A-Level Edexcel

PHYSICS

UNIT 2(IAL)

2020 — 2025

1 – (WPH11/2(IAL)_Summer_2020_Q1) – *Waves And Particle Nature Of Light*

Waves can be represented on graphs of displacement against distance and displacement against time.

Which of the following properties can only be determined by combining information from both graphs?

☒ **A** amplitude

☒ **B** frequency

☒ **C** speed

☒ **D** wavelength

2 – (WPH11/2(IAL)_Summer_2020_Q2) – *Waves And Particle Nature Of Light*

Two waves from the same source arrive at a point with a path difference of $\frac{3\lambda}{8}$, where λ is the wavelength.

Which of the following is the phase difference of the waves at this point?

☒ **A** 34°

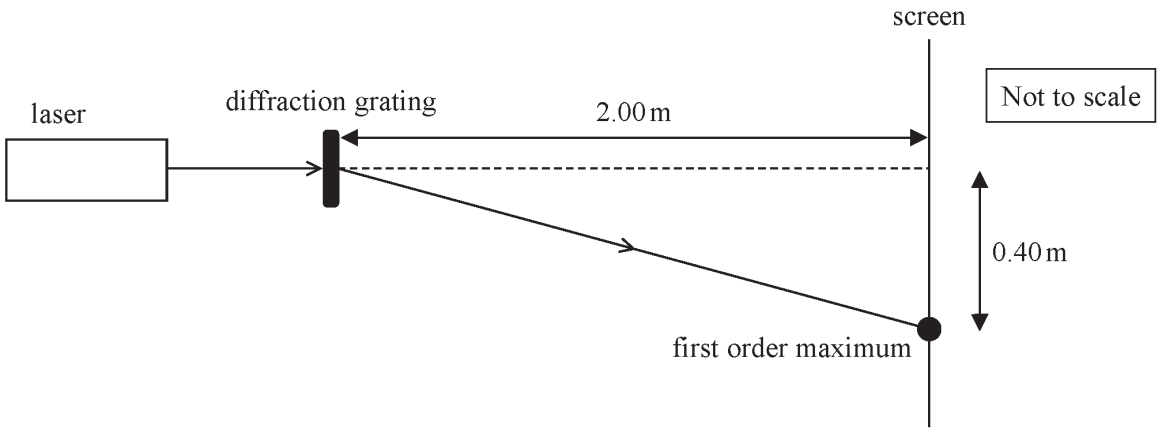
☒ **B** 68°

☒ **C** 135°

☒ **D** 270°

3 – (WPH11/2(IAL)_Summer_2020_Q3) – *Waves And Particle Nature Of Light*

A diffraction grating has 300 lines per mm. When laser light is directed towards the diffraction grating, a diffraction pattern is observed on a screen. The position of a first order maximum on the screen is shown in the diagram.



Which of the following calculations should be used to determine the wavelength, in mm, of the laser light used?

☒ **A** $300\sin\theta$ where $\theta = \sin^{-1}\left(\frac{0.40}{2.00}\right)$

☒ **B** $300\sin\theta$ where $\theta = \tan^{-1}\left(\frac{0.40}{2.00}\right)$

☒ **C** $\frac{\sin\theta}{300}$ where $\theta = \sin^{-1}\left(\frac{0.40}{2.00}\right)$

☒ **D** $\frac{\sin\theta}{300}$ where $\theta = \tan^{-1}\left(\frac{0.40}{2.00}\right)$

4 – (WPH11/2(IAL)_Summer_2020_Q5) – *Waves And Particle Nature Of Light*

Ultrasound has a number of different uses in medicine.

Which of the following is the main reason why ultrasound is not used to perform scans of the chest and lungs?

☒ **A** The air in the lungs causes most of the ultrasound to be reflected back.

☒ **B** The duration of the pulses of ultrasound limits the amount of detail that can be seen.

☒ **C** The wavelength of the ultrasound is too long.

☒ **D** Ultrasound can damage the lungs.

5 - (WPH11/2(IAL)_Summer_2020_Q8) - *Waves And Particle Nature Of Light*

Which of the following statements about waves is correct?

