Name: _____

Student ID: _____

Physics 1C - Winter 2022: Midterm 2

February 25, 2022

- Write your name and student ID at the top.
- Answer ALL 4 questions.
- Write your answers inside the borders on this handout. **Show all your work.** PLEASE write clearly so the graders can give you all the points you deserve.
- You are allowed to use the textbook and lecture notes, but you are not allowed to communicate with your classmates.
- You have 60 minutes. Upload your exam to Gradescope as soon as you are done. You will have 10 minutes after the end of the exam to upload your submission.

(extra space)

Problem 1

(29/100)

A source of microwaves produces pulses of monochromatic radiation with a frequency of 20.0 GHz. Each pulse emitted by the source lasts for 1.00 ns, and parabolic reflector with a radius of 6.00 cm is used to focus the radiation into parallel beams. The average power radiated during each pulse is 25.0 kW. (Note: $c = 3.00 \times 10^8$ m/s, $\epsilon_0 = 8.854 \times 10^{-12}$ C^2/N $\cdot$ m^2, $\mu_0 = 4\pi \times 10^{-7}$ T $\cdot$ m/A)

(a) (5 points) What is the wavelength of these microwaves?

(b) (5 points) How much total energy is contained in each pulse?

(c) (6 points) What is the average energy density within each pulse?

(d) (6 points) Find the amplitude of the electric and magnetic fields in the microwaves.

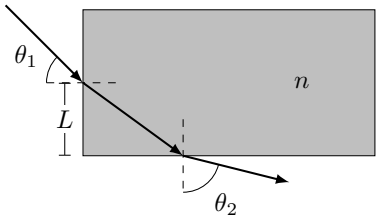
(e) (7 points) If the pulsed beam strikes an absorbing surface, what is the force exerted on the surface during the 1.00 ns duration of each pulse?

(problem 1 extra space)

Problem 2

(25/100)

A light ray is incident on a rectangular slab of plastic at an angle $\theta_1 = 45.0°$. It then emerges from the slab at an angle of $\theta_2 = 76.0°$ as shown below. (Note: $c = 3.00 \times 10^8$ m/s)



(a) (12 points) What is the index of refraction for the plastic?

(b) (5 points) Suppose the wavelength of the light in vacuum is $\lambda_0 = 530$ nm. What is the wavelength and frequency of the light in the plastic?

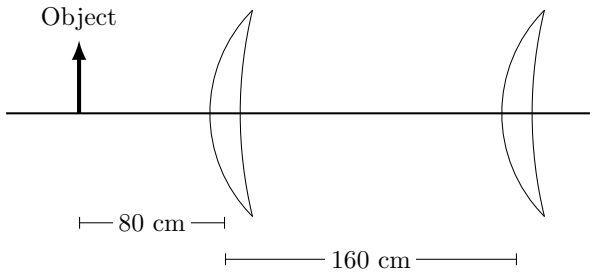
(c) (8 points) If the vertical distance between the bottom of the slab and the point at which the light enters the plastic is $L = 50.0$ cm, how long does it take for the light to travel through the plastic?

(problem 2 extra space)

Problem 3

(24/100)

A concavo-convex lens made of glass ($n = 1.5$) has surfaces of radii 20 cm and 60 cm.



(a) (6 points) Locate the image of an object placed 80 cm to the left of the lens along the principal axis.

(b) (12 points) A similar lens is placed coaxially at a distance of 160 cm to the right of the first. Locate the final position of the image after the rays from the object have passed through both lenses.

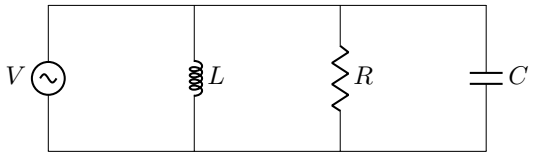
(c) (6 points) Determine the overall magnification of the image.

(problem 3 extra space)

Problem 4

(22/100)

Suppose we connect an inductor L, a capacitor C, and a resistor R to an ac voltage source of angular frequency ω with amplitude V such that all circuit elements are connected in **parallel** to the source. (Hint: This is **not** a series LRC circuit! Think about what that means for the voltages across each circuit element. The expressions for resistance and reactance are still valid in this case.)



(a) (4 points) What is the voltage amplitude across each circuit element?

(b) (4 points) What is the current amplitude across each circuit element?

(c) (7 points) Draw the phasor diagram with the voltage and current amplitudes for all the circuit elements.

(d) (7 points) Is the magnitude of the current amplitude through the ac source equal to the sum of the magnitudes of the current through the other circuit elements? If not, is it lesser or greater than the sum of the magnitudes?

(problem 4 extra space)