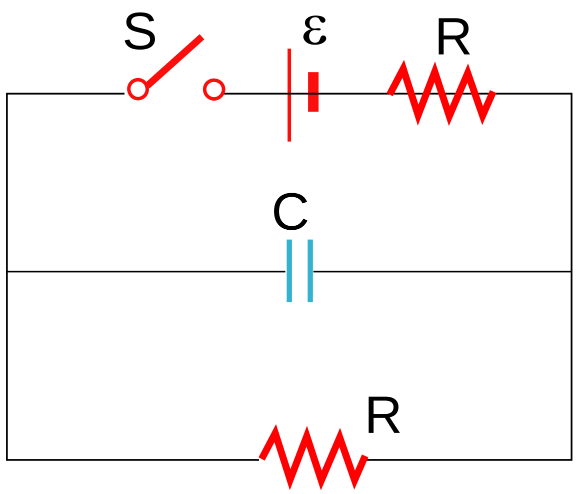
RC Circuit



Consider the above circuit, with an initially uncharged capacitor and two identical resistors. At the instant the switch is closed:

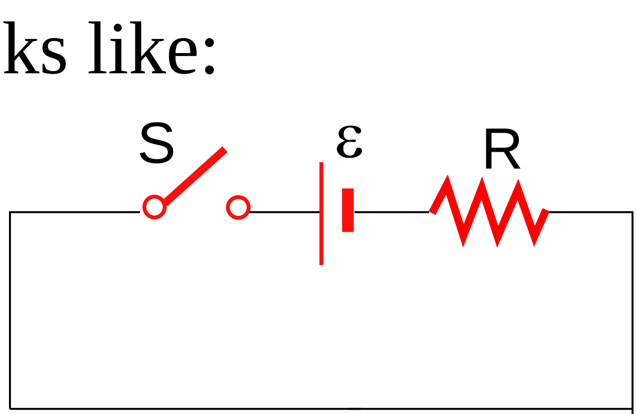
1. $I_R = I_C = 0$
2. $I_R = I_C = \varepsilon/R$
3. $I_R = \varepsilon/2R$; $I_C = 0$
4. $I_R = 0$; $I_C = \varepsilon/R$
5. $I_R = \varepsilon/2R$; $I_C = \varepsilon/R$

RC Circuit



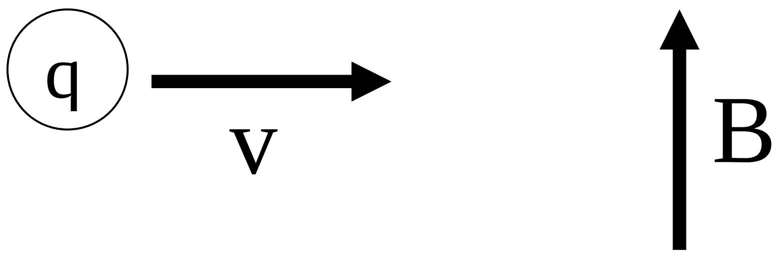
(4) $I_R = 0$; $I_C = \varepsilon/R$

Initially there is no charge on the capacitor and hence no voltage drop across it – it looks like a short. Thus all current will flow through it rather than through the bottom resistor. So the circuit looks like:



Force on Charged Particle

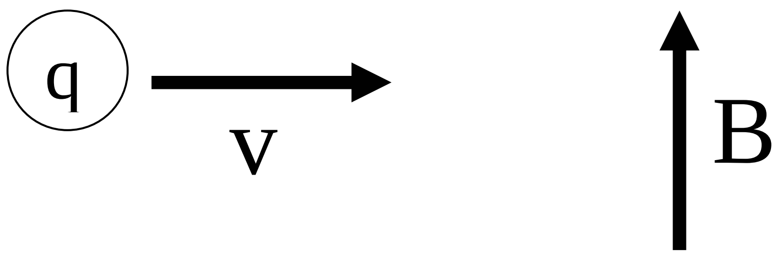
What direction is the force on a positive charge when entering a uniform B field in the direction indicated?



1) up
2) down
3) left
4) right
5) into page
6) out of page
7) there is no net force

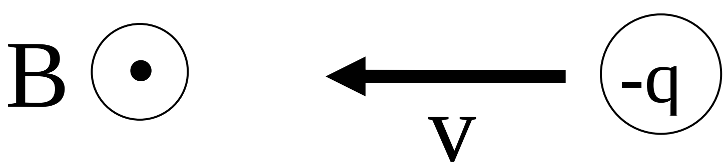
Force on Charged Particle

(6) Force is out of the page



Force on Charged Particle

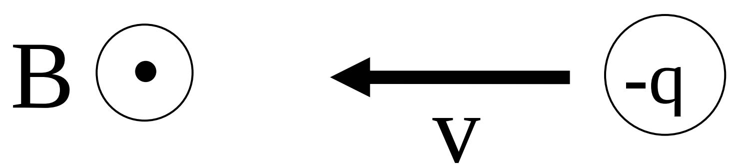
What direction is the force on a negative charge when entering a uniform B field in the direction indicated?



