proprep

Workbook

Table of Contents

Faraday's Law of Induction

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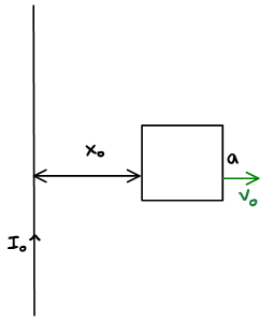
Questions

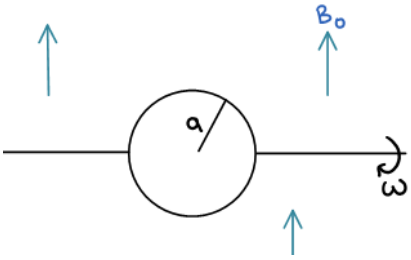
1) An infinite wire has current I_0 flowing through it. A square frame of side length a and resistance R is located at x_0. At $t = 0$ the frame begins to move with a velocity $v_0\hat{x}$. There is a magnetic field $\vec{B}$.

a. Calculate the emf.
b. Calculate the current.
c. What external force is required in order for the frame to move at a constant velocity?



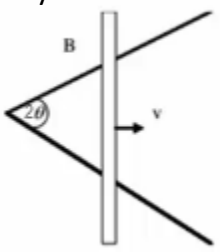
2) A conducting ring, of radius a and resistance R, is attached to two non conducting rods. These rods rotate the ring with an angular velocity ω. There is a magnetic field B_0 throughout.

a. Calculate the emf.
b. Calculate the current in the ring
c. Now the magnetic field is $B = B_0\, cos(\omega t)$. Calculate the emf.

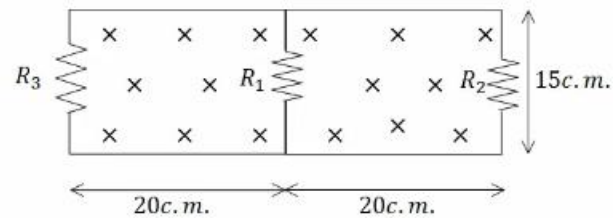


3) Two conducting tracks are placed at an angle of 2θ to one another. A conducting rod is placed on top of them, creating an equilateral triangle. At $t = 0$ the rod is at the vertex. The rod moves across the tracks at a velocity v. There is a constant magnetic field B out of the page.

a. Calculate the emf.
b. The resistance of the rod, per unit length, is R_1 and the tracks have no resistance. Calculate the current.
c. Calculate the power transferred to the system to produce the current.

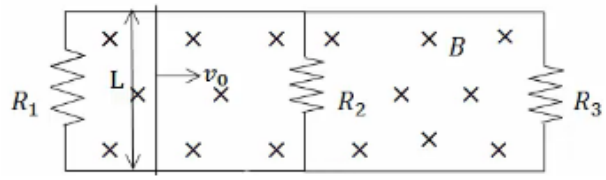


4) The resistors have the following resistances: $R_1 = 1\Omega,\ R_2 = 2\Omega$ and $R_3 = 3\Omega$.
There is a magnetic field $B = 2\frac{T}{sec} \cdot t$ into the page. The height of the circuit is $15cm$, and the width of each sub-circuit is $20cm$. Calculate the current through each resistor.



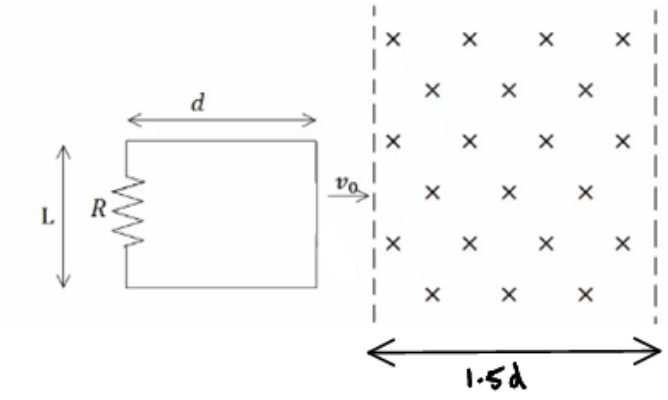
5) A conducting rod of length L moves along the sides of a circuit (see diagram).
Inside the circuit is a uniform magnetic field B into the page. We are given $B,\ R_1,\ R_2, R_3,\ v_0, L$.
Calculate the current when:

a. The rod is located between resistors R_1 and R_2.
b. The rod is located between resistors R_2 and R_3.



6) Given is a rectangular frame of length d and width L. It moves with a constant velocity v_0 in the direction of a constant magnetic field B. The length of the region is $1.5d$ and its width is infinite. The frame has a total resistance R.
At $t = 0$ the right side of the frame enters the region of the magnetic field.

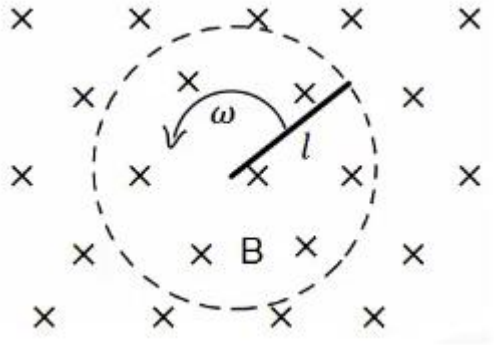
a. Calculate the emf of the frame.
b. Calculate the current in the frame.
c. Calculate the force required in order for the frame to move at a constant velocity.
d. What is the power of the force and the power turned to heat in the resistor?



7) A rod of length L rotates about one of its edges at a constant angular velocity ω.
The rod is in a uniform magnetic field B, which is perpendicular to the plane of rotation.

a. Calculate the voltage between the two edges of the rod by integration using Lorentz's law.

b. Calculate the voltage in the rod using Faraday's law.



*For the solutions go see the vidoes