Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

(a) **A** and **B** are in antiphase or π rad out of phase or 180° out of phase ✔

*Condone: **A** and **B** are **completely** out of phase. Allow a description of one being a peak when other is a trough.*

(difference in distance travelled =) 178 (nm) or 2 x 89 (nm)

OR

A and **B** travel different distances

OR

There is a path difference

OR

states the path difference = $(n + \frac{1}{2})\lambda$ ✔

The path difference is half of a wavelength (of the light in the thin layer) ✔

***MP2 Alternative**: thickness of layer is ¼ of wavelength (of light in layer) **or** 89 nm is a ¼ of the wavelength (of light in layer) **or** journey through layer is ½ of wavelength (of light in layer)*

Condone path difference = nλ where n ≠ 0

***MP2 and MP3** time-based alternative: **MP2** it takes (some) time for **B** to travel through medium (before meets **A**)*

MP3

time taken to travel this (half wavelength) equals half of the period.

Do not accept half of a wavelength out of phase.

3

(b) Correctly reads off 0.93 and (-)0.37

Allow a range of 0.90 to 0.95 for A's read off and a range of (-)0.35 to (-)0.40 for B's read off.

Or

Adds their two read-offs provided one is negative ✔

Allows values of 0.9 and (-)0.4 for read-offs.

Look to graph for read-offs.

Downloaded from www.merit-minds.com

0.56 ✔

Answer in range 0.59 to 0.53

Answer to 2 sf answer here.

*An answer of 0.6 or 0.5 scores **1 mark maximum.***

2

(c) Use of $T = \frac{1}{f}$

OR

Fraction of a cycle determined:

$\frac{137}{360}$ or $\frac{8\text{ (squares)}}{21(.3)\text{ (squares)}}$ or 0.38 seen✔

(T=) $\frac{1}{4.72 \times 10^{14}}$ *OR (T =) 2.12 × 10^{-15} (s) seen*

*Condone use of their T in **MP2***

Equation has been rearranged and t would be the subject.

*Condone use of their decimal fraction of a cycle in **MP2**.*

Expect to see decimal fraction of 0.38 or 0.37

Answer to at least 2 significant figures

(*t* =) $\frac{137}{360}$ × *T* seen

OR

(*t* =) $\frac{8\text{ (squares)}}{21(.3)\text{ (squares)}}$ × *T* seen

OR

(*t* =) $\frac{137}{360} \times \frac{1}{4.72 \times 10^{14}}$ *seen* ✔

(*t* =) 8.1 × 10^{-16} (s) ✔ must include valid supporting work

Alternative:

***MP1** finds wavelength above surface (636 nm) and determines fraction of wavelength corresponding to fraction of cycle (242 nm)*

***MP2** divides the fraction of the wavelength by the speed of the light above the surface.*

***MP3** answer to at least 2 significant figures.*

Accept any answer to 2 significant figures that would round to 8.1 × 10^{-16} (s).

*Use of λ = 356 nm is incorrect. Only **MP1** is available for fraction of a cycle.*

• Do not allow answers where c = f λ is used to determine c = 1.68 × 10^{8} m s^{-1}.

• Do not allow use $\frac{135.5}{356}$ × *T OR* $\frac{135.5}{356} \times \frac{1}{4.72 \times 10^{14}}$ *in MP2*

3

Downloaded from www.merit-minds.com

(d) Use of speed = $\frac{\text{distance}}{2 \times 89 \times 10^{-9}}$ ✔

(Speed =) 2.2×10^{8} (m s^{-1}) ✔

Use of $n_s = \frac{c}{c_s}$ ✔

n_s = 1.36 or 1.4✔

Their incorrect t must round to 8 x 10^{-16} (s). for ecf.

Condone POT in MP1 ***OR*** *condone use of 89 nm for distance. (Will give an answer for n of 2.72 or 2.7)*

Condone use of their c_s in MP3

Where 3 sf answer seen, range is 1.35 to 1.37

OR

Use of $\frac{t}{T} \times \lambda = 178 \times 10^{-9}$ ✔

λ = 468 nm ✔

Use of $c_s = f\lambda$ and $n_s = \frac{c}{c_s}$ ✔

n_s = 1.36 or 1.4✔

Allow 2 marks maximum for an answer for n of 1.79 or 1.8 with working. (Error in use of of λ = 356 nm) .