☒ **A** Both longitudinal and transverse waves can be polarised.

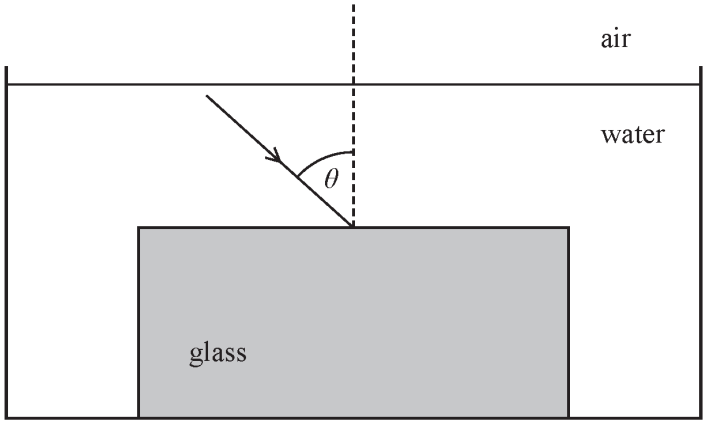
☒ **B** Neither longitudinal nor transverse waves can be polarised.

☒ **C** Only longitudinal waves can be polarised.

☒ **D** Only transverse waves can be polarised.

6 - (WPH11/2(IAL)_Summer_2020_Q11) - *Waves And Particle Nature Of Light*

A block of glass is submerged in a container of water. A ray of light travelling in the water is directed towards the glass surface as shown.



refractive index of water = 1.33
refractive index of glass = 1.52

(a) Calculate the angle of refraction within the glass block when $\theta = 43.0°$.

(2)

.....

.....

.....

.....

Angle of refraction = ...

(b) Determine the critical angle for light at a glass-water boundary.

(2)

.....

.....

.....

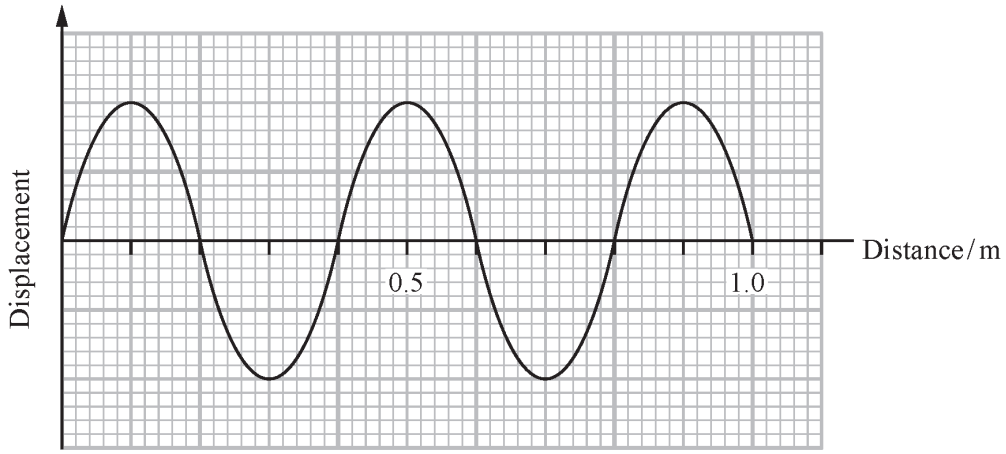
.....

Critical angle = ...

7 - (WPH11/2(IAL)_Summer_2020_Q13) - *Waves And Particle Nature Of Light*

Active Noise Reduction (ANR) is a system used to reduce unwanted noise. In ANR a second sound wave is produced that cancels the first. ANR is used in aircraft to reduce the noise heard from the engine.

(a) On a particular flight, the noise from the engine has a frequency of 0.85 kHz. The graph shows a possible second wave.

