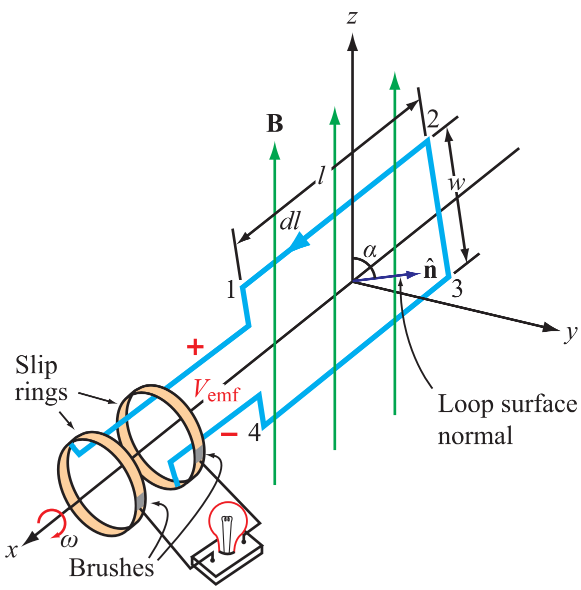
Test 6.1: Faraday's Law

According to Faraday's law, an electromotive force V_{emf} is induced:

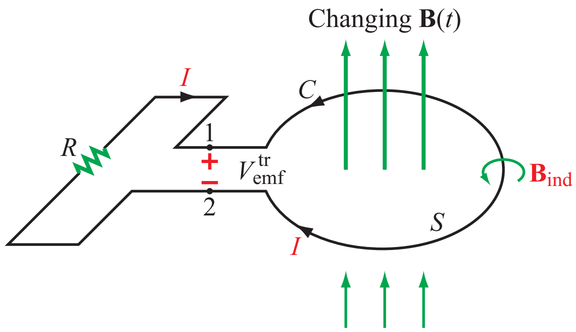
- **(a)** whenever a magnetic field **B** crosses through the loop cross section.
- **(b)** only if **B** is time-varying.
- **(c)** only if the loop is rotating.
- **(d)** Either **B** is changing with time, the loop is rotating and **B** is static, or **B** is changing in time and the loop is rotating.



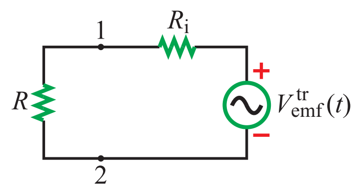
Test 6.2: Lenz's Law

The purpose of Lenz's law is to:

- **(a)** Compute the magnetic flux through the loop surface.
- **(b)** Compute the induced field $\mathbf{B}_{ind}$.
- **(c)** Determine the direction of I.
- **(d)** Determine the internal resistance R_i.



(a) Loop in a changing **B** field



(b) Equivalent circuit

Test 6.3: Ideal Transformer

In an ideal transformer, the secondary to primary turns ration is $N_2/N_1 = 10$. Consequently, only one of the following statements is true, which one?

(a) $\dfrac{V_2}{V_1} = 0.1, \quad \dfrac{I_2}{I_1} = 10, \quad \dfrac{P_2}{P_1} = 100$

(b) $\dfrac{V_2}{V_1} = 10, \quad \dfrac{I_2}{I_1} = 0.1, \quad \dfrac{P_2}{P_1} = 1$

(c) $\dfrac{V_2}{V_1} = 10, \quad \dfrac{I_2}{I_1} = 10, \quad \dfrac{P_2}{P_1} = 100$

(d) $\dfrac{V_2}{V_1} = 0.1, \quad \dfrac{I_2}{I_1} = 10, \quad \dfrac{P_2}{P_1} = 1$

Test 6.4: Piezoelectricity

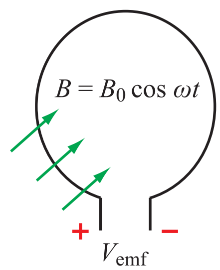
Piezoelectric crystals are used in:

(a) Ultrasound transducers, microphones, and speakers.
(b) Thermocouples to measure temperature.
(c) Accelerometers.

(d) Proximity sensors.

Test 6.5: TV Antenna

A circular-loop TV antenna with 0.02-m^2 area is in the presence of a uniform-amplitude 300 MHz signal. When oriented for maximum response, the loop develops an emf with a peak value of 15 (mV). What is the peak magnitude B_0 of the incident wave?



