November 20, 2007
Physics 272 Exam 3:

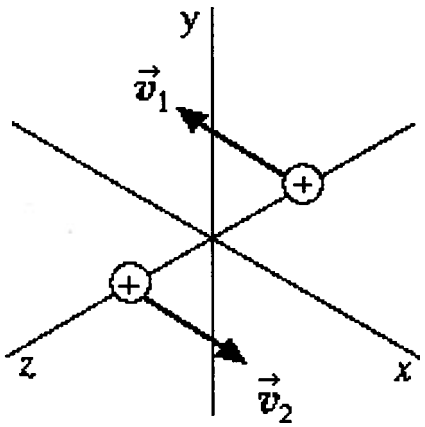
Name: Solution

The value of the electric constant $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$.
The value of the magnetic constant $\mu_0 = 4\pi \times 10^{-7}\ T\ m/A^2$

Solve the five questions in the exam.

1.

i) Two positively charged bodies are moving in opposite directions on parallel paths that lie in the *xz* plane. Their speeds are equal and their trajectories are equidistant from the *x* axis. The magnetic field at the origin, due to the motion of these charged bodies will be

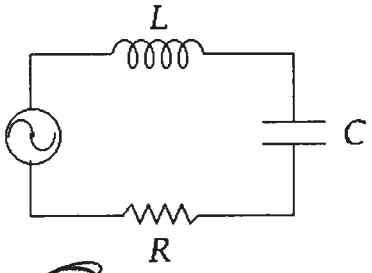


A) in the x direction
B) in the y direction
C) in the z direction
D) Zero

ii) A conducting loop around a bar magnet begins to move away from the magnet. Which of the following statements is true?

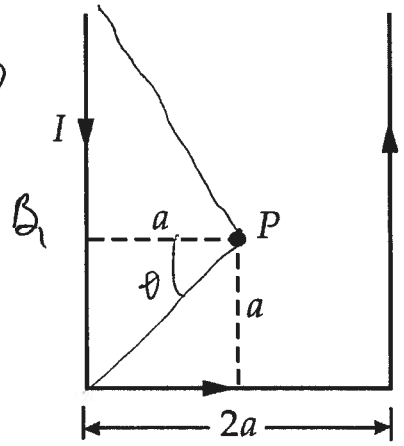
A) The magnet and the loop repel one another.
B) The magnet and the loop attract one another.
C) The magnet is attracted, but the loop is repelled.
D) The magnet is repelled, but the loop is attracted.
E) The magnet and loop neither attract nor repel one another.

iii) If you double the frequency in the circuit shown, the impedance of the inductor (reactance of the inductor)



A) increases by a factor of 2
B) does not change
C) decreases by a factor of 2
D) increases by a factor of 4
E) decreases by a factor of 4

103 2.- A very long wire carrying a current I is bent into the shape of the figure. Find the magnetic field at point P.



B_1 B_2

Biot Savart

$$dB = \frac{\mu_0}{4\pi} \frac{I\,dx}{r^2} \cos\theta$$

$$B = \frac{\mu_0}{4\pi} \frac{I}{R} (\sin\theta_2 - \sin\theta_1)$$

$2B_1 + B_2$

$\sin\theta_1 = \frac{1}{\sqrt{2}}$

$\sin\theta_2 = 1$

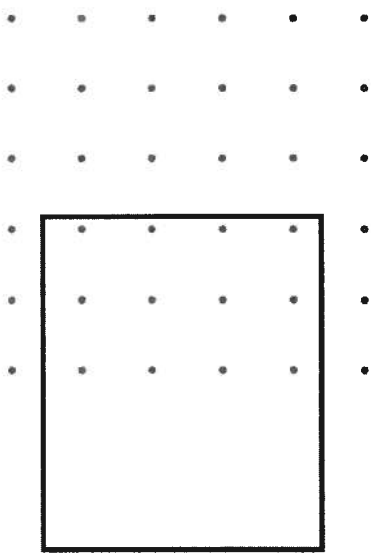
$$B_1 = \frac{\mu_0}{4\pi} \frac{I}{a} \left(1 + \frac{1}{\sqrt{2}}\right)$$

$$B_2 = \frac{\mu_0}{4\pi} \frac{I}{a} \frac{2}{\sqrt{2}}$$

$$B = \frac{\mu_0}{4\pi} \frac{I}{a} \left(2 + \frac{2}{\sqrt{2}} + \frac{2}{\sqrt{2}}\right) = \frac{\mu_0}{2\pi} \frac{I}{a} \left(1 + \sqrt{2}\right)$$

