The University of Nottingham

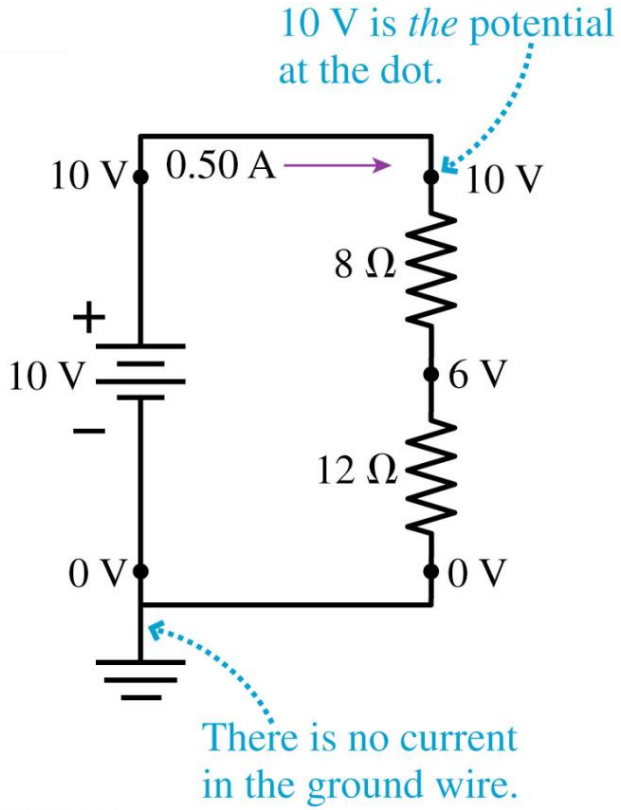
UNITED KINGDOM · CHINA · MALAYSIA

Science A Physics

Lectures 23-30:

Additional Problems: Circuits, Magnetism, Induction, Reactance, and Series Resonance

A Grounded Circuit



Q.1 Suppose the circuit above were grounded at the junction between the two resistors instead of at the bottom. Find the potential at each corner of the circuit.

Magnetism

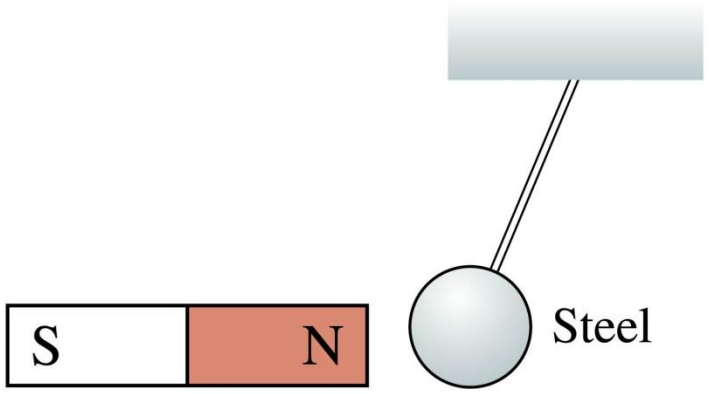
Q.2 If the bar magnet is flipped over and the south pole is brought near the hanging ball, the ball will be

a) Attracted to the magnet.

b) Repelled by the magnet.

c) Unaffected by the magnet.

d) I'm not sure.



Magnetism

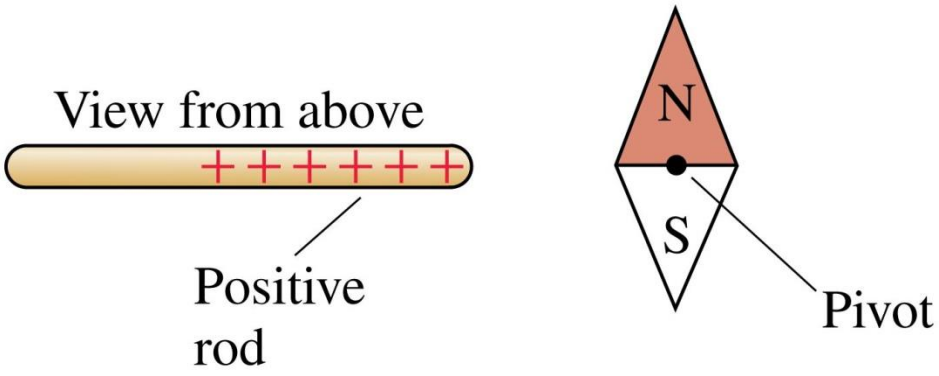
Q.3 The compass needle can rotate on a pivot in a horizontal plane. If a positively charged rod is brought near, as shown, the compass needle will

a) Rotate clockwise.

b) Rotate counterclockwise.

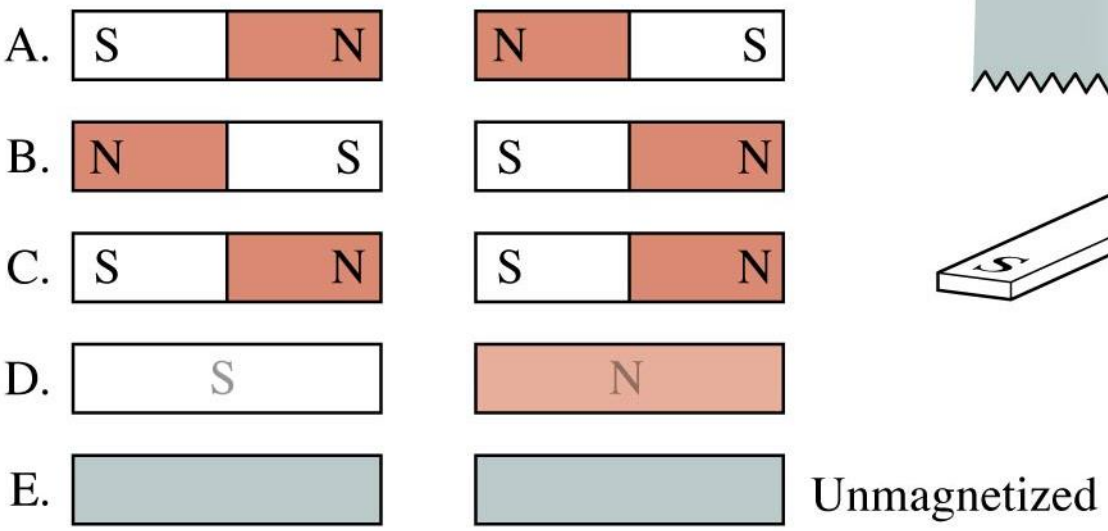
c) Do nothing.

