**PH 113** Spring Term 2016

Physics III

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| Practice Problems – Set C |

1. In AC circuits, there are two quantities in a general circuit that interact with the current in the circuit. List and describe the difference between these two quantities.
2. What is the purpose behind using an iron core in a transformer? Would it work just as well with a wood core?
3. List and describe the three fundamental mechanisms that we know of that can result in the production of electromagnetic radiation.
4. List and describe the two types of lenses. Which one(s) always generate(s) a virtual image? Explain.

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1. Describe what is meant by the focal point of a convex lens. Does the image produced by the lens always appear at the focal point? Explain.
2. Briefly describe the physical (conceptual as opposed to the formulaic) model for the index of refraction. Does the speed at which light actually travels between atoms change when light propagates in a medium?
3. What is dispersion? Using the physical (conceptual) model for the index of refraction, explain why dispersion occurs in transparent materials?
4. Explain what optical polarization is and explain how dichroic filters (linear polarizers) work.

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1. List and describe the three ways that we can affect the propagation of light.
2. List and briefly describe the three main characteristics of an image.
3. List and describe the two types of mirrors we have talked about in class. Which one always produces a virtual image? Explain.

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1. A generator at a utility company produces 100 A of current at 4000 V. The voltage is stepped up to 240,000 V by a transformer before it is sent on high-voltage transmission lines across a rural area to a city. Assume that the effective resistance of the power line is 30.0 Ω. (A) What is the ratio of turns of the secondary to primary coils in the transformer? (B) Determine the percentage of power lost in the transmission line. (C) What percentage of the original power would be lost in the transmission line if the voltage were not stepped up?

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1. A series AC circuit contains the following components: a 150 Ω resistor, a 250 mH inductor, a 2.00 μF capacitor and a generator with Vm = 210 V. (A) What frequency should the generator operate at to maximize the efficiency of energy transfer from the generator to the receiving circuit? If the generator operates at 50 Hz, calculate the (B) inductive reactance, (C) capacitive reactance, (D) impedance and (E) the peak current.

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1. A concave spherical mirror has a radius of curvature of 20.0 cm. Locate the images for object distances of (A) 40.0 cm, (B) 20.0 cm and (C) 10.0 cm. In each case, state whether the image is real or virtual and erect or inverted, and find the magnification.
2. A converging lens has a focal length of 20.0 cm. Locate the images for object distances of (A) 40.0 cm, (B) 20.0 cm and (C) 10.0 cm. In each case, state whether the image is real or virtual and erect or inverted, and find the magnification.

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1. An object is placed 20.0 cm to the left of a converging lens of focal length 25 cm. A diverging lens of focal length 10 cm is 25 cm to the right of the converging lens. Find the position and magnification of the final image.
2. A submarine is 300 m horizontally out from the shore and 100 m beneath the surface of the water. A laser beam is sent from the sub so that it strikes the surface of the water at a point 210 m from the shore. If the beam just strikes the top of a building standing directly at the water’s edge, find the height of the building.

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1. The critical angle for total internal reflection for sapphire surrounded by air is 34.4°. Calculate the Brewster angle for sapphire if the light is incident from the air.
2. The figure below depicts a simplistic optical fiber: a plastic core (with index of refraction 1.58) is surrounded by a plastic sheath (with index of refraction 1.53). Determine the maximum angle, θ, for which the light rays incident on the end of the plastic fiber shown below are subject to total internal reflection along the interior walls of the core plastic fiber (point A, in the figure).

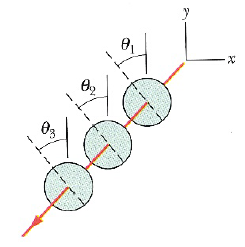


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1. A small tropical fish is 10.0 cm away from a side of a water-filled, spherical fish bowl that is 30.0 cm in diameter. (A) Find the apparent position and magnification of the fish to an observer outside the bowl, but near the side closest to the fish. (B) Is this image real or virtual? (C) If the bowl were placed in the sun, where would the light be focused? (D) What image appears at this focal point?

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1. A beam of unpolarized light of intensity I0 passes through a series of ideal polarizing filters with their transmission axes oriented as shown in the figure below (angles are NOT to scale). θ1 = 10.0°, θ2 = 25.0°, and θ3 = 37.0° (A) What is the light intensity (in terms of I0) after the first polarizer? (B) What is the intensity after the second polarizer? (C) What is the intensity after the third polarizer? (D) If the middle polarizer is removed, what is the light intensity after the last polarizer?



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1. A 30.0 mW laser beam is focused to a circular spot with a diameter of 100.0 μm. (A) What is the intensity of the laser beam? (B) What is the magnitude of the electric field? (C) What is the magnitude of the magnetic field? (D) What is the force delivered by the laser beam to a perfectly reflective surface at normal incidence?

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1. A plane electromagnetic wave has an electric field amplitude of 31.0 V/m and a wavelength of 1.35 m. (A) Calculate the frequency of the wave. (B) Write a mathematical expression for the electric field of this wave propagating in vacuum. (C) Write a mathematical expression for the magnetic field of this wave propagating in vacuum. (D) Determine the average intensity of this wave. (E) Determine the energy density of this wave.