\( \text{Ch 29) } \)

For a current going clockwise, we use the right-hand rule ("RHHR") to find the direction of \( \mathbf{F} \)

\[
|\mathbf{F}| = |i\mathbf{A}| = (20)(0.1\mathbf{A})(0.5\mathbf{m})(0.05\mathbf{N} \cdot \text{m}) = 0.01 \text{ N} \cdot \text{m}
\]

\[
|\mathbf{F}| = |i\mathbf{A}| = (0.01 \text{ N} \cdot \text{m})(0.5\mathbf{A})(0.5\mathbf{m}) = 0.005 \text{ N} \cdot \text{m} \cdot \cos(20^\circ) = 0.004 \text{ N} \cdot \text{m}
\]

Direction: By RHHR in the opposite direction, or \((-\mathbf{F})\)

45. a) Look at a piece of wire \( \mathbf{dl} \)

- Is out of page

- Force on \( \mathbf{dl} \) is \( \mathbf{F} = i \mathbf{dl} \times \mathbf{B} \)

- At angle \( \theta \) to horizontal,

- By symmetry, opposite side of loop has

\( \mathbf{F}_\theta \) with force pointing this way:

So the \( \mathbf{F} \) components cancel. \( \mathbf{F}_\theta \) component is

\[
\mathbf{F}_\theta = i \mathbf{dl} \mathbf{B} \sin(\theta) \theta \sin(\theta) \theta \sin(\theta)
\]

Now integrate around loop (easy!)

\[
\int \mathbf{F}_\theta = a \mathbf{dl} \int \mathbf{B} \sin(\theta) \theta \sin(\theta)
\]

47. Even though the book usually gives us problems with no friction, we can't assume this unless they say so!

Remember 13P?

\[
\sum \mathbf{F}_x = 0 = f - mg \sin \theta \quad (i)
\]

Also, since there is a current loop in a uniform field:

\[
\mathbf{F}_B = 0, \quad \text{but } \mathbf{E} \cdot \mathbf{A} \neq 0. \quad \text{Sum of torques must be zero to avoid rolling:}
\]

\[
\sum \tau = \int \mathbf{r} \times \mathbf{F} = 0 \quad (ii)
\]

\[
\text{From eq}(i) \quad f = mg \sin \theta \quad \text{area} = 2 \mathbf{L}
\]

So from (ii) get:

\[
mg \sin \theta - (2 \mathbf{L}) B \sin \theta = 0
\]

Cancel out \( B \sin \theta \), get:

\[
\frac{f}{3 \mathbf{N} \mathbf{L}} = 2.45 \mathbf{A}
\]
Ch. 29

5)\( r = 15 \text{ cm} = 0.15 \text{ m} \)
\( \Theta = 2.60 \text{ A} \)
\( \theta = 41^\circ \)
\( \Phi = 12 \text{ m} \)

a) \( \vec{B} = N_i A \times (2.60 \text{ A})( \tau (0.15^2)) = 0.18 \text{ Am}^2 \)

\[ \vec{F} = \vec{m} \times \vec{B} \text{ since we assumed a direction for } \vec{l} \]

b) \( |\vec{F}| = (N_i A) \cdot (2.60 \text{ A})( \tau (0.15^2)) \text{ Nm} \)

5)\( \vec{F} \text{ with direction of } \vec{l} = \vec{a} \text{ is not } \vec{a} \text{ or } \vec{a} \times \vec{E} \)
\[ \vec{F} = |\vec{l}| = 1 \text{ ft} \text{ of } (6 \text{ in})^2 - (3 \text{ in})^2 \text{ ft}^2 \]
\[ = 1.10 \text{ ft lb} \]

HW8

Ch. 30

4) From the diagram,\( \vec{B} \) is direction.

From MRI, direction of \( \vec{B} \) is direction as shown. It points opposite the \( \vec{B} \) field for a certain angle \( \theta \), according to the way we draw my axes. \( \theta = \frac{\pi}{2} \)

Anyway, we use \( \beta = \frac{B}{B_0} = 5 \text{ mT} \) to see which gives us calculation (at \( \theta = \beta \))

\[ \gamma = \frac{M_0 \beta}{2 \pi} = 4 \times 10^{-3} \text{ m} \]

7) By MRI, \( \vec{B} \) contributions from straight wires point out of the page, curved part gives \( \vec{B} \) into page.