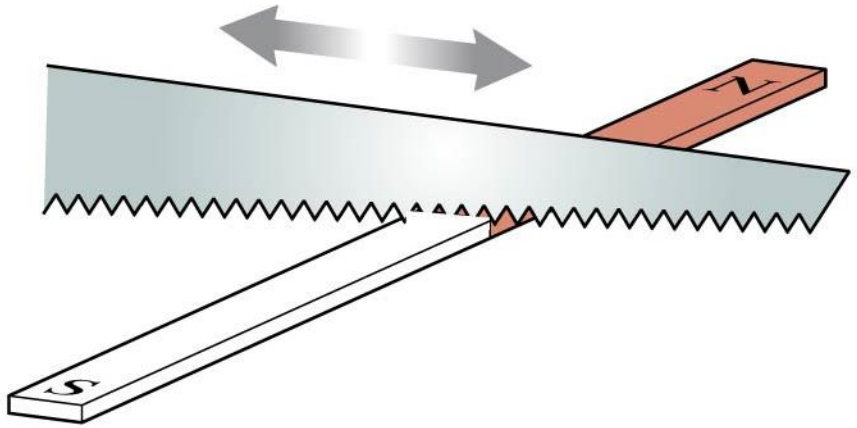
d) I'm not sure.



Magnetism

Q.4 If a bar magnet is cut in half, you end up with





Magnetism

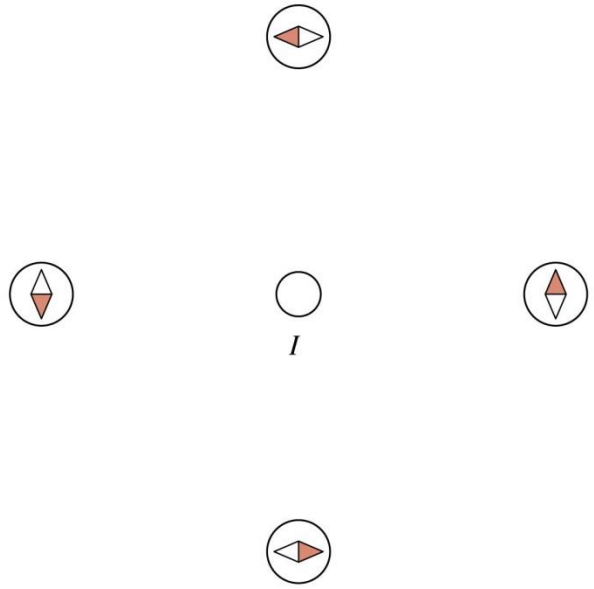
Q.5 A long, straight wire extends into and out of the screen. The current in the wire is

a) Into the screen.

b) Out of the screen.

c) There is no current in the wire.

d) Not enough info to tell the direction.



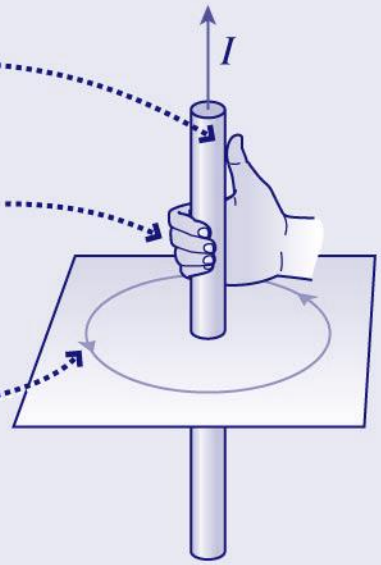
TACTICS BOX 32.1

Right-hand rule for fields

❶ Point your *right* thumb in the direction of the current.

❷ Curl your fingers around the wire to indicate a circle.

❸ Your fingers point in the direction of the magnetic field lines around the wire.



Exercises 6–8

Magnetism

Q.6 Where is the north magnetic pole of this current loop?

a) Top side.
b) Bottom side.
c) Right side.
d) Left side.
e) Current loops don't have north poles.

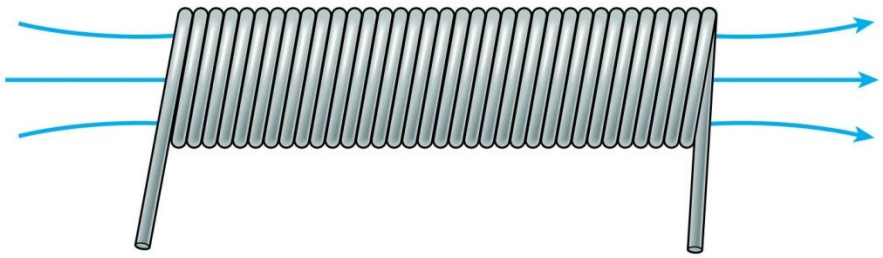
Magnetism

Q.7 The current in this solenoid

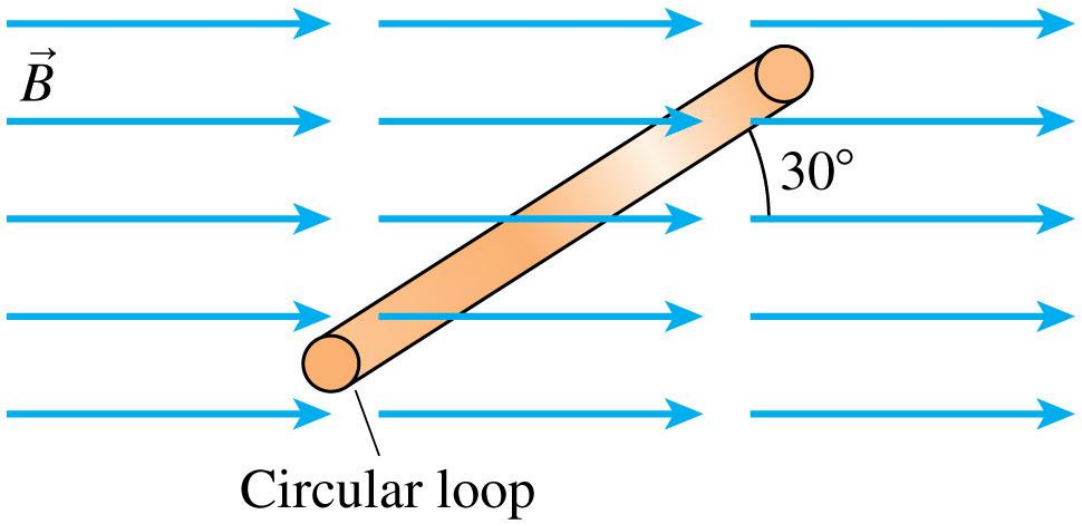
a) Enters on the left, leaves on the right.

b) Enters on the right, leaves on the left.

c) Either A or B would produce this field.