1) up
2) down
3) left
4) right
5) into page
6) out of page
7) there is no net force

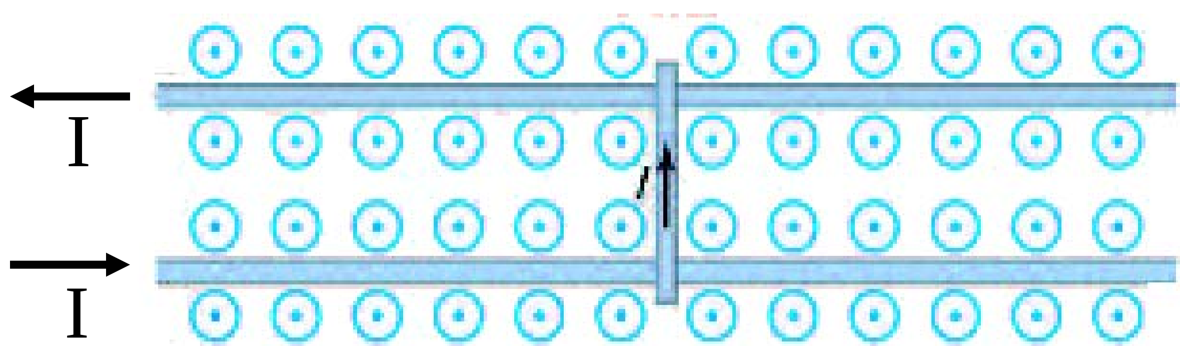
Force on Charged Particle

(2) Force on the negative charge is down



Rail Gun

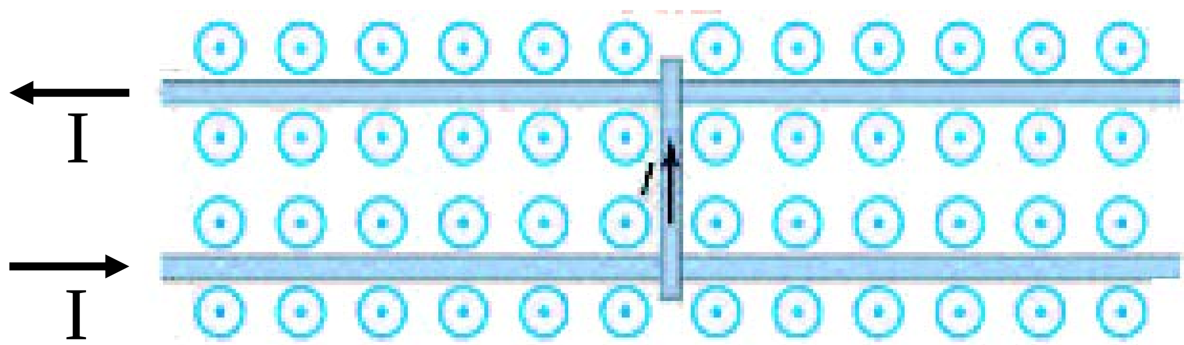
A bar is free to slide on two parallel rails. A current I flows through the bar in the direction shown. An external magnetic field points out of the page. The bar in the center of the figure will:



