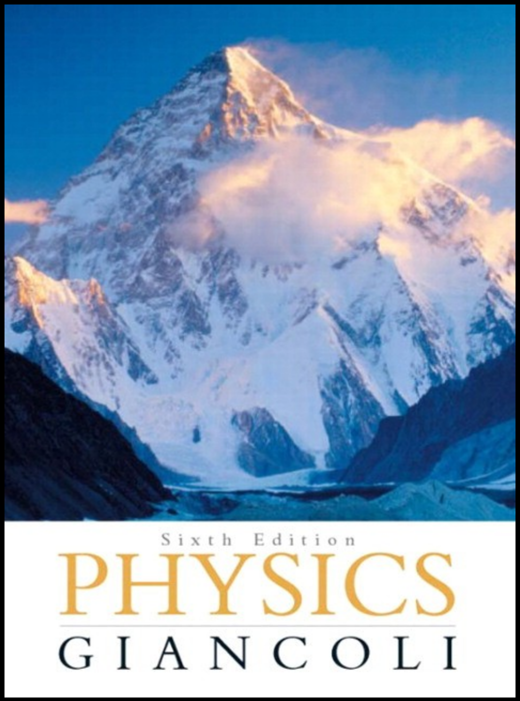


ConcepTest PowerPoints

Chapter 21

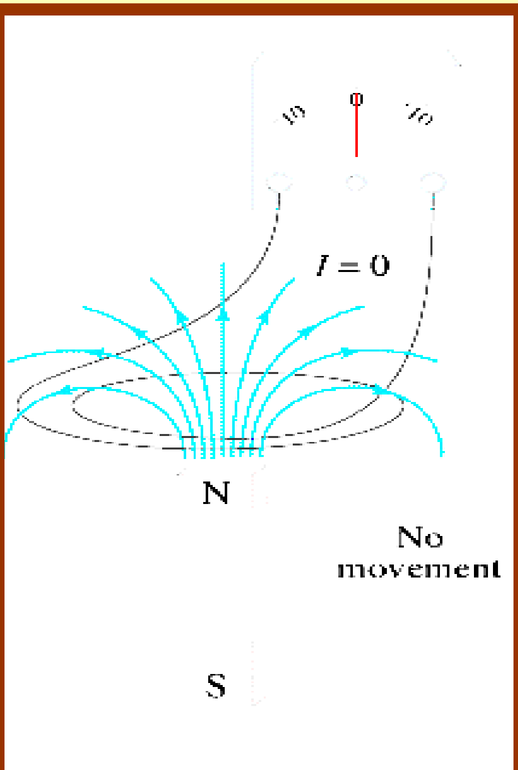
Physics: Principles with Applications, 6th edition

Giancoli

ConcepTest 21.1a Magnetic Flux I

In order to change the magnetic flux through the loop, what would you have to do?

1) drop the magnet
2) move the magnet upwards
3) move the magnet sideways
4) only (1) and (2)
5) all of the above

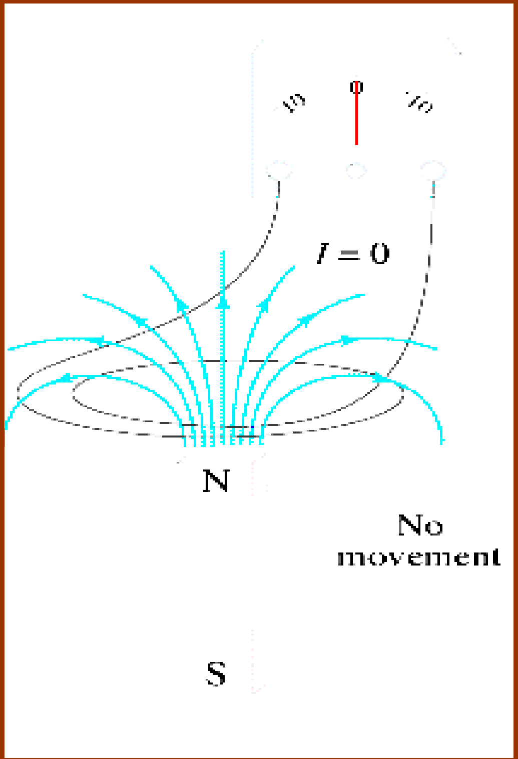


ConcepTest 21.1a Magnetic Flux I

In order to change the magnetic flux through the loop, what would you have to do?

1) drop the magnet
2) move the magnet upwards
3) move the magnet sideways
4) only (1) and (2)
5) all of the above

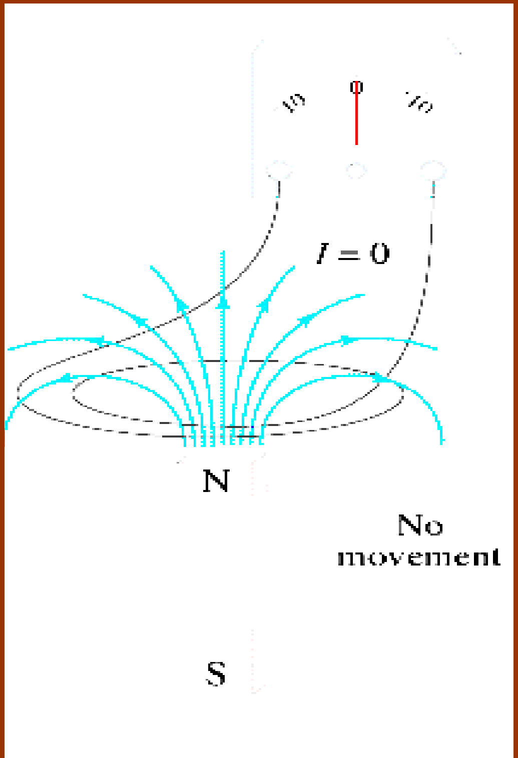
Moving the magnet in **any direction** would change the magnetic field through the loop and thus the magnetic flux.



ConcepTest 21.1b Magnetic Flux II

In order to change the magnetic flux through the loop, what would you have to do?

1) tilt the loop
2) change the loop area
3) use thicker wires
4) only (1) and (2)
5) all of the above

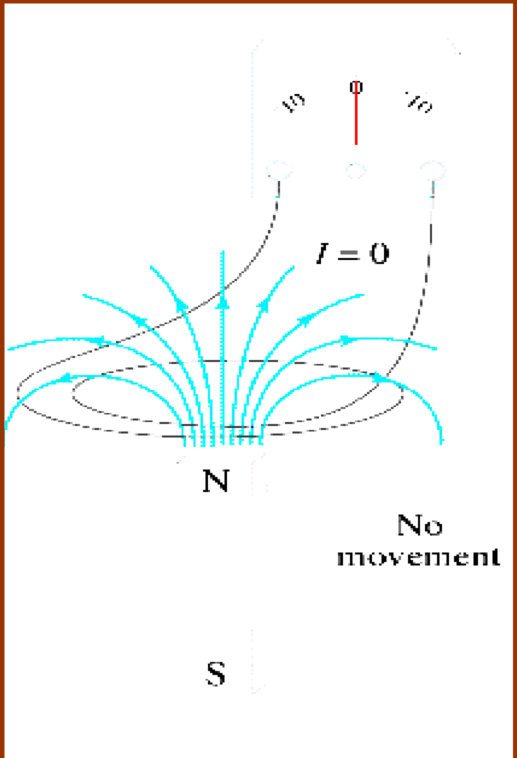


ConcepTest 21.1b Magnetic Flux II

In order to change the magnetic flux through the loop, what would you have to do?

1) tilt the loop
2) change the loop area
3) use thicker wires
4) only (1) and (2)
5) all of the above

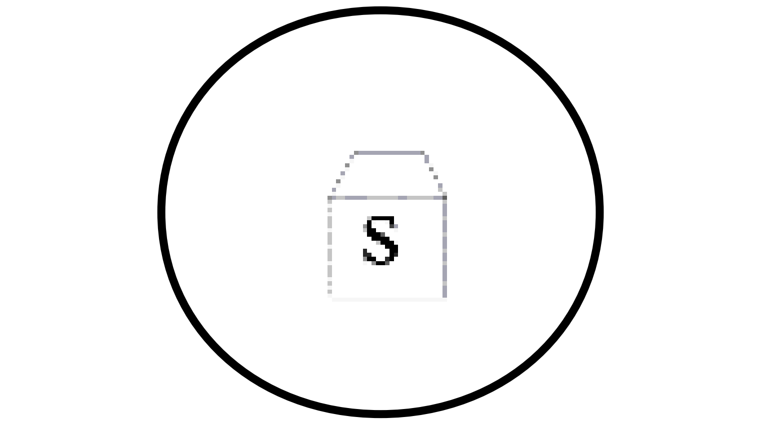
Since $\Phi = B\,A\cos\theta$, **changing the area** or **tilting the loop** (which varies the projected area) would change the magnetic flux through the loop.