A Circular Loop in a Magnetic Field



Q.8 The figure above is an edge view of a 10-cm-diameter circular loop in a uniform 0.050 T magnetic field. What is the magnetic flux through the loop?

Magnetic Flux

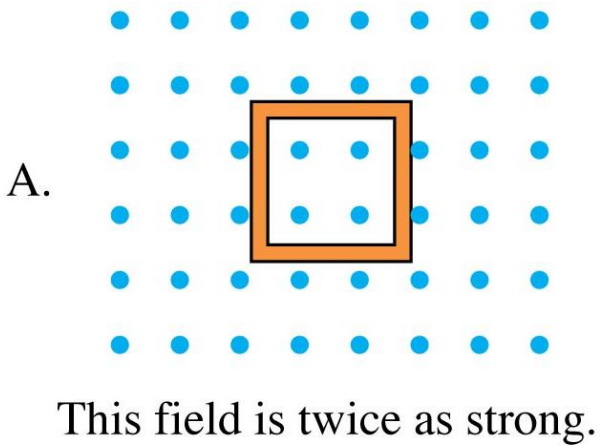
Q.9 Which loop has the larger magnetic flux through it?

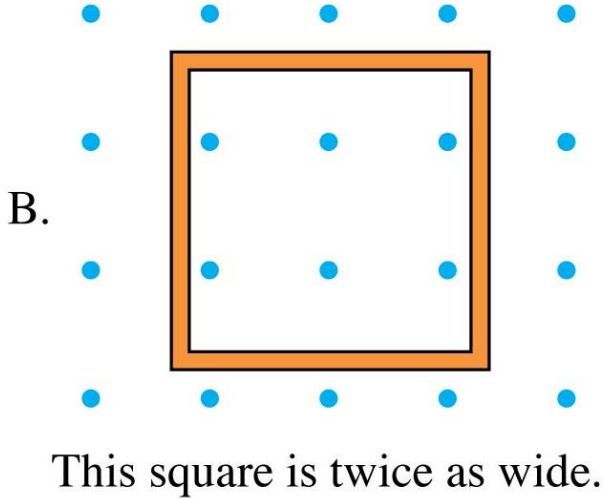
a) Loop A.

b) Loop B.

c) The fluxes are the same.

d) Not enough information to tell.



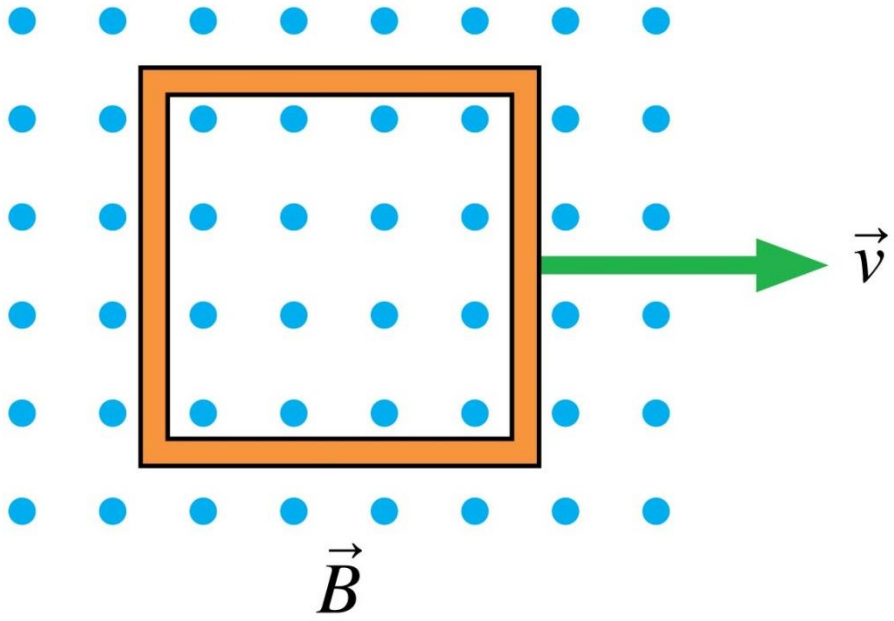


Magnetic Flux

Q.10 The metal loop is being pulled through a uniform magnetic field. Is the magnetic flux through the loop changing?

a) Yes.

b) No.

