WAVES, SOUND & PHYSICAL OPTICS DAY 12: DOUBLE-SLIT INTERFERENCE AND DIFFRACTION GRATINGS

CED 14.8 · Skill 2.B · FRQ: Multiple Representations

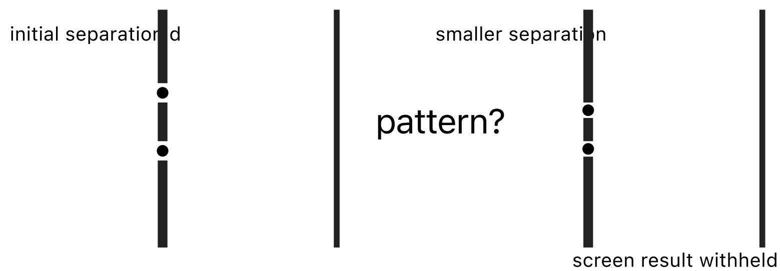
PREDICT

A laser illuminates two coherent slits. The slit separation d is reduced while λ and screen distance remain fixed. Bright fringes:

A. spread apart **B. move closer** **C. stay fixed** **D. vanish**

Commit before the pattern is revealed.

SLIT SEPARATION CHANGES; PATTERN WITHHELD



BRIGHT-FRINGE CONDITION

$$d \sin\theta_m = m\lambda, \qquad m = 0, \pm 1, \pm 2, \ldots$$

NOTES / REASONING

FROM ANGLE TO SCREEN SPACING

Exact position: $y_m = L\tan\theta_m$. For small angles, neighboring bright-fringe spacing is

$$\Delta y \approx \frac{\lambda L}{d}$$

Use the two relations to explain why decreasing d spreads bright fringes apart.

Single-slit dark fringes use width a. Double-slit bright fringes use separation d.

CALCULATE A DOUBLE-SLIT PATTERN

WE DO Two slits have $d = 25.0\,\mu\text{m}$. Light has $\lambda = 500\,\text{nm}$. Find the first-order bright angle.

YOU DO The screen is $1.50\,\text{m}$ away. Find the small-angle fringe spacing.

GRATINGS AND TRANSLATION

A grating has many equally spaced slits. The bright-order condition remains $d\sin\theta = m\lambda$, but additional slits make principal maxima narrower and sharper.

1. Sketch a qualitative two-slit intensity profile and a sharper grating profile with the same order locations.

2. Predict the spacing if wavelength increases by 20% at fixed d, L.

3. State one difference between a single-slit dark condition and a double-slit bright condition.