Exercise walk-through

Double-Slit Interference and Diffraction Gratings ▪ 14.8

eXercise

You must be able to

- describe **Young's double-slit 杨氏双缝** experiment as evidence for the wave nature of light
- apply $d\sin\theta = m\lambda$ to locate bright fringes (maxima)
- explain how a **diffraction grating 衍射光栅** produces sharp, widely spaced maxima

Method — Young's double slit

Light passing through two close slits produces bright and dark **fringes** — clear evidence of wave interference.

Method — Fringe condition

$d \sin\theta = m\lambda$, where d is the slit spacing and $m = 0, 1, 2, \ldots$ labels the bright fringes.

Method — Diffraction grating

A grating has many slits, so it gives very **sharp, widely spaced** maxima — ideal for measuring wavelength.

Practice 2.1 ▪ 1 mark

State what the double-slit experiment demonstrates about light.

Solution 2.1

Method: Young's double slit

Worked steps

that light behaves as a wave (it interferes) B1.

Practice 2.2 ▪ 1 mark

Write the condition for bright fringes in a double-slit pattern.

Solution 2.2

Worked steps

$d \sin\theta = m\lambda$ (B1).

Practice 2.3 ▪ 2 marks

Light of wavelength 600 nm falls on slits 0.20 mm apart. Find the angle to the first bright fringe ($m = 1$).

Solution 2.3

Method: Young's double slit

Worked steps

$$\sin\theta = \frac{m\lambda}{d} = \frac{600 \times 10^{-9}}{0.20 \times 10^{-3}} = 3.0 \times 10^{-3} \Rightarrow \theta = 0.17^\circ$$ M1 A1.

Exam-style 3.1 ▪ 1 mark

In a double-slit experiment, bright fringes occur when $d\sin\theta$ equals

A $m\lambda$

B $(m+\frac{1}{2})\lambda$

C λ/m

D $2m\lambda$

Solution 3.1

A $m\lambda$ ✓

B $(m+\frac{1}{2})\lambda$

C λ/m

D $2m\lambda$

Worked steps

A.

Exam-style 3.2 ▪ 1 mark

Compared with a double slit, a diffraction grating gives maxima that are

A blurrier

B sharper and more widely spaced

C closer together

D absent

Solution 3.2

Method: Diffraction grating

A blurrier

B sharper and more widely spaced ✓

C closer together

D absent

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

A grating has 300 lines per millimetre and is lit by light of wavelength 500 nm.
(a) Find the slit spacing d.
(b) Find the angle to the first-order maximum.

Solution 3.3

Worked steps

(a) $d = \dfrac{1}{300 \times 10^3 \text{ m}^{-1}} = 3.33 \times 10^{-6}$ m M1 A1. (b) $\sin\theta = \dfrac{\lambda}{d} = \dfrac{500 \times 10^{-9}}{3.33 \times 10^{-6}} = 0.15 \Rightarrow \theta = 8.6^\circ$ M1 A1.