Magnetic Induction (II)

- Lenz's Law
- Eddy currents

Serway and Jewett sections 31.3, 31.6

Practice: Chapter 31,
Objective Questions 3, 7, 9, 11
Conceptual Questions 4, 6, 8, 10
Problem 50

Faraday's Law:

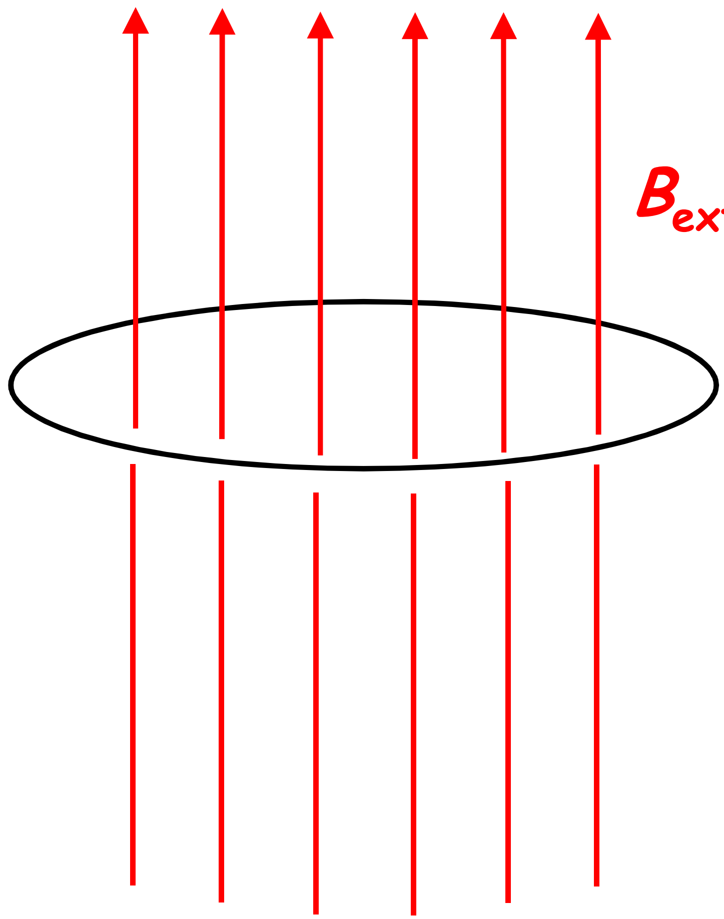
A changing magnetic flux induces an emf in a circuit:

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

Lenz's Law

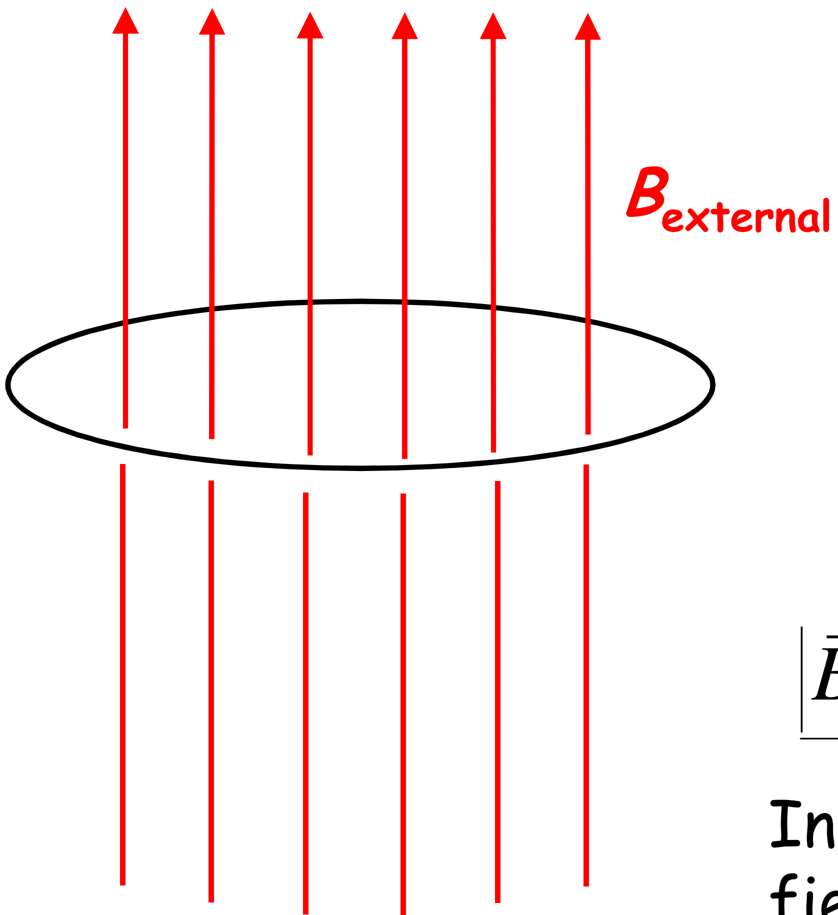
(for the direction of the emf)