1) move left
2) move right
3) stay in place

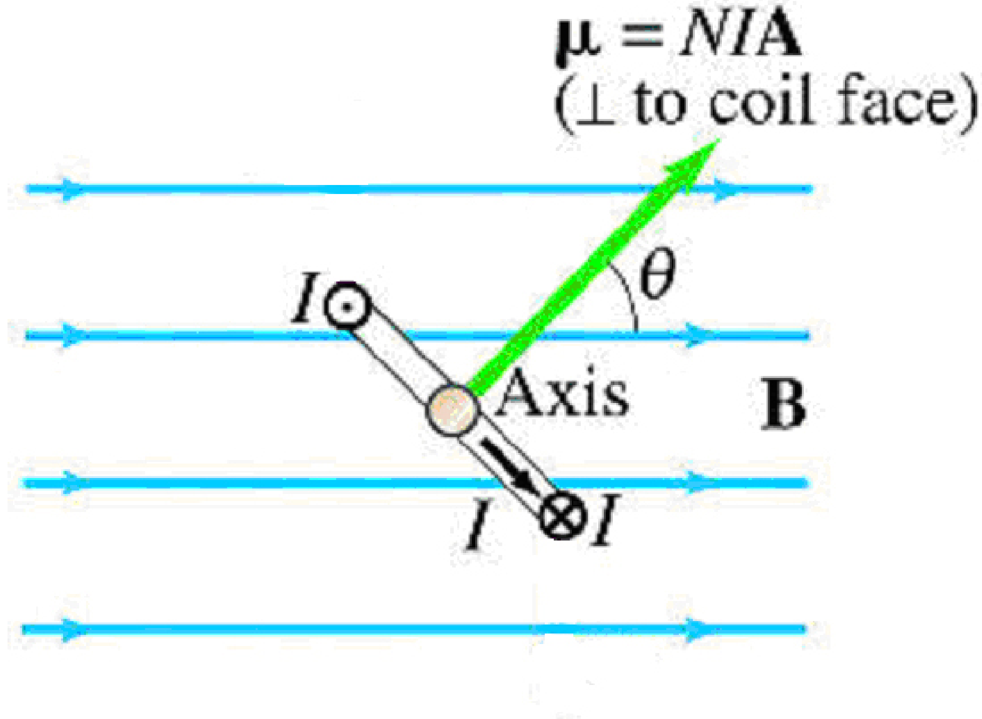
Rail Gun

(2) The rail will move to the right



$\vec{\mathbf{F}}_B = I\vec{\mathbf{l}} \times \vec{\mathbf{B}}$, and up cross out is right

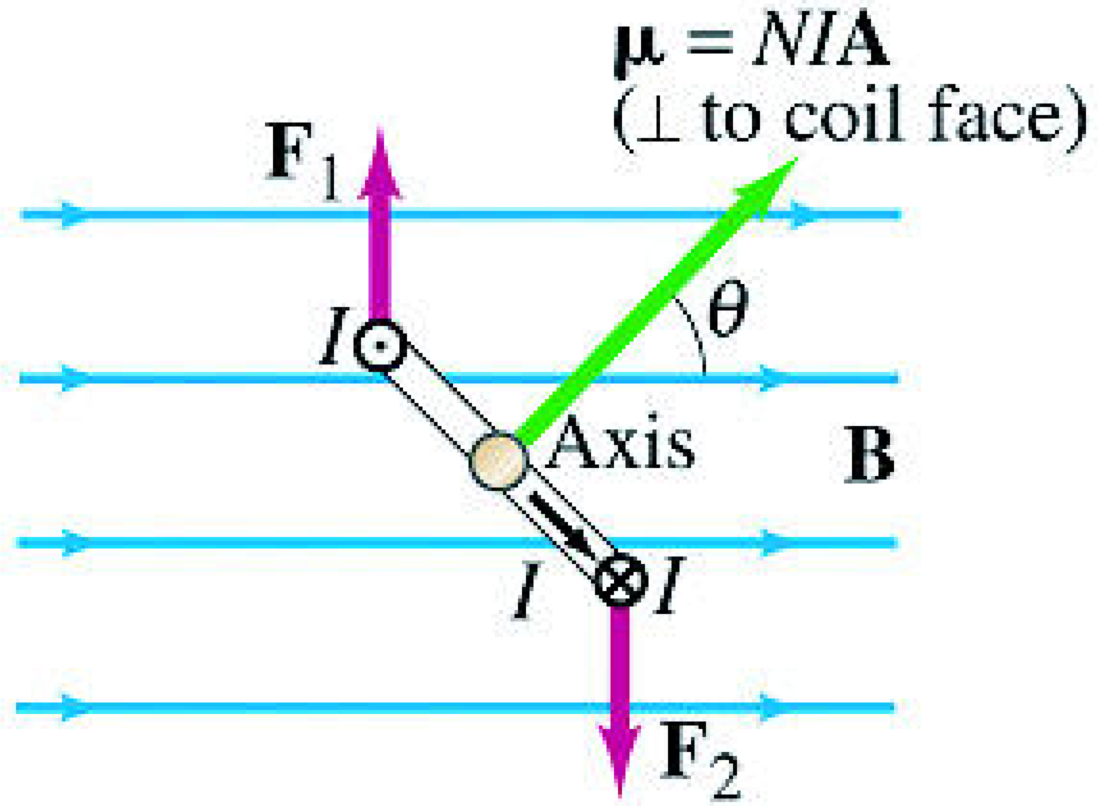
Dipole in Field



The coil above will rotate

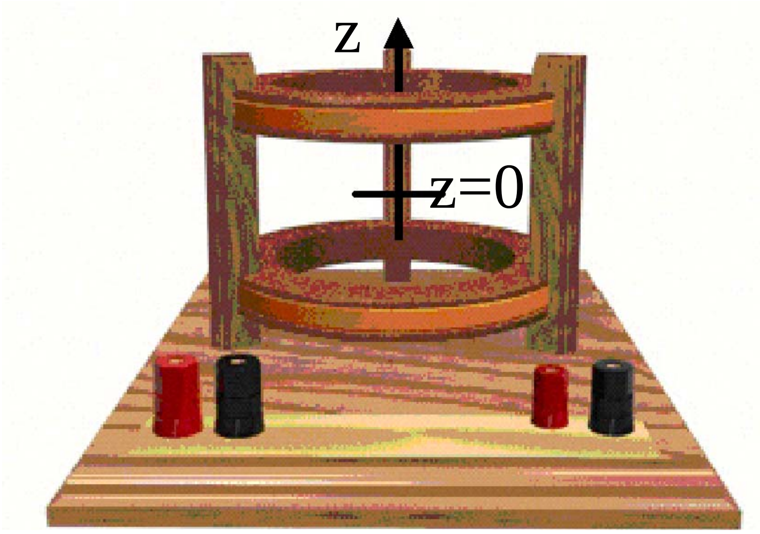
1. clockwise
2. counterclockwise
3. stay in the orientation shown because the total force is zero

Dipole in Field



Answer: 1. The coil above will rotate clockwise because the ***I ds x B*** forces shown produce a torque ***r x F*** into the page. This implies clockwise rotation.