ConcepTest 21.2a Moving Bar Magnet I

If a North pole moves toward the loop from above the page, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

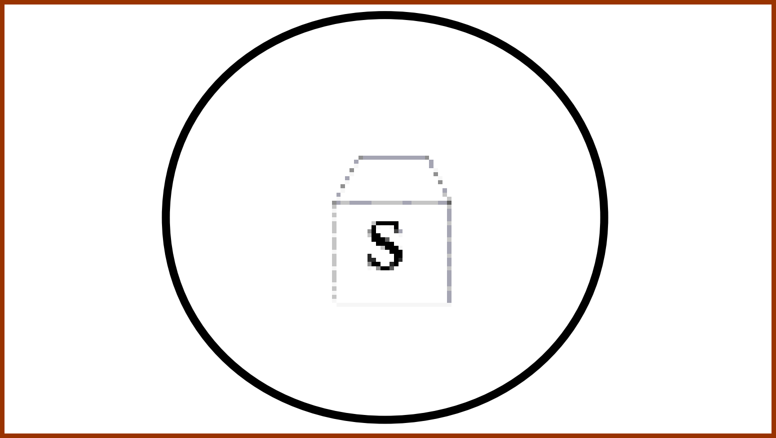


ConcepTest 21.2a Moving Bar Magnet I

If a North pole moves toward the loop from above the page, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

The magnetic field of the moving bar magnet is pointing ***into the page*** and getting ***larger*** as the magnet moves closer to the loop. Thus the induced magnetic field has to point ***out of the page***. A ***counterclockwise*** induced current will give just such an induced magnetic field.

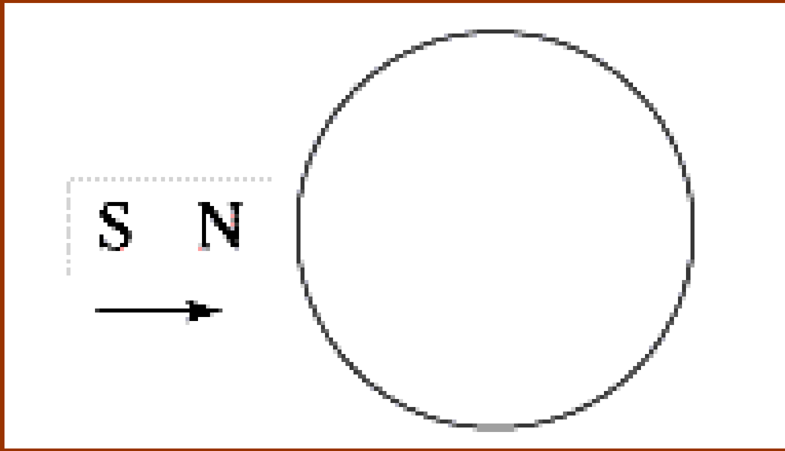


Follow-up: What happens if the magnet is stationary but the loop moves?

ConcepTest 21.2b Moving Bar Magnet II

If a North pole moves toward the loop in the plane of the page, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

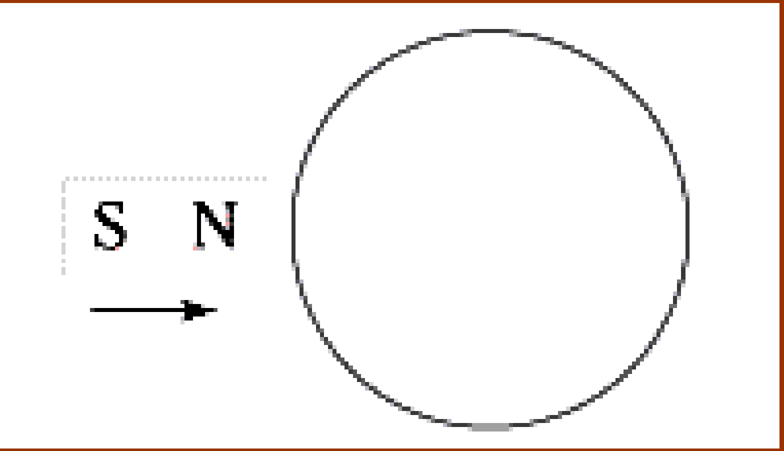


ConcepTest 21.2b Moving Bar Magnet II

If a North pole moves toward the loop in the plane of the page, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

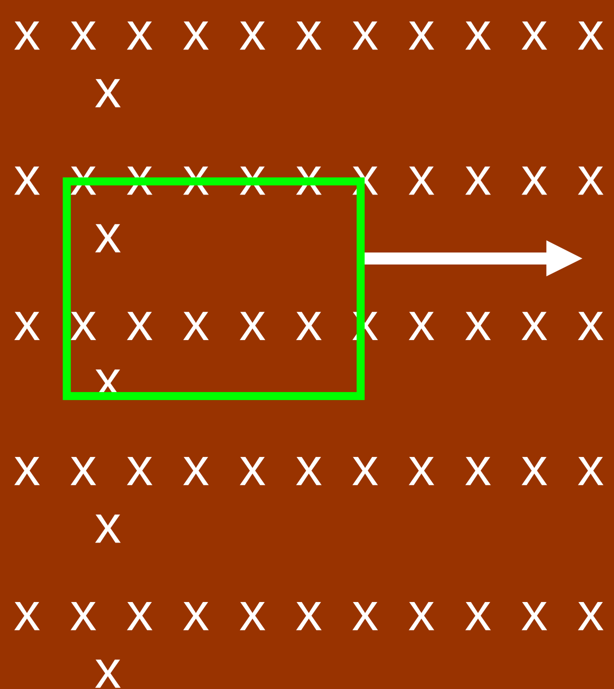
Since the magnet is moving parallel to the loop, there is **no magnetic flux through the loop**. Thus the **induced current is zero**.



ConcepTest 21.3a Moving Wire Loop I

A wire loop is being pulled through a uniform magnetic field. What is the direction of the induced current?

1) clockwise
2) counterclockwise
3) no induced current



ConcepTest 21.3a Moving Wire Loop I

A wire loop is being pulled through a uniform magnetic field. What is the direction of the induced current?

1) clockwise
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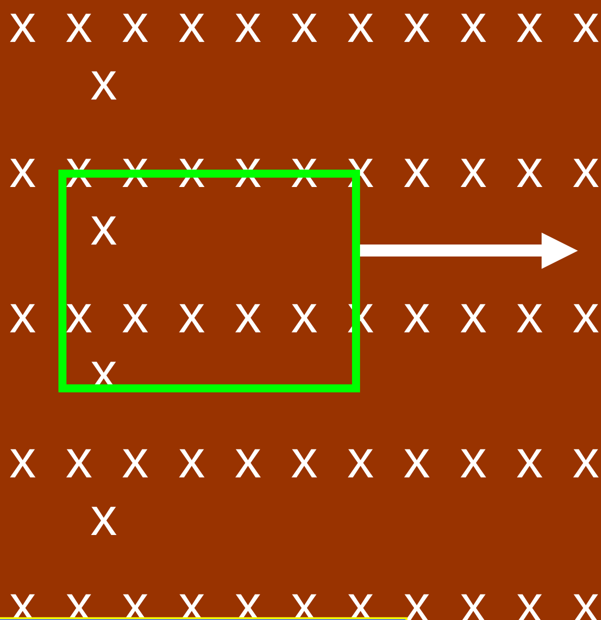
3) no induced current



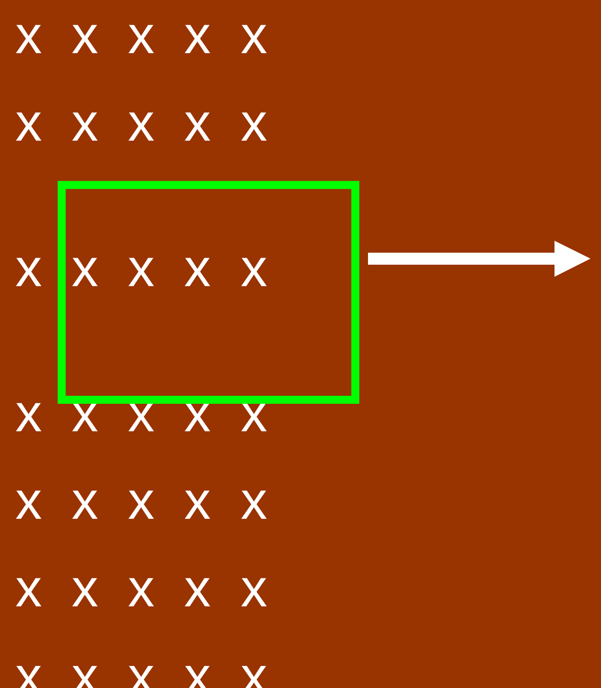
Since the magnetic field is uniform, the magnetic flux through the loop is not changing. Thus no current is induced.

Follow-up: What happens if the loop moves out of the page?

ConcepTest 21.3b Moving Wire Loop II

A wire loop is being pulled through a **uniform magnetic field that suddenly ends**. What is the direction of the induced current?

