Rec 16: Oct. 15, 2009

27.28 a) \[ \vec{E}_B \uparrow \rightarrow \vec{E} \]

b) See diagram

\[ v = \frac{E}{B} = 3.38 \times 10^6 \text{ m/s} \]

\[ r = \frac{mv}{qB} = \frac{9.11 \times 10^{-21} \times 3.38 \times 10^6}{1.6 \times 10^{-19} \times 4.62 \times 10^{-3}} = 4.16 \text{ m} \]

\[ T = \frac{2 \pi r}{v} = 7.74 \text{ ns} \]

b) \[ \vec{T} = \mu \vec{A} \times \vec{B} = \ni \vec{A} \times \vec{B} = 0 \]

\[ \vec{F} = I \vec{L} \times \vec{B} \]

For left and right sides \( \vec{L} \times \vec{B} = 0 \) so \( \vec{F} = \vec{F}_L = 0 \)

For top \( \vec{L} \times \vec{B} \) is down

\[ \vec{F}_T = I \vec{L} \vec{B} = (1.4)(0.35)(1.5) = 0.74 \text{ N down} \]

\[ \vec{F}_B = I \vec{L} \vec{B} \uparrow = 0.74 \text{ N up} \]

Net force = 0

b) Top view

\[ \vec{T} = \ni \vec{A} \times \vec{B} \Rightarrow (\vec{T}) = \ni \vec{A} \vec{B} \sin \theta \]

\[ \theta = 150^\circ \]

\[ |\vec{T}| = I\vec{n}_x(0.22)(0.35)(1.5) \sin 150^\circ = 0.081 \text{ N-m} \]

Net force is still 0.

27.63 \[ \vec{F}_L = \ni \vec{A} \vec{B} \sin \theta \]

Triple d (or r) and A increased by factor of 9. All else same so \( |\vec{T}| \) increased by factor of 9.
Need $I$ through bar for parallel combination of $R + 10 \Omega$

$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{R} = \frac{1}{10} + \frac{1}{10} = \frac{1}{5}$

$R_{eq} = 5 \Omega$

For all 3 resistors $R_{eq} = 25 + 5 = 30 \Omega$

So $I_{eq} = \frac{30}{30} = 4 \text{A}$

Now $V_{5\Omega} = 4(5) = 20 \text{V} = V_{bar} \Rightarrow I_{bar} = \frac{V_{bar}}{R} = 2 \text{A}$

$F_B = I_{LB} \times \text{max}$

$F_B$ is out of page

$F_a = mg$ is into page

So $ma = I_{LB} - mg$

$a = \frac{I_{LB}}{m} - g = \frac{I(15)(1.6)}{3/9.8} - 9.8 = 5.88 \text{m/s}^2$ out of page

2.7B4

a) $F = I \hat{L} \times \hat{B}$

$\hat{L} = \hat{L} \hat{k}$

$F = I \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 1 \\ B_x & B_y & B_z \end{vmatrix} = I (-B_y \hat{z} + B_x \hat{j})$

$F = 9 (-0.25) (-0.985) \hat{z} + (0.25) (-0.242) \hat{j}$

$F = (2.22 \hat{z} - 0.545 \hat{j}) \text{N}$

b) $F = \sqrt{2.22^2 + (0.545)^2} = 2.29 \text{N}$
1. The diagram shows a side view of three current loops in a uniform magnetic field. All three loops are identical and each carries the same current. For which loop is the torque zero?

[A] 1  [B] 2  [C] 3  [D] None of these

2. A square conducting coil with 50 turns and sides of length $a = 20.0$ cm is located in a region of uniform magnetic field pointing toward the top of the page. The current in the coil is $I = 10.0$ A, and the magnitude of the magnetic field is $B = 100$ mT.

(a) Calculate the magnitude and direction of the magnetic force on each side of the coil (that is find the magnetic force on the top, bottom, left, and right sides of the coil).

(b) If the coil is allowed to rotate about a horizontal axis that bisects it (see figure) what is the maximum torque exerted on the coil? Indicate on the figure above the direction of rotation for the coil.

\[
\tau = \vec{\mu} \times \vec{B} = NI \vec{A} \times \vec{B} \quad \tau_{\text{max}} \text{ when } \vec{A} \perp \vec{B} \text{ (as in figure)}
\]

\[
\tau_{\text{max}} = NIAB = NIa^2B = (50)(10)(0.2^2) \approx 10 \text{ Nm}
\]

\[
\tau_{\text{max}} = 2 \text{ Nm}
\]