Name_____

Physics 121 Quiz #7 November 11, 2022

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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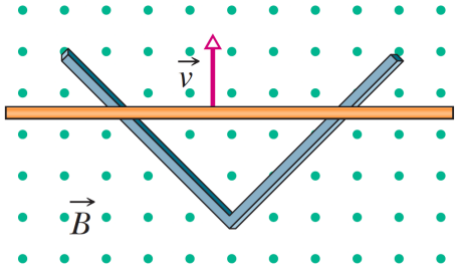
Consider the situation below in which two straight conducting rails form a right angle. A conducting bar is in contact with the rails and starts at the vertex (intersection of the two rails) at time $t = 0$. The bar moves at constant velocity $v = 5.2\frac{m}{s}$ through a magnetic field $B = 0.35T$ directed out of the page.

1. What is the expression for the magnetic flux ϕ_B, as a function of time, through the triangular loop? Hint the area of a triangle is given by $A = \frac{1}{2} \times base \times height$



$$\phi_B = BA\cos\theta = BA = 2B\left(\frac{1}{2}bh\right) = 2B\left(\frac{1}{2}(vt\tan 45)(vt)\right)$$

$$\phi_b = Bv^2t^2$$

2. What is the potential difference induced across the triangular loop at a time $t = 3s$?

$$\varepsilon = \left|-N\frac{d\phi_B}{dt}\right| = \frac{d\phi_B}{dt} = \frac{d}{dt}(Bv^2t^2) = 2Bv^2t = 2 \times 0.35T \times \left(5.2\frac{m}{s}\right)^2 \times 3s = 56.8V$$

3. If the bar has a resistance of $R = 5\Omega$, what is the magnitude and direction of the current induced in the bar?

   $I = \frac{\varepsilon}{R} = \frac{56.8V}{5\Omega} = 11.3A$

   The direction of the current flow would be clockwise to undo the change in magnetic flux, which is increasing out of the page.

4. At a time $t = 3s$, what is the magnitude and direction of the magnetic force on the bar?

   $F_B = ILB = I(2vt \tan 45)B = 11.3A \times \left(2 \times 5.2\frac{m}{s} \times 3s\right) \times 0.35T = 123.4N$ and by the right-hand rule, the force is directed opposite to the velocity, or down the page.

5. What is energy dissipated as heat across the bar at a time $t = 3s$?

   $P = \frac{\Delta E}{\Delta t} \rightarrow \Delta E = P\Delta t = I^2 R\Delta t = (11.3A)^2 \times 5\Omega \times 3s = 1915.4J$