WAVES, SOUND & PHYSICAL OPTICS DAY 11: SINGLE-SLIT DIFFRACTION

CED 14.7 · Skill 2.B · FRQ: Multiple Representations

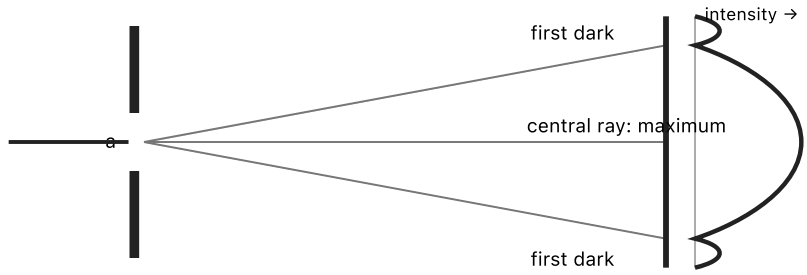
PREDICT

A wave passes through a gap. If the gap becomes narrower while wavelength stays fixed, the outgoing wave spreads:

A. more **B. less** **C. the same** **D. only upward**

Commit before viewing the pattern.

SINGLE APERTURE AND SCREEN PATTERN



DIFFRACTION

Diffraction is spreading around an opening or edge. It becomes pronounced when the opening is comparable to wavelength.

NOTES / REASONING

DARK FRINGES

$$a \sin \theta_m = m\lambda, \qquad m = 1, 2, 3, \ldots$$

Here a is single-slit width. The central maximum lies between the $m = -1$ and $m = +1$ dark fringes, so it is twice the center-to-first-dark distance.

Explain from the equation why decreasing a or increasing λ widens the pattern.

CALCULATE A PATTERN

WE DO Light with $\lambda = 600\,\text{nm}$ passes through a slit $a = 40.0\,\mu\text{m}$. Find the first-dark angle.

YOU DO The screen is $L = 2.00\,\text{m}$ away. Find the center-to-first-dark distance and central-maximum width using the small-angle approximation.

REPRESENTATION CHECK

1. Mark the central maximum and first dark fringes on a qualitative intensity graph.

2. If slit width doubles, predict the first-dark angle for the same wavelength.

3. If wavelength doubles at fixed slit width, predict central width.

4. Explain why a wider central maximum is not the same claim as a brighter pattern.