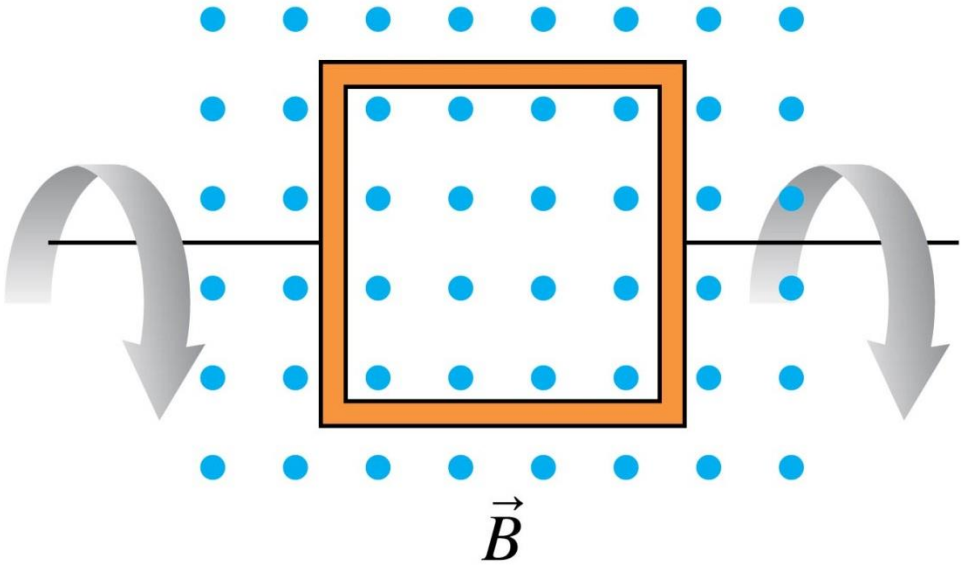


Magnetic Flux

Q.11 The metal loop is rotating in a uniform magnetic field. Is the magnetic flux through the loop changing?

a) Yes.

b) No.



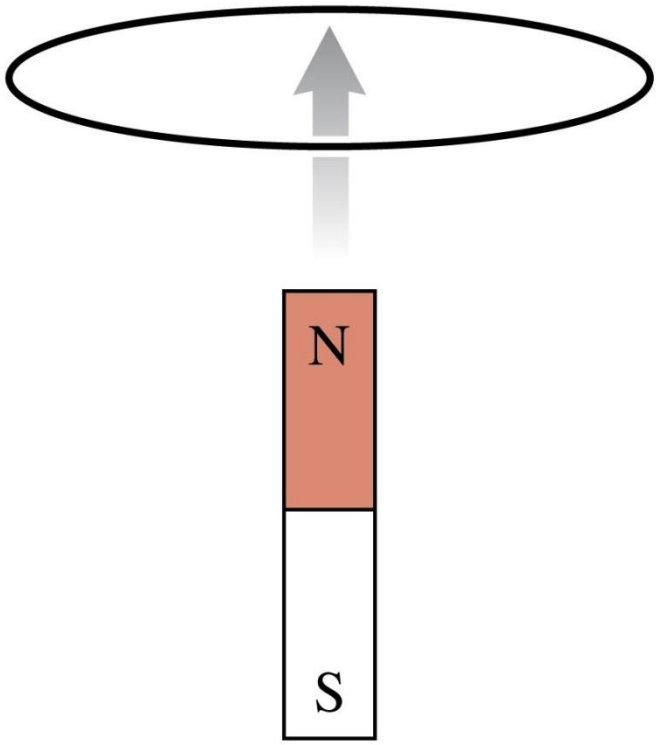
Lenz's Law

Q.12 The bar magnet is pushed toward the center of a wire loop. Which is true?

a) There is a clockwise induced current in the loop.

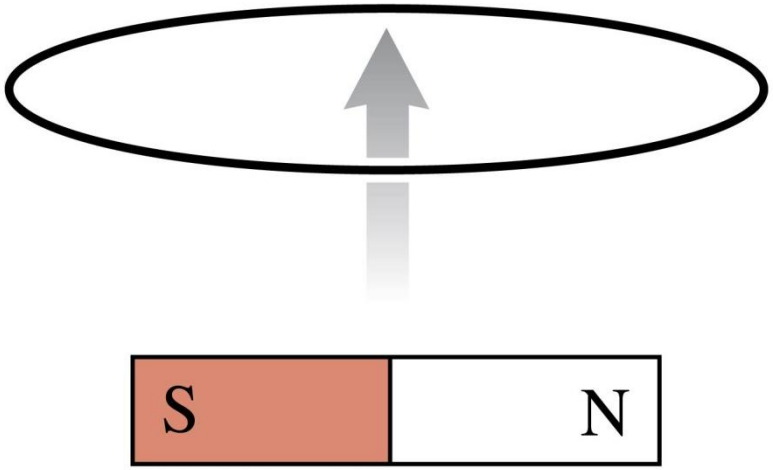
b) There is a counterclockwise induced current in the loop.

c) There is no induced current in the loop.



Lenz's Law

Q.13 The bar magnet is pushed toward the center of a wire loop. Which is true?



a) There is a clockwise induced current in the loop.

b) There is a counterclockwise induced current in the loop.

c) There is no induced current in the loop.

TACTICS BOX 33.1 Using Lenz's law

1. **Determine the direction of the applied magnetic field.** The field must pass through the loop.
2. **Determine how the flux is changing.** Is it increasing, decreasing, or staying the same?
3. **Determine the direction of an induced magnetic field that will oppose the *change* in the flux.**
   - Increasing flux: the induced magnetic field points opposite the applied magnetic field.
   - Decreasing flux: the induced magnetic field points in the same direction as the applied magnetic field.
   - Steady flux: there is no induced magnetic field.
4. **Determine the direction of the induced current.** Use the right-hand rule to determine the current direction in the loop that generates the induced magnetic field you found in step 3.

Exercises 10–14

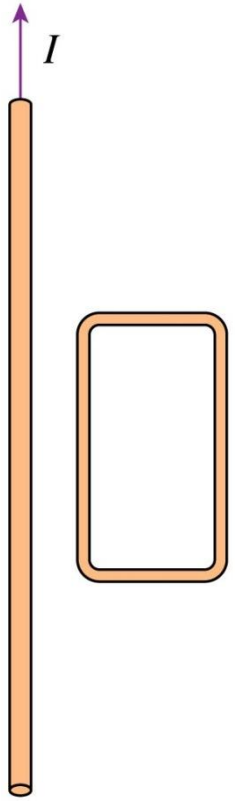
Lenz's Law

Q.14 The current in the straight wire is decreasing. Which is true?

a) There is a clockwise induced current in the loop.

b) There is a counterclockwise induced current in the loop.

c) There is no induced current in the loop.