The induced emf *tends* to cause a current which would *oppose the change in flux.*



$\left|\vec{B}_{ext}\right|$ decreasing

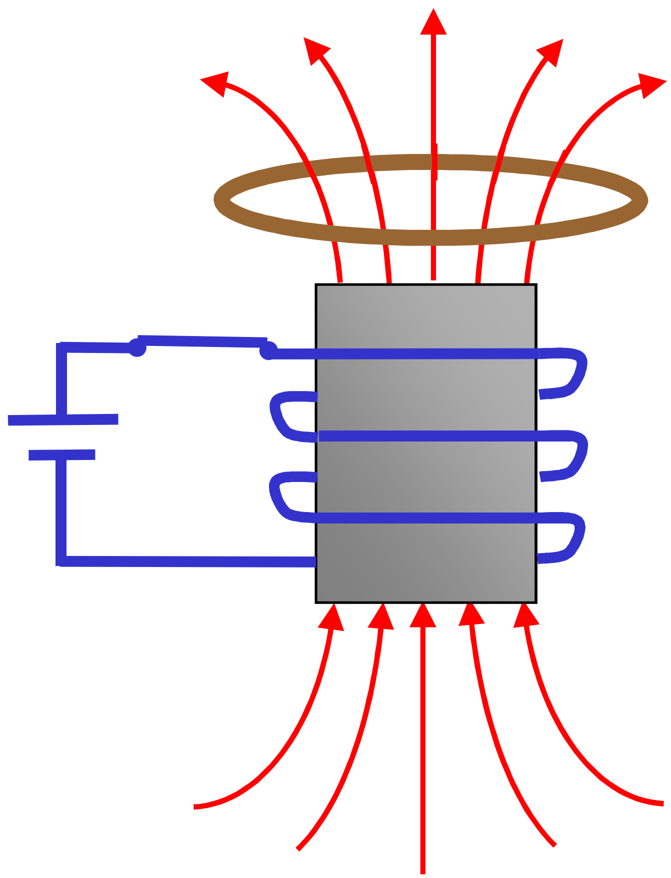
Induced current creates a field in the same direction (inside the loop).



$\left|\vec{B}_{ext}\right|$ increasing

Induced current creates a field in opposite direction.

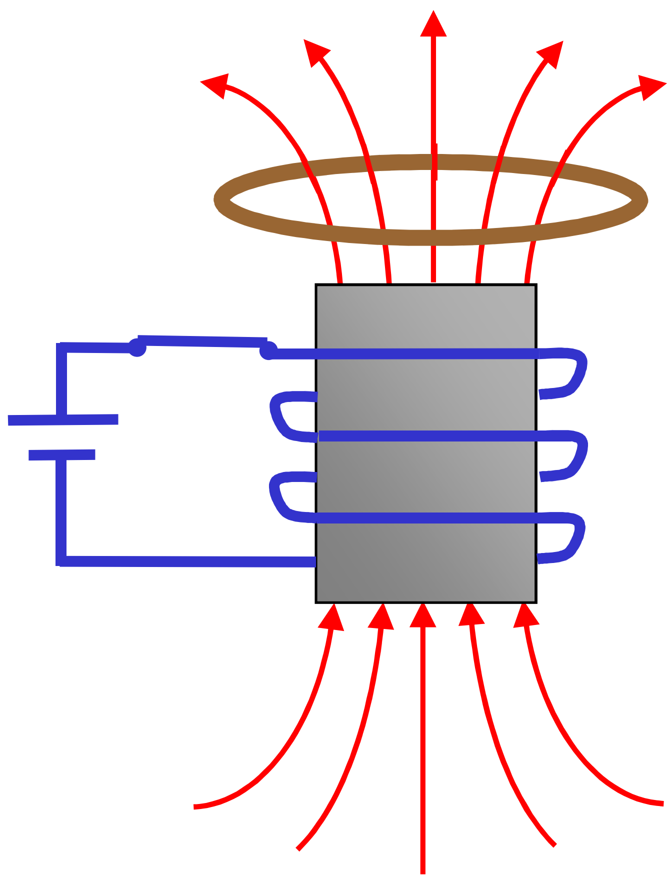
Example: Electromagnet & Copper Ring



What happens to the ring:

i) Just after the switch is initially closed?
ii) When the switch is opened again?