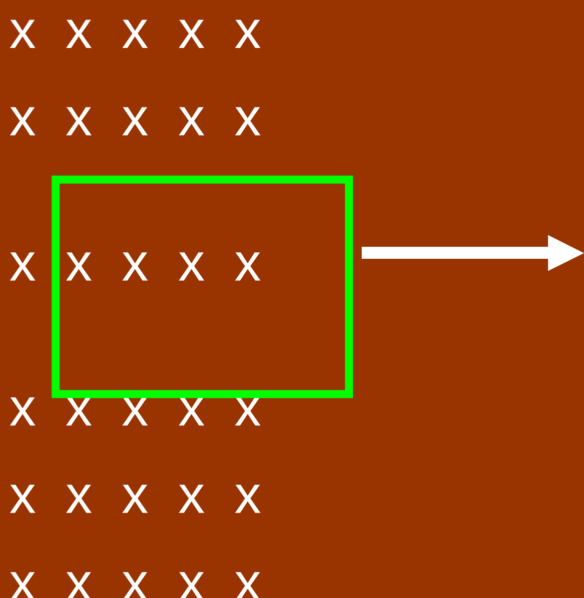
1) clockwise
2) counterclockwise
3) no induced current



ConcepTest 21.3b Moving Wire Loop II

A wire loop is being pulled through a uniform magnetic field that suddenly ends. What is the direction of the induced current?

1) clockwise
2) counterclockwise
3) no induced current



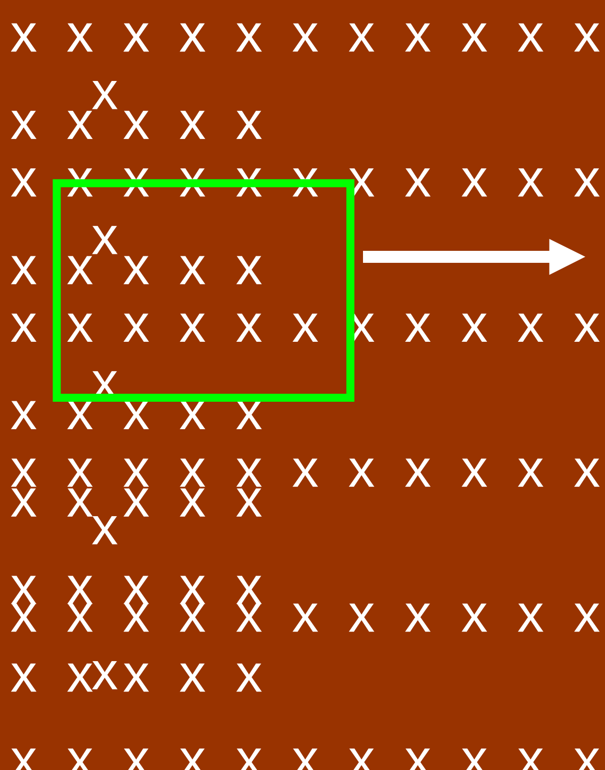
The *B* field into the page is disappearing in the loop, so it must be compensated by an induced flux also into the page. This can be accomplished by an induced current in the clockwise direction in the wire loop.

Follow-up: What happens when the loop is completely out of the field?

ConcepTest 21.3c Moving Wire Loop III

What is the direction of the induced current if the *B* field suddenly increases while the loop is in the region?

1) clockwise
2) counterclockwise
3) no induced current

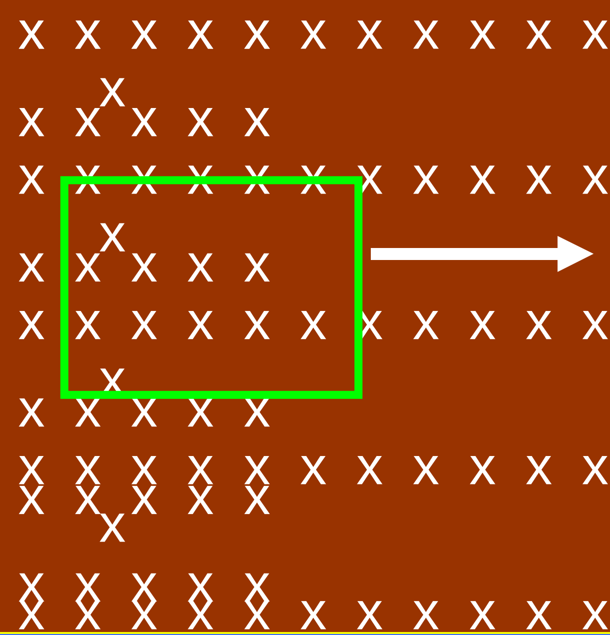


ConcepTest 21.3c Moving Wire Loop III

What is the direction of the induced current if the *B* **field suddenly increases** while the loop is in the region?

1) clockwise
2) counterclockwise
3) no induced current

The **increasing *B* field into the page** must be countered by an **induced flux out of the page**. This can be accomplished by **induced current in the counterclockwise direction** in the wire loop.

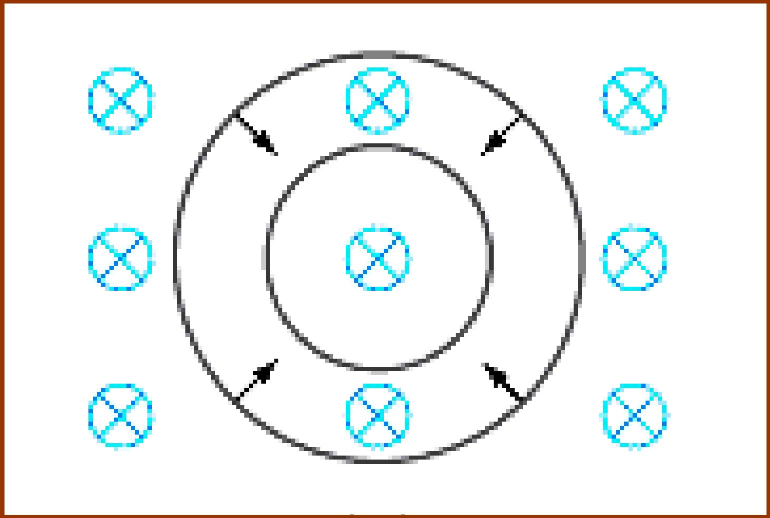


Follow-up: What if the loop stops moving while the field increases?

ConcepTest 21.4 Shrinking Wire Loop

If a coil is shrinking in a magnetic field pointing into the page, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

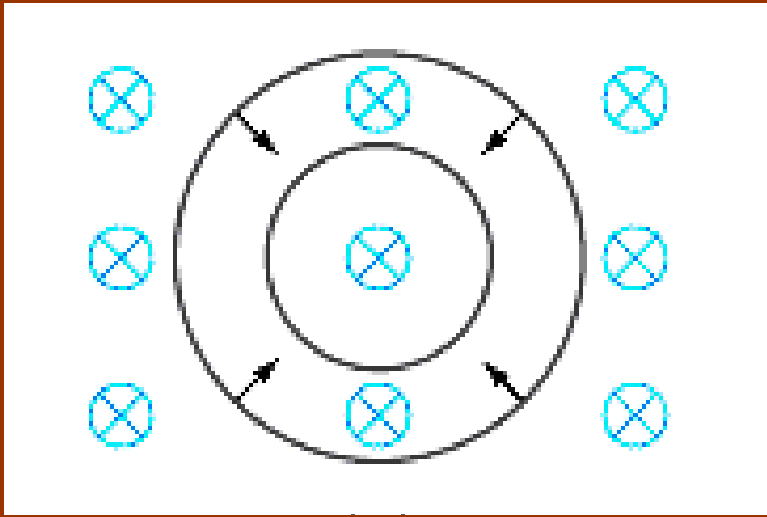


ConcepTest 21.4 Shrinking Wire Loop

If a coil is shrinking in a magnetic field pointing into the page, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

The magnetic flux through the loop is ***decreasing***, so the induced B field must try to reinforce it and therefore points in the same direction — ***into the page***. According to the right-hand rule, an induced ***clockwise*** current will generate a magnetic field **into the page**.

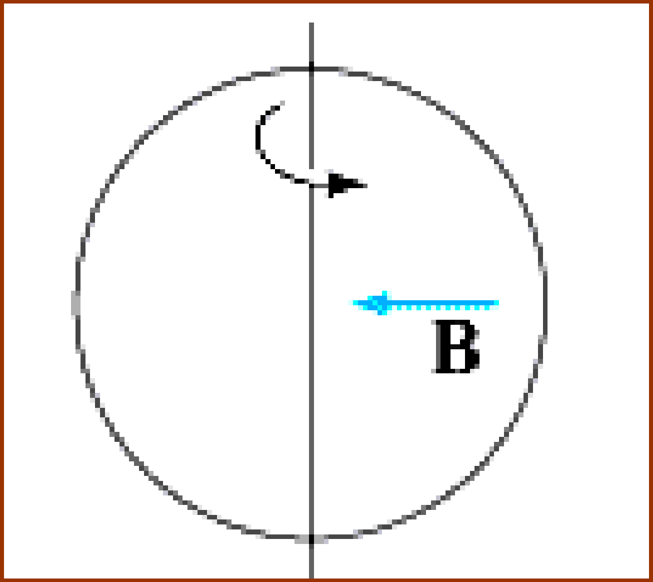


Follow-up: What if the *B* field is oriented at 90° to its present direction?