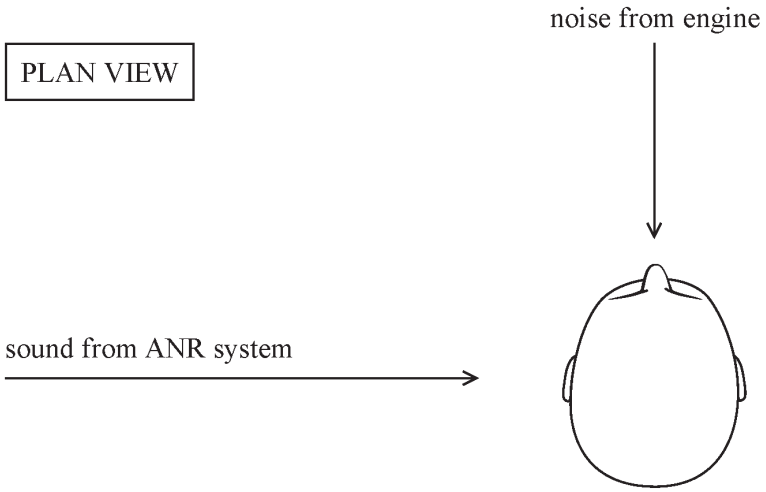


Determine whether this wave could be suitable to cancel the noise from the engine.

speed of sound in air = 340 m s^{-1}

(3)

*(b) For a particular passenger in an aircraft, the noise from the engine travels as a wave towards the passenger from the front. An ANR system creates a second sound wave that is directed towards the passenger from the side, as shown.



Explain how this can lead to the sound being cancelled for one ear but louder for the other ear.

(6)

8 – (WPH11/2(IAL)_Summer_2020_Q16) – *Waves And Particle Nature Of Light*

The speed of sound in sea water varies with depth as shown in diagram A.

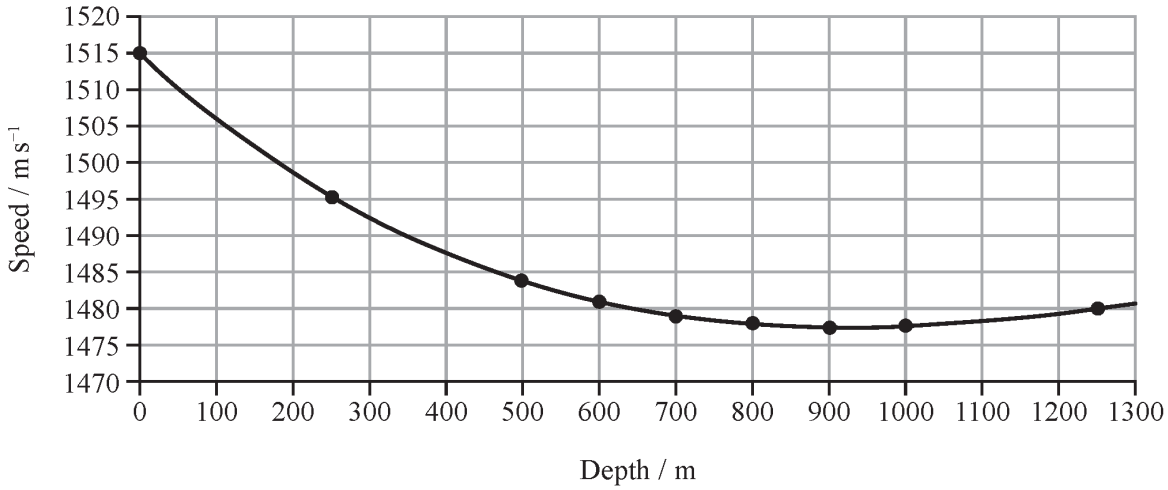


Diagram A

Sound produced at a depth of 900 m initially travels towards the water surface. As the sound approaches a depth of 700 m it changes direction and follows the path shown to the point P in diagram B.