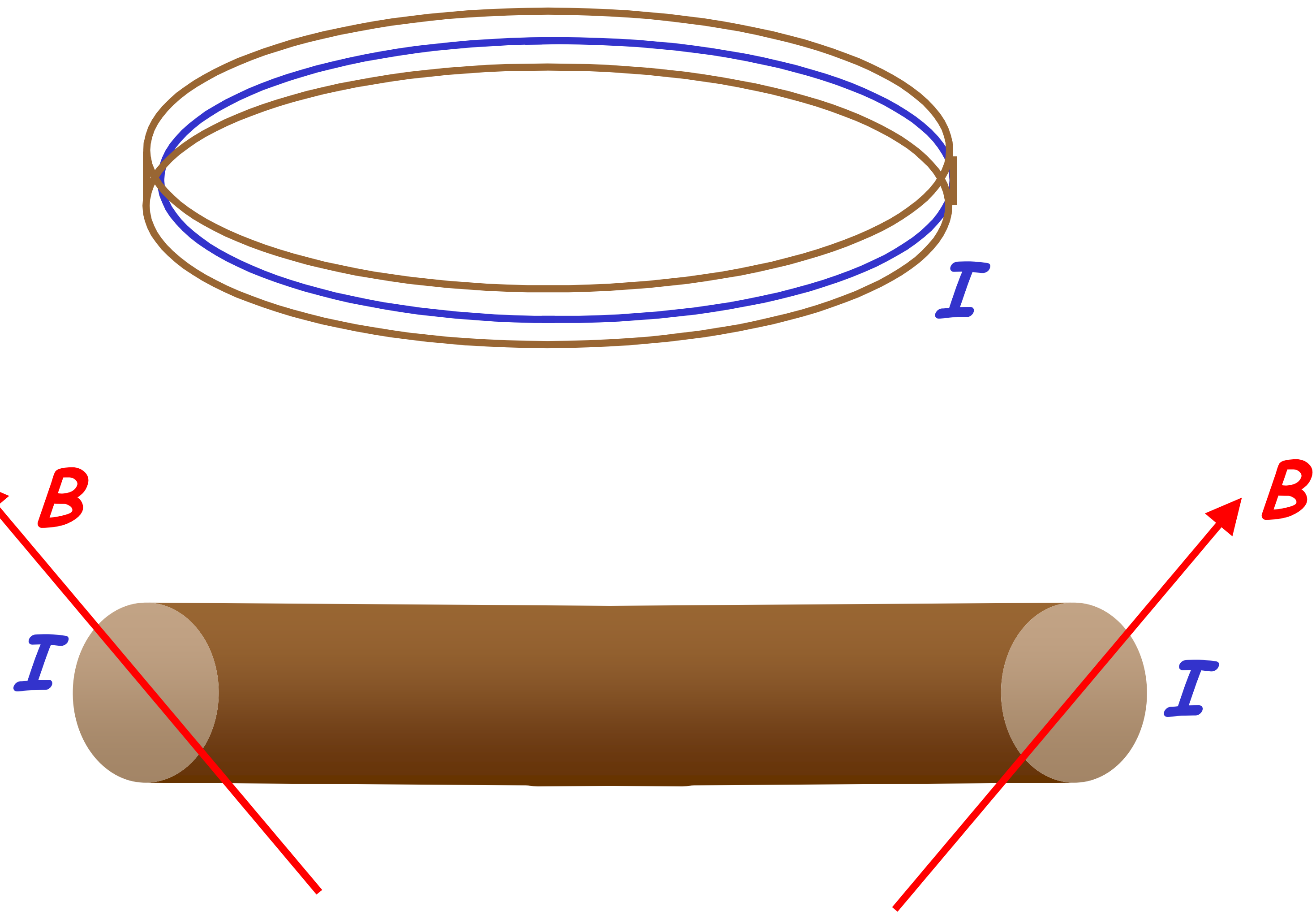
Quiz:



