1 A progressive wave of frequency 150 Hz travels along a stretched string at a speed of 30 m s^{-1}.

What is the phase difference between two points that are 50 mm apart on the string?

A   zero

B   90°

C   180°

D   360°

(Total 1 mark)

2 Which of the following statements about the behaviour of waves is **incorrect**?

A   All waves can be diffracted.

B   All waves can be made to undergo superposition.

C   All waves can be refracted.

D   All waves can be polarised.

(Total 1 mark)

3 Two radio transmitters emit waves at a frequency of 1.4 MHz. A stationary wave is set up between the two transmitters due to the superposition of the radio waves.

What is the minimum distance between two nodes in the stationary wave?

A   107 m

B   214 m

C   428 m

D   857 m

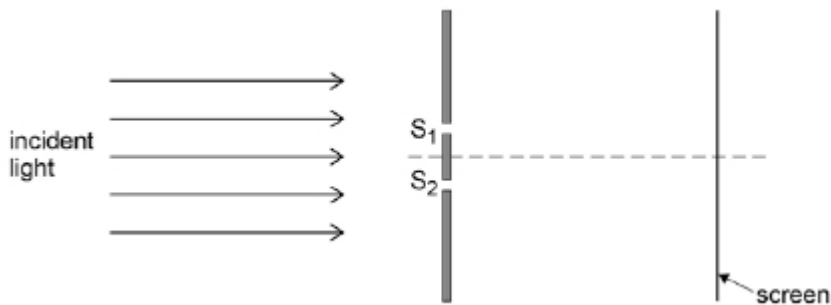**(Total 1 mark)**

4 Two loudspeakers emit sound waves.

Which line in the table gives the correct frequency condition and the correct phase condition for the waves from the loudspeakers to be coherent?

	Frequency condition	Phase condition	
A	same frequency	variable phase difference	⬚
B	constant frequency difference	constant phase difference	⬚
C	constant frequency difference	in phase	⬚
D	same frequency	constant phase difference	⬚

(Total 1 mark)

5 When a parallel beam of monochromatic light is directed at two narrow slits, S_1 and S_2, interference fringes are observed on a screen.

Which line in the table gives the changes that will increase the spacing of the fringes?

	Slit spacing	Distance from slits to screen	
A	halved	halved	⬚
B	halved	doubled	⬚
C	doubled	halved	⬚
D	doubled	doubled	⬚

(Total 1 mark)

6 A parallel beam of monochromatic light is directed normally at a plane transmission grating which has N slits per metre. The second order diffracted beam is at angle θ to the zero order transmitted beam.
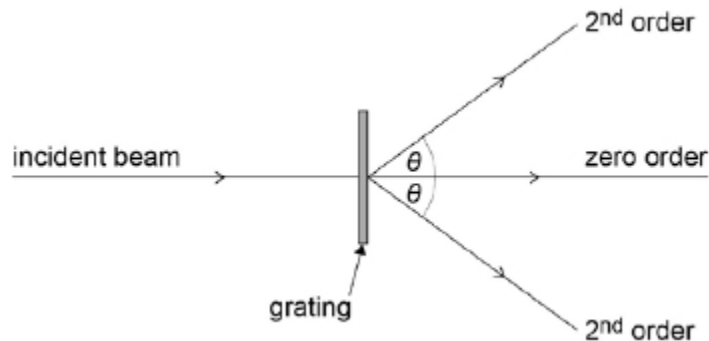
The grating is then replaced by a plane transmission grating which has $2N$ slits per metre.

Which one of the following statements is correct?

A   With the first grating, the first order beam is at angle 0.5θ to the zero order transmitted beam.

B   With the second grating, the first order beam is at angle 0.5θ to the zero order transmitted beam.

C   With the second grating, the first order beam is at angle θ to the zero order transmitted beam.

D   With the second grating, the second order beam is at angle θ to the zero order transmitted beam.