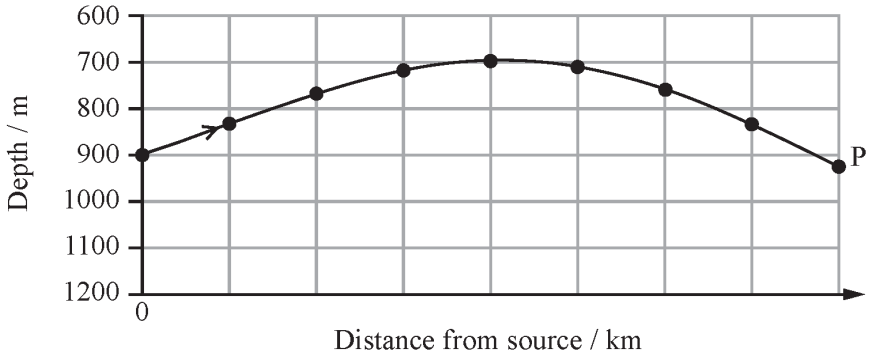


Diagram B

(a) Explain why the sound follows the path shown in diagram B.

Your answer should refer to refraction and diagram A.

(5)

(b) Sound that travels in a straight line from the source to point P takes longer to arrive than sound that travels along the path shown in diagram B.

Suggest why.

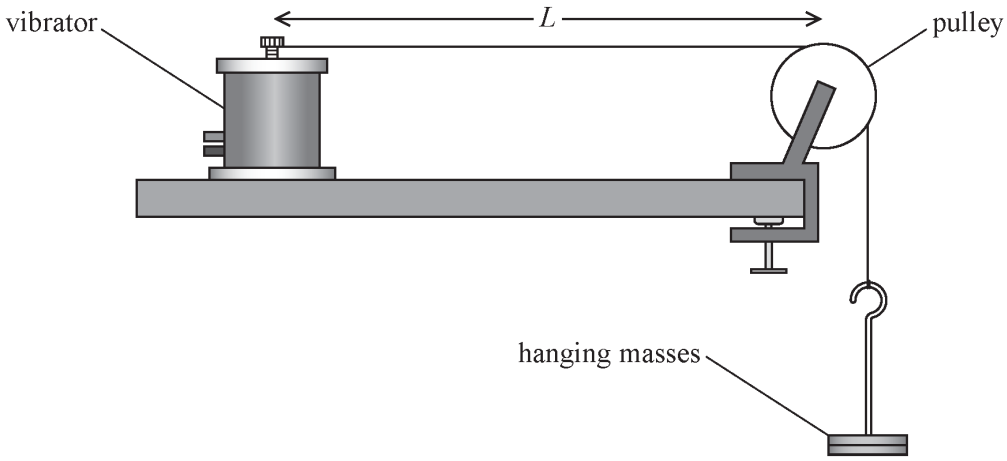
(2)

(c) Suggest two factors that might cause the speed of sound to vary with the depth of the sea.

(2)

9 – (WPH11/2(IAL)_Summer_2020_Q17) – *Waves And Particle Nature Of Light*

A student investigated how the frequency of vibration of a string varies with the tension in the string. The student connected masses to one end of the string and attached the other end to a vibrator as shown.



(Source: http://www.schoolphysics.co.uk/age16-19/Sound/text/Vibrating_strings/index.html)

A signal generator was connected to the vibrator. The signal generator was adjusted until a stationary wave was produced on the string. The stationary wave had nodes at both ends of the vibrating length of the string, L, and an antinode in the middle.

(a) Explain how nodes and antinodes are created on a string.

(3)

(b) The student changed the weight W applied to the string and adjusted the frequency f of the signal generator until the same stationary wave was set up on the string.

The student plotted a graph of f^2 against W.

Explain why the graph was a straight line through the origin.

(5)

(c) Describe a method that can be used to confirm that the frequency value stated on the signal generator is correct.

(2)

(d) When W is 80.0 N, f is 659 Hz.

Calculate the mass per unit length of the string.

length $L = 0.328$ m

(3)

Mass per unit length = ...

10 – (WPH11/2(IAL)_Winter_2020_Q1) – *Waves And Particle Nature Of Light*

Two waves, of wavelength λ, from a single source diverge and then meet again.
Which of the following situations would cause constructive interference?

☒ **A** a path difference of $\frac{\lambda}{2}$

☒ **B** a path difference of λ

☒ **C** a phase difference of $\frac{\pi}{2}$

☒ **D** a phase difference of π

11 – (WPH11/2(IAL)_Winter_2020_Q2) – *Waves And Particle Nature Of Light*

Which of the following describes the oscillations in polarised waves?

