(1) [Based on Ch. 22, P14] A loop of wire has the shape and dimensions shown in the drawing. The top part of the wire is bent into a semicircle or radius \( r = 35 \) cm. The normal to the plane of the loop is parallel to an external magnetic field \( \vec{B}_{\text{ext}} \) as shown in the figure. The magnetic field \( \vec{B}_{\text{ext}} \) is made to increase from 0.4 T to 1.2 T in a time interval 0.6 s.

(a) Is there a current induced in this loop? If so, what is the direction (clockwise or counter-clockwise) of the induced current? Justify your answer.

(b) How much heat energy is dissipated in the 5.0 \( \Omega \) resistor during this 0.6 s? First think about what things you need to determine before you can calculate the dissipated energy.

\[
\begin{align*}
\text{Area} &= \text{(Base)} \times \text{(Height)} + \frac{1}{2} \pi r^2 \\
&= (1.1 \text{ m}) \times (0.78 \text{ m}) + \frac{1}{2} \pi (0.35 \text{ m})^2 \\
&= 1.05 \text{ m}^2
\end{align*}
\]

\[
E = \frac{\text{Area}}{\text{time}} = \frac{1.05 \text{ m}^2}{0.6 \text{ s}} = \frac{613}{5} \text{ V}
\]

\[
\text{Since } n = 1 \text{, } \text{the area doesn't change,}
\]

\[
E = (1.05 \text{ m}^2) \times \frac{(1.2T - 0.4T)}{0.6 \text{ s}} = 1.40 \text{ V}
\]

\[
P = \frac{E^2}{R} = \frac{(1.40 \text{ V})^2}{5 \Omega} = 0.235 \text{ J}
\]

[Group Work Continued on the other side]
(2) Next, the top part of the loop is modified so that it can be turned with a crank as shown. Now \( \vec{B}_{\text{ext}} \) is held constant at 1.2 T, and the crank is turned so the semicircle part of the loop rotates once complete revolution in 0.20 seconds.

(a) During this first \( \frac{1}{2} \) revolution, will a current be induced in the loop? If so, in which direction (clockwise or counter-clockwise) is the induced current?

(b) What is the magnitude of the average induced current in the loop during the first \( \frac{1}{2} \) revolution?

\[
|I_{\text{ind}}| = \frac{\Phi}{|\vec{E}|} = \frac{N \Phi}{|\vec{E}|} = \frac{N \vec{B} \cdot \vec{A}}{|\vec{E}|}
\]

But here, \( B \) stays constant & the area changes. As before, \( N = 1 \).

\[
|I_{\text{ind}}| = \frac{B \cdot \Delta A}{\Delta t} = \frac{1.2 \times 5 \pi (0.35)^2}{0.15} = 0.92 A
\]

(c) During the second \( \frac{1}{2} \) revolution (to complete one full revolution), determine the direction and average magnitude of the induced current.

During the 2nd half of the revolution, the area increases.
Thus, the average \( I_{\text{ind}} \) is the same, but its direction reverses to flow in a CCW direction,