(Total 1 mark)

7 A layer of liquid of refractive index 1.6 covers the horizontal flat surface of a glass block of refractive index 1.5. A ray of light strikes the boundary between them at an angle such that it travels along the boundary afterwards.

How does the ray strike the boundary?

A   it travels in glass at an angle of 70° to the boundary

B   it travels in glass at an angle of 20° to the boundary

C   it travels in the liquid at an angle of 70° to the boundary

D   it travels in the liquid at an angle of 20° to the boundary

(Total 1 mark)

8 Electrons and protons in two beams are travelling at the same speed. The beams are diffracted by objects of the same size.

Which correctly compares the de Broglie wavelength λ_e of the electrons with the de Broglie wavelength λ_p of the protons and the width of the diffraction patterns that are produced by these beams?

	comparison of de Broglie wavelength	diffraction pattern	
A	$\lambda_e > \lambda_p$	electron beam width > proton beam width	⬭
B	$\lambda_e < \lambda_p$	electron beam width > proton beam width	⬭
C	$\lambda_e > \lambda_p$	electron beam width < proton beam width	⬭
D	$\lambda_e < \lambda_p$	electron beam width < proton beam width	⬭

(Total 1 mark)

9 Two points on a progressive wave are one-eighth of a wavelength apart. The distance between them is 0.5 m, and the frequency of the oscillation is 10 Hz. What is the minimum speed of the wave?

A   0.2 m s^{-1} ⬭

B   10 m s^{-1} ⬭

C   20 m s^{-1} ⬭

D   40 m s^{-1} ⬭

(Total 1 mark)

10 Which of the following waves **cannot** be polarised?

A   radio   ⬭

B   ultrasonic   ⬭

C   microwave   ⬭

D   ultraviolet   ⬭

(Total 1 mark)

11 A diffraction pattern is formed by passing monochromatic light through a single slit. If the width of the single slit is reduced, which of the following is true?

	Width of central maximum	Intensity of central maximum	
A	unchanged	decreases	⬭
B	increases	increases	⬭
C	increases	decreases	⬭
D	decreases	decreases	⬭

(Total 1 mark)

12 A light source emits light which is a mixture of two wavelength, λ_1 and λ_2. When the light is incident on a diffraction grating it is found that the fifth order of light of wavelength λ_1 occurs at the same angle as the fourth order for light of wavelength λ_2. If λ_1 is 480 nm what is λ_2?

A   400 nm   ⬭

B   480 nm   ⬭

C   600 nm   ⬭

D   750 nm   ⬭

(Total 1 mark)

13 Which of the following is correct for a stationary wave?

A   Between two nodes the amplitude of the wave is constant.   ⬭

B   The two waves producing the stationary wave must always be 180° out of phase.   ⬭

C   The separation of the nodes for the second harmonic is double the separation of nodes for the first harmonic.   ⬭

D   Between two nodes all parts of the wave vibrate in phase.   ⬭

(Total 1 mark)

14 Sound waves cross a boundary between two media X and Y. The frequency of the waves in X is 400 Hz. The speed of the waves in X is 330 m s^{-1} and the speed of the waves in Y is 1320 m s^{-1}. What are the correct frequency and wavelength in Y?

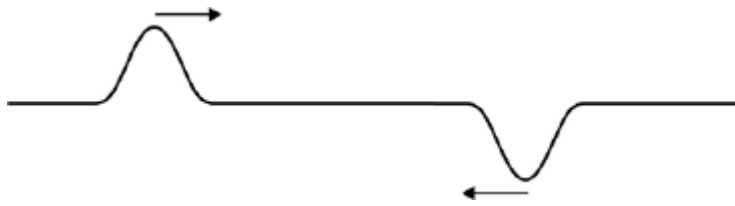|	Frequency / Hz	Wavelength / m	
A	100	0.82	⬭
B	400	0.82	⬭
C	400	3.3	⬭
D	1600	3.3	⬭

(Total 1 mark)

15 When comparing X-rays with UV radiation, which statement is correct?

A   X-rays have a lower frequency.   ⬭

B   X-rays travel faster in a vacuum.   ⬭

C   X-rays do not show diffraction and interference effects.   ⬭

D   Using the same element, photoelectrons emitted using X-rays have the greater maximum kinetic energy.   ⬭

(Total 1 mark)

16 The diagram shows two pulses on a string travelling towards each other.

Which of the following diagrams shows the shape of the string when the pulses have passed through each other?

