Name________________________

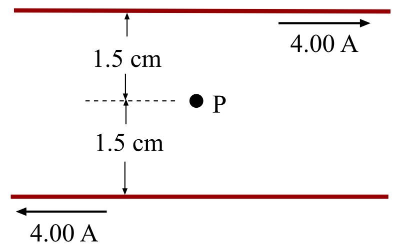
Mar. 19, 2008

Quiz #2 — Spring 2008

Phys 2020 (NSCC)

1. Two long straight parallel wires are separated by 3.00 cm and carry current of 4.00 A in opposite directions, as shown.

Find the magnitude and direction of the magnetic field at a point which is equidistant from the wires, as shown.



Since the wires carry the same current and P is equidistant from the two wires, the magnitude of the magnetic field from *each* wire is

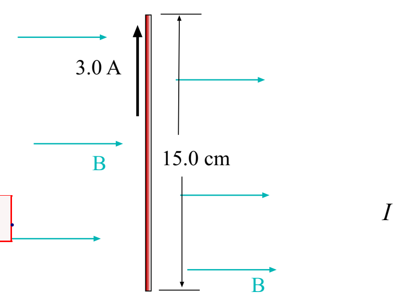
$$B = \frac{\mu_0 I}{2\pi r} = \frac{(4\pi \times 10^{-7})(4.0)}{2\pi(1.5 \times 10^{-2})} = 5.33 \times 10^{-5}\ \mathrm{T}$$

Now, at point P --using the right-hand rule-- the fields from the two wires are both directed *into the page* so we need to add the magnitudes:

$$B_{\text{total}} = 2(5.33 \times 10^{-5}\ \mathrm{T}) = 1.07 \times 10^{-4}\ \mathrm{T}$$

The direction of the total field is $\boxed{\text{into the page}}$.

2. A wire segment of length 15.0 cm carries a current of 3.00 A. It is placed in a uniform magnetic field of which points in the direction shown.



a) What is the direction of the force on the wire?

By the right-hand rule, the force on the wire will be $\boxed{\text{into the page}}$.

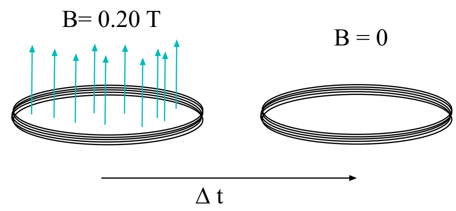
b) What is magnitude of the B field if the magnitude of force is 3.00×10^{-2} N?

Since current is perpendicular to B field, use $F = ILB$, then

$$B = \frac{F}{IL} = \frac{(3.00 \times 10^{-2}\ \mathrm{N})}{(3.00\ \mathrm{A})(0.150\ \mathrm{m})} = 0.067\ \mathrm{T}$$

3. A conducting circular loop of radius 4.00 cm and 100 turns of wire is in a uniform magnetic field of magnitude 0.200 T which is directed perpendicular to the plane of the loop.

In a time Δt the magnetic field is decreased to zero. In that time there was an average induced emf of 0.400 V.



a) What was the magnitude of the change in magnetic flux through the loop?

Since the final flux is zero, it's the same as the magnitude of the initial flux. THe B field is perpendicular to the plane of the loop, so

$$\Delta\Phi = BA = B(\pi r^2) = (0.200\ \mathrm{T})\pi(0.040\ \mathrm{m})^2 = 1.01 \times 10^{-3}\ \mathrm{Wb}$$

where we recall that $1\ \mathrm{Wb} = 1\ \mathrm{T}\cdot\mathrm{m}^2$.

b) In what time Δt did the field shut off?

Working with magnitudes only we use

$$\mathcal{E} = N\frac{\Delta\Phi}{\Delta t} \qquad \Longrightarrow \qquad \Delta t = \frac{N\Delta\Phi}{\mathcal{E}}$$

Plug in numbers,

$$\Delta t = \frac{100(1.01 \times 10^{-3}\ \mathrm{Wb})}{(0.400\ \mathrm{V})} = 0.25\ \mathrm{s}$$

so the magnetic field needs to shut off in $\boxed{0.25\ \mathrm{s}}$.

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

$$k = 8.99 \times 10^9\ \frac{\mathrm{N\cdot m^2}}{\mathrm{C^2}} \qquad \epsilon_0 = 8.854 \times 10^{-12}\ \frac{\mathrm{C^2}}{\mathrm{N\cdot m^2}} \qquad e = 1.60 \times 10^{-19}\ \mathrm{C}$$

$$V = IR \qquad P = IV = I^2R \qquad R_{\mathrm{ser}} = R_1 + R_2 \ldots \qquad \frac{1}{R_{\mathrm{par}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$

$$F = |qvB\sin\theta| \qquad F = ILB\sin\theta \qquad r = \frac{mv}{qB} \qquad m = \left(\frac{qr^2}{2V}\right)B^2$$

$$B_{\mathrm{wire}} = \frac{\mu_0 I}{2\pi r} \qquad B_{\mathrm{loop}} = \frac{\mu_0 I}{2R} \qquad \mathcal{E} = vBL \qquad \mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \qquad \mathcal{E} = -L\frac{\Delta I}{\Delta t}$$