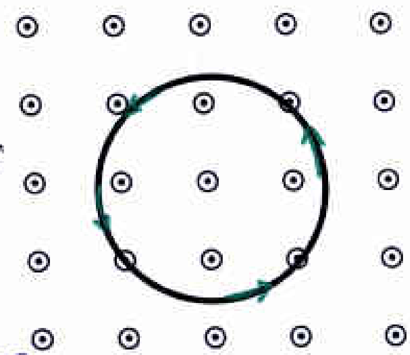
Name________________ Units? Units?

Mar. 31, 2004

Phys 2020
Quiz #4 — Spring 2004



1. A single circular loop of wire of radius 3.00 cm in the plane of the page is perpendicular to a uniform magnetic field directed out of the page, as shown at the right.

a) If the magnitude of the magnetic field decreases from 0.200 T to zero in 0.300 s, find the magnitude of the (average) induced emf in the coil.

Area of loop is $A = \pi r^2 = \pi (0.0300\,m)^2$

$= 2.83 \times 10^{-3}\, m^2$

Area & orientation of loop stay the same, so $\Delta\Phi = A\Delta B$

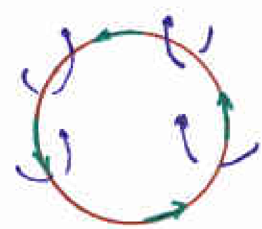
Then using Faraday's law the avg induced emf is

$$|\mathcal{E}| = N\frac{\Delta\Phi}{\Delta t} = 1\cdot\frac{A\Delta B}{\Delta t} = \frac{(2.83\times10^{-3} m^2)(0.200 T)}{(0.300 s)} = \boxed{1.88\times10^{-3} V}$$

b) On the figure show the direction of the induced current, and give the *reason* for your choice here. You be as clear and explicit as possible. No credit for coin–flipping.

The $\vec{B}$ field is out of the page and decreasing. To oppose this change we need to generate a flux out of the page.

By RHR-2 we will an out magnetic field (and flux) in the loop's interior if the current goes $\boxed{\text{counter clockwise}}$, as shown.



2. A 50.0 mH inductor stores 2.0×10^{-3} J of energy in its magnetic field. What is the current in the inductor?

Use $E = \frac{1}{2}LI^2$, then

$$I^2 = \frac{2E}{L} = \frac{2(2.0\times10^{-3} J)}{50.0\times10^{-3} H} = 0.080\ A^2$$

$$\rightarrow\ I = \boxed{0.283\ A}$$

3. A radio station broadcasts a signal at a frequency of 91.7 MHz. What is the wavelength of these EM waves?

Use $\lambda f = c$, then with $f = 91.7 \times 10^6$ Hz,

$$\lambda = c/f = \frac{(2.998 \times 10^8 \, m/s)}{(91.7 \times 10^6 \, 1/s)} = \boxed{3.27 \text{ m}}$$

4. An electromagnetic wave traveling in vacuum has a electric field amplitude of $65 \, \frac{\text{V}}{\text{m}}$.

a) Find the magnetic field amplitude of the wave.

Use $E_0 = c B_0$, then

$$B_0 = E_0/c = \frac{(65 \, V/m)}{(2.998 \times 10^8 \, m/s)} = \boxed{2.17 \times 10^{-7} \text{ T}}$$

b) Find the average power per unit area associated with the wave.

Use $\bar{S} = \frac{c\epsilon_0}{2} E_0^2$, then

$$\bar{S} = \frac{(2.998 \times 10^8 \, m/s)(8.854 \times 10^{-12} \, \frac{C^2}{Nm^2})(65 \, V/m)^2}{2}$$

$$= \boxed{5.61 \, W/m^2}$$

You must show all your work and include the right units with your answers!

$e = 1.602 \times 10^{-19}$ C $\quad \epsilon_0 = 8.854 \times 10^{-12} \frac{\text{C}^2}{\text{N} \cdot \text{m}^2} \quad \mu_0 = 4\pi \times 10^{-7} \frac{\text{T} \cdot \text{m}}{\text{A}} \quad B_{\text{wire}} = \frac{\mu_0 I}{2\pi r}$

$\Phi = BA\cos\phi \quad \mathcal{E} = vBL \quad \mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \quad \mathcal{E} = -L\frac{\Delta I}{\Delta t} \quad L_{\text{sol}} = \mu_0 n^2 A\ell \quad E = \frac{1}{2}LI^2$

$\lambda f = c \quad c = 2.998 \times 10^8 \frac{\text{m}}{\text{s}} \quad E_0 = cB_0 \quad \overline{S} = \frac{c\epsilon_0}{2}E_0^2 = \frac{c}{2\mu_0}B_0^2 \quad \overline{S} = \overline{S}_0 \cos^2\theta$