

PHY 114 – Third Hour Test

Note: This exam has 4 problems each worth 25 points. For some problems, you may wish to draw on this exam paper, but most of your work – algebraic setup, mathematical manipulations, and your answers – should be recorded in the blue book. Please show your intermediate steps so that partial credit can be awarded if appropriate. When your work is completed, please turn in: (1) the exam booklet, (2) your equation sheet, and (3) this exam paper. It is assumed that all work will be done under the guidelines of the honor code.

Useful constants

Coulomb Constant: $k_e \equiv \frac{1}{4\pi\epsilon_0}$: $8.98755 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$

Permittivity constant: ϵ_0 : $8.854 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$

Permeability constant: μ_0 : $4\pi \times 10^{-7} \text{ T} \cdot \text{m}/\text{A}$

Elementary charge e : $1.602177 \times 10^{-19} \text{ C}$

Mass of electron m_e : $9.10939 \times 10^{-31} \text{ kg}$

Mass of proton m_p : $1.6726 \times 10^{-27} \text{ kg}$

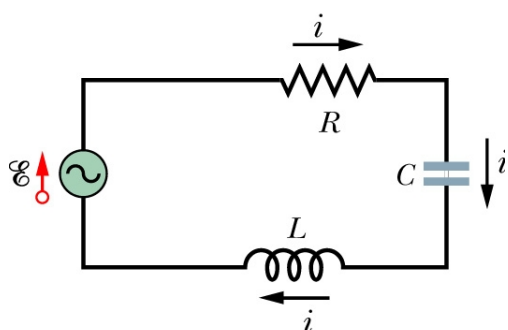
Area of a circle of radius r : πr^2

Circumference of a circle of radius r : $2\pi r$

Area of a sphere of radius r : $4\pi r^2$

Speed of light in vacuum c : $3 \times 10^8 \text{ m/s}$

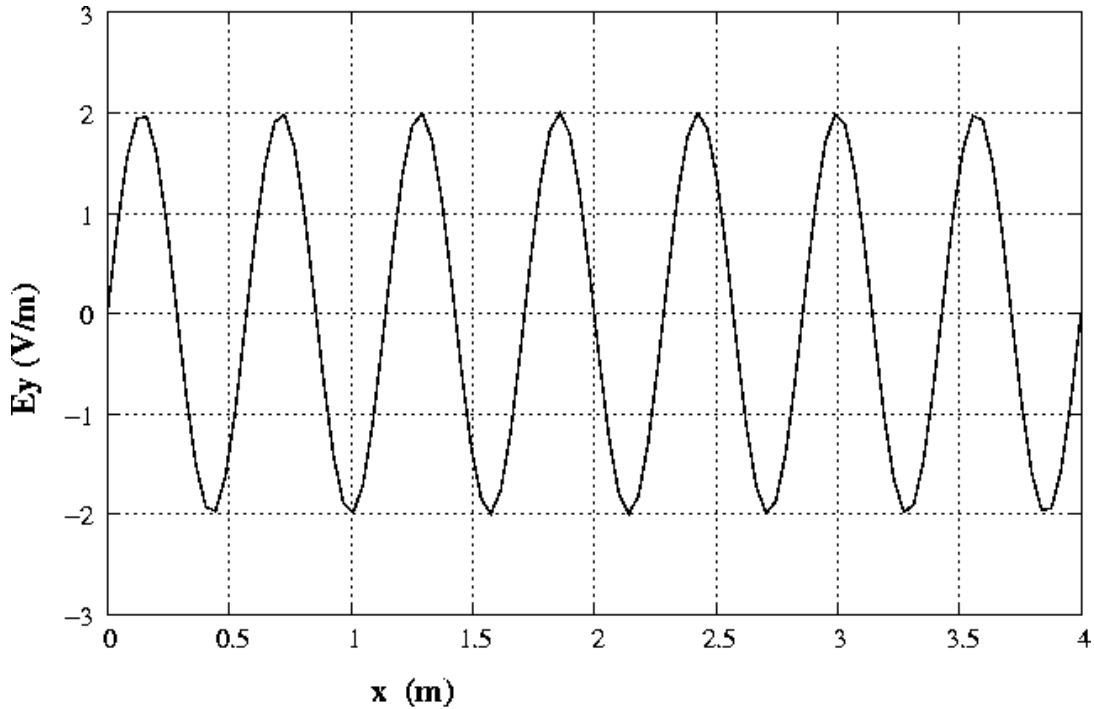
1.



The figure on the left shows a series circuit with a resistor $R = 15\Omega$, a capacitor $C = 3.2 \times 10^{-6} \text{ F}$, an inductor $L = 4 \text{ H}$, and an emf $\mathcal{E} = \mathcal{E}_{\text{max}} \cos(\omega_1 t)$, with $\mathcal{E}_{\text{max}} = 75 \text{ V}$ and $\omega_1 = 280 \text{ rad/s}$. Assume that the circuit has been in operation long enough so that all transient currents are negligible.

- What is the maximum current in the resistor?
- What is the maximum charge on the capacitor?
- What is the maximum voltage through the inductor?
- What is rate of power dissipation through the circuit?

2. Write down Maxwell's equations. For each equation, provide a brief explanation of the physical phenomena it describes. In as much detail as you can (within a page or less), describe how these equations explain electromagnetic radiation.

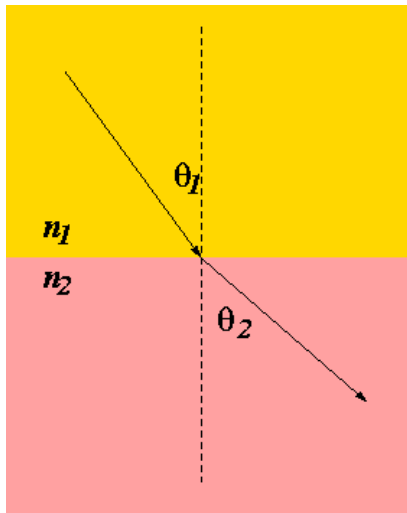


3.

The figure above shows a snapshot of the electric field (along the \hat{y} axis) of an electromagnetic wave which is traveling through vacuum.

- What is the maximum magnitude of the electric field?
- What is the wavelength of the electromagnetic wave?
- What is the frequency of the electromagnetic wave?
- What is the maximum magnitude and the direction of the magnetic field?

4.



The figure on the left shows laser light (propagation direction indicated by the arrows) passing through a material with refractive index n_1 and through a material with refractive index n_2 . The angle of incidence is $\theta_1 = 20^\circ$ and the angle of refraction is $\theta_2 = 47^\circ$.

- From the incidence and refraction angles given above, what can you say about the refractive indices n_1 and n_2 ?
- Suppose you would like to demonstrate total internal reflection for this system. Sketch the directions of the incident and reflected light beams for this case, and determine the incidence angle(s) for which total internal reflection occurs.

*****End of Exam*****