☒ **A** in a single plane which is perpendicular to the direction of wave travel

☒ **B** in many planes, which include the direction of wave travel

☒ **C** in many directions and parallel to the direction of wave travel

☒ **D** in one direction and perpendicular to the direction of wave travel

12 – (WPH11/2(IAL)_Winter_2020_Q8) – *Waves And Particle Nature Of Light*

Waves may be longitudinal or transverse.

Which of the following statements is correct?

☒ **A** All transverse waves travel at the same speed.

☒ **B** All transverse waves have vibrations that are parallel to the direction of wave travel.

☒ **C** Both transverse and longitudinal waves can be refracted.

☒ **D** No transverse waves can travel through liquids.

13 – (WPH11/2(IAL)_Winter_2020_Q9) – *Waves And Particle Nature Of Light*

In an experiment, laser light is shone through a diffraction grating so that a series of bright dots appears on a screen. The equation $n\lambda = d\sin\theta$ can be used to determine the wavelength of the laser light.

Which of the following is a **correct** description of how the experiment should be performed?

☒ **A** The angle θ is measured using a protractor.

☒ **B** The diffraction grating is set up so that it is parallel to the laser light beam.

☒ **C** The diffraction grating is set up so that it is parallel to the screen.

☒ **D** The distance between the bright dots is measured with a micrometer.

14 – (WPH11/2(IAL)_Winter_2020_Q10) – *Waves And Particle Nature Of Light*

The evidence for the wave nature of electrons came from experiments involving

☒ **A** diffraction.

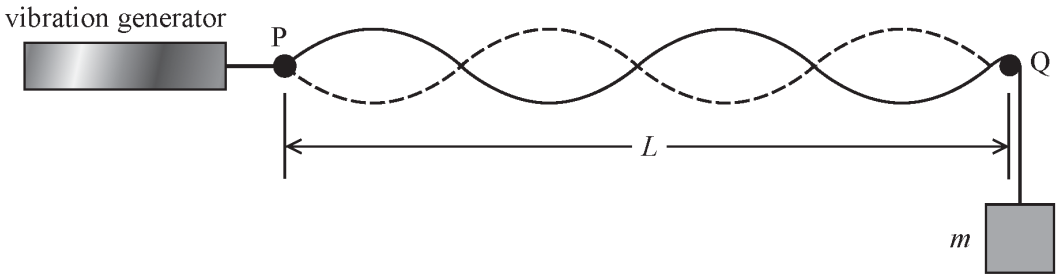
☒ **B** polarisation.

☒ **C** reflection.

☒ **D** refraction.

15 – (WPH11/2(IAL)_Winter_2020_Q11) – *Waves And Particle Nature Of Light*

An experiment is carried out to investigate the speed of transverse waves on a stretched string of length L. A vibration generator causes the string to oscillate so that a stationary wave is produced. The frequency of the vibration generator is adjusted until the wave pattern shown in the diagram is produced.



Sourced from: https://people.highline.edu/iglozman/classes/physnotes/media/waves_9.jpg

(a) Determine the wavelength of the waves on the string when vibrating as shown.

length L = 1.70 m

(2)

Wavelength = ...

(b) Calculate the speed of waves on the string.

mass m = 0.20 kg
mass per unit length of string = 4.5×10^{-3} kg m^{-1}

(3)

Speed = ...

(c) The frequency of the vibration generator is reduced until the wave pattern shown below is produced.

Explain the effect that this would have on the speed of the waves on the string.

(2)

16 – (WPH11/2(IAL)_Winter_2020_Q13) – *Waves And Particle Nature Of Light*

A pulse-echo technique, using ultrasound, can be used to produce images of an unborn baby as shown.

Explain how the ultrasound scan of the unborn baby is produced.