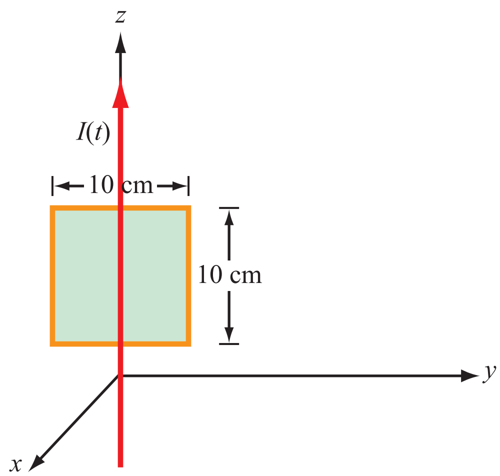
(a) $B_0 = 2$ (nT)
(b) $B_0 = 0.4$ (nT)
(c) $B_0 = 0.1$ (nT)
(d) $B_0 = 2$ (μT)

Test 6.6: Square Loop

The square loop shown in the figure is coplanar with (but not touching) a long, straight wire carrying a current

$$I(t) = 5\cos(2\pi \times 10^4 t) \qquad \text{(A)}.$$

What is the emf induced across a small gap created in the loop?

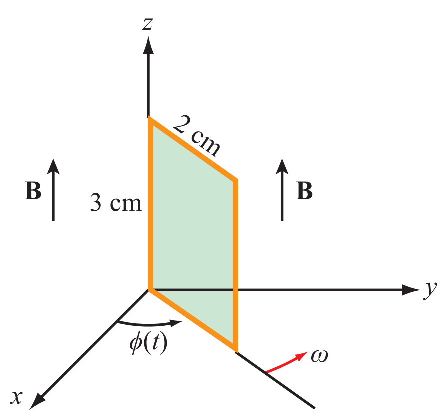


(a) $V_{\text{emf}} = 7\cos(2\pi \times 10^4 t)$ (mV)
(b) $V_{\text{emf}} = 3.5\sin(2\pi \times 10^4 t)$ (mV)
(c) $V_{\text{emf}} = 0$
(d) $V_{\text{emf}} = 7\sin(2\pi \times 10^4 t)$ (mV)

Test 6.7: EM Generator

The rectangular conducting loop shown in the figure rotates at 6,000 revolutions per minute in a uniform magnetic flux density given by

$$\mathbf{B} = \hat{\mathbf{z}}50 \qquad \text{(mT)}.$$

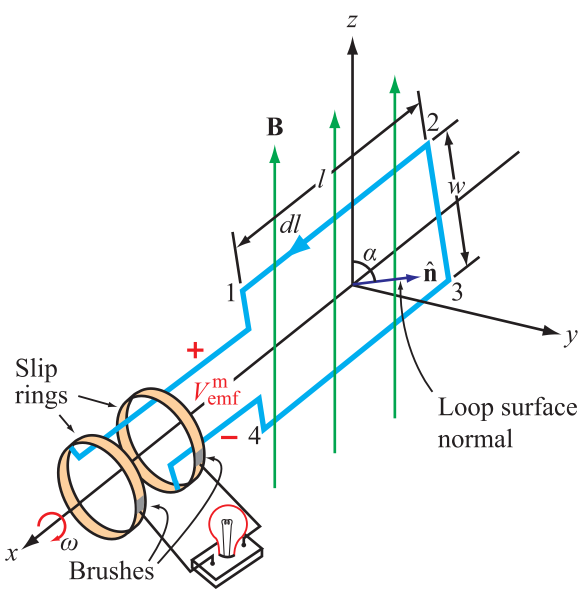


When an EE student connected a voltmeter across a small gap in the loop, the voltmeter registered a voltage of zero. How should the configuration be changed so as to generate the maximum possible emf?

(a) Reverse direction of **B**.
(b) Reverse direction of loop rotation.
(c) Increase the magnitude of **B**.
(d) Change **B** so it points along any direction in the x–y plane.

Test 6.8: EM Generator

The electromagnetic generator shown in the figure is connected to an electric bulb with a resistance of 150 Ω. If the loop area is 0.1 m^2 and it rotates at 1800 revolutions per minute in a uniform magnetic flux density $B_0 = 1.6$ T, determine the amplitude of the current generated in the light bulb.



(a) $I \approx 200$ (mA)
(b) $I \approx 10$ (mA)
(c) $I \approx 100$ (mA)
(d) $I \approx 1$ (mA)

Test 6.9: EM Potentials

The magnetic field in a dielectric material with $\varepsilon = 9\varepsilon_0$, $\mu = \mu_0$, and $\sigma = 0$ is given by

$$\mathbf{H}(y,t) = \hat{\mathbf{x}}5\cos(2\pi \times 10^7 t + 0.2\pi y) \qquad \text{(A/m)}.$$

Find the associated electric field $\mathbf{E}$.