ConcepTest 21.5 Rotating Wire Loop

If a coil is rotated as shown, in a magnetic field pointing to the left, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

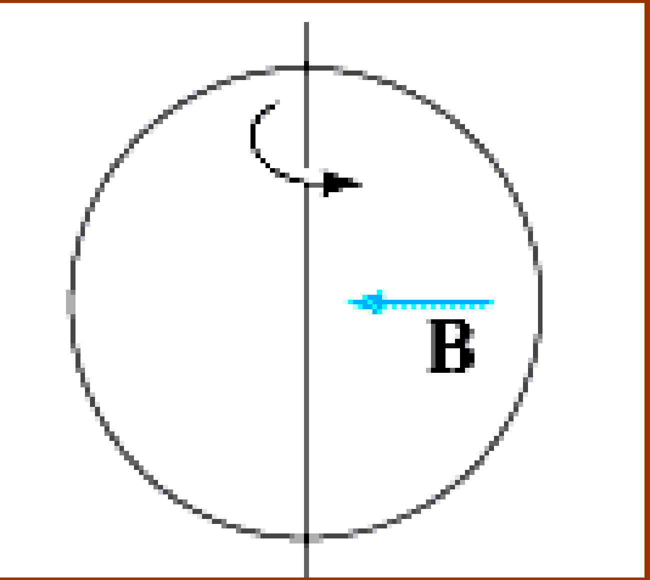


ConcepTest 21.5 Rotating Wire Loop

If a coil is rotated as shown, in a magnetic field pointing to the left, in what direction is the induced current?

1) clockwise
2) counterclockwise
3) no induced current

As the coil is rotated into the *B* field, the magnetic flux through it ***increases***. According to Lenz's Law, the induced B field has to ***oppose this increase***, thus the new *B* field points ***to the right***. An induced ***counterclockwise*** current produces just such a *B* field.



ConcepTest 21.6a Voltage and Current I

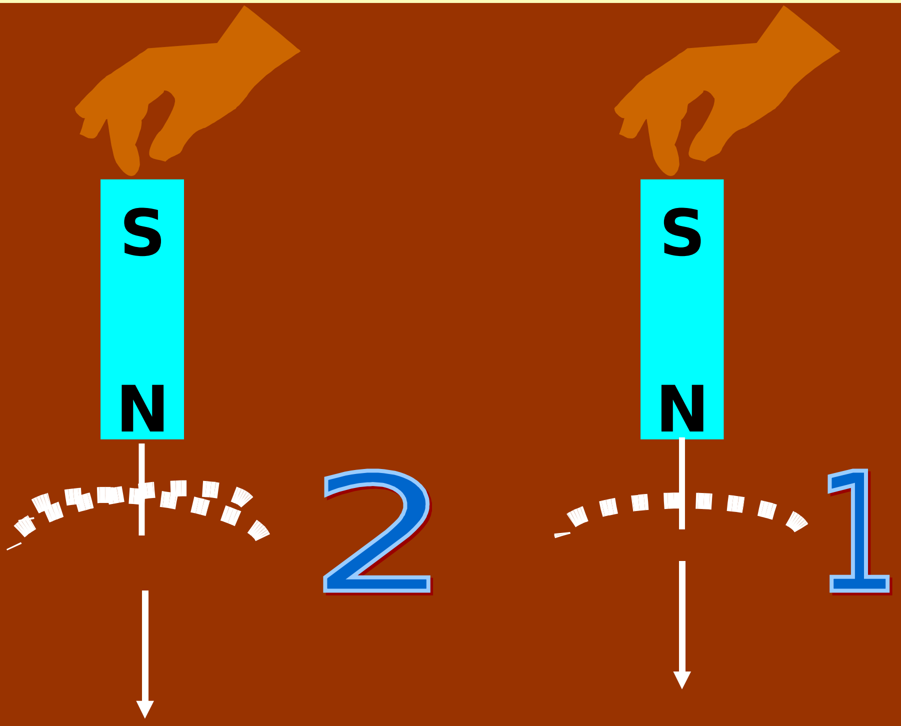
Wire #1 (length L) forms a one-turn loop, and a bar magnet is dropped through. Wire #2 (length $2L$) forms a two-turn loop, and the same magnet is dropped through. Compare the magnitude of the induced voltages in these two cases.

1) $V_1 > V_2$

2) $V_1 < V_2$

3) $V_1 = V_2 \neq 0$

4) $V_1 = V_2 = 0$



ConcepTest 21.6a Voltage and Current I

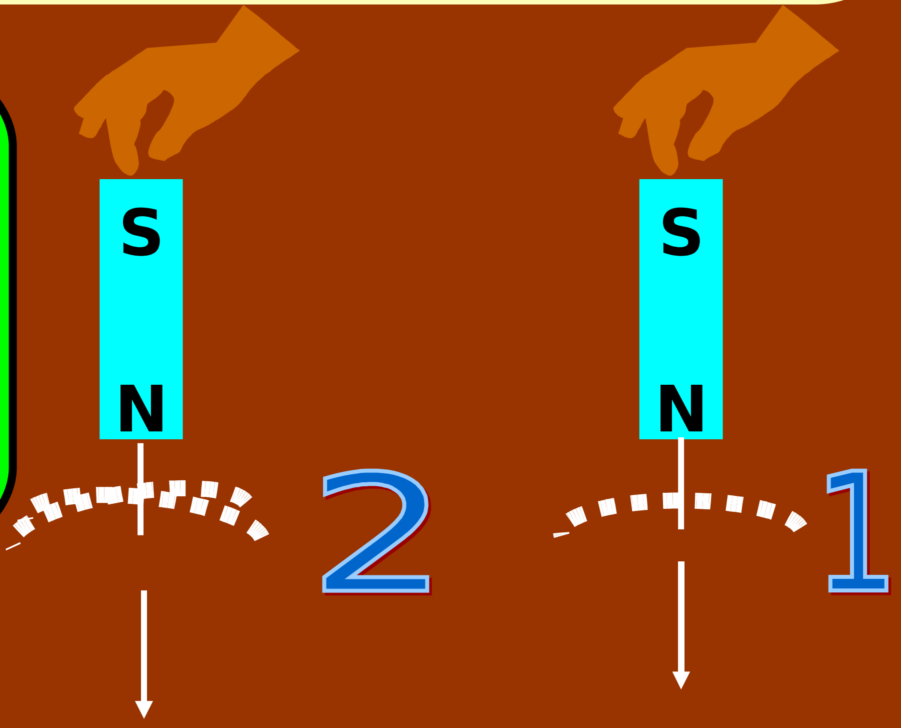
Wire #1 (length *L*) forms a **one-turn loop**, and a bar magnet is dropped through. **Wire #2** (length 2*L*) forms a **two-turn loop**, and the same magnet is dropped through. Compare the magnitude of the **induced voltages** in these two cases.

1) $V_1 > V_2$
2) $V_1 < V_2$
3) $V_1 = V_2 \neq 0$
4) $V_1 = V_2 = 0$

Faraday's law:

$$\varepsilon = -N \frac{\Delta \Phi_B}{\Delta t}$$

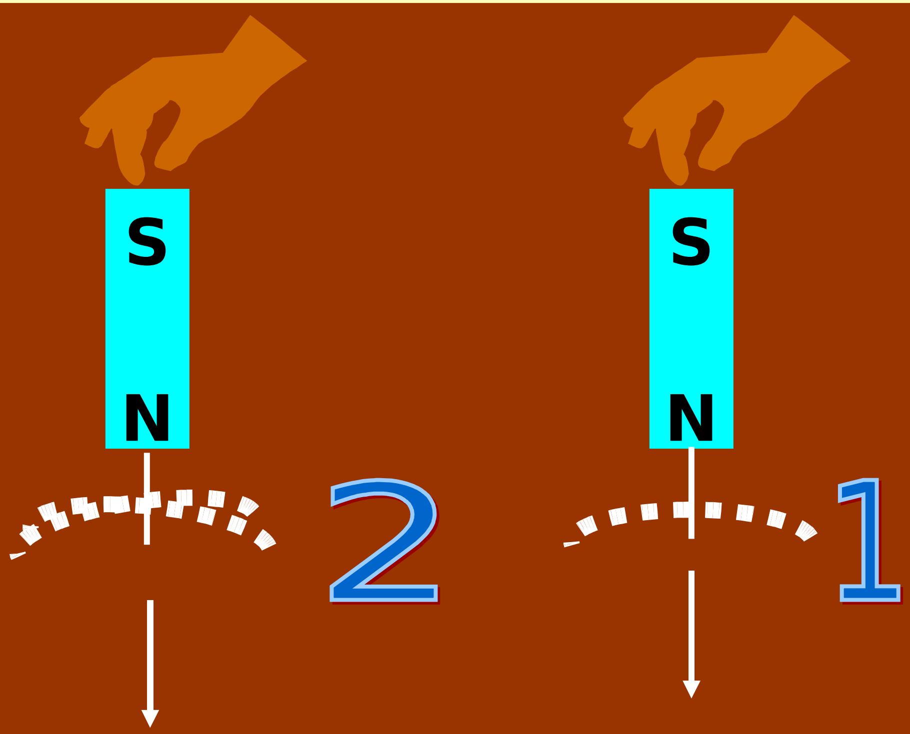
depends on N (**number of loops**) so the **induced emf is twice as large in the wire with 2 loops**.



ConcepTest 21.6b Voltage and Current II

Wire #1 (length L) forms a **one-turn loop**, and a bar magnet is dropped through. **Wire #2** (length $2L$) forms a **two-turn loop**, and the same magnet is dropped through. Compare the magnitude of the **induced currents** in these two cases.

