Practice Problems from Previous Exams

Note: Since the quiz is only 25 minutes, the problems are likely to be shorter. But the physics covered is that in this set of problems.

1. In the figure shown below, point O is a source of light. Two rays from O are shown passing through a thin converging lens and crossing each other at the point marked C.

(a) On the figure, find the two principal foci of the lens by drawing appropriate rays. Label the foci F1 and F2. Explain why you drew the lines you did.

(b) If the point source is a distance of 8 cm on the left of the lens and the rays cross at point C a distance 6 cm on the right of the lens, use the lens equation to calculate the focal length of the lens. Does it agree with your analysis using the ray diagram? If not, explain why not.

(c) Suppose that the point source was moved farther away from the lens. What would happen to the crossing point? Explain your reasoning.

(d) If a cardboard is slid into place against the lens so that it covers the lower half of the lens, would an image of the point source still be visible on a screen placed at C? Explain.

2. The ray model and the wave model are two descriptions of light that help us understand many observable optical phenomena. Describe the basic elements of each model, one phenomenon where we might use each one, and discuss whether these models are compatible or contradictory.

3. In an eye that is farsighted, the eye focuses parallel rays so that the image would form behind the retina as in the figure at the left below. In an eye that is nearsighted, the image is formed in front of the retina as shown in the figure on the right. How would you design a corrective lens for each eye defect? Make a ray diagram for each case.
4. Coherent red light is incident on a mask with two identical, very narrow slits separated by a distance \( d \). The photograph below on the top left illustrates the pattern that appears on a distant screen. Point \( P \) marks a minimum; point \( Q \), a maximum. The slit pattern is shown on the bottom left.

(a) For each of the points \( P \) and \( Q \), what is the difference in the distances from the slits to that point? Express your answers in terms of \( \lambda \).

(b) Suppose that the mask with two slits were replaced by a mask with a single slit whose width was exactly \( d \). (See diagram at right.)

(c) After the mask is replaced, for each of the points \( P \) and \( Q \), would the brightness of the screen increase, decrease, or stay the same? Explain your reasoning in each case.

5. In the diagram below, \( M \) is a plane mirror, \( B \) is a very small bulb that can be treated as a point source, and \( P \) is an opaque plate that does not transmit light. \( O \) is a line anywhere along which an observer can stand to try to see the image of the light bulb in the mirror.

By using relevant rays of light, determine the locations along line \( O \) from which the image of \( B \) is visible in the mirror and the locations from which it is not visible. Mark these regions accordingly along line \( O \) and explain your reasoning.