AP PHYSICS 2 • EXERCISE SHEET

14.8 Double-Slit Interference and Diffraction Gratings

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

Objective

Build the skills to answer exam questions on **double-slit interference and diffraction gratings**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ Young's double slit

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

■ Fringe condition

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

■ Diffraction grating

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

2 Practice

2.1 State what the double-slit experiment demonstrates about light. [1]

2.2 Write the condition for bright fringes in a double-slit pattern. [1]

2.3 Light of wavelength 600 nm falls on slits 0.20 mm apart. Find the angle to the first bright fringe ($m = 1$). [2]

3 Exam-style questions

3.1 In a double-slit experiment, bright fringes occur when $d \sin\theta$ equals [1]

- **A** $m\lambda$
- **B** $(m + \frac{1}{2})\lambda$
- **C** λ/m
- **D** $2m\lambda$

3.2 Compared with a double slit, a diffraction grating gives maxima that are [1]

- **A** blurrier
- **B** sharper and more widely spaced
- **C** closer together
- **D** absent

3.3 A grating has 300 lines per millimetre and is lit by light of wavelength 500 nm.

(a) Find the slit spacing d. [2]

(b) Find the angle to the first-order maximum. [2]

4 Go further

- work through the **14.8 Double-Slit Interference and Diffraction Gratings** lesson on the **Learn** page;
- read the **Waves and Sound** section of the AP Physics 2 handout on the **Know** page.

Solutions

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

2.2 $d \sin\theta = m\lambda$.

2.3 $\sin\theta = \dfrac{m\lambda}{d} = \dfrac{600 \times 10^{-9}}{0.20 \times 10^{-3}} = 3.0 \times 10^{-3} \Rightarrow \theta = 0.17°$.

3.1 A.

3.2 B.

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