Wave Basics

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Waves
Sub Topic	Wave Basics
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **80 minutes**

Score: **/66**

Percentage: **/100**

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

1 **(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)

(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]

2 **(a)** **(i)** amplitude scale reading 2.2 (cm)
amplitude = 2.2×2.5 = 5.5 mV [2]

(ii) time period scale reading = 3.8 (cm)
time period = $3.8 \times 0.5 \times 10^{-3}$ = 0.0019 (s)

frequency f = 1 / 0.0019 = 530 (526) Hz A1 [3]

(iii) uncertainty in reading = ± 0.2 in 3.8 (cm) or 5.3% or 0.2 in 7.6 (cm) or 2.6% [allow other variations of the distance on the x-axis]

actual uncertainty = 5.3% of 526 = 27.7 or 28 Hz
or 2.6% of 526 = 13 or 14 A1 [2]

(b) frequency = 530 ± 30 Hz or 530 ± 10 Hz [1]

3 **(a)** **(i)** progressive: energy is moved / transferred / propagated from one place to another (without the bulk movement of the medium) B1

transverse: (particles) oscillate / vibrate at right angles to the direction of travel of the energy / wavefront B1 [2]

(ii) number of oscillations per unit time / number of wavefronts passing a point per unit time B1 [1]

(b) **(i)** P and T B1 [1]

(ii) P and S or Q and T B1 [1]

(c) λ = 1.2×10^{-2} (m) C1

$v = f\lambda$
= $15 \times 1.2 \times 10^{-2}$ C1
= 0.18 m s^{-1} A1 [3]

(d) ratio = $(1.4)^2 / (2.1)^2$ C1
= 0.44 A1 [2]

4 **(a (i)** displacement is the distance from the
equilibrium position / undisturbed position / midpoint / rest position B1

amplitude is the maximum displacement B1 [2]

(ii) frequency is the number of wavefronts / crests passing a point
per unit time / number of oscillations per unit time B1

time period is the time between adjacent wavefronts
or time for one oscillation B1 [2]

(b) (i) 1. amplitude = 1.5 mm A1 [1]

2. wavelength = 25 / 6 C
= 4.2 cm or 4.2×10^{-2} m A [2]

(ii) $v = \lambda / T$ *or* $v = f\lambda$ *and* $T = 1/f$ C1
$T = 4.2 / 7.5 = 0.56$ s A [2]

(c) (i) progressive
wavefront / crests moving / energy is transferred by the waves A1 [1]

(ii) transverse
the vibration is perpendicular to the direction of energy transfer / wave velocity
or travel of the wave / wavefronts [1]

5 **(a** $d = v \times t$ C1
$t = 0.2 \times 4$ (allow $t = 0.2 \times 2$) C1
$d = 3 \times 10^8 \times 0.8 \times 10^{-6}$ OR $3 \times 10^8 \times 0.4 \times 10^{-6}$ C1
$d = 240$ m hence distance from source to reflector = 120 m A [4]

(b) speed of sound 300 cf speed of light 3×10^8 OR time = 240 / 300 (= 0.8)
OR time = 120 / 300 (= 0.4) C1
sound slower by factor of 10^6 OR time for one division 0.8 / 4
OR time for one division 0.4 / 2 C1
time base setting 0.2 s cm^{-1} [unit required] A1 [3]

6 **(a) (i)** displacement is the distance the rope / particles are (above or below) from the equilibrium / mean / rest / undisturbed position (not 'distance moved') B1 [1]

(ii) 1. amplitude (= 80 / 4) = 20 mm [1]

2. $v = f\lambda$ or $v = \lambda / T$ C1
$f = 1 / T = 1 / 0.2$ (5 Hz) C1
$v = 5 \times 1.5 = 7.5\ \text{m s}^{-1}$ A1 [3]

(b) point A of rope shown at equilibrium position B1
same wavelength, shape, peaks / wave moved ¼λ to right B1 [2]

(c) (i) progressive as energy OR peaks OR troughs is/are transferred/moved /propagated (by the waves) B1 [1]

(ii) transverse as particles/rope movement is perpendicular to direction of travel /propagation of the energy/wave velocity B1 [1]

7 **(a) (i) 1.** wavelength: minimum distance between two points moving in phase
OR distance between neighbouring or consecutive peaks or troughs
OR wavelength is the distance moved by a wavefront in time T or one oscillation/cycle or period (of source) B1 [1]

2. frequency: number of wavefronts / (unit) time
OR number of oscillations per unit time or oscillations/time B1 [1]

(ii) speed = <u>distance</u> / time = <u>wavelength / time period</u> M1
$= \lambda / T = \lambda f$ A0 [1]

(b) (i) amplitude = 4.0 mm (allo 1 s.f.) A1 [1]

(ii) wavelength = 18 / 3.75 (= 4.8) C1
speed = $2.5 \times 4.8 \times 10^{-2} = 12 \times 10^{-2}\ \text{m s}^{-1}$ unit consistent with numerical answer, e.g. in cm s^{-1} if cm used for λ and unit changed on answer line A1 [2]
[if 18 cm = 3.5λ used giving speed 13 (12.9) cm s^{-1} allow max. 1].

(iii) 180º or π rad A1 [1]

(c) light and screen and correct positions above and below ripple tank B1
strobe or video camera B1 [2]