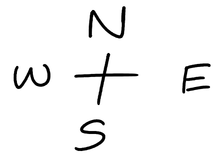
Quick Notes

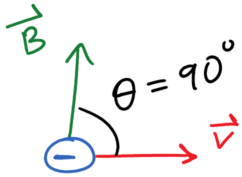
Saturday, March 13, 2021 8:13 PM

Determine the magnitude and direction of the force on an electron traveling 8.75×10^5 m/s horizontally to the East in a vertically upward magnetic field of strength 0.45 T.

Useful info: $q = -1.6 \times 10^{-19}$ C for the charge of an electron.

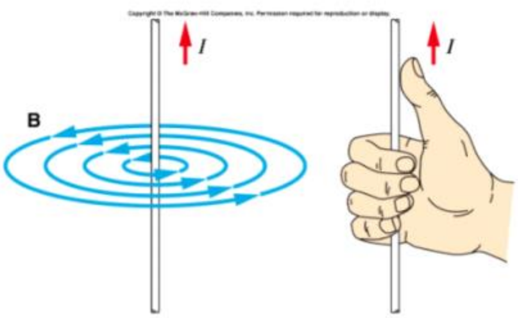
Answer: $\vec{F}_B = 6.3 \times 10^{-14}\,\mathrm{N}(-\hat{z})$, into the page (i.e. away from you).





$$\vec{F} = q(\vec{v} \times \vec{B})$$
$$= qvB\sin\theta = qvB\,\cancel{\sin 90°}^{+1}$$
$$= (1.6\times10^{-19})(8.75\times10^{5})(0.45)$$
$$= \boxed{6.3\times10^{-14}\,N}$$

Just as magnetic fields push moving charges; moving charges can create magnetic fields. In other words, a current may produce a magnetic field. Let's consider the scenario of current moving through a straight wire:

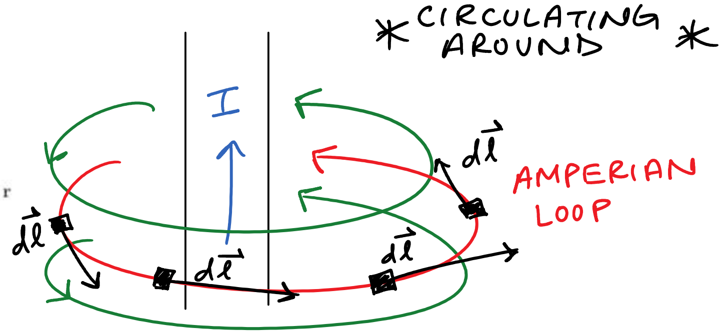


Derive an expression for the **magnitude of the magnetic field B** $= |\vec{B}|$ at a certain radius r away from the wire with current I running vertically upwards as shown in the figure.

Answer: $B = \frac{\mu_0}{2\pi}\frac{I}{r}$

EXPERIMENTALLY, WE'VE DISCOVERED WHAT THE MAGNETIC FIELD LOOKS LIKE FOR A STRAIGHT WIRE:

CIRCULATING AROUND



PREVIOUSLY WE USE GAUSS' LAW TO FIND E; DRAW GAUSSIAN SURFACE

NOW WE USE AMPERE'S LAW TO FIND B; DRAW AMPERIAN LOOP

CONSIDER HOW SIMILAR THE 2 LAWS ARE:

$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0} \qquad \int \vec{B}\cdot d\vec{l} = \mu_0 I_{enc}$$

$$\oint E\,dA\cos\theta = \dots \qquad \int B\,dl\cos\theta = \dots$$

$$\oint E\,dA\,\cancel{\cos 0°}^{+1} = \dots \qquad \int B\,dl\,\cancel{\cos 0°}^{+1} = \dots$$

$$E\oint dA = \dots \qquad B\int dl = \dots$$

$$E \oint dA = \ldots$$

$$E A_{TOTAL} = \frac{Q}{\epsilon_0}$$

$$B \int dl = \ldots$$

$$B\, l_{TOTAL} = \ldots$$

$$B(2\pi r) = \mu_0 I$$

$$\hookrightarrow B = \frac{\mu_0}{2\pi} \frac{I}{r}$$