Physics 251 **Exam 3 (100 pts)**
November 13, 2006 Name _____

DIRECTIONS: Please clearly print your name on each page. You are allowed to use your calculator and the attached formula sheet. This exam consists of two parts.

Part A has four multiple choice questions each worth 4 points, answer *all* of these.

Part B has four problems (each worth 28 points). You are required to solve three out of these four problems.

You **MUST** indicate on the chart below which **three** problems you choose to be graded.

Question 1	/4
Question 2	/4
Question 3	/4
Question 4	/4
Problem __	/28
Problem __	/28
Problem __	/28
Total	/100

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Part A: Multiple choice questions (4 points each)

Please answer each question by circling the letter of the best answer.

Question 1: An object placed at the center of curvature of a concave mirror (R>0) produces:

a) No image.
b) An image at infinity.
c) A virtual image a distance R behind the mirror.
d) A real image at the center of curvature, R.
e) A virtual image at the focus, R/2.
f) A real image a distance R/2 behind the mirror.

Question 2: The velocity of propagation for the pair of electromagnetic fields given by $\vec{\mathbf{E}} = E_m \cos(kz - t\varpi)\hat{\mathbf{j}}$ and $\vec{\mathbf{B}} = B_m \cos(kz - t\varpi)\hat{\mathbf{i}}$ is

a) $\vec{\mathbf{v}} = c\hat{\mathbf{i}}$
b) $\vec{\mathbf{v}} = c\hat{\mathbf{j}}$
c) $\vec{\mathbf{v}} = c\hat{\mathbf{k}}$
d) $\vec{\mathbf{v}} = -c\hat{\mathbf{i}}$
e) $\vec{\mathbf{v}} = -c\hat{\mathbf{j}}$
f) $\vec{\mathbf{v}} = -c\hat{\mathbf{k}}$

Question 3: A helium-neon laser (wavelength = 632.8 nm) is incident on a container of liquid with index of refraction n_{liquid} = 1.23. Consider the index of refraction of air as n_{air} =1. Which of the following statements is true?

a) The frequency in the liquid is less than the frequency in air.
b) The wavelength in the liquid is larger than the wavelength in air.
c) The laser light travels faster in the liquid.
d) Total internal reflection occurs for every possible angle of incidence from air into the liquid.
e) None of these.

Question 4: Unpolarized light of intensity I_0 is passed through **two** polarizers whose transmission axes make a 60° angle with respect to each other. (*Hint: Remember to consider the intensity after passing through the first polarizer.*) After the light passes through both polarizers, it has an intensity given by:

a) $3\ I_0/8$
b) $I_0/8$
c) $7\ I_0/16$
d) $I_0/2$
e) $I_0/6$

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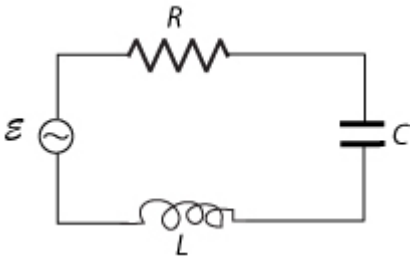
Part B: Problems (28 points each)

Please show all of your calculations and reasoning. Missing or incorrect work will earn no credit.



Problem 1: A single loop RCL series circuit is driven by an alternating emf given by $\mathcal{E} = \mathcal{E}_0 \sin \omega t$ where $\mathcal{E}_0 = 10V$. You are given that the frequency is f = 60 Hz, the inductance is L=0.11 H and the resistance. The current leads the emf, $\mathcal{E}$, by 37°.

a) What is the capacitance in the circuit?

b) What is the impedance of the circuit?

c) At resonance what is the value of the current amplitude (I_0)?

d) What is the average power dissipated in (i) the resistor, (ii) the capacitor and (iii) the inductor?