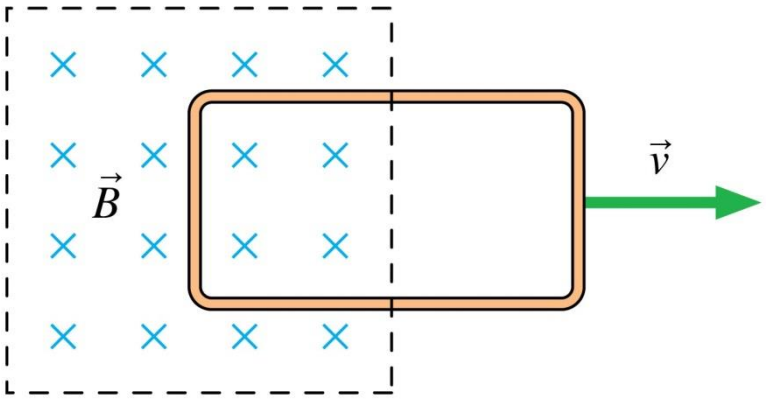
Lenz's Law

Q.15 The magnetic field is confined to the region inside the dashed lines; it is zero outside. The metal loop is being pulled out of the magnetic field. Which is true?

a) There is a clockwise induced current in the loop.

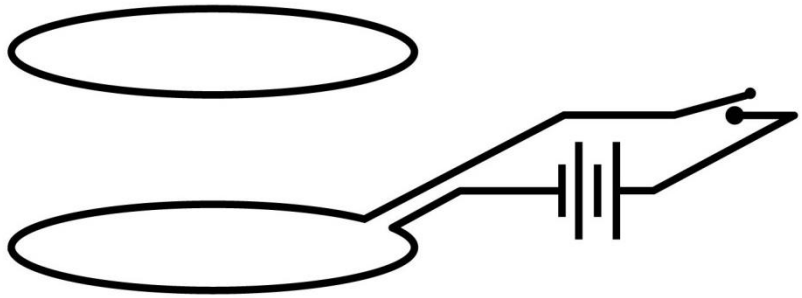
b) There is a counterclockwise induced current in the loop.

c) There is no induced current in the loop.



Lenz's Law

Q.16 Immediately after the switch is closed, the lower loop exerts ____ on the upper loop.



a) a torque

b) an upward force

c) a downward force

d) no force or torque

PROBLEM-SOLVING STRATEGY 33.1

Electromagnetic induction

MODEL Make simplifying assumptions about wires and magnetic fields.

VISUALIZE Draw a picture or a circuit diagram. Use Lenz's law to determine the direction of the induced current.

SOLVE The mathematical representation is based on Faraday's law

$$\mathcal{E} = \left| \frac{d\Phi_m}{dt} \right|$$

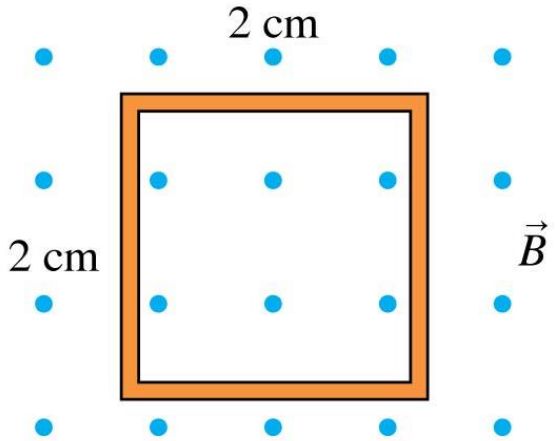
For an N-turn coil, multiply by N. The size of the induced current is $I = \mathcal{E}/R$.

ASSESS Check that your result has the correct units, is reasonable, and answers the question.

Exercise 18

Electromagnetic Induction

Q.17 The induced emf around this loop is



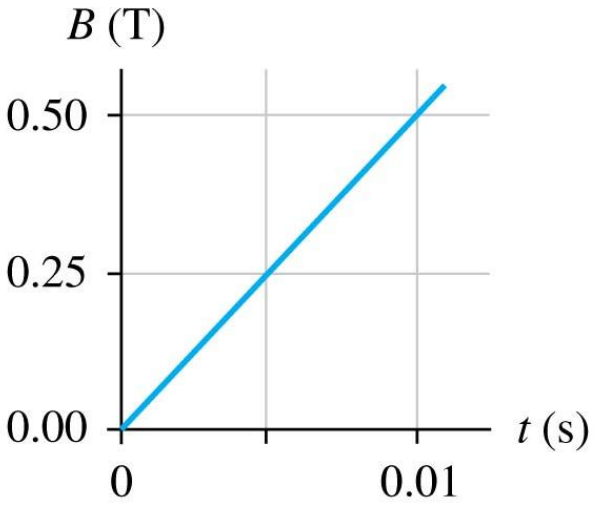
a) 200 V.

b) 50 V.

c) 2 V.

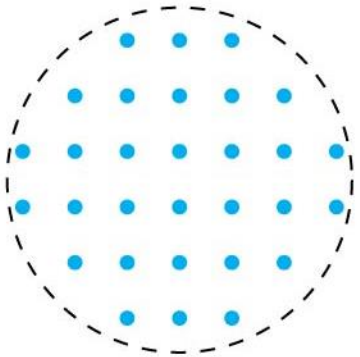
d) 0.5 V.

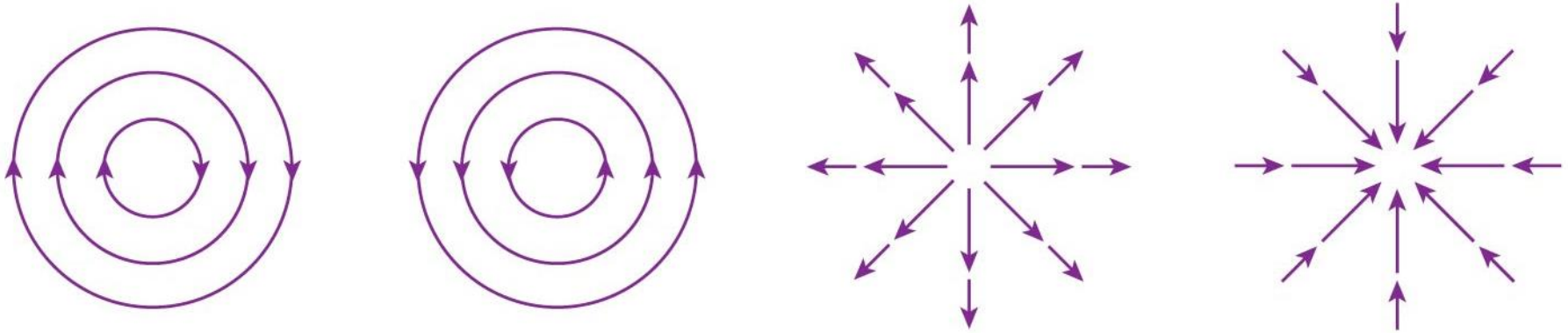
e) 0.02 V.