A Helmholtz coil is hooked up with current running parallel in both coils. A magnetic dipole is placed along the z-axis at the point z = 0 with the magnetic moment pointing in the +x direction. Which of the following statements is true?



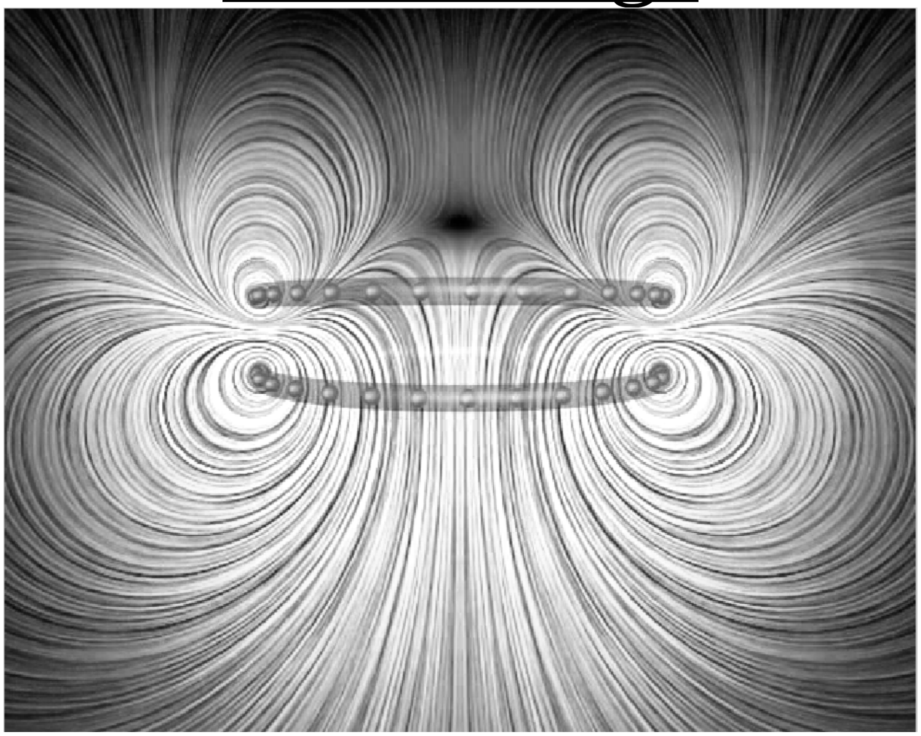
1. Force & torque on the dipole are zero
2. Force on the dipole is zero and torque on the dipole is non-zero
3. Force & torque on the dipole are nonzero
4. The force on the dipole is non-zero and the torque on the dipole is zero

Helmholtz Coil

(2) Zero force, non-zero torque

In a Helmholtz coil with parallel currents, the field is uniform at the center. There will be a torque to align the dipole with the field (along the z-axis) but no force, since the field has no gradient.