(a) $\hat{\mathbf{y}}\,30\cos(2\pi \times 10^7 t + 0.2\pi y)$ (V/m)
(b) $-\hat{\mathbf{z}}630\cos(2\pi \times 10^7 t + 0.2\pi y)$ (V/m)
(c) $\hat{\mathbf{z}}\,30\cos(2\pi \times 10^7 t + 0.2\pi y)$ (V/m)
(d) $\hat{\mathbf{x}}\,60\cos(2\pi \times 10^7 t + 0.2\pi y)$ (V/m)

Test 6.10: EM Potentials

The electric field of an electromagnetic wave propagating in air is given by

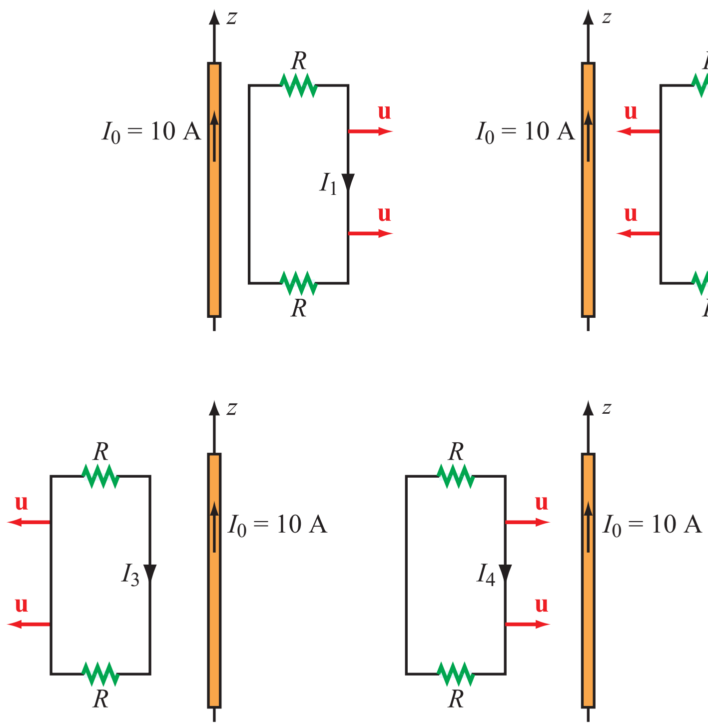
$$\mathbf{E}(z,t) = \hat{\mathbf{x}}4\cos(3 \times 10^8 t - z) + \hat{\mathbf{y}}3\sin(3 \times 10^8 t - z) \qquad \text{(V/m)}.$$

Find the associated magnetic field $\mathbf{H}(z,t)$.

(a) $\mathbf{H}(z,t) = \hat{\mathbf{x}}\,12\cos(3 \times 10^8 t - z) + \hat{\mathbf{y}}\,8\cos(3 \times 10^8 t - z)$ (A/m)
(b) $\mathbf{H}(z,t) = -\hat{\mathbf{x}}\,8\cos(3 \times 10^8 t - z) + \hat{\mathbf{y}}\,10.6\cos(3 \times 10^8 t - z)$ (mA/m)
(c) $\mathbf{H}(z,t) = -\hat{\mathbf{x}}\,8\sin(3 \times 10^8 t - z) + \hat{\mathbf{y}}\,10.6\cos(3 \times 10^8 t - z)$ (mA/m)
(d) $\mathbf{H}(z,t) = \hat{\mathbf{x}}\,16\cos(3 \times 10^8 t - z) + 2y\cos(3 \times 10^8 t - z)$ (A/m)

Test 6.11: Lenz's Law

Based on your understanding of Lenz's law, which of currents I_1 through I_4 is/are pointed in the wrong direction?



(a) I_2 and I_3 are printed in the wrong direction.
(b) All four currents are printed in the wrong direction.
(c) I_1 and I_4 are printed in the wrong direction.
(d) All four currents are printed correctly.

Test 6.12: Charge Dissipation

Suppose a certain amount of electric charge is placed at a point inside a block of carbon. Given that for carbon, $\varepsilon_r = 20$ and $\sigma = 3 \times 10^4$ (S/m), how long does it take the charge density at that point to dissipate to 0.1% of its original value?

(a) $t \approx 4$ ms
(b) $t \approx 4$ ns
(c) $t \approx 40$ ps
(d) $t \approx 40$ fs

Test 6.13: Boundary Conditions

At the interface between two different materials, the boundary conditions for electric and magnetic fields:

(a) are the same for static and dynamic (time-varying) conditions.
(b) are not the same for static and dynamic (time-varying) conditions.
(c) may or may not be the same depending on the relative conductivities of the two materials.
(d) may or may not be the same depending on the charge relaxation time constants for the two materials.