Straight wires by eq. 30-9: \( \vec{B} = \frac{2}{I} \left( \frac{M_0 \beta}{4\pi \tau} \right) \)

Center of semi-circular curved wire:

eq 30-11 \( \vec{B} = \frac{M_0 \beta}{4\pi \tau} \)

\( \vec{B} = \vec{B}_s - \vec{B}_c = 0 \Rightarrow \beta = \frac{M_0 \beta}{4\pi \tau} \cdot \tau = 2 \text{ rad} \)
c) Each straight segment contributes nothing.
   Long should use \( B = \frac{\mu_0 L}{2\pi r} \), where \( L \) is the length of the wire, \( r \) the radius at the center (radius is \( 2R \) or \( \frac{1}{2} \) of circle).
   Eq. 30-93 \( B = \frac{\mu_0 I}{2\pi r} \) \( \frac{1}{2} \) by RHR
   \( B = \frac{\mu_0 I}{4\pi R} \) (into page)

   c) \( \vec{B} = \vec{0} + \vec{B}_c = \frac{\mu_0 I}{4\pi R} \) \( \frac{1}{2} \) (as long as you say into page, we don't care if you call that \( \vec{B} \) or \( \vec{B} \).

24) \( \vec{P}_1 = \vec{F}_1 \times \vec{B}_1 \)

   To find force use \( P = \vec{F} \times \vec{B} \)

   Since \( \vec{E} \) is parallel to \( \vec{B} \),

   \( 1 \) cancels \( \vec{B}_1 = \frac{\mu_0 I_1}{2\pi R} \) \( \vec{E} \) just means into page since square loop

   Segments ii + iv \( \vec{P}_i = -\vec{P}_i \) in plane of page.

   Since \( B \) is not \( \theta \)-dependent, the minus sign is due to \( \vec{E} \).

   \( \vec{F} = \vec{F}_i + \vec{F}_iv = \frac{\mu_0 I_1 L}{2\pi} \left( \frac{1}{\alpha + i} - \frac{1}{\alpha - i} \right) \vec{E} \) direction comes from \( \theta \).

   \( \frac{1}{\alpha + \beta} \) is directed toward straight wire.
37) to make a hole appear in our mathematical description, we need (a) current going one way in wire with radius $a$, (b) current going opposite that in wire radius $b$. How much current? The densities have to be the same:

$$J = \frac{i}{(a^2 - b^2)}$$

(a) due to wire $a$,

$$B = \frac{\mu_0 i}{2\pi a} \frac{R_a}{R_a^2} \Rightarrow B = \frac{\mu_0 i}{2\pi a} \frac{R_a}{R_a^2}$$

Similarly for $b$

$$B = \frac{\mu_0 i}{2\pi b} \frac{R_b}{R_b^2}$$

but $R_a^2 = a^2 - b^2$, $R_b^2 = a^2 - b^2$ so field is

$$B = \frac{\mu_0 i}{(a^2 - b^2)2\pi}$$

(b): $b = 0$, then there's no hole: $B = 0$. $d = 0$, $r = 0$ which is true for center of cylindrical shell of current.

c) deserves its own page $\rightarrow$ next

$$B_x = B_1 \sin \theta_1 - B_2 \sin \theta_2$$

$$B_x = \frac{\mu_0 i}{2\pi (a^2 - b^2)} \left( R_1 \sin \theta_1 - R_2 \sin \theta_2 \right)$$

$$\therefore B_x = 0$$

$$B_y = B_1 \cos \theta_1 + B_2 \cos \theta_2$$

$$B_y = \frac{\mu_0 i}{2\pi (a^2 - b^2)} \left( R_1 \cos \theta_1 + R_2 \cos \theta_2 \right)$$

$$\therefore B_y = 0$$

Independent of $r_1, r_2, \theta_1, \theta_2$

The field is uniform inside hole!

Wheew!