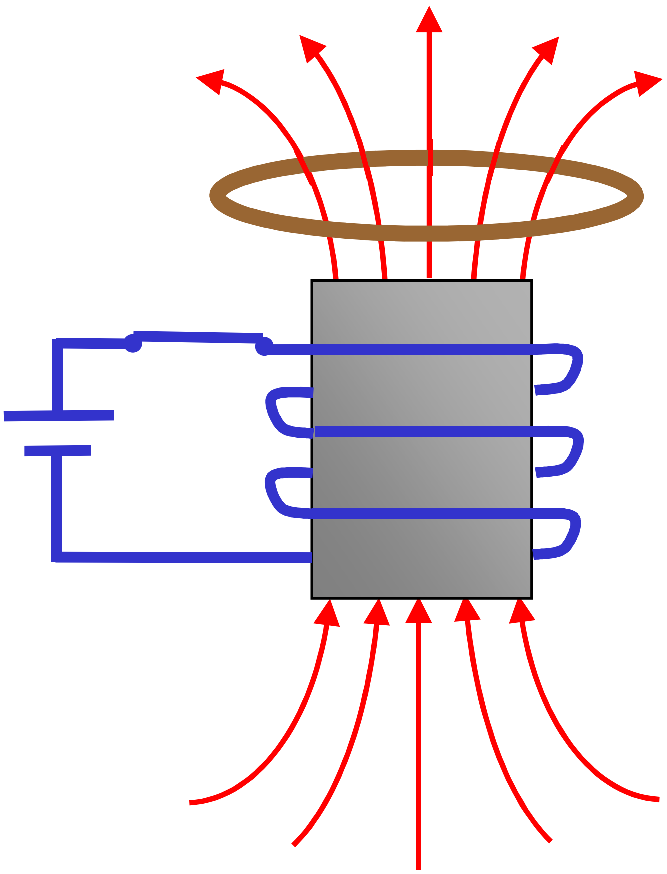
Just after the switch is initially closed, the induced emf in the copper ring will be

A) clockwise
B) counterclockwise
C) zero

i)



Quiz:

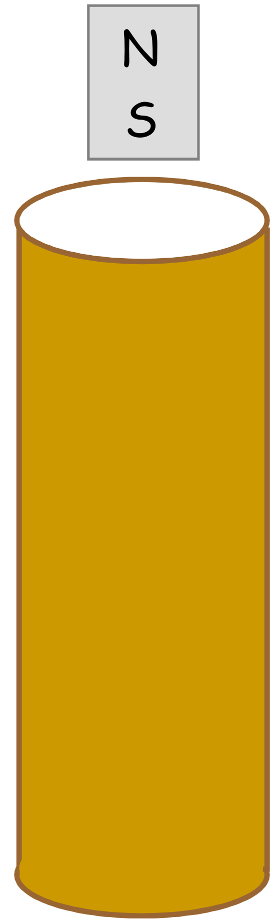


Just after the switch is initially closed, the net force on the copper ring will be

A) up
B) down
C) zero

Demonstration: Eddy Currents

What happens if you drop a small magnet down a copper (or aluminum) pipe?



Quiz

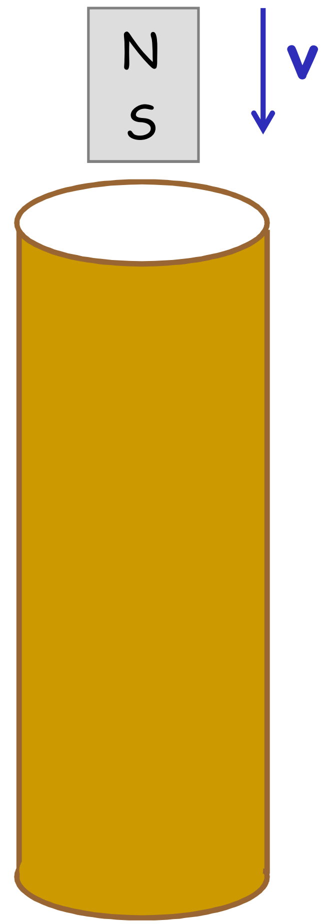
The induced currents ***below*** *the falling magnet in the copper pipe flow:*

A) clockwise

B) counterclockwise

C) down the pipe

D) up the pipe



Quiz

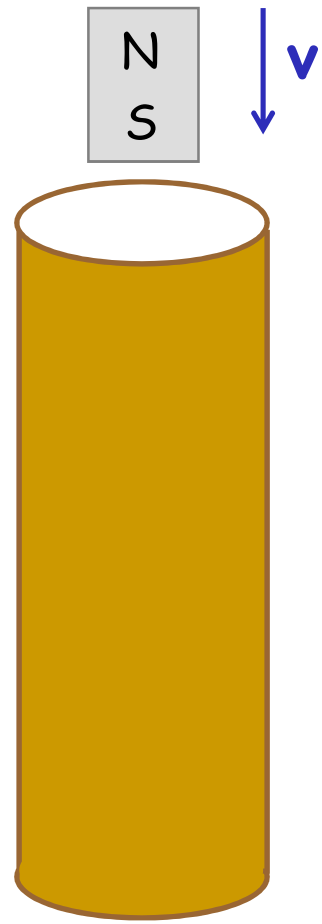
The induced currents ***below*** *the magnet in the copper pipe create a magnetic dipole moment vector pointing*