1) $I_1 > I_2$
2) $I_1 < I_2$
3) $I_1 = I_2 \neq 0$
4) $I_1 = I_2 = 0$



ConcepTest 21.6b Voltage and Current II

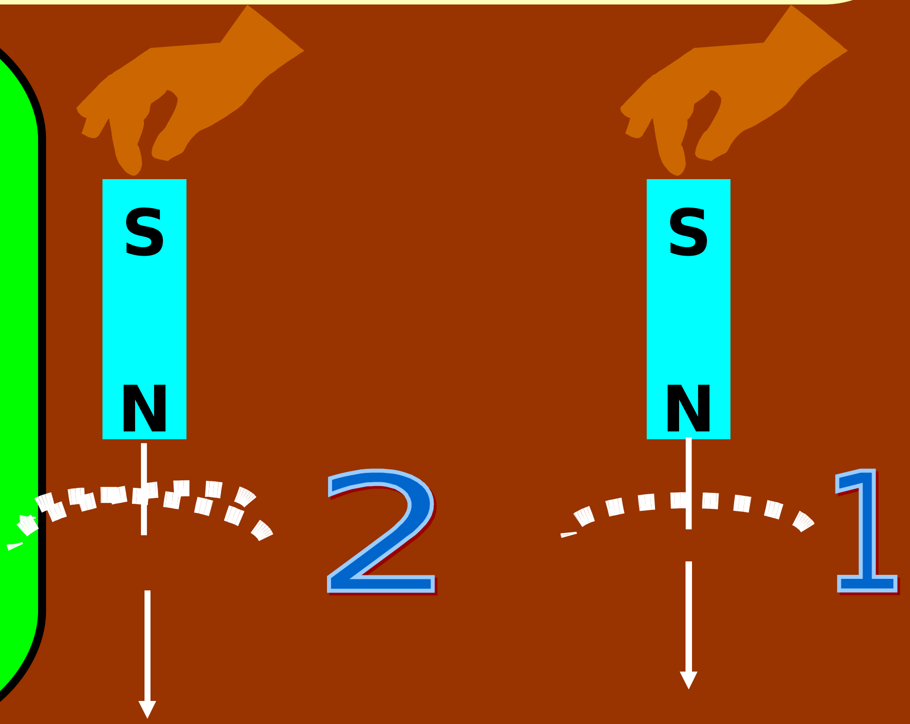
Wire #1 (length L) forms a one-turn loop, and a bar magnet is dropped through. Wire #2 (length $2L$) forms a two-turn loop, and the same magnet is dropped through. Compare the magnitude of the induced currents in these two cases.

1) $I_1 > I_2$
2) $I_1 < I_2$
3) $I_1 = I_2 \neq 0$
4) $I_1 = I_2 = 0$

Faraday's law:

$$\varepsilon = -N \frac{\Delta \Phi_B}{\Delta t}$$

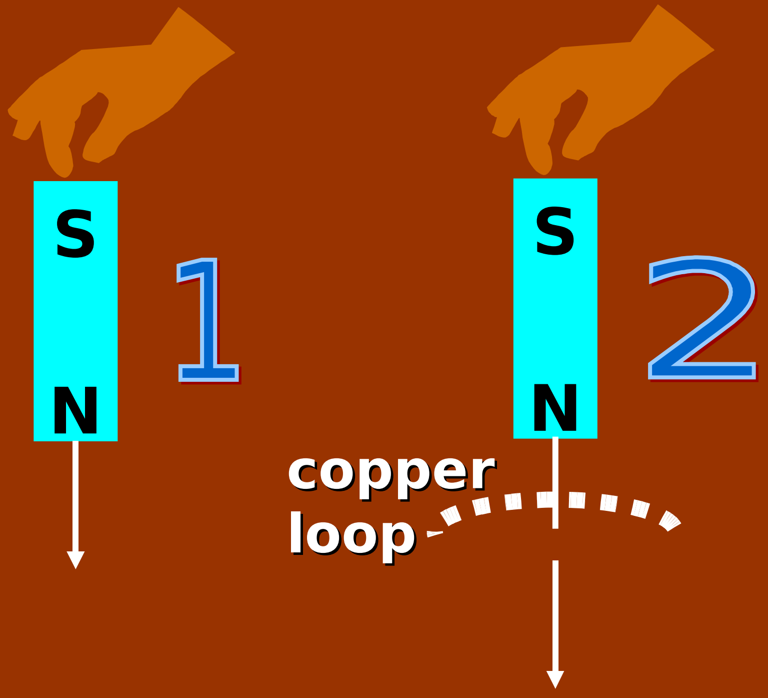
says that the induced emf is twice as large in the wire with 2 loops. The current is given by Ohm's law: $I = V/R$. Since wire #2 is twice as long as wire #1, it has twice the resistance, so the current in both wires is the same.



ConcepTest 21.7a Falling Magnet I

A bar magnet is held above the floor and dropped. In 1, there is nothing between the magnet and the floor. In 2, the magnet falls through a copper loop. How will the magnet in case 2 fall in comparison to case 1?

1) it will fall slower
2) it will fall faster
3) it will fall the same



ConcepTest 21.7a Falling Magnet I

A bar magnet is held above the floor and dropped. In 1, there is nothing between the magnet and the floor. In 2, the magnet falls through a copper loop. How will the magnet in case 2 fall in comparison to case 1?

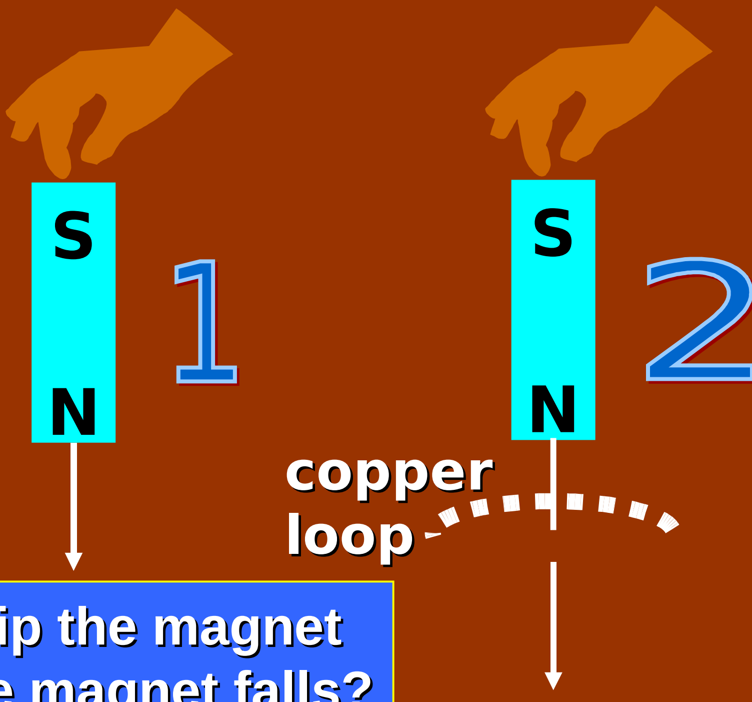
1) it will fall slower

2) it will fall faster

3) it will fall the same

When the magnet is falling from ***above*** the loop in 2, the induced current will produce a ***North pole on top of the loop***, which repels the magnet.

When the magnet is ***below*** the loop, the induced current will produce a ***North pole on the bottom of the loop***, which attracts the South pole of the magnet.

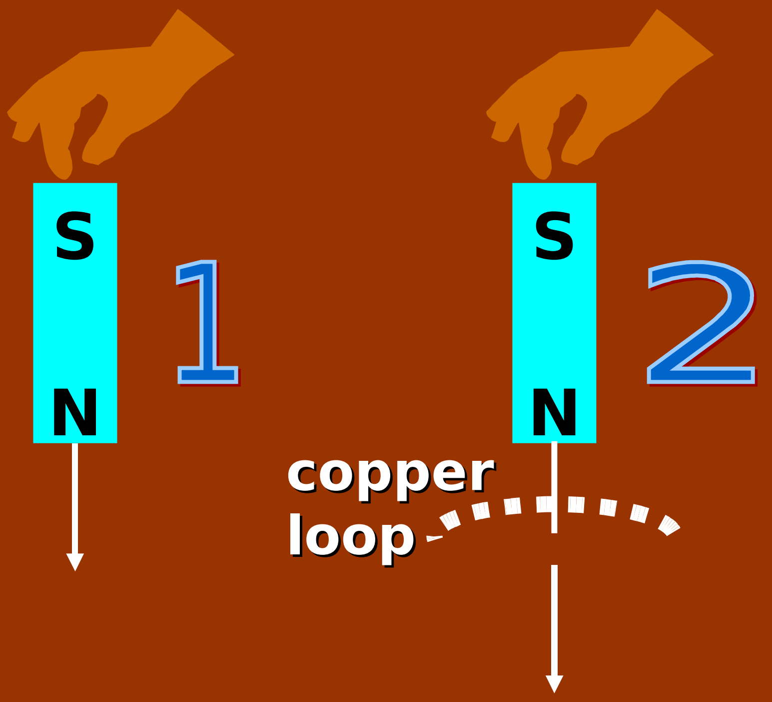


Follow-up: What happens in case 2 if you flip the magnet so that the South pole is on the bottom as the magnet falls?