Condone as an ***ECF on MP4.***

Condone POT in MP1 ***OR*** *condone use of 89 nm for fraction of wavelength. (Will give an answer for n of 2.72 or 2.7)*

Condone use of their λ in MP3

Where 3sf answer seen, range is 1.35 to 1.37

OR

Use of $\frac{137}{360} \times \lambda = 178 \times 10^{-9}$ ✔

λ = 468 nm ✔

Use of $c_s = f\lambda$ and $n_s = \frac{c}{c_s}$ ✔

n_s = 1.36 or 1.4✔

Condone POT in MP1 ***OR*** *condone use of 89 nm for fraction of wavelength. (Will give an answer for n of 2.72 or 2.7)*

Condone use of their λ in MP3

Where 3sf answer seen, range is 1.35 to 1.37

Allow an ECF in MP4 for one arithmetical error / transcription error.

Where t = 8 × 10^{-16} is used:

Speed = 2.225 × 10^{8} m s^{-1}

Wavelength in layer = 471 nm

Refractive index = 1.35

Downloaded from www.merit-minds.com

[12]

Q2.

(a) 6.75 ✔

CAO

1

(b) any sensible answer describing possible consequences of use of the thimble, e.g. can cause the wire to be distorted/damaged; or reduces the diameter. ✔

Accept 'the frame of the micrometer might become warped' / 'damage might occur to the screw thread mechanism' / 'may lead to the reading shown being smaller than true value'

Condone 'squeezed'. Condone 'change diameter'.

Reject 'might change the reading', 'affect results', 'cause a reading below zero', 'could lead to systematic error', 'over-tighten' or 'holds wire more securely'.

1

(c) fully correct calculation $_1$✔$_2$✔

OR

partly correct calculation $_{12}$✔

((2 × 1.2%) + 2.0% =) 4.4% $_1$✔$_2$✔

*For $_{12}$✔ allow any of (2 × 1.2%) **OR** 2.4% **OR** 1.2% + 2.0% **OR** 3.2% **OR** 1.44% + 2.0% **OR** 3.4% seen in working.*

*For 1 mark condone misreading leading to '(2 × 2.0%) + 1.2% = 5.2%' **OR** '4% + 1.2% = 5.2%'.*

2

(d) length of wire between oscillator and pulley $_1$✔

mass of **M** $_2$✔

For $_1$✔ allow 'distance between oscillator and pulley' or 'length of horizontal/oscillating wire' or use of annotation to Figure 2 to identify correct dimension with a symbol, eg L.

For $_1$✔ 'length of wire' is insufficient.

*For $_2$✔ allow 'weight of **M**' or 'suspended mass'.*

For $_2$✔ accept 'tension in wire'.

*Reject bland '**M**' or 'the mass' or 'tension'.*

Treat 'mass per unit length of wire' as neutral.

2

(e) calculates $d \times f$ at least twice $_1$✔

states how their calculations support a conclusion that f is inversely proportional to d $_2$✔

d / mm	f / Hz	$(d \times f)$ / mm s^{-1}
0.85	28.5	24.2 (24.23)
0.68	36.0	24.5 (24.48)

Downloaded from www.merit-minds.com

0.54	*44.5*	*24.0 (24.03)*
0.44	*55.5*	*24.4 (24.42)*
0.37	*65.0*	*24.1 (24.05)*

Allow reverse working or use of readings from a line of best-fit.

For $_1$✔ condone misreading of scale of one axis, or one misreading.

For $_2$✔ apply list principle to calculations i.e. for 2 or 3 calculations, all must be correct; for 4 calculations, condone 1 error; for 5 calculations, condone 2 errors.

Do not allow 1 sf for constant of proportionality.

2

(f) *f* values increase $_1$✔

by $\sqrt{2}$ $_2$✔

For $_1$✔ allow (all) points / line / graph move(s) up.

*Must not imply d changes **OR** points / line moves right **OR** that μ changes.*

Treat 'graph is stretched upwards / in the y- direction' as neutral.

2

[10]

Downloaded from www.merit-minds.com