90

3.- The rectangular coil in the figure has N turns, is a (cm) wide and b (cm) long. It is located in a magnetic field B directed out of the page. Only half of the coil is in the region of the magnetic field. The resistance of the coil is R (Ohms). Find the magnitude and direction of the induced current if the coil is moved with a velocity v (m/s) down.



$$\Phi = NBw\,x \qquad a \times .01$$

$$\frac{d\Phi}{dt} = NBw\frac{dx}{dt} \qquad a \times .01$$

$$I = \frac{NBw\frac{dx}{dt}}{R} \qquad a$$

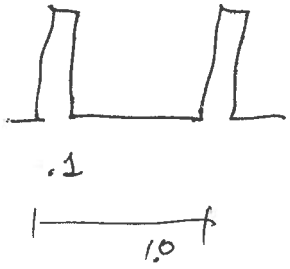
2

1

counter cb

116 4.- A pulse current has a constant value of I for the first 0.1 s of each second as is then 0 for the next 0.9 s of each second.

a) What is the rms value for this current waveform?
b) Each current pulse is generated by a voltage pulse of maximum value V. What is the average power delivered by the pulse generator?



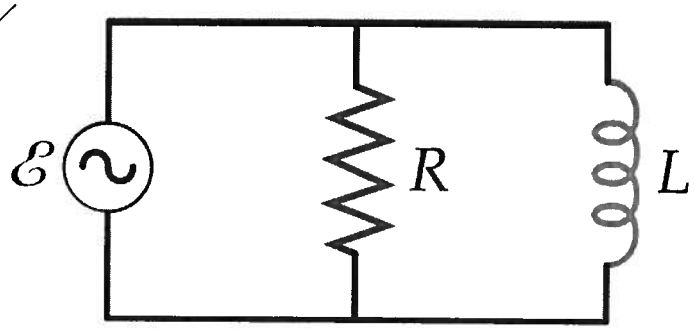
$I_{av} = I_0\sqrt{0.1} = 0.316\, I_0$ 1

$V_{av} = V_0\sqrt{0.1} = 0.316\, V_0$

$P_{av} = I_{av} \cdot V_{av} = .1\, I_0 V_0$ 2

44 5.- A resistor and an inductor are connected in parallel across a sinusoidal emf $E=E_{max}\cos\omega t$ as shown in the figure.

3



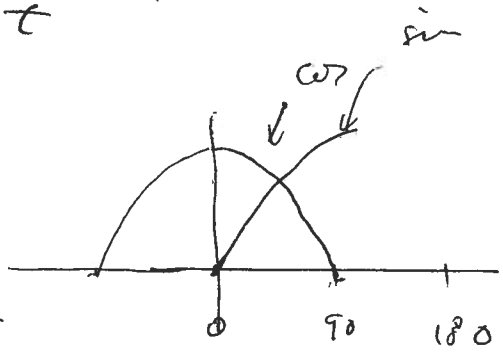
a) Find the current in the resistor
b) Find the current in the inductor.

They are in parallel

$$\frac{\mathcal{E}}{R} = \frac{I}{}$$

$$I = \frac{\mathcal{E}_{max}\cos\omega t}{R}$$

1



$$\mathcal{E} = L\frac{dI}{dt}$$

$$\int \mathcal{E}\,dt = \int L\,dI$$

$$\frac{\mathcal{E}_{max}}{\omega}\sin\omega t = L\,I$$

2

$$I = \frac{\mathcal{E}_{max}}{\omega L}\sin\omega t$$

$$\cos(\omega t - 90)$$