ConcepTest 21.7b Falling Magnet II

If there is induced current, doesn't that cost energy? Where would that energy come from in case 2?

1) induced current doesn't need any energy
2) energy conservation is violated in this case
3) there is less KE in case 2
4) there is more gravitational PE in case 2

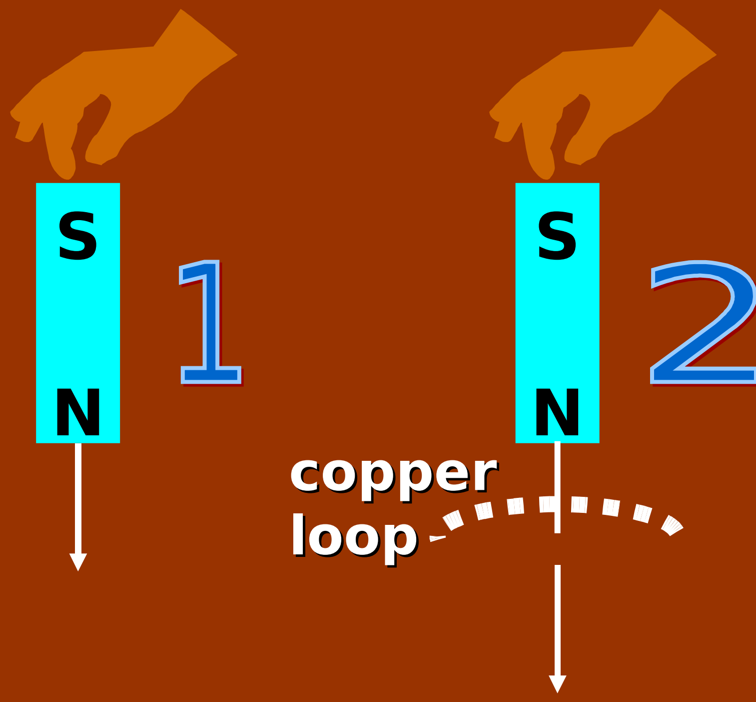


ConcepTest 21.7b Falling Magnet II

If there is induced current, doesn't that cost energy? Where would that energy come from in case 2?

1) induced current doesn't need any energy
2) energy conservation is violated in this case
3) there is less KE in case 2
4) there is more gravitational PE in case 2

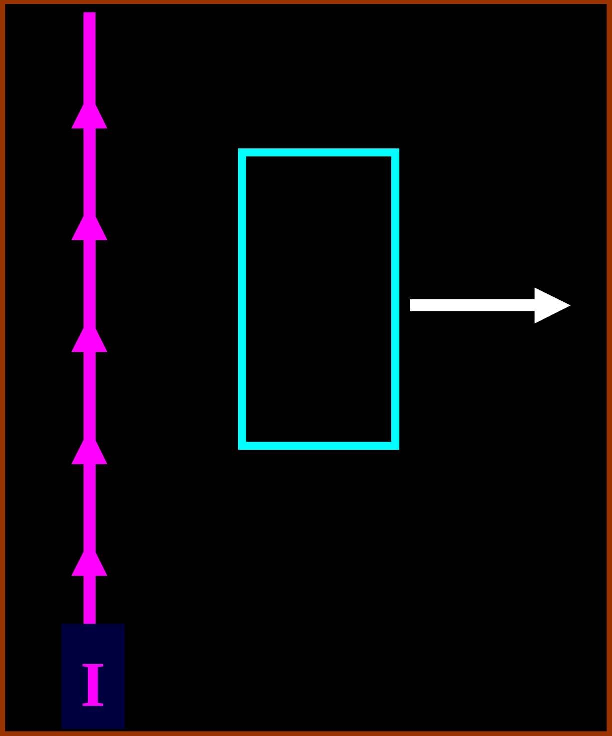
In both cases, the magnet starts with the same initial gravitational PE.
In case 1, all the gravitational PE has been converted into kinetic energy.
In case 2, we know the magnet falls slower, thus there is less KE. The difference in energy goes into making the induced current.



ConcepTest 21.8a Loop and Wire I

A wire loop is being pulled away from a current-carrying wire. What is the direction of the induced current in the loop?

1) clockwise
2) counterclockwise
3) no induced current

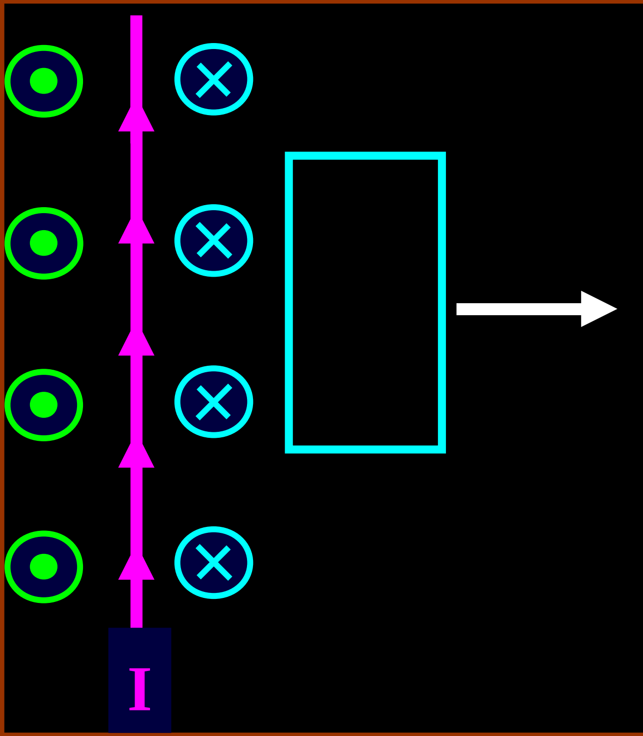


ConcepTest 21.8a Loop and Wire I

A wire loop is being pulled away from a current-carrying wire. What is the direction of the induced current in the loop?

1) clockwise
2) counterclockwise
3) no induced current

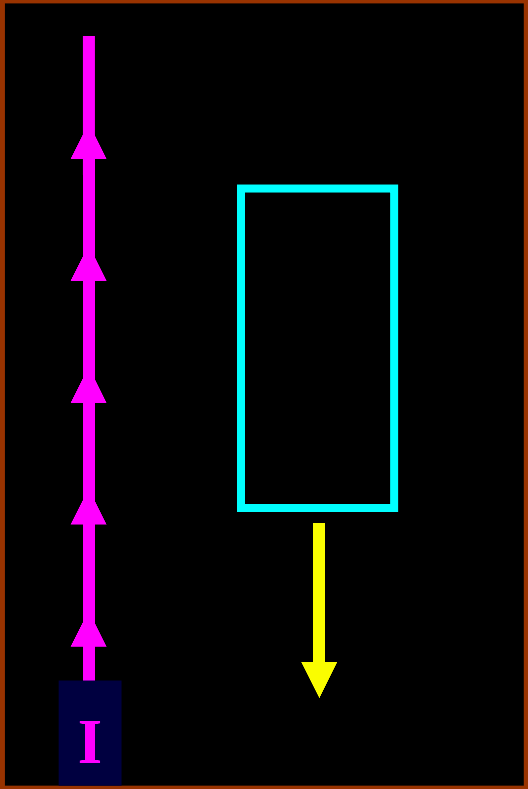
The magnetic flux is ***into the page*** on the right side of the wire and ***decreasing*** due to the fact that the loop is being pulled away. By Lenz's Law, the induced *B* field will ***oppose this decrease***. Thus, the new *B* field points ***into the page,*** which requires an induced ***clockwise*** current to produce such a *B* field.



ConcepTest 21.8b Loop and Wire II

What is the induced current if the wire loop moves in the direction of the yellow arrow ?

1) clockwise
2) counterclockwise
3) no induced current

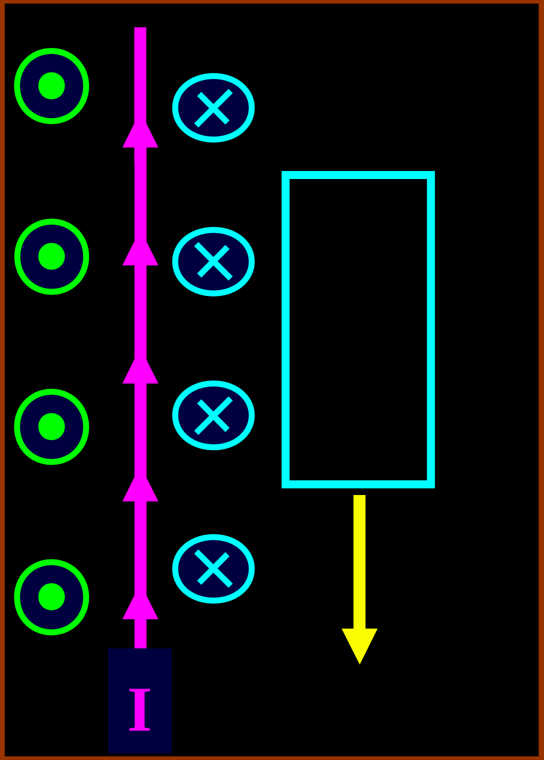


ConcepTest 21.8b Loop and Wire II

What is the induced current if the wire loop moves in the direction of the yellow arrow ?