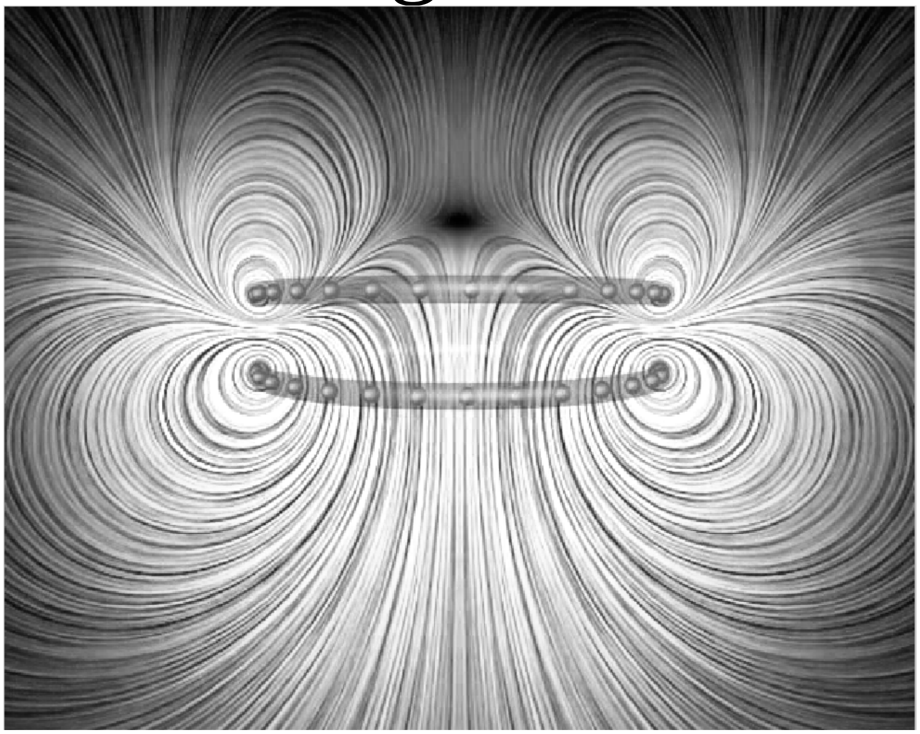
Iron Filings



Above is a iron filings representation of the magnetic field created by two loops of current. Which is true?

1. Currents are parallel (bigger in top); loops attracted
2. Currents are parallel (bigger in bottom); loops repelled
3. Currents are anti-parallel (bigger in bottom); loops attracted
4. Currents are anti-parallel (bigger in top); loops repelled
5. None of the above

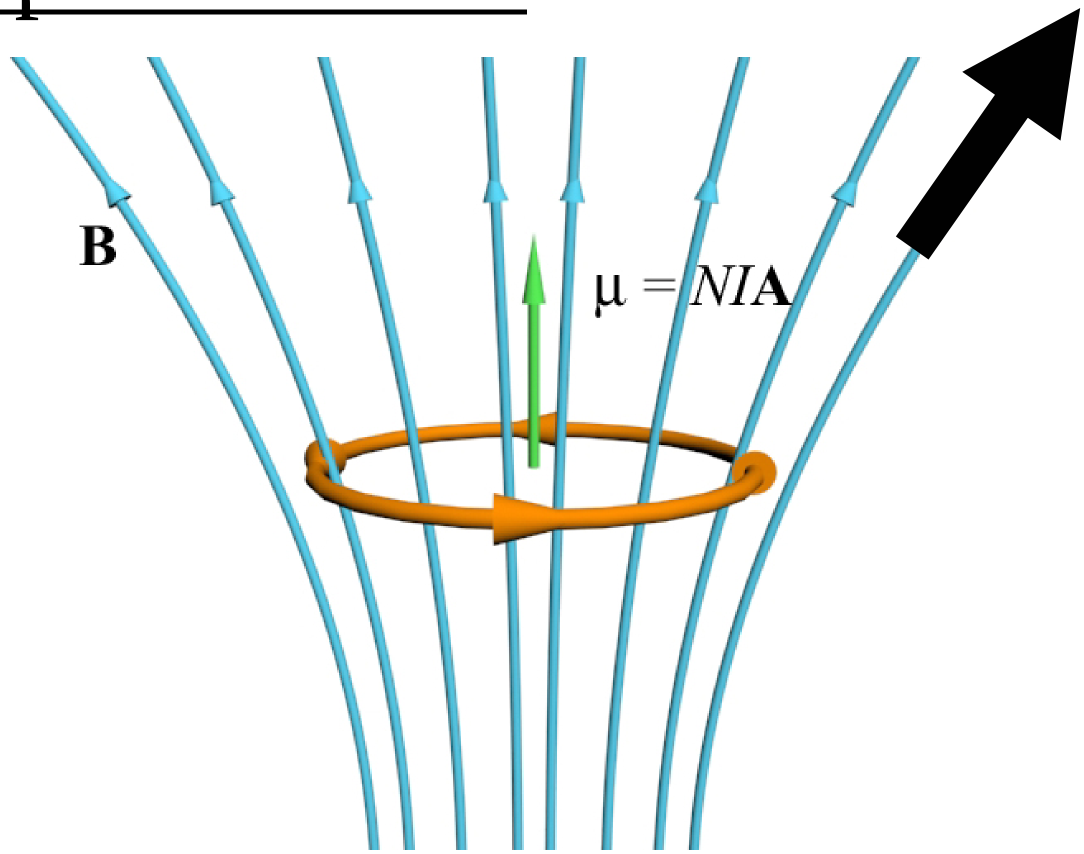
Iron Filings



(5) None of the above
Loops are repelling so currents must be anti-parallel. But the field zero is above the top loop, so the field from the bottom is stronger, so the current must be bigger in the bottom loop.