Electromagnetic Induction

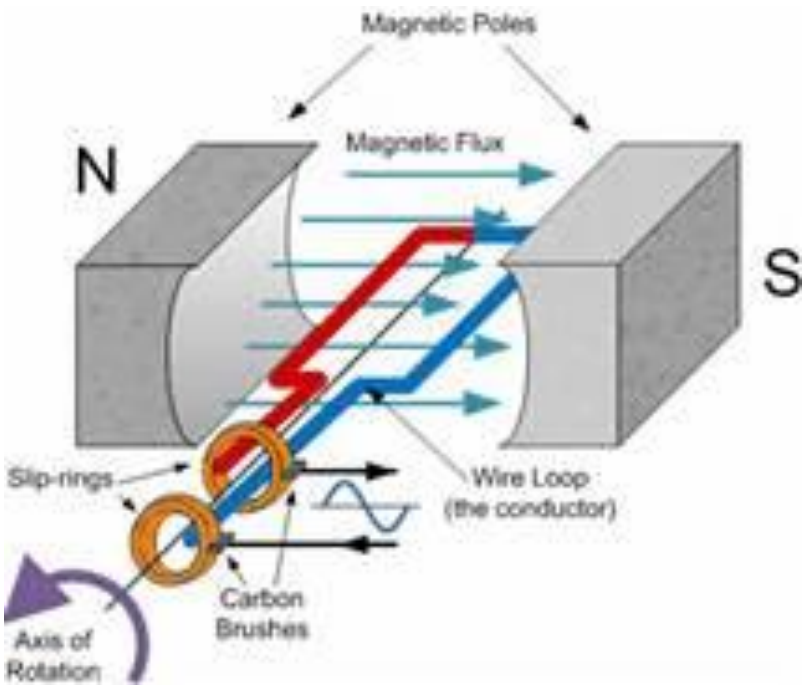
Q.18 The magnetic field is decreasing. Which is the induced electric field?





E. There's no induced field in this case.

An AC Generator



Q.19 A coil with area 2.0 m^2 rotates in a 0.010 T magnetic field at a frequency of 60 Hz. How many turns are needed to generate a peak voltage of 160 V?

Potential Difference Across an Inductor

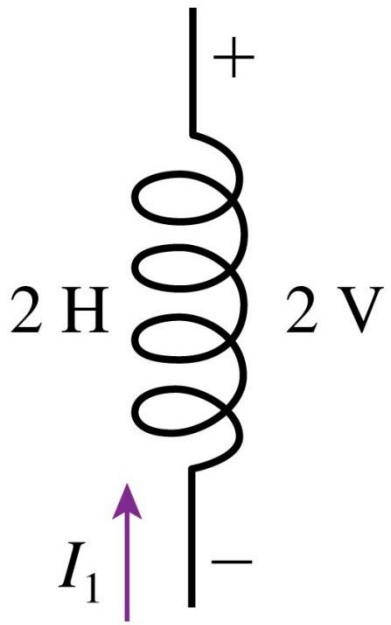
Q.20 Which current is changing more rapidly?

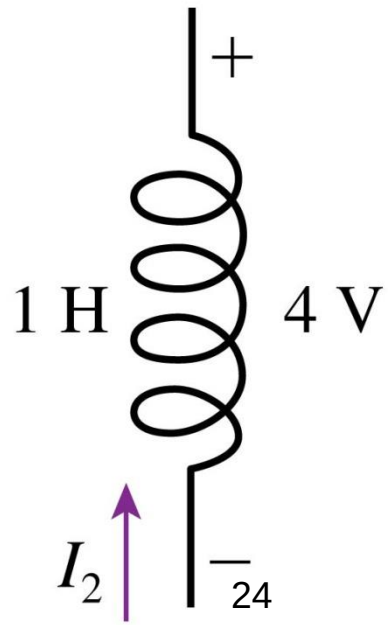
a) Current I_1.

b) Current I_2.

c) They are changing at the same rate.

d) Not enough information to tell.



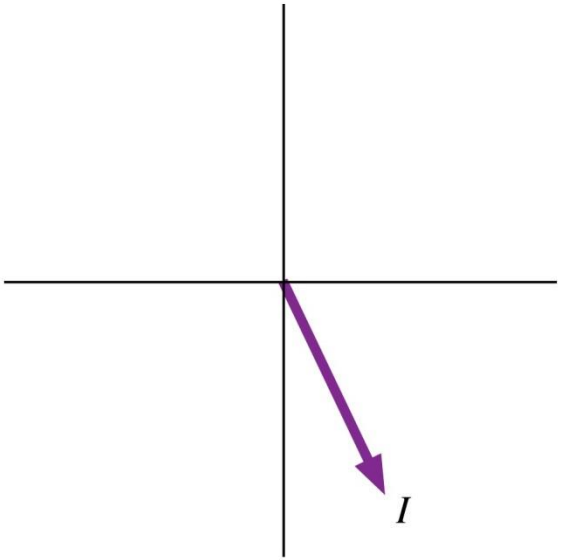


Large Voltage Across an Inductor

Q.21 A 1.0 A current passes through a 10 mH inductor coil. What potential difference is induced across the coil if the current drops to zero in 5.0 μs?

Phasors

Q.22 This is a current phasor. The magnitude of the instantaneous value of the current is



a) Increasing.

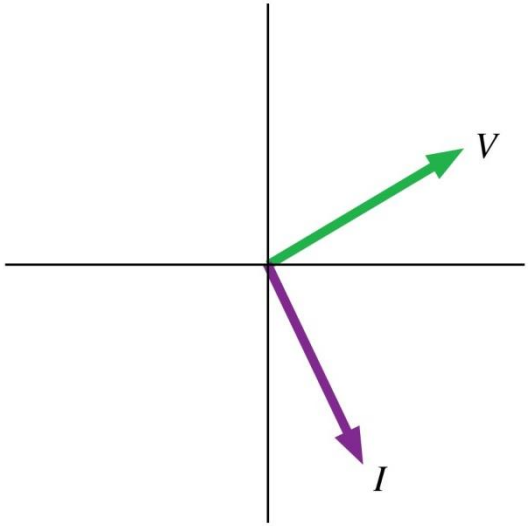
b) Decreasing.

c) Constant.

d) Can't tell without knowing which way it is rotating.