(6)

ANSWERS

1 – (WPH11/2(IAL)_Summer_2020_Q1) – *Waves And Particle Nature Of Light*

C

2 – (WPH11/2(IAL)_Summer_2020_Q2) – *Waves And Particle Nature Of Light*

C

3 – (WPH11/2(IAL)_Summer_2020_Q3) – *Waves And Particle Nature Of Light*

D

4 – (WPH11/2(IAL)_Summer_2020_Q5) – *Waves And Particle Nature Of Light*

A

5 – (WPH11/2(IAL)_Summer_2020_Q8) – *Waves And Particle Nature Of Light*

D

6 – (WPH11/2(IAL)_Summer_2020_Q11) – *Waves And Particle Nature Of Light*

a	Use of $n_1\sin\theta_1 = n_2\sin\theta_2$ with both 1.33 and 1.52 seen angle of refraction = 37° **Example of calculation** $n_1\sin\theta_1 = n_2\sin\theta_2$ 1.33 sin (43°) = 1.52 sin r r = 36.6°	(1) (1)	**2**
b	Use of sin C = 1/n critical angle = 61° **OR** Use of sin C = 1 / 1.14 (if ratio calculated in (a)) critical angle = 61° (Allow an ecf of n_1/ n_2 ratio from (a)) **Example of calculation** sin C = 1/n $C = \sin^{-1}$ (1.33/1.52) = 61.0°	(1) (1) (1) (1)	**2**

7 – (WPH11/2(IAL)_Summer_2020_Q13) – *Waves And Particle Nature Of Light*

a	Use of $v = f\lambda$	(1)	
	$\lambda = 0.40$ (m)	(1)	
	Wave is suitable	(1)	
	OR		
	Use of $v = f\lambda$	(1)	
	$f = 850$ (Hz) / 0.85 (kHz)	(1)	
	Wave is suitable	(1)	
	OR		
	Use of $v = f\lambda$	(1)	
	$v = 340$ (m/s)	(1)	
	Wave is suitable	(1)	**3**
	(MP3 by any method is dependent upon awarding both MP1 and MP2)		
	Example of calculation		
	$v = f\lambda$		
	$340\ \text{m s}^{-1} = 850\ \text{Hz} \times \lambda$		
	$\lambda = 0.40$ m		

*** b**

This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.

IC points	IC mark	Max linkage mark	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content

- Sound (from ANR) has to diffract to reach the furthest/right ear
- (Sound) cancelled when destructive interference takes place
- (Sound) louder when constructive interference takes place
- Destructive interference is where waves are in antiphase
- Constructive interference is where waves are in phase
- When distance between the ears is half a wavelength
  Or distance between the ears is approximately 20cm.

(For IC1, do not allow "noise from engine diffracts to reach the right ear")
(For IC2 to IC5, interference or superposition are accepted)
(For IC2 and IC3 accept correct reference to minimum/maximum amplitude)
(For IC4 and IC5, accept answers in terms of path difference. However, path difference must be in terms of λ and phase difference in terms of π or °)

Linkage mark 1 – needs at least 2 from IC1-IC3 to consider this.
Linkage mark 2 – needs at least 2 from IC4-IC6 to consider this.

6

8 – (WPH11/2(IAL)_Summer_2020_Q16) – *Waves And Particle Nature Of Light*

a	Idea that when waves rise from 900 m depth they speed up **Or** indication that speed at 700m is greater than at 900m	(1)	
	Curving is due to the change in speed being gradual **Or** not a sudden change in direction as there is no sudden change in speed.	(1)	
	Waves are refracted away from the normal	(1)	
	Angle of incidence reaches/exceeds the critical angle (at 700m) **Or** angle of refraction becomes 90° (at 700m)	(1)	
	(At 700 m, total internal) reflection takes place (allow TIR)	(1)	**5**
b	Path in diagram B is a longer (distance) **Or** straight line path is a shorter (distance)	(1)	
	Sound waves travel faster on path in diagram B **Or** sound waves travel slower on straight line path **Or** sound waves travel faster at 700m than at 900m	(1)	**2**
c	Any **two** from:		
	(Change in) temperature in the sea	(1)	
	(Change in) pressure in the sea	(1)	
	(Change in) density/salinity of the sea	(1)	**2**