So:
Currents are anti-parallel (bigger in bottom); loops repelled

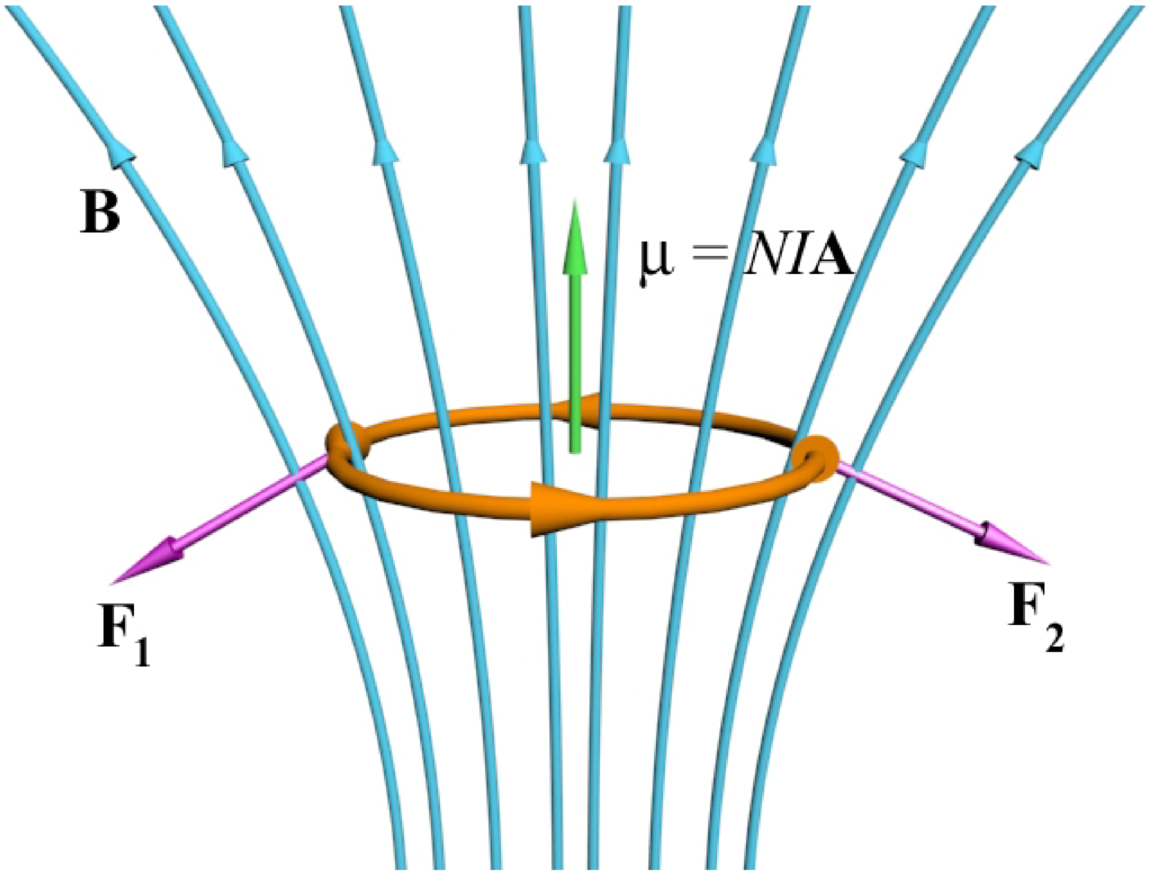
Dipole in Field



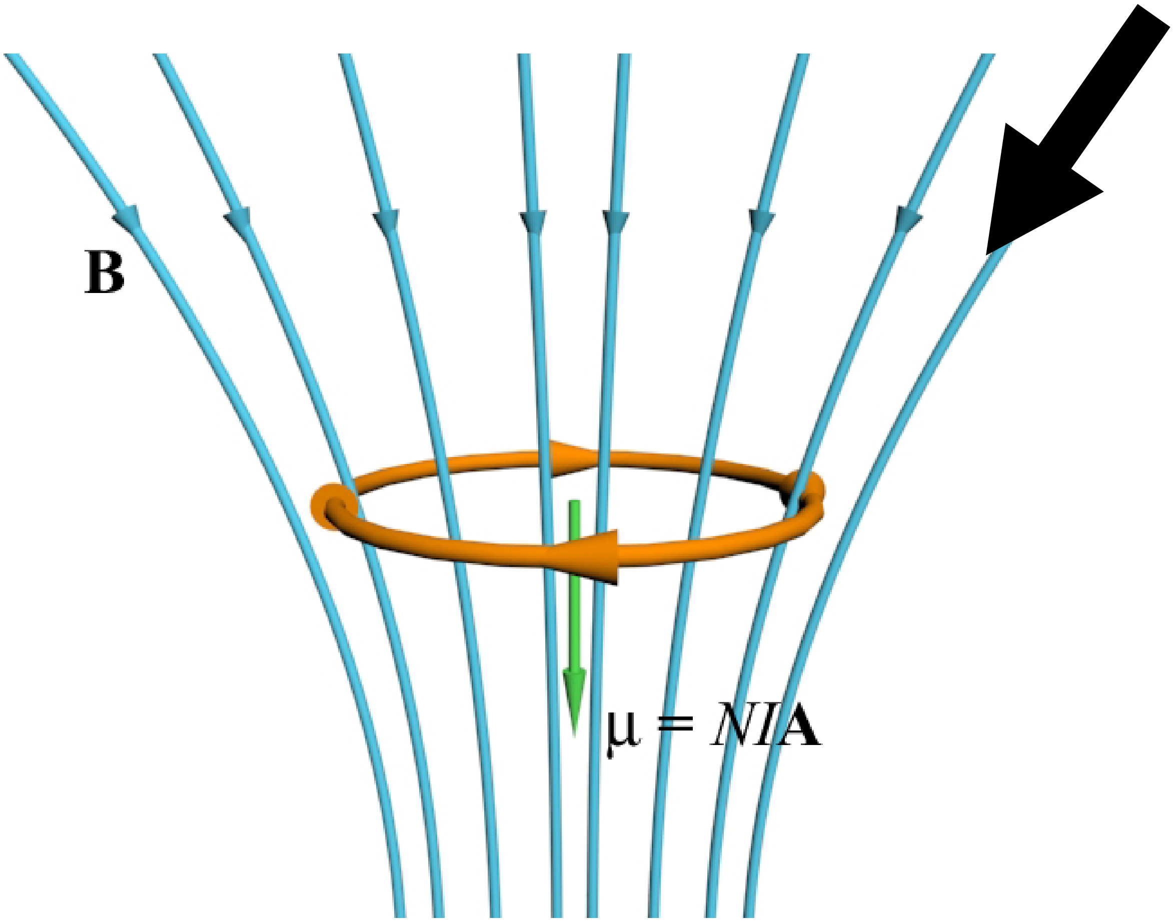
The current carrying coil above will move