1) clockwise
2) counterclockwise
3) no induced current

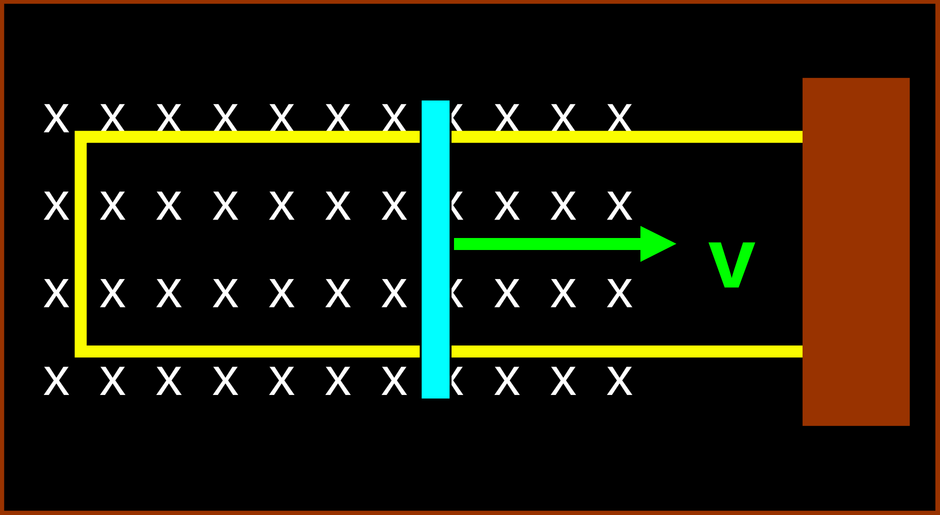
The magnetic flux through the loop is not changing as it moves parallel to the wire. Therefore, there is no induced current.



ConcepTest 21.9 Motional EMF

A conducting rod slides on a conducting track in a constant *B* field directed into the page. What is the direction of the induced current?

1) clockwise
2) counterclockwise
3) no induced current

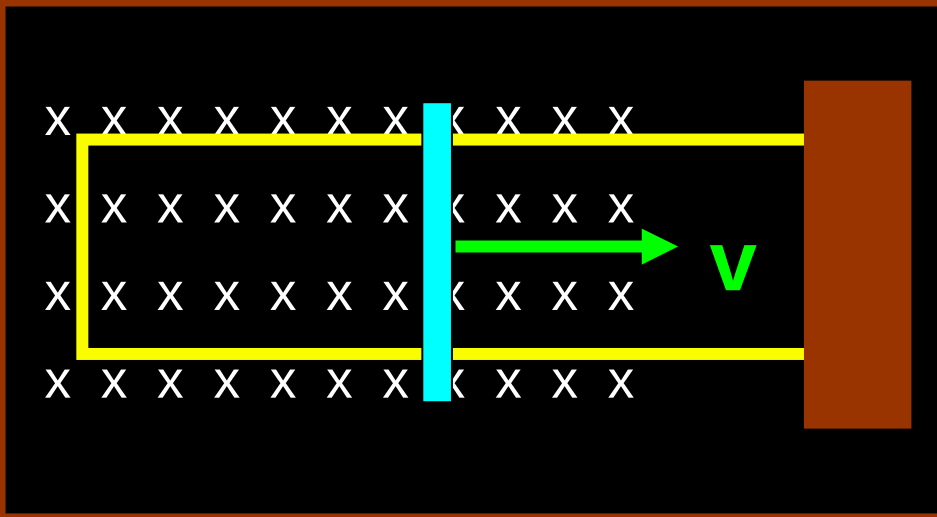


ConcepTest 21.9 Motional EMF

A conducting rod slides on a conducting track in a constant *B* field directed into the page. What is the direction of the induced current?

1) clockwise
2) counterclockwise
3) no induced current

The *B* field points ***into the page***. The flux is ***increasing*** since the area is increasing. The induced *B* field opposes this change and therefore points ***out of the page***. Thus, the induced current runs ***counterclockwise*** according to the right-hand rule.

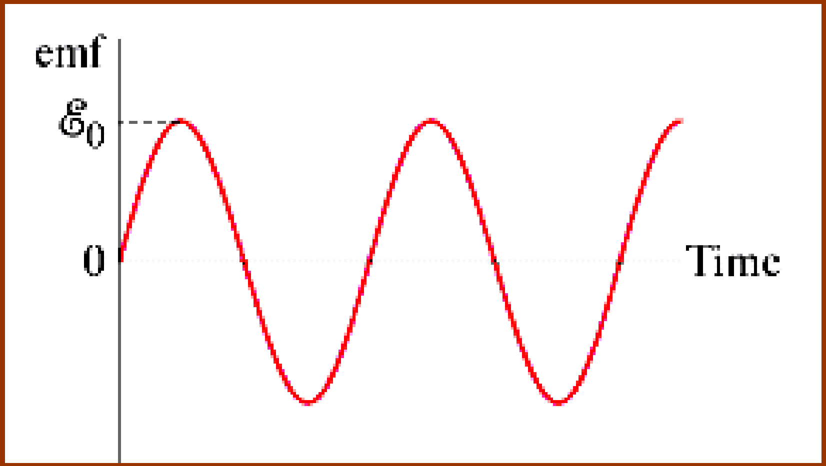


Follow-up: What direction is the magnetic force on the rod as it moves?

ConcepTest 21.10 Generators

A generator has a coil of wire rotating in a magnetic field. If the ***rotation rate increases***, how is the ***maximum output voltage*** of the generator affected?

1) increases
2) decreases
3) stays the same
4) varies sinusoidally



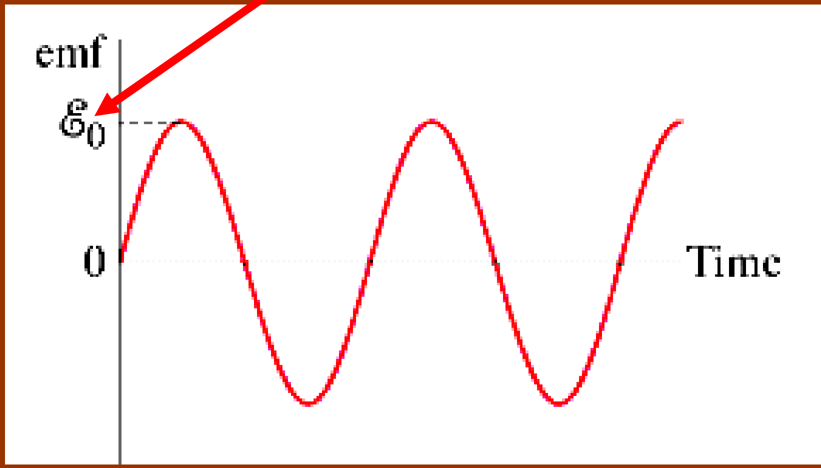
ConcepTest 21.10 Generators

A generator has a coil of wire rotating in a magnetic field. If the ***rotation rate increases***, how is the ***maximum output voltage*** of the generator affected?

1) increases
2) decreases
3) stays the same
4) varies sinusoidally

The maximum voltage is the leading term that multiplies sin(ωt) and is given by $\varepsilon_0 = NBA\omega$. Therefore, if ω increases, then ε_0 must increase as well.

$$|\varepsilon| = NBA\omega \sin(\omega t)$$



ConcepTest 21.11 Magic Loop

A wire loop is in a uniform magnetic field. Current flows in the wire loop, as shown. What does the loop do?

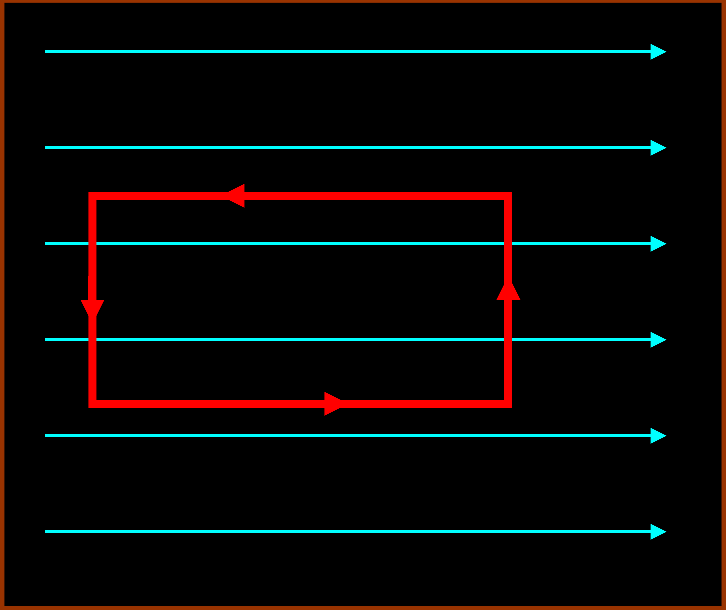
(1) moves to the right

(2) moves up

(3) remains motionless

(4) rotates

(5) moves out of the page



ConcepTest 21.11 Magic Loop

A wire loop is in a uniform magnetic field. Current flows in the wire loop, as shown. What does the loop do?