9 – (WPH11/2(IAL)_Summer_2020_Q17) – *Waves And Particle Nature Of Light*

a	(Two) waves travelling in opposite directions **Or** wave meeting its reflection	(1)	
	Nodes are points of zero/minimum amplitude **and** antinodes are points of maximum amplitude	(1)	
	Nodes linked to destructive interference **and** antinodes linked to constructive interference	(1)	**3**
b	Equates $v = f\lambda$ and $v = \sqrt{(T/\mu)}$	(1)	
	Rearranges to give $f^2 = \frac{T}{\mu\lambda^2}$ **Or** $f^2 = \frac{T}{\mu(2L)^2}$	(1)	
	Replaces T with W in equation	(1)	
	Where μ and λ are constants **Or** where μ and L are constants	(1)	
	$f^2 \propto W$ **Or** no "c" in "$y=mx+c$" **Or** y-intercept is 0 **Or** in the format $y = mx$	(1)	**5**
	(MP5 is dependent on some correct working leading to an equation) (Award MP4 if stated that $\frac{1}{\mu\lambda^2}$ = constant or equivalent in terms of l)		
c	(Connect signal generator to) cathode ray oscilloscope **Or** record movement of the string with a video camera	(1)	
	(Measure time period T and) calculate $f = 1/T$	(1)	**2**
d	Use of $v = \sqrt{(T/\mu)}$	(1)	
	Identifies that $\lambda = 2L$	(1)	
	$\mu = 4.3 \times 10^{-4}$ kg m^{-1}	(1)	**3**
	Example of calculation $f\lambda = \sqrt{(T/\mu)}$, 659 Hz × (2 × 0.328 m) = $\sqrt{(80.0\ \text{N} / \mu)}$, $\mu = 4.3 \times 10^{-4}$ kg m^{-1}		

10 – (WPH11/2(IAL)_Winter_2020_Q1) – *Waves And Particle Nature Of Light*

B

11 – (WPH11/2(IAL)_Winter_2020_Q2) – *Waves And Particle Nature Of Light*

D

12 – (WPH11/2(IAL)_Winter_2020_Q8) – *Waves And Particle Nature Of Light*

C

13 – (WPH11/2(IAL)_Winter_2020_Q9) – *Waves And Particle Nature Of Light*

C

14 – (WPH11/2(IAL)_Winter_2020_Q10) – *Waves And Particle Nature Of Light*

A

15 – (WPH11/2(IAL)_Winter_2020_Q11) – *Waves And Particle Nature Of Light*

a	Recognises that node to node distance = $\lambda/2$ **Or** $\lambda = L/2$ stated (1) Wavelength = 0.85m (1) Example of calculation Node to node distance = $\lambda/2$. String has 4 loops so total length of string is 2λ λ = 1.70 m / 2 = 0.85 m.	**(2)**
b	Use of $v = \sqrt{(T/\mu)}$ (1) Use of $T = mg$ (1) $v = 21$ m s^{-1} (1) Example of calculation $T = mg$ = 0.20 kg × 9.81 N kg^{-1} = 1.96 N $v = \sqrt{(T/\mu)} = \sqrt{(1.96 \text{ N} / 4.5 \times 10^{-3} \text{ kg m}^{-1})} = 20.9$ m s^{-1}	**(3)**
c	T and μ are the same **Or** (As f decreases,) λ *in*creases (1) Speed would be the same **Or** There is no effect (on the speed) (1)	**(2)**

16 – (WPH11/2(IAL)_Winter_2020_Q13) – *Waves And Particle Nature Of Light*

*

This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.

Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points
6	4
5–4	3
3–2	2
1	1
0	0

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content

- Ultrasound is reflected from boundaries/baby
- (This reflection is caused by) change in density
- Time taken between pulse being sent and received measured
- Speed of ultrasound is known
- Speed = distance/time can be used (to calculate the distance to boundary)
- Clear indication that this calculation includes ½ time or ½ distance

(Candidates can potentially achieve 1 linkage mark if they have scored both IC1 and IC2. They can potentially achieve 1 linkage mark if they have scored 3 of IC3-6)

(6)