Diffraction & Interference

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Diffraction & Interference
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **66 minutes**

Score: **/55**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a) (i)** to produce coherent sources or constant phase difference B1 [1]

(ii) **1.** 360° / 2π rad allow n × 360° or n × 2π (unit missing –1) B1 [1]
2. 180° / π rad allow (n × 360°) – 180° or (n × 2π) – π B1 [1]

(iii) **1.** waves overlap / meet B1
(resultant) displacement is sum of displacements of each wave B1 [2]
2. at P crest on trough (OWTTE) B1 [1]

(b) $\lambda = ax / D$ C1
$= 2 \times 2.3 \times 10^{-3} \times 0.25 \times 10^{-3} / 1.8$ C1
= 639 nm A1 [3]

2 **(a)** when a wave passes through a slit / by an edge M1
the wave spreads out / changes direction A1 [2]

(b) diagram: wavelength unchanged M1
wavefront flat at centre, curving into geometrical shadow A1 [2]

(c) $d \sin \theta = n\lambda$ C1
for $\theta = 90°$
$1 / (650 \times 10^3) = n \times 590 \times 10^{-9}$ M1
$n = 2.6$
number of orders is 2 A1 [3]

(d) intensity / brightness decreases (as order increases) B1 [1]

3 **(a** when two (or more) waves meet (at a point) B1
(resultant) displacement is (vector) sum of individual displacements B1 [2]

(b) (i) $\lambda = ax / D$ (if no formula given and substitution is incorrect then 0/3) C1
$590 \times 10^{-9} = (1.4 \times 10^{-3} \times x) / 2.6$ C1
$x = 1.1\,\text{mm}$ [3]

(ii) 1. 180° (*allow* π *if rad stated*) A [1]

2. at maximum, amplitude is 3.4 units and at minimum, 0.6 units C1
intensity ~ *amplitude*^{2} allow $I \sim a^2$ C1
ratio = $3.4^2 / 0.6^2$
= 32 A1 [3]

4 (a) when a wave (front) passes by/incident on an edge/slit ……
wave bends/spreads (into the geometrical shadow) …… A1 [2]

(b) $\tan\theta = \frac{38}{165}$
$\theta = 13°$ …… C1
$d \sin\theta = n\lambda$ ……
$d = 2.82 \times 10^{-6}$ …… C1
number = $(1/d =) 3.6 \times 10^5$ …… A1 [4]

(c) P remains in same position B1
X and Y rotate through 90° …… B1 [2]

(d) *either* screen not parallel to grating
or grating not normal to (incident) light …… B1 [1]

5 **(a** *either* phase difference is π rad / 180°
or path difference (between waves from S_1 and S_2) is $\frac{1}{2}\lambda$ / $(n + \frac{1}{2})\lambda$. B1
either same amplitude / intensity at M
or ratio of amplitudes is 1.28 / ratio of intensities is 1.28^2 ..... B1 [2]

(b) path difference between waves from S_1 and S_2 = 28 cm B1
wavelength changes from 33 cm to 8.25 cm B1
minimum when λ = (56 cm,) 18.7 cm, 11.2 cm, (8.0 cm) B1
so two minima ..... B1 [4]

6 **(a)** constant <u>phase difference</u> …….. B1 [1]

(b) allow wavelength estimate 750 nm → 550 nm …….. C1
separation = $\lambda D / x$ …….. C1
= $(650 \times 10^{-9} \times 2.4) / (0.86 \times 10^{-3})$
= 1.8 mm …….. A1 [3]
(*allow 2 marks from inappropriate estimate if answer is in range 10 cm → 0.1 mm)*

(c) no longer complete destructive interference /
amplitudes no longer completely cancel …….. M1
so dark fringes are lighter …….. A1 [2]

7 **(a** <u>wave</u> incident at an edge / aperture / slit /(edge of) obstacle M1
bending / spreading of wave (into geometrical shadow) A1 [2]
(*award 0/2 for bending at a boundary*)

(b) (i) apparatus e.g. laser & slit / point source & slit / lamp and slit & slit
microwave source & slit
water / ripple tank, source & barrier B1
detector e.g. screen
aerial / microwave probe
strobe / lamp B1
what is observed B1 [3]

(ii) apparatus e.g. loudspeaker, and slit / edge B1
detector e.g. microphone & c.r.o. / ear B1
what is observed B1 [3]