1. upwards
2. downwards
3. stay where it is because the total force is zero

Dipole in Field

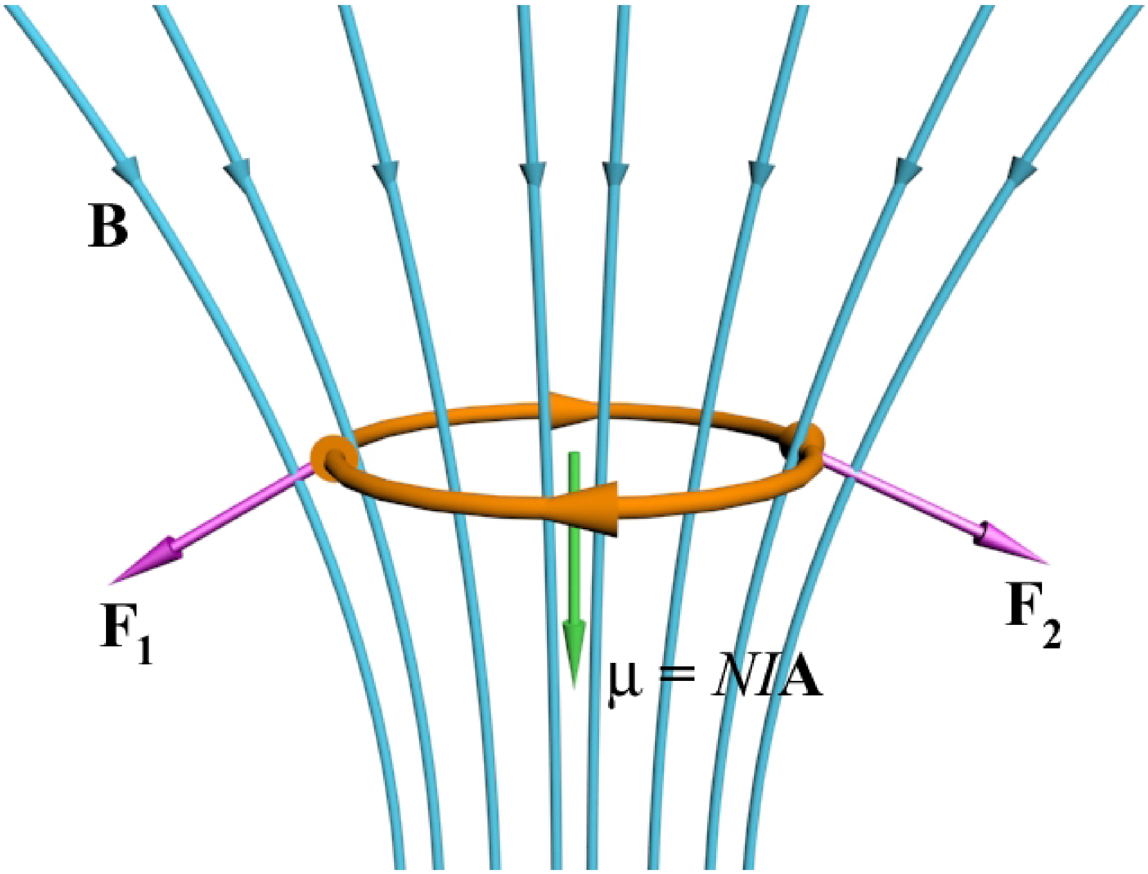


Answer: 2. The coil above will move downward because the ***I ds x B*** forces shown produce a net force downward



