

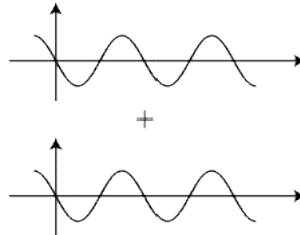
This is how I initially formulated the questions. For the actual exam they were typeset differently and slightly re-worded.

QUESTION 1 (ray optics)

1. State the law of refraction (Snell's law) and indicate the relevant angles in a diagram. **[2 marks]**
2. A light ray passes through a glass window ($n_{\text{glass}} = 1.5$) with air ($n_{\text{air}} = 1$) on both sides. The angle of incidence is $\theta_i = 10^\circ$. What is the angle of refraction in the glass? What is the angle of refraction when the light ray re-emerges from the window? **[4 marks]**
3. Draw a ray diagram that shows what happens to light rays that are originally parallel to the optical axis after having passed through a converging (i.e. convex) lens. In your diagram, indicate the position of the two focal points and the focal length, f . **[2 marks]**
4. State the thin-lens equation. For a lens of focal length $f = 20\text{mm}$, use this equation to calculate the image distance corresponding to an object distance $p = 40\text{mm}$. Draw a ray diagram in which the focal length and the image and object distances are indicated. **[5 marks]**
5. An object is placed a distance $p = 10\text{mm}$ in front of a converging lens. An image appears a distance $q = 30\text{mm}$ behind the lens. What is the magnification M of this imaging process? What is the magnification if the image appears a distance 30mm *in front of* the lens? **[3 marks]**

QUESTION 2 (wave optics)

1. Do the two waves in the following diagram interfere constructively or destructively? Sketch two waves that interfere in the opposite way.

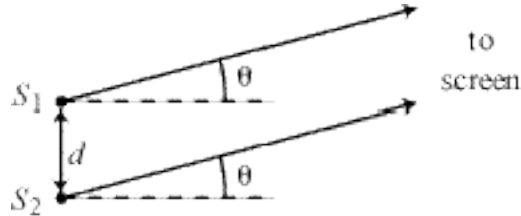


[2 marks]

2. State the condition for constructive interference on the path difference Δ between two light beams that were initially in phase.

[1 mark]

3. Two point light sources, S_1 and S_2 , are separated by a distance $d = 0.1\text{mm}$. They are in phase with each other and emit light of wavelength $\lambda = 500\text{nm}$. The resulting interference pattern is observed on a screen that is placed far away from the two light sources. State the expression for the path difference Δ between the respective paths taken by light from the two light sources. At which angle θ with respect to the normal between the two sources (see diagram) does the first minimum occur?



[5 marks]

4. Describe the conditions under which a light beam suffers a “ π phase change”. Sounds very esoteric. Can a π phase change be described as a shift of half a wavelength, an inversion of the amplitude, or both?

[3 marks]

5. Describe briefly how anti-reflection lens coatings work.

[5 marks]