Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) **Max 2**

Antiphase / completely out of phase / π radian out of phase ✔

Allow ½ cycle or 180° out of phase
Condone:
'Move in opposite directions'
'Displaced in opposite directions'
'when P is at its peak then Q is at its trough'
for loose descriptions of antiphase
'Opposite amplitudes' too vague (treat as neutral)
'When P is positive Q is negative' too vague

Similar amplitudes (of vibration) **or** similar (magnitudes of) displacement (at any instant in time) ✔

Same period **or** same frequency ✔

Move with the same speed ✔

Allow same amplitude / same (magnitude of) displacement

2

(b) Use of $v = f\lambda$ or determines the wavelength = 0.275 m ✔

Condone use of wavelength = 0.55 m or
0.1375 m in substitution for 1st MP
Condone Power of ten errors on wavelength for 1st MP
Two errors forfeit 1st mark:
Allow wavelength in range 0.27 to 0.28 m

(v =) 69 m s^{-1} ✔

Allow answers in range 67.5 to 70.0 m s^{-1}

2

(c) Same speed ✔

Moving in opposite directions ✔

same wavelength / same frequency/ similar amplitudes ✔

The following are insufficient:
Progressive / transverse / transfer energy
Allow same amplitudes

3

(d) Horizontal line drawn from **P** to **Q** ✔

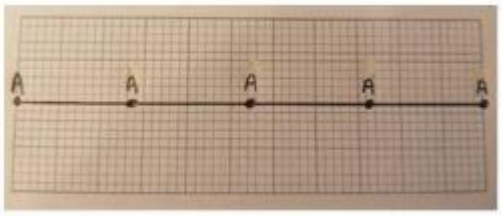
1

(e) Marks an A at each end of the string ✔

Condone other incorrect antinodes or nodes drawn (1st MP)

Marks all 5 As (evenly spaced by eye) on a horizontal line ✔
cao

Penalise incorrect number A or poorly positioned A (2nd MP)



2

(f) Third harmonic / third harmonic drawn in **Figure 6** ✔

Frequency for first harmonic has reduced to 1/3 of previous or

$$f = \frac{1}{3} \times \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

or

speed reduces to 1/3 of previous ✔

String being driven at three times this frequency ✔

*Must be a clear statement that this is 3rd harmonic / accept 3 symmetrical loops drawn in **Figure 6***

*Where no other mark has been scored allow **1 mark** for:*

- *Speed decreases*
- *Fundamental frequency is lower/ frequency of 1st harmonic is lower*
- *use of*

$$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

where 9μ has been substituted correctly (accept in any correct rearrangement)

3

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Q2.

(a) Max one from: ✔
internal ray is a <u>radius</u> (of the block)
OR
internal ray travels along a <u>normal</u>
OR
ray meets (glass-air) boundary at 90°
OR
angle of incidence is zero
(so angle of emergence/refraction is zero)

1

(b) Straight line ruled from centre of protractor through **ABC** ✔

*for $_1$✔ line must be reasonable and must pass through intersection of the cross-wires and must not pass above the centre of **A** or below the centre of **B***

Takes a pair of readings: 24 or 66; and angle consistent with their line ✔

Must be between 0° and 90°

Use of Snell's Law with their angles ✔

1.48 or 1.52 ✔

Must be a positive value to 3 sf.

4

(c) 1.47 or 1.471 ✔

Reject 1.5 or >4 sf; ignore any unit written

1

(d) 0.08 (mm) ✔

Only acceptable answer

1

(e) Calculates one percentage uncertainty

*For $_1$✔ allow ecf from **(d)**; expected answers are*

% uncertainty in ($R_2 - R_0$) =

$$100 \times \frac{0.08}{14.28} = 0.56(0)\%$$

% uncertainty in ($R_2 - R_1$) =

$$100 \times \frac{0.08}{9.71} = 0.82(4)\%$$

OR

Calculates max or min value ✔

$$n_{min} = \frac{14.28 - 0.08}{9.71 + 0.08} = 1.45(0);$$

$$n_{max} = \frac{14.28 + 0.08}{9.71 - 0.08} = 1.49(1);$$

Adds their percentage uncertainties
OR

attempt to use percentage $n = \frac{0.5(\text{max} - \text{min})}{1.47} \times 100$ ✓

Ecf for $_2$✔ from wrong percentage uncertainties or wrong max or min values

1.4(%) ✔

Condone 3 or 4 sf

3

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