Waves Questions MS

1. Single wavelength/frequency **(1)**
Waves in antiphase superimpose giving complete or partial cancellation **(1)** 2

$f = c/\lambda = 3 \times 10^8$ m s^{-1}/ 780×10^{-9} m **(1)**
$= 3.85 \times 10^{-4}$ Hz **(1)**

$n = \upsilon_{air}/\upsilon_{plastic}$
$\upsilon_{plastic} = 3 \times 10^8$ m s^{-1}/ 1.55
$= 1.94 \times 10^8$ m s^{-1} **(1)**

$\lambda = \upsilon / f = 1.94 \times 10^8$ m s^{-1}/3.85×10^{14} Hz
$= 5.04 \times 10^{-7}$ m **(1)** 4

Path difference between two sets of waves = 2 × ridge height **(1)**
= 2 × 125 nm = 250 nm or approx. $\lambda/2$ **(1)**

Waves are in antiphase when they combine and produce small amplitude **(1)** 3

No. Path difference is now $\approx\lambda$ so waves from ridge and valley almost in phase when they recombine **(1)**

The pattern of ridges and valleys will not give an on/off signal **(1)**

[‘No’ must have an attempt at an explanation for a mark] 2

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2. Calculate υ or υ^2 and t and plots correct **(1)(1)(1)** 3

M/kg	f/Hz	λ/m	υ/ms^{-1}	υ^2/m^2 s^{-2}	T/N
0.16	30.6	0.37	12.3	151	1.96
0.20	30.0	0.41	11.3	128	1.57

Best fit line **(1)** 1

Yes **(1)**
Best fit line *through origin* is near all plots **(1)** 2

Large Δ drawn **(1)**

Gradient = $\frac{160}{2.01}$ =79.6 **(1)**

$\mu = \frac{1}{\text{Gradient}}$ = 0.0126 kg m^{-1} (accept 0.12 – 0.013) **(1)** 3

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3. Polarised – vibrations of transverse wave in 1 plane only (or E or B field)
Non –polarised – vibrations can be in any plane perpendicular to direction of travel **(1)** 1

No light **(1)** 1

Align sunglasses so that axis allows absorption of polarised light **(1)** 1

$r + 90° + \theta = 180°$ (on straight line)
$r = 180 - 90 - \theta$
$= 90 - \theta$ **(1)**

$$\mu = \frac{\sin\theta}{\sin r} = \frac{\sin\theta}{\sin(90-\theta)}$$

$$1.33 = \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$\theta = \tan^{-1} 1.33$

$= 53°$ **(1)** 3

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4. Explanation of words:

Coherent

Same frequency and constant phase relationship **(1)** 1

Standing wave

Any **two** points from:

Superposition/interference

Two (or more) wavetrains passing through each other

Having equal A, f, λ

+ system of nodes and antinodes **(1) (1)** 2

Position of one antinode marked on diagram

Correctly marked A (in centre of rings – hot zone) **(1)** 1

Wavelength demonstration:

$\lambda = c/f = 3 \times 10^8 / 2.45 \times 10^9$ m

= 12.2 cm **(1)** 1

Path difference:

(22.1 + 14) – (20 + 10) cm

= 6.1 cm **(1)** 1

Explanation:

6.1 cm = ½ × λ **(1)** 1

Waves at X in antiphase/ destructive interference **(1)** 1

→ node **(1)** 1

Explanation of how two separate microwave frequencies overcomes uneven heating problem:

Different wavelengths **(1)** 1

So a path difference which gives destructive interference at one wavelength may not do so at another **(1)** 1

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5. ${}_{w}\mu_{h} = 1.0$ 1

Eye diagram:

Both rays bend inwards on entering spherical lens **(1)**

Then inwards again on leaving spherical lens to cross at retina **(1)** 2

Explanation:

Object distance reduced, so image distance must be increased **(1)**

so lens must move away from the retina **(1)**

Use of $\frac{1}{u} + \frac{1}{\upsilon} = \frac{1}{f}$ to explain

OR good use of diagrams for maximum marks **(1)** 3

Lake diagram

Ray of light drawn from person, refracting in correct direction at water surface **(1)**

Ray drawn from below fish, reflecting at water surface [angles approximately correct] **(1)**

Arrows on both rays towards fish **(1)** 3

Critical angle calculation:

Sin$C = 1/{}_{a}\mu_{w}$ **(1)**

= 1/1.33

$\therefore$ C = 49° **(1)** 2

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6. Physics principles

Requires 9 V battery:

Battery required for electronic circuitry / microphone / speaker **(1)**

Rubberized foam ear cups:

Air filled material / material has large surface area **(1)**

Air molecules collide frequently with material **(1)**

Foam deforms plastically/collisions are inelastic **(1)**

Sound converted to heat in material **(1)**

Active noise attenuation:

Noise picked up by microphone **(1)**

Feedback signal inverted / 180° out of phase with noise / antiphase **(1)**

Amplified [OR amplitude adjusted] and fed to earphones / speaker **(1)**

Sound generated cancels/superimposes/minimum noise **(1)**

Diagrams of superposing waves showing (approx.) cancellation **(1)**

Amplifier gain automatically adjusted if noise remains **(1)**

Device only works over frequency range 20 – 800 Hz **(1)** Max 6

<u>Where does the energy go?</u>

Some places will have constructive interference **(1)**

More intense noise **(1)**

Some noise dissipated as heat in air / foam **(1)**

increased kinetic energy of air [OR foam] molecules **(1)** Max 2

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7. <u>Explanation of pressure nodes or antinodes</u>

Pressure constant **(1)**

Node as a result **(1)** 2

<u>Relationship between length and wavelength</u>

$l = \lambda/2$ or $\lambda = 2l$ **(1)** 1

<u>Calculation of fundamental frequency</u>

$\lambda = 2 \times 0.28$ m = 0.56 m [ecf for relationship above] **(1)**

$v = f\lambda$ **(1)**

$f = v/\lambda = 330 \text{ m s}^{-1} \div 0.56 \text{ m}$

= 590 Hz **(1)** 3

<u>Calculation of time period</u>

$T = 1/f$ **(1)**

$T = 1 \div 590$ Hz [ecf]

= 0.0017 s **(1)** 2

<u>State another frequency and explain choice</u>

e.g. 590 Hz × 2 = 1180 Hz (or other multiple) **(1)**

multiple of f_0 or correct reference to changed wavelength **(1)**

diagram or description, e.g. N A N A N, of new pattern [ecf for A & N] **(1)** 3

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