InkPhysics

QUESTION WORKBOOK

Diffraction and the single slit

Waves · Year 12

AQA 3.3.2.2 · CIE 8.2.1, 8.2.2 · OCR A 4.4.1(f)(i)

16 questions · 45 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 Describe what is meant by diffraction, and state when the spreading of a wave at a gap is greatest. [2]

A2 Sketch the intensity pattern produced when monochromatic light passes through a single narrow slit, and describe its main features. [2]

A3 State what happens to the single-slit diffraction pattern when the slit is made narrower. [2]

A4 Sea waves of wavelength 12 m pass through a harbour entrance 15 m wide. State and explain how the waves behave beyond the entrance. [2]

A5 State two ways in which the appearance of a single-slit diffraction pattern differs from the double-slit fringe pattern produced with the same light. [2]

SECTION B · Standard

B1 Explain why sound is clearly diffracted through an open doorway but light passing through the same doorway is not noticeably diffracted. [3]

B2 Describe how the single-slit diffraction pattern changes when the light is switched from blue to red, for the same slit. [3]

B3 Describe the single-slit diffraction pattern produced with white light. [3]

B4 Explain why the central maximum of a single-slit pattern is both wider and brighter than the other fringes. [3]

B5 A student illuminates an adjustable slit with a red laser and slowly narrows the slit, starting from a width of several millimetres. Describe how the pattern on a distant screen changes as the slit narrows. [3]

B6 Microwaves of wavelength 2.8 cm pass through a vertical gap between two metal plates whose separation can be adjusted. State the approximate gap width that gives the greatest spreading of the microwaves, and describe and explain what a detector moved across the region beyond the gap records when the gap is 50 cm wide. [3]

B7 In a single-slit experiment, the slit width and the wavelength of the light are both doubled. Explain what happens to the width of the central maximum. [3]

SECTION C · Stretch

C1 Two single slits of different widths are each illuminated with the same monochromatic light. Explain which slit produces the wider central maximum, and what happens to the brightness. [4]

C2 Explain why a laser is well suited to demonstrating diffraction patterns. [3]

C3 A teacher wants to project the widest possible single-slit central maximum. Three arrangements are available.
Arrangement W: laser of wavelength 650 nm, slit width 0.10 mm.
Arrangement X: laser of wavelength 532 nm, slit width 0.10 mm.
Arrangement Y: laser of wavelength 650 nm, slit width 0.20 mm.
Deduce which arrangement the teacher should choose. [3]

C4 A single slit is illuminated with white light. A student then places a red filter between the lamp and the slit. Describe and explain how the pattern on the screen changes. [4]