A) left

B) right

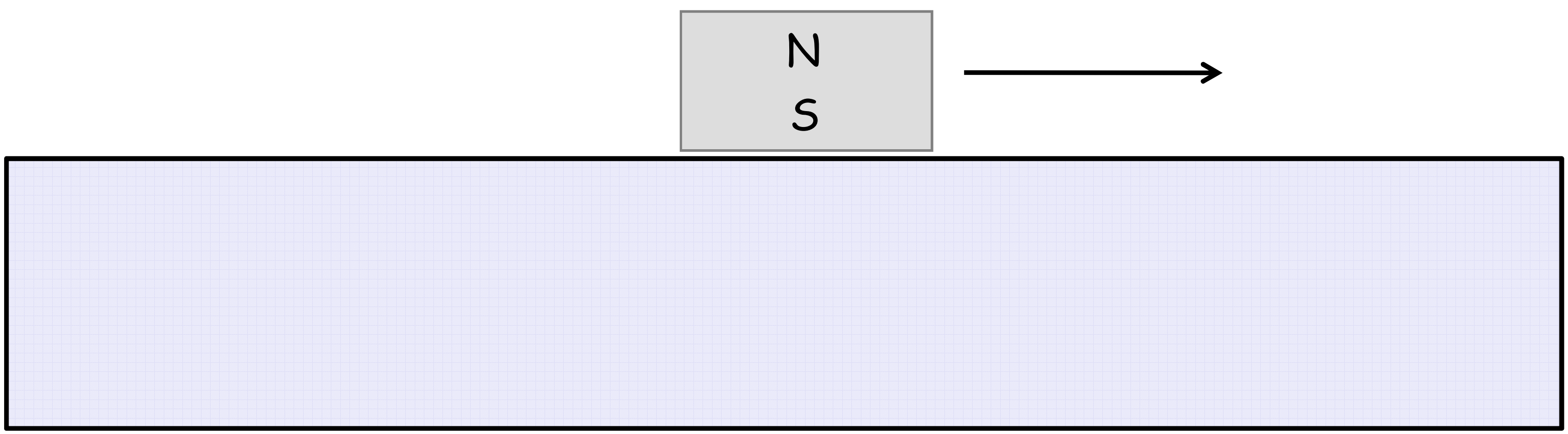
C) down

D) up

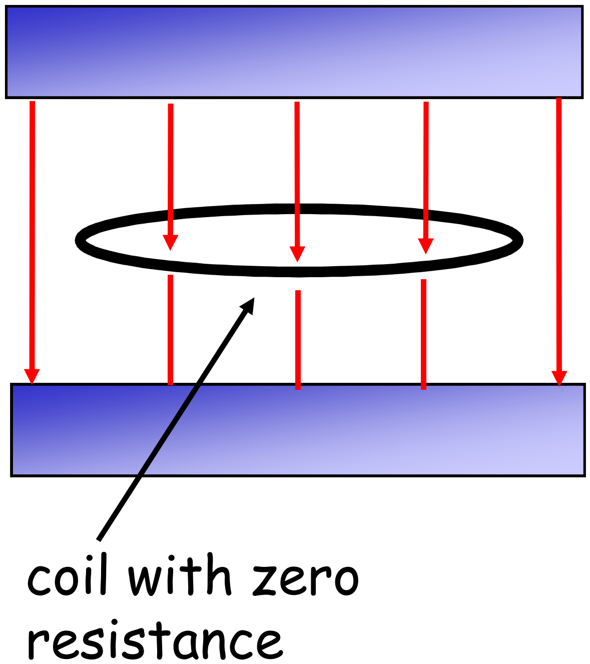


Eddy Currents

What if a magnet slides along an aluminum plate? Sketch in the induced "magnets" created by the eddy currents.



Question



Increase ***B*** at constant rate.
⟹ Constant induced emf in coil.

Is the current in the coil infinite?

($I = \mathcal{E}/R$?)

Summary

1) $$\mathcal{E} = -\frac{d\Phi_B}{dt}$$ (induced emf)

2) $$|\varepsilon| = |B\ell v|$$ (induced emf)

3) Lenz's Law: Direction of ε tends to oppose *changes* in flux.