Ch 35 Diffraction & Polarization

tags: #LessonPlan, #SingleSlitDiffraction, #DiffractionGrating, #X-RayDiffraction

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Objective

I. Solve problems involving **Diffraction**

- By first identifying what **type of diffraction:**
    1. Single Slit
    2. Grating
    3. X-Ray
- and then identifying the corresponding **path difference** Δs

Content Review

REMARK: diffraction occurs when waves encounter obstacles while interference occurs when two waves meet each other.

Double-Slit Interference

The **path difference** Δs equation is given by

$$\Delta s = d\sin\theta = \begin{cases} m\lambda & [\text{maxima}] \\ (m+\frac{1}{2})\lambda & [\text{minima}] \end{cases} \qquad m = 0, \pm 1, \pm 2, \pm 3, \dots$$

where d is the distance between the slits.

Single-Slit Diffraction

The **path difference** Δs equation is given by

$$\Delta s = D\sin\theta = m\lambda, \qquad m = \pm 1, \pm 2, \pm 3, \dots \qquad [\text{minima}]$$

where D is the width of the slit.

Diffraction Grating

The **path difference** Δs equation is given by

$$\Delta s = d \sin\theta = m\lambda \qquad m = 0, 1, 2, \ldots \qquad [\text{maxima}]$$

where d is the separation between adjacent slits.

X-Ray Diffraction

The **path difference** Δs equation is given by

$$\text{Bragg's equation:} \qquad \Delta s = m\lambda = 2d \sin\phi \qquad m = 1, 2, 3, \ldots \qquad [\text{maxima}]$$

where d is the spacing between atomic layers and ϕ is the angle of incidence (measured from the horizontal!)

[10mins]

Guided Practice

Single-Slit Diffraction #1

Light of wavelength $780\,\text{nm}$ passes through a slit $1 \times 10^{-3}\,\text{mm}$ wide. How wide is the central maximum on a screen $20\,\text{cm}$

(a) in degrees

(b) in centimeters

Single-Slit Diffraction #2

If a slit diffracts $580\,\mathrm{nm}$ light so that the diffraction maximum is $6\,\mathrm{cm}$ wide on a screen $2.20\,\mathrm{m}$ away, what will be the width of the diffraction maximum for light with a wavelength of $460\,\mathrm{nm}$?

[30mins]

Group Activity

Diffraction Grating

At what angle will $480\,\mathrm{nm}$ light produce a second-order maximum when falling on a grating whose slits are $1.35 \times 10^{-3}\,\mathrm{cm}$ apart?

X-Ray Diffraction

X-rays of wavelength $0.138\,\mathrm{nm}$ fall on a crystal whose atoms, lying in planes, are spaced $0.285\,\mathrm{nm}$ apart. At what angle ϕ (relative to the horizontal) must the X-rays be directed if the first diffraction maximum is to be observed?

Solutions

Single-Slit Diffraction #1

(a) $\theta = 98^\circ$

(b) $d = 46\,\text{cm}$

Single-Slit Diffraction #2

$\Delta y = 4.8\,\text{cm}$

Diffraction Grating

$\theta = 4.1^\circ$

X-Ray Diffraction

$\phi = 14.0^\circ$