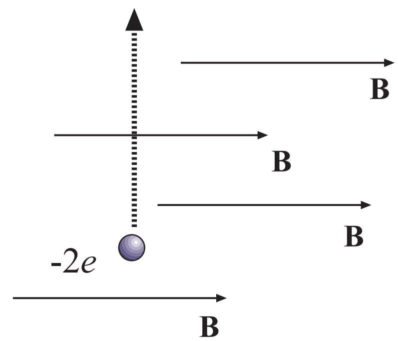
Name________________________________

Mar. 22, 2006

Phys 2020, NSCC – Spring 2006
Quiz #2

1. A negative charge $-2e$ is moving in the plane of the page, as shown at the right (upward), with a speed of $3.5 \times 10^6 \frac{\mathrm{m}}{\mathrm{s}}$. A magnetic field of magnitude 0.500 T is also in the plane of the page, as shown (pointing to the right).

Find the magnitude *and direction* of the force on the charge.



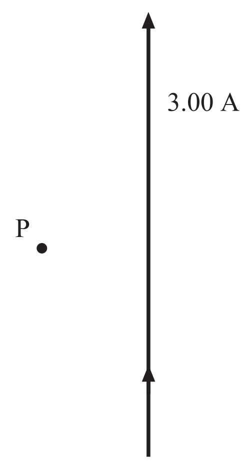
Using $F = |qvB|$ (since B is perp to v), the magnitude of the force is

$$\begin{aligned} F &= (2e)vB = 2(1.60 \times 10^{-19}\ \mathrm{C})(3.5 \times 10^6 \tfrac{\mathrm{m}}{\mathrm{s}})(0.500\ \mathrm{T}) \\ &= 5.6 \times 10^{-13}\ \mathrm{N} \end{aligned}$$

As for the direction, use the right-hand rule; with thumb in direction of velocity and fingers in direction of field, the palm faces into the page...but watch out! This is a *negative* charge, so we reverse that direction and conclude that the force points $\boxed{\text{out of the page}}$.

2. A very long straight wire carries a current of 3.00 A in the plane of the page, as shown at the right. The point P (also shown) is 2.50 cm from the wire.

Find the magnitude *and direction* of the magnetic field at point P.

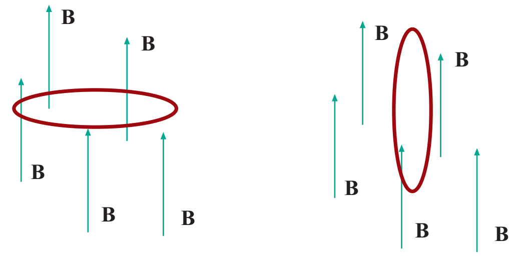


The B field at the given distance is

$$B = \frac{\mu_0 I}{2\pi r} = \frac{(4\pi \times 10^{-7})(3.00)}{2\pi(0.0250)}\ \mathrm{T} = 2.4 \times 10^{-5}\ \mathrm{T}$$

Use the right-hand rule to get the direction of the field. With the thumb in the direction of the current and the fingers wrapping around the wire, we find that the field at P points $\boxed{\text{out of the page}}$.

3. A circular loop of radius 2.00 cm is oriented perpendicular to a magnetic field of magnitude 0.600 T. In a time of 3.00 ms it flips so that it lies along the field, as shown at the right.



a) Find the average emf induced in the loop during the period of the flip.

The induced emf has a magnitude given by

$$\mathcal{E} = \frac{\Delta\Phi}{\Delta t}$$

and here the initial flux is BA while the final flux is zero (from the angle of the plane of the loop with respect to the magnetic field). So the magnitude of $\Delta\Phi$ is BA and that gives

$$\mathcal{E} = \frac{AB}{\Delta t} = \frac{\pi(0.020\ \mathrm{m})^2(0.600\ \mathrm{T})}{(3.00\times 10^{-3}\ \mathrm{s})} = 0.251\ \mathrm{V}$$

b) If the loop has a resistance of $3.00\,\Omega$, what is the average current in the coil during the time of the flip?

From Ohm's law and the average emf found in (a), the average current is

$$I = \frac{V}{R} = \frac{(0.251\ \mathrm{V})}{(3.00\,\Omega)} = 8.4\times 10^{-2}\ \mathrm{A}$$

4. Find the wavelength of radio waves which have a frequency of 6050 kHz.

Using $\lambda f = c$, get

$$\lambda = \frac{c}{f} = \frac{(3.00\times 10^{8}\frac{\mathrm{m}}{\mathrm{s}})}{(6050\times 10^{3}\ \mathrm{s}^{-1})} = 49.6\ \mathrm{m}$$

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

$e = 1.60\times 10^{-19}$ C $\quad k = 8.99\times 10^{9}\,\frac{\mathrm{N\cdot m^2}}{\mathrm{C^2}}$ $\quad \epsilon_0 = 8.85\times 10^{-12}\,\frac{\mathrm{C^2}}{\mathrm{N\cdot m^2}}$ $\quad c = 2.998\times 10^{8}\,\frac{\mathrm{m}}{\mathrm{s}}$ $\quad \omega = 2\pi f$

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

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

Rt hand rules! $\quad B_{\mathrm{wire}} = \dfrac{\mu I}{2\pi r} \qquad B_{\mathrm{loop}} = \dfrac{\mu_0 I}{2R} \qquad B_{\mathrm{sol}} = \mu_0 nI \qquad \Phi = BA\cos\phi$

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \qquad \mathcal{E} = -L\frac{\Delta I}{\Delta t} \qquad L_{\mathrm{sol}} = \mu_0 n^2\pi r^2 l \qquad \mathcal{E}_{\mathrm{max}} = NAB\omega \qquad \lambda f = c$$