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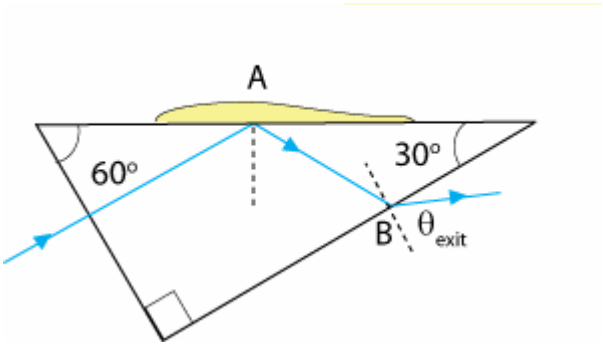
Problem 2: Light is incident normally on the short face of a 30°-60°-90° prism. The index of refraction of the prism is n = 1.62.



a) A drop of liquid is placed on the hypotenuse of the prism. Find the maximum index of refraction for the liquid so that the light will be totally reflected.

b) If such total internal reflection occurs, find the value of Θ_{exit} , the exit angle at point B (into air which has an index of refraction of 1).

c) If the liquid on the hypotenuse were wiped away and then replaced with a drop of liquid having an index of refraction equal to 1.82, explain why the intensity of light exiting at point B suddenly drops.

Problem 3: A small circular target with a diameter of 5.00 cm faces a monochromatic light source that is 4.33 m away. At the target the electric field amplitude of the light from the source is 1.27 x 10^3 V/m. *(Hint: Recall that power is measured in watts, energy is measured in joules, intensity is measured in watts per square meter, and pressure in pascals. Also 1 Pa = 1 N/m^2 and 1 W = 1J/s.)*

a) What is the amplitude of the magnetic field at the target?

b) What is the intensity from the light source at the target?

c) Assuming the target is 100 % absorptive, what is the average radiation pressure exerted by the light on the mirror?

d) What is the force felt by the target?

e) What is the **total** radiant power output of the source if it is assumed to radiate uniformly in all directions?

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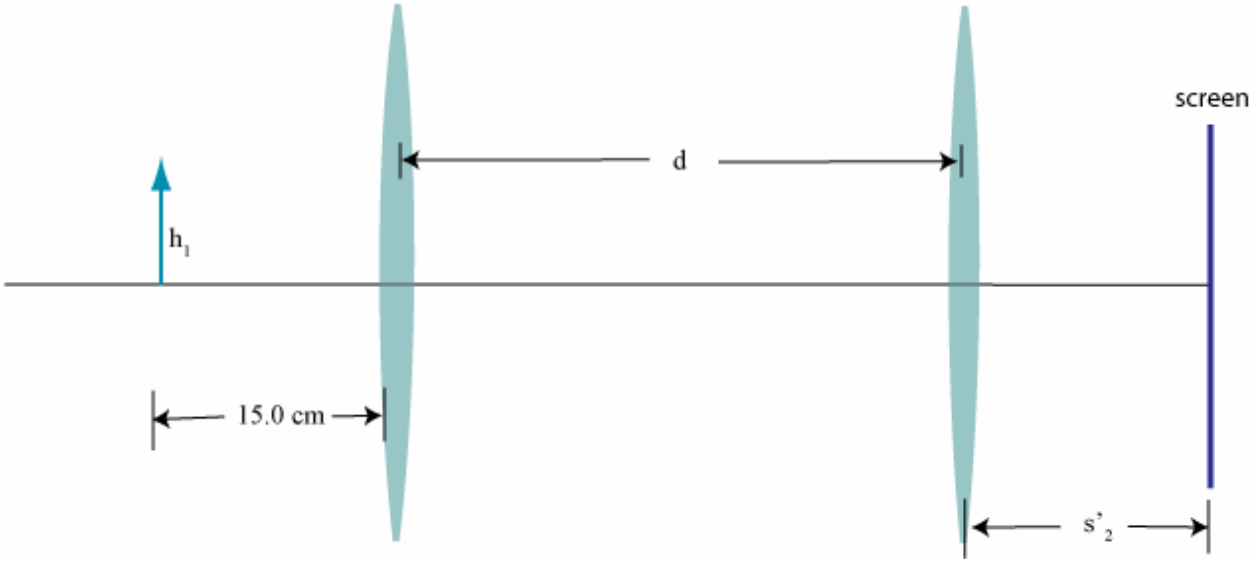
Problem 4: You are given two thin lenses with focal lengths, f_1 = 12.0 cm and f_2 = 7.50 cm separated by a distance, d=70.0 cm. Placing an object 15.0 cm to the left of the first lens (f_1) will produce a real image on the screen at the right.



a) Are these lenses both converging, both diverging or one of each?

b) What is position of this final image, s'_2, with respect to the second lens?

c) Is the final image erect or inverted?

d) If the original object has a height of h_1 = 8.50 mm, what is the height of the final image?