1. When a magnetic field causes a charged particle to move, which of the following is true?
   (a) The energy of the particle changes.
   (b) The momentum of the particle changes.
   (c) Both energy and momentum of the particle change.
   (d) Neither energy nor momentum of the particle changes. (0.5/5)

2. An electron is moving north in a region where the magnetic field is north. The magnetic force exerted on the electron is
   (a) zero
   (b) up
   (c) down
   (d) east
   (e) west. (0.5/5)

3. There is a current \( I \) flowing in a clockwise direction in a loop of wire that is in the plane of the paper, where \( \overrightarrow{ab} = L \) and \( \overrightarrow{acb} = 2L \). There is a uniform magnetic field \( \overrightarrow{B} \) toward the right, and \( \overrightarrow{B} \perp \overrightarrow{ab} \),
   (a) what is the direction and magnitude of the magnetic force on \( \overrightarrow{ab} \)? (0.5/5)
   (b) what is the direction and magnitude of the magnetic force on \( \overrightarrow{acb} \)? (0.5/5)

Answer:

(a) \( \overrightarrow{F_{ab}} = ILB \) out of the page (⊙).
(b) The magnetic force on a closed current loop in a uniform magnetic field is zero. Therefore,
   \[ \overrightarrow{F_{ab}} + \overrightarrow{F_{acb}} = 0. \]

Hence, \( \overrightarrow{F_{acb}} = ILB \) into the page (⊙).
Four long, parallel conductors carry equal currents of \( I \). The direction of the current is into the page at points \( A \) and \( B \) (indicated by the crosses) and out of the page at \( C \) and \( D \) (indicated by the dots).

(a) Draw vectors to represent the directions of magnetic fields at the central point \( P \), produced by currents at points \( A, B, C, \) and \( D \). Label them as \( B_A, B_B, B_C, \) and \( B_D \). (1/5)

(b) Calculate the magnitude and direction of the magnetic field at point \( P \), located at the center of the square with edge of length \( L \). (2/5)

Answer:

(a) See the figure.

(b)

\[
B_A + B_D = B_B + B_C = 2 \times \frac{\mu_0 I}{2\pi \sqrt{\left(\frac{L}{2}\right)^2 + \left(\frac{L}{2}\right)^2}}
\]

\[
= \frac{\sqrt{2}\mu_0 I}{\pi L}.
\]

Therefore,

\[
|B| = \sqrt{(B_A + B_D)^2 + (B_B + B_C)^2}
\]

\[
= \frac{2\mu_0 I}{\pi L}.
\]

The direction is pointing downward.

formula:

force: \( \mathbf{F} = q\mathbf{v} \times \mathbf{B} \); \( \mathbf{F} = I\mathbf{l} \times \mathbf{B} \).

magnetic field: \( B = \frac{\mu_0 I}{2\pi r} \) (infinitely long straight line); \( B = \frac{\mu_0 I}{2r} \) (circular loop).

\( r = \frac{mv}{qB}; g = 9.8m/s^2 \).