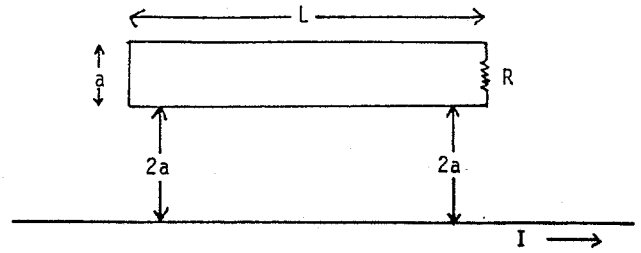
7. Given a long, straight wire carrying current to the right as shown. A
25 pts. rectangular loop of wire is placed near the wire as shown. If the current in the wire is given by $I = I_0 \sin \omega t$, find an expression for the voltage across the resistor R as a function of time.



Physics 1/2 Winter Quarter 1982

GRADER: FINAL EXAM Mean: 7.7

Name (Print) Rino

Name (Sign) _____ S.S. No. _____

Discussion Instructor: Abbott Allen
Brumbaugh Bruno Ho Gehrke
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Problem No. 7

BE SURE TO SHOW ALL WORK!

The magnetic field at a distance r from the long straight wire is:

$$B(r,t) = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0 I_0}{2\pi r} \sin \omega t \quad \text{(5 points)}$$

The magnetic flux through the rectangular loop is:

$$\Phi_B(t) = \int \vec{B} \cdot d\vec{S} = \int B\,dS$$

$$= \int_{2a}^{3a} \left(\frac{\mu_0 I}{2\pi r}\right)(L\,dr) \qquad (dS = L\,dr)$$

$$= \frac{\mu_0 I_0 \sin \omega t}{2\pi} L \left[\ln r \Big|_{2a}^{3a}\right]$$

$$= \frac{\mu_0 I_0 L \ln(3/2)}{2\pi} \sin \omega t \quad \text{(13 points)}$$

$$V_R(t) = \mathcal{E}(t) = -\frac{d\Phi_B}{dt} = \frac{-\mu_0 I_0 L \ln(3/2)}{2\pi} \omega \cos \omega t$$

(7 points)