Stationary waves

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Superposition
Sub Topic	Stationary Waves
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

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

1 **(a) (i)** frequency: number of oscillations per unit time — M1
of the source / of a point on the wave — A1 [2]

(ii) speed: speed at which energy is transferred / speed of wavefront — B1 [1]

(b) (i) does not transfer energy (along the wave) — B1 [1]

(ii) position (along wave) where amplitude of vibration is a maximum — B1 [1]

(iii) all three positions marked — B1 [1]

(c) wavelength = 2 × 17.8 = 35.6 cm — C1
$v = f\lambda$ — C1
$v = 125 \times 0.356$
$= 44.5 \text{ m s}^{-1}$ — C1
$44.5^2 = 4.00 / m$ — C1
$m = 2.0 \times 10^{-3} \text{ kg m}^{-1}$ — A1 [5]

2 **(a) (i)** vibrations (in plane) normal to direction of energy propagation — B1 [1]

(ii) vibrations in one direction (normal to direction of propagation) — B1 [1]

(b) (i) at (displacement) antinodes / where there are no heaps, wave has maximum amplitude (of vibration) — B1
at (displacement) nodes/where there are heaps, amplitude of vibration is zero/minimum
dust is pushed to / settles at (displacement) nodes — B1 [3]

(ii) $2.5\lambda = 39$ cm — C1
$v = f\lambda$ — C1
$v = 2.14 \times 10^3 \times 15.6 \times 10^{-2}$
$= 334 \text{ m s}^{-1}$ (*allow 330, not 340*) — A [3]

(c) Stationary wave formed by interference / superposition / overlap of — B1
either wave travelling down tube and its reflection
or two waves of same (type and) frequency travelling in opposite directions — B1
speed is the speed of the incident / reflected waves — B1 [3]

3 **(a)** **(i)** correct shape drawn B1 **[1]**

(ii) two nodes marked correctly B1 **[1]**

(b) $\frac{1}{2}\lambda = 0.324$ m C1

$v = f\lambda$ C1

$= 512 \times 2 \times 0.324$

$= 332$ m s^{-1} A1 **[3]**

(c) $\frac{1}{4}\lambda = 16.2$ cm C1

either antinode is 0.5 cm above top of tube

or antinode is 16.2 cm above water surface A1 **[2]**

4 **(a)** wavelength = 1.50 m **B1** **[1]**

(b) v = $f\lambda$ **C1**

speed = 540 m s^{-1} **A1** **[2]**

(c) (progressive) wave reflected at the (fixed) ends **B1**

wave is formed by superposition of (two travelling) waves **B1**

this quantity is the speed of the travelling wave **B1** **[3]**

5 **(a** progressive waves transfer/propagate energy **and** stationary waves do not B1

amplitude constant for progressive wave **and** varies (from max/antinode to min/zero/node) for stationary wave B1

adjacent particles in phase for stationary wave **and** out of phase for progressive wave **(B1)** [2]

(b) (i) wave / microwave from source/S reflects at reflector/R B1

reflected and (further) incident waves overlap/meet/superpose B1

waves have same frequency/wavelength/period **and** speed (so stationary waves formed) B1 [3]

(ii) detector/D is moved between reflector/R and source/S (or v.v.) B1

maximum, minimum/zero, (maximum… etc.) observed on meter/deflections/readings/measurements/recordings B1 [2

(iii) determine/measure the distance between adjacent minima/nodes or maxima/antinodes **or** across specific number of nodes/antinodes B1

wavelength is twice distance between adjacent nodes/minima or maxima/ antinodes (or other correct method of calculation of wavelength from measurement) B1 [2

(c) $v = f\lambda$ C1

$f = 3.0 \times 10^8 / (2.8 \times 10^{-2})$ [$= 1.07 \times 10^{10}$ Hz] C1

11 (10.7) GHz [3]