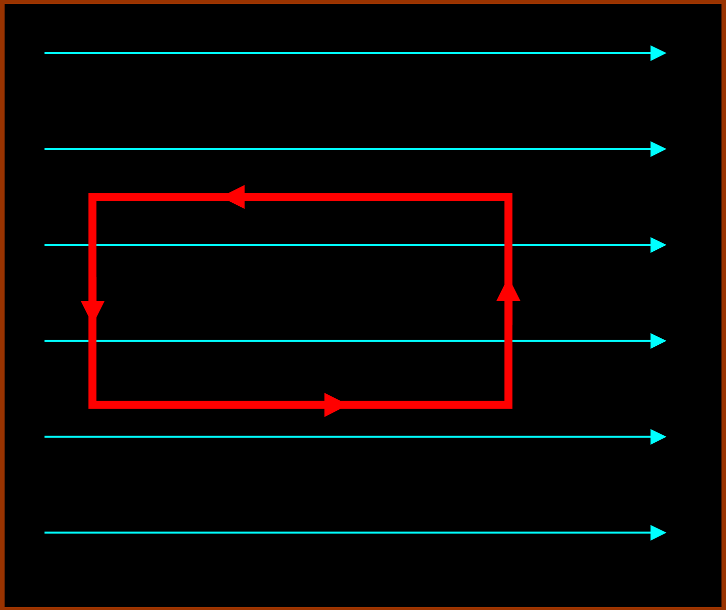
(1) moves to the right

(2) moves up

(3) remains motionless

(4) rotates

(5) moves out of the page



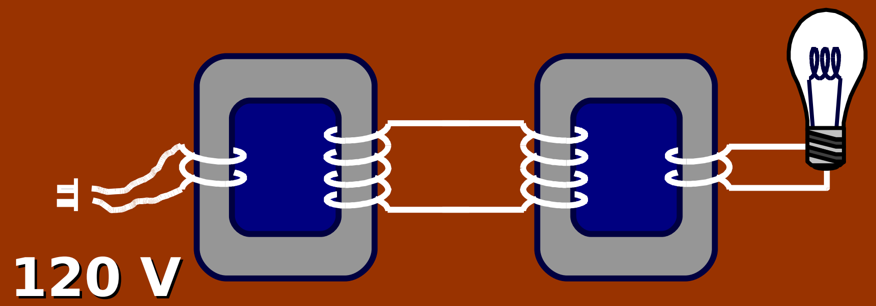
There is no magnetic force on the top and bottom legs, since they are parallel to the *B* field. However, the magnetic force on the right side is into the page, and the magnetic force on the left side is out of the page. Therefore, the entire loop will tend to rotate.

This is how a motor works !!

ConcepTest 21.12a Transformers I

What is the voltage across the lightbulb?

1) 30 V
2) 60 V
3) 120 V
4) 240 V
5) 480 V

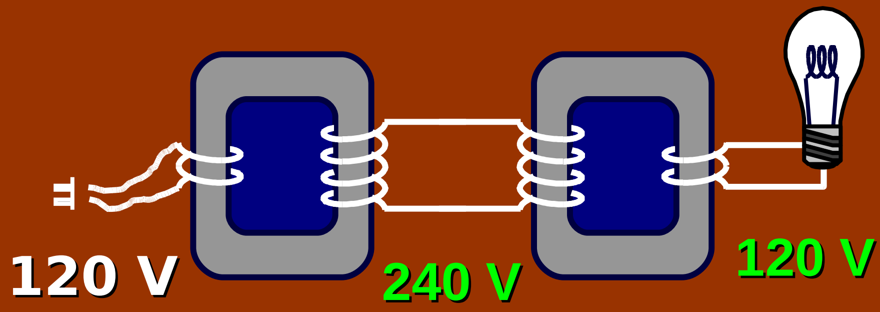


ConcepTest 21.12a Transformers I

What is the voltage across the lightbulb?

1) 30 V
2) 60 V
3) 120 V
4) 240 V
5) 480 V

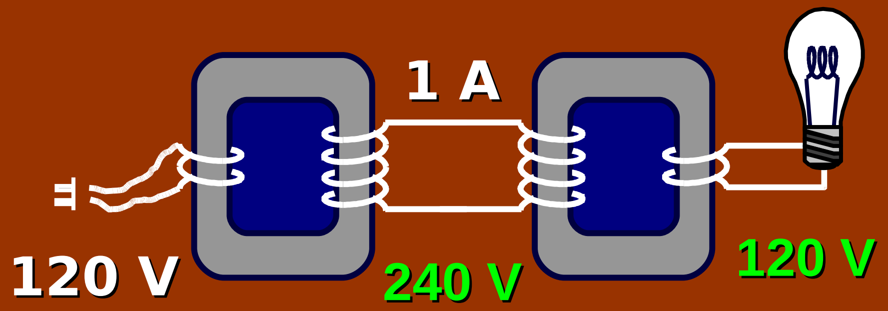
The **first transformer** has a **2:1 ratio** of turns, so the **voltage doubles**. But the **second transformer** has a **1:2 ratio**, so the **voltage is halved** again. Therefore, the end result is the **same as the original voltage**.



ConcepTest 21.12b Transformers II

Given that the intermediate current is 1 A, what is the current through the lightbulb?

1) 1/4 A
2) 1/2 A
3) 1 A
4) 2 A
5) 5 A



ConcepTest 21.12b Transformers II

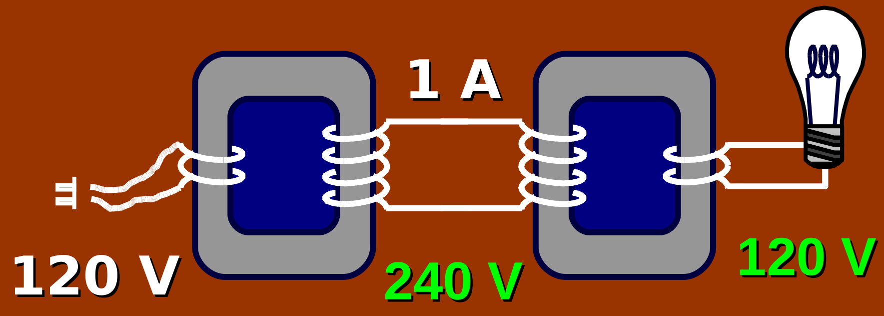
Given that the intermediate current is 1 A, what is the current through the lightbulb?

1) 1/4 A
2) 1/2 A
3) 1 A
4) 2 A
5) 5 A

Power in = Power out

240 V × 1 A = 120 V × ???

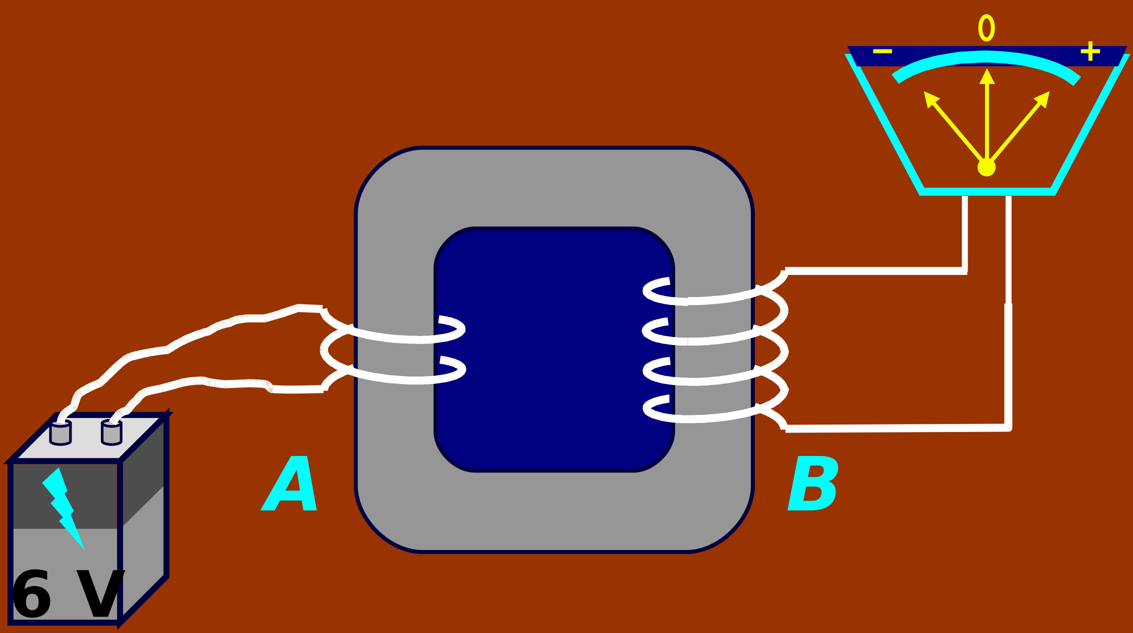
The unknown current is 2 A.



ConcepTest 21.12c Transformers III

A 6 V battery is connected to one side of a transformer. Compared to the voltage drop across coil A, the voltage across coil B is:

1) greater than 6 V
2) 6 V
3) less than 6 V
4) zero



ConcepTest 21.12c Transformers III

A 6 V battery is connected to one side of a transformer. Compared to the voltage drop across coil A, the voltage across coil B is:

1) greater than 6 V
2) 6 V
3) less than 6 V
4) zero

The voltage across B is zero. Only a **changing** magnetic flux induces an EMF. Batteries can only provide **DC current**.