Phasors

Q.23 In the circuit represented by these phasors, the current ____ the voltage



a) leads

b) lags

c) is perpendicular to

d) is out of phase with

Sinusoidal Graphs

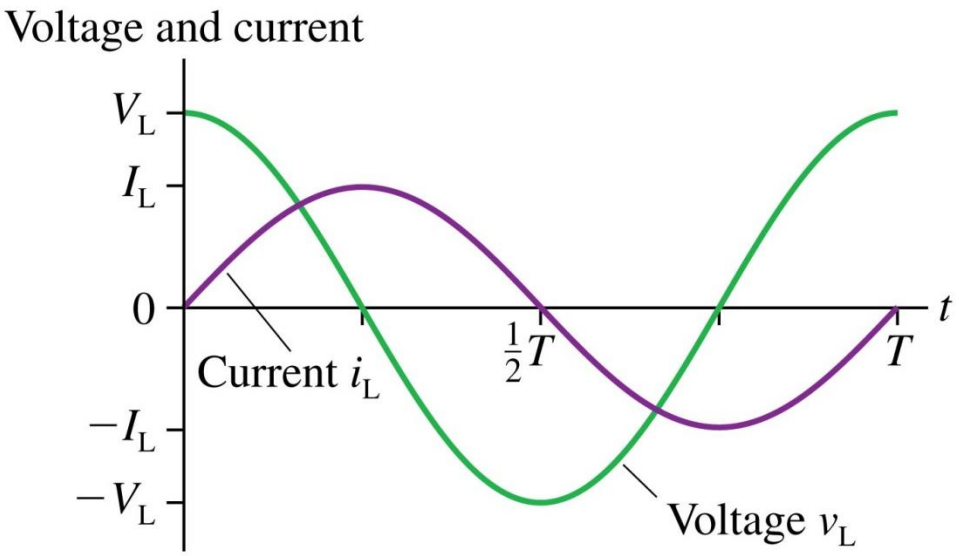
Q.24 In the circuit represented by these graphs, the current ____ the voltage

a) leads

b) lags

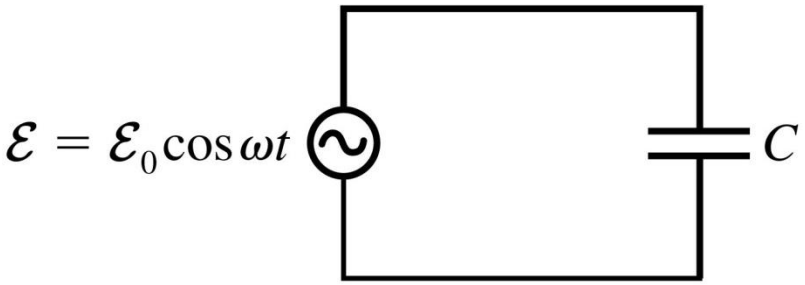
c) is less than

d) is out of phase with



Reactance

Q.25 If the value of the capacitance is doubled, the capacitive reactance



a) Is quartered.

b) Is halved.

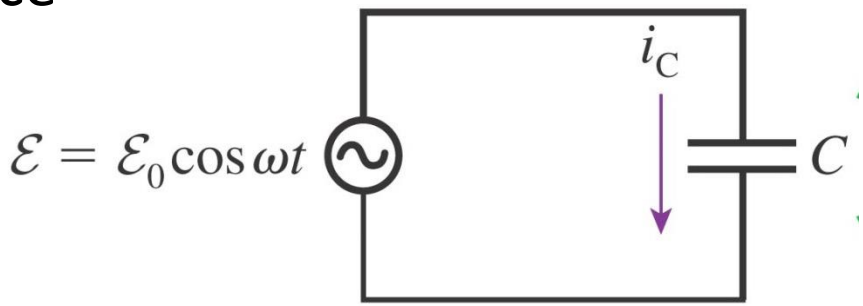
c) Is doubled.

d) Is quadrupled.

e) Can't tell without knowing ω.

Reactance

Q.26 If the value of the capacitance is doubled, the peak current



a) Is quartered.

b) Is halved.

c) Is doubled.

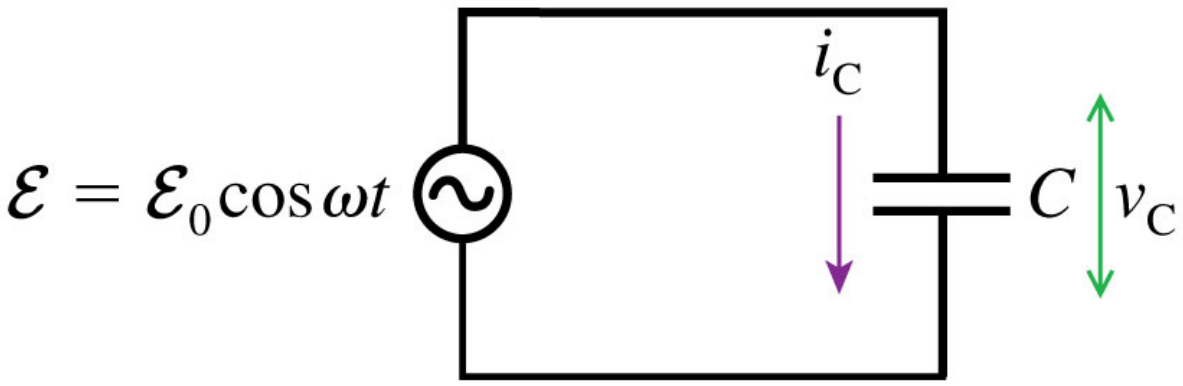
d) Is quadrupled.

e) Can't tell without knowing *C*.