The current-carrying coil above will move

1. upwards
2. downwards
3. stay where it is because the total force is zero



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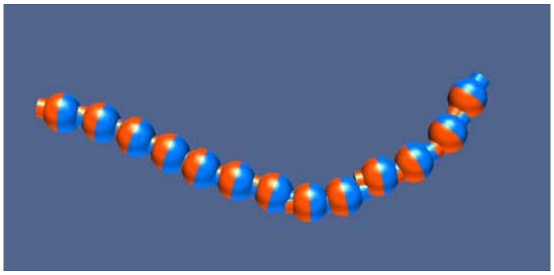
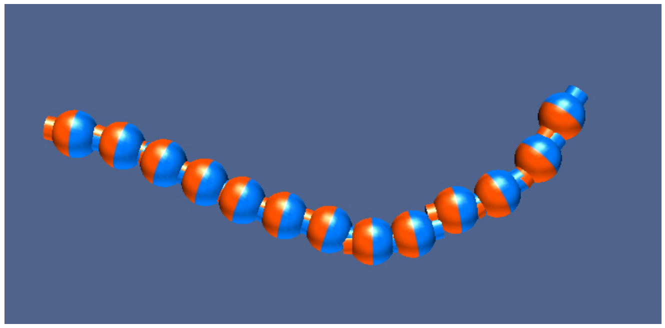


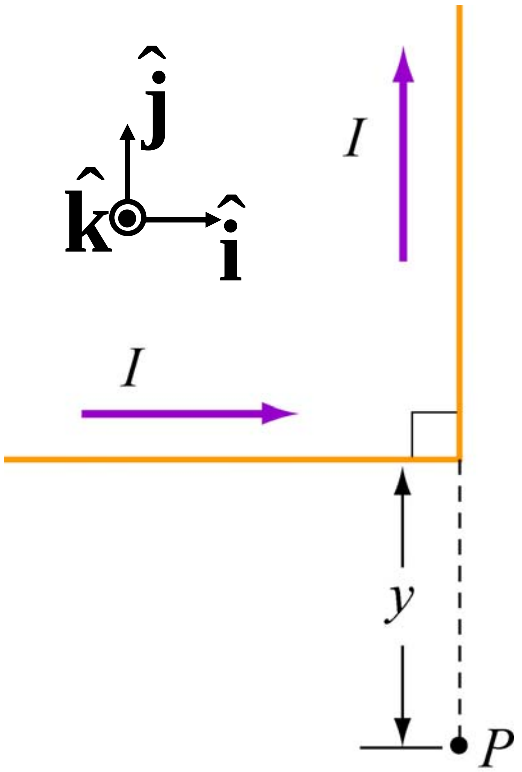
Free dipoles attract because:

1. The force between dipoles is always attractive independent of orientation.
2. A dipole will always move towards stronger field, independent of orientation.
3. The torque on the dipole aligns it with the local field and the dipole will then move toward stronger field strength.



Answer: 3. Free dipoles attract because the torque on a dipole aligns the dipole with the local field and the dipole then moves toward stronger field strength—that is closer to another dipole. If the dipole were anti-aligned with the local field then it would move toward regions of *weaker* field strength.

Bent Wire

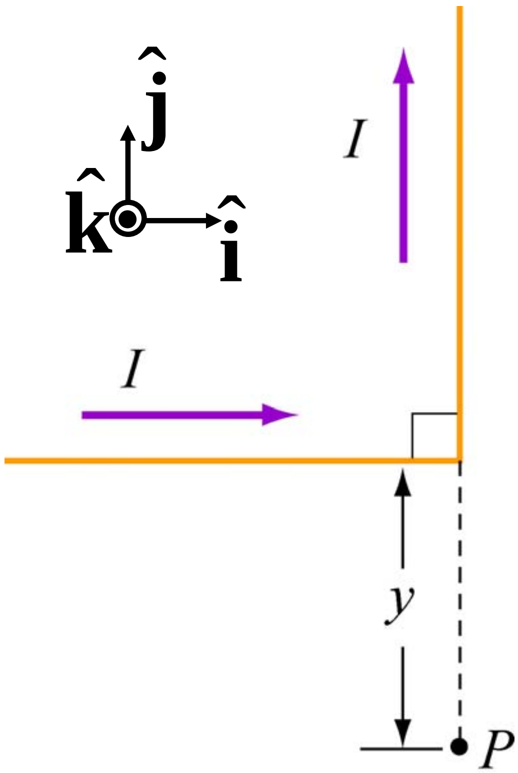


The magnetic field at point P

1. points towards the +x direction
2. points towards the +y direction
3. points towards the +z direction
4. points towards the -x direction
5. points towards the -y direction
6. points towards the -z direction
7. points nowhere because it is zero

Bent Wire

(6) B is in the –z direction



The vertical line segment contributes nothing to the field at P (it is parallel to the displacement). The horizontal segment makes a field into the page.