

# Wave Optics



Here are six problems focused on **constructive and destructive interference** conditions, involving path difference and phase difference.

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## Problem 1

**Given:** Two waves meet at a point with a path difference of 600 nm. The wavelength of the waves is  $\lambda = 600 \text{ nm}$ .

**Question:** Determine whether the interference is constructive or destructive.

**Solution:** For constructive interference, the path difference  $\Delta x$  should be an integer multiple of  $\lambda$ :

$$\Delta x = n\lambda$$

Since  $\Delta x = \lambda$ , it is an integer multiple ( $n=1$ ), thus the interference is **constructive**.

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## Problem 2

**Given:** Two waves have a path difference of 450 nm and wavelength  $\lambda = 600 \text{ nm}$ .

**Question:** Is the interference constructive or destructive?

**Solution:** For destructive interference, the path difference should be an odd multiple of  $\frac{\lambda}{2}$ :

$$\Delta x = \left(n + \frac{1}{2}\right) \lambda$$

Here,  $\Delta x = \frac{3\lambda}{4}$ , which does not satisfy the conditions for constructive interference. Therefore, the interference is **destructive**.

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## Problem 3

**Given:** The path difference between two waves is  $1.5 \mu\text{m}$  and their wavelength is 750 nm.

**Question:** Determine whether the interference is constructive or destructive.

**Solution:** Convert path difference to match the wavelength units:

$$1.5 \mu\text{m} = 1500 \text{ nm}$$

Since  $\Delta x = 2\lambda$ , it is a whole multiple of  $\lambda$ , meaning **constructive interference** occurs.

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## Problem 4

**Given:** Two waves with wavelength  $\lambda = 500 \text{ nm}$  meet at a point where the path difference is  $750 \text{ nm}$ .

**Question:** Is the interference constructive or destructive?

**Solution:** Calculate path difference in terms of  $\lambda$ :

$$\Delta x = \frac{3\lambda}{2}$$

Since this is an odd multiple of  $\frac{\lambda}{2}$ , it satisfies the condition for **destructive interference**.

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### Problem 5

**Given:** In Young's double-slit experiment, the wavelength of light is  $600 \text{ nm}$ , and the path difference between light from the slits to a point on the screen is  $1.2 \mu\text{m}$ .

**Question:** Does constructive or destructive interference occur at this point?

**Solution:** Convert path difference to the same units as the wavelength:

$$1.2 \mu\text{m} = 1200 \text{ nm} = 2\lambda$$

Since this path difference is an integer multiple of  $\lambda$ , **constructive interference** occurs.

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### Problem 6

**Given:** In a two-source interference setup, the wavelength of light is  $700 \text{ nm}$  and the phase difference between two waves is  $\pi$ .

**Question:** Is the interference constructive or destructive?

**Solution:** A phase difference of  $\pi$  corresponds to a path difference of  $\frac{\lambda}{2}$ , which satisfies the condition for **destructive interference**.