Capacitive Reactance

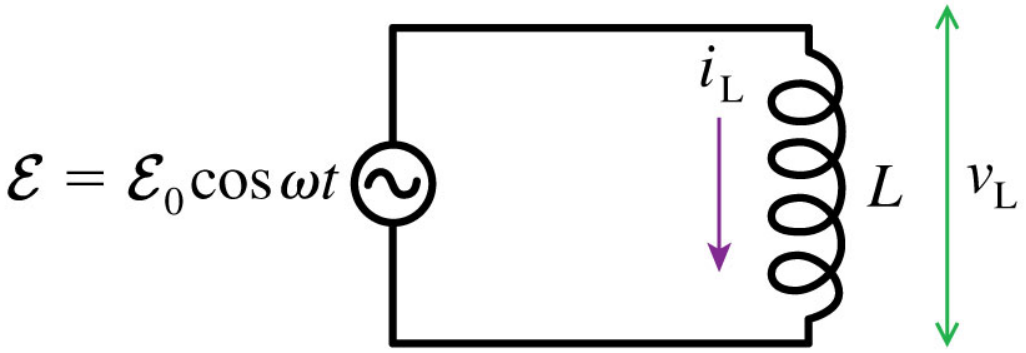
Q.27 What is the capacitive reactance of a 0.10 μF capacitor at a 100 Hz audio frequency and at a 100 MHz FM-radio frequency?

Capacitor Current



Q.28 A 10 μF capacitor is connected to a 1000 Hz oscillator with a peak emf of 5.0 V. What is the peak current to the capacitor?

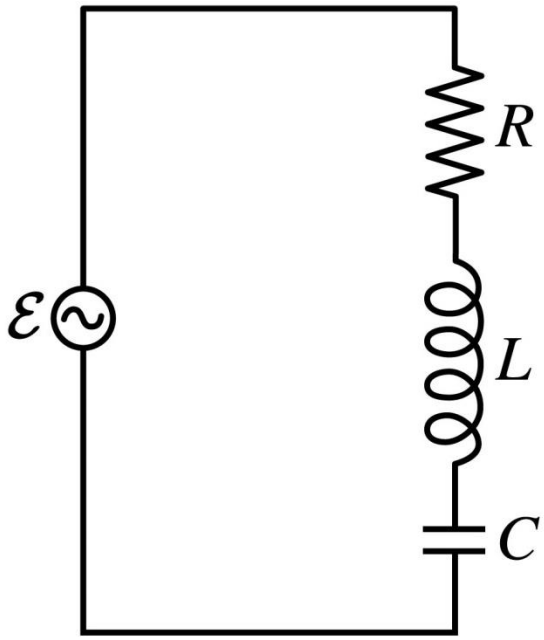
Current & Voltage of an Inductor



Q.29 A 25 μH inductor is used in a circuit that oscillates at 100 kHz. The current through the inductor reaches a peak value of 20 mA at t = 5.0 μs. What is the peak inductor voltage, and when, closest to t = 5.0 μs, does it occur?

Series Resonance

Q.30 If the value of *R* is increased, the resonance frequency of this circuit



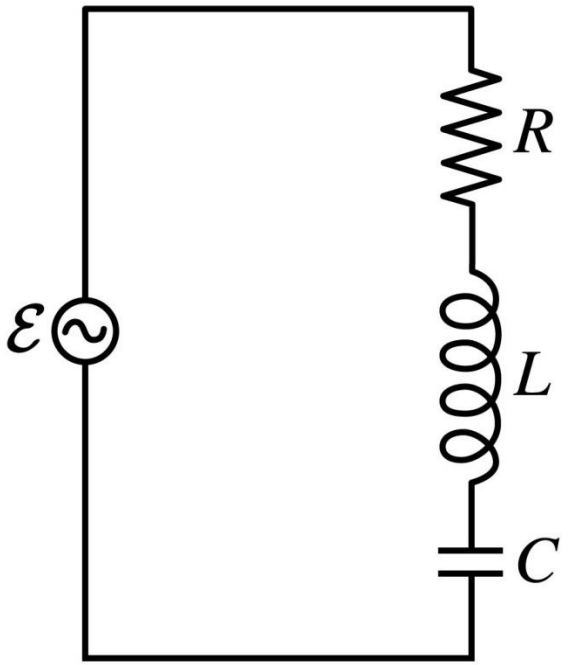
a) Increases.

b) Decreases.

c) Stays the same.

Series Resonance

Q.31 The resonance frequency of this circuit is 1000 Hz. To change the resonance frequency to 2000 Hz, replace the capacitor with one having capacitance



a) C/4.

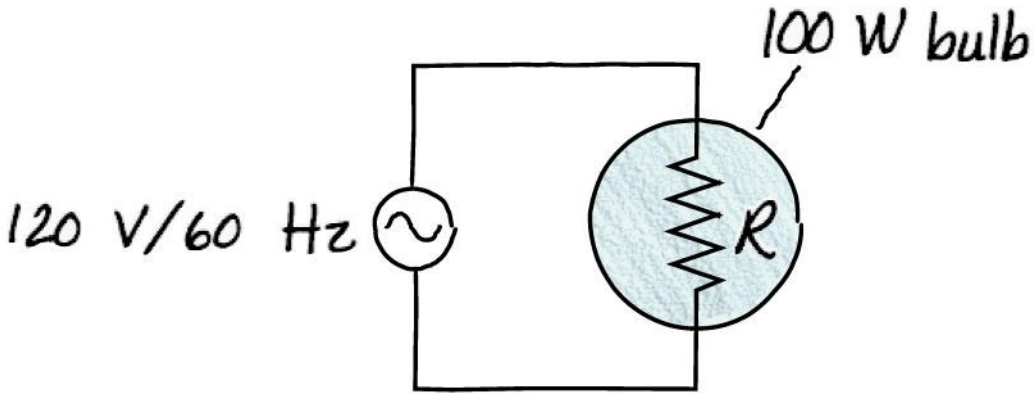
b) C/2.

c) 2C.

d) 4C.

e) It's impossible to change the resonance frequency by changing only the capacitor.

Lighting a Bulb



Q.32 A 100 W incandescent lightbulb is plugged into a 120 V/60 Hz outlet. What is the resistance of the bulb's filament? What is the peak current through the bulb?