A

B

C

D

(Total 1 mark)

17 Monochromatic light may be characterised by its speed, frequency and wavelength. Which of the following quantities change when monochromatic light passes from air into glass?

A   Speed only.

B   Speed and wavelength only.

C   Speed and frequency only.

D   Wavelength and frequency only.

(Total 1 mark)

18 Monochromatic light of wavelength 490 nm falls normally on a diffraction grating that has 6×10^5 lines per metre. Which one of the following is correct?

A   The first order is observed at angle of diffraction of 17°.   ☐

B   The second order is observed at angle of diffraction of 34°.   ☐

C   The third and higher orders are not produced.   ☐

D   A grating with more lines per metre could produce more orders.   ☐

(Total 1 mark)

19 What is the phase difference between two points 0.16 m apart on a progressive sound wave of frequency 256 Hz?

speed of sound = 330 m s^{-1}

A $\dfrac{\pi}{8}$ ☐

B $\dfrac{\pi}{6}$ ☐

C $\dfrac{\pi}{4}$ ☐

D $\dfrac{\pi}{3}$ ☐

(Total 1 mark)

20 Which one of the following provides direct experimental evidence that light is a transverse wave motion rather than a longitudinal wave motion?

A   Two light waves that are coherent can be made to interfere.   ☐

B   Light can be diffracted.   ☐

C   Light can be polarised.   ☐

D   The intensity of light from a point source falls off inversely as the square of the distance from the source.   ☐

(Total 1 mark)

21 The frequency of the first harmonic of a standing wave on a wire is f. The length of the wire and tension in the wire are both doubled.

What is the frequency of the first harmonic as a result?

A $\quad \dfrac{f}{\sqrt{2}}$ ☐

B $\quad f$ ☐

C $\quad \sqrt{2}f$ ☐

D $\quad 2f$ ☐

(Total 1 mark)

22 In a diffraction-grating experiment the maxima are produced on a screen.

What causes the separation of the maxima of the diffraction pattern to decrease?

A using light with a longer wavelength ☐

B increasing the distance between the screen and grating ☐

C increasing the distance between the source and grating ☐

D using a grating with a greater slit separation ☐

(Total 1 mark)

23 White light passes through a single narrow slit and illuminates a screen.

What is observed on the screen?

A a set of equally spaced white fringes ☐

B a central maximum made up of a spectrum surrounded by white fringes ☐

C a white central maximum surrounded by coloured fringes ☐

D a single narrow white line ☐

(Total 1 mark)

24 Which of the following is correct when total internal reflection occurs?

A   the angle of incidence is less than the critical angle

B   the light meets an optically less dense medium

C   the light enters a medium with a higher refractive index

D   the angles that the incident and refracted rays make with the normal are the same

(Total 1 mark)

25 What is the speed of light in glass of refractive index 1.42?

A 4.26×10^7 m s^{-1}

B 2.11×10^8 m s^{-1}

C 3.00×10^8 m s^{-1}

D 4.73×10^8 m s^{-1}

(Total 1 mark)

Mark schemes

1   B

                                                [1]

2   D

    [1]

3   A

    [1]

4   D

    [1]

5   B

    [1]

6   C

    [1]

7   D

    [1]

8   A

    [1]

9   D

    [1]

10   B

    [1]

11   C

    [1]

12   C

    [1]

13   D

    [1]

14   C

    [1]

15   D

    [1]

16   C

    [1]

17   B

    [1]

18 A

[1]

19 C

[1]

20 C

[1]

21 A

[1]

22 D

[1]

23 C

[1]

24 B

[1]

25 B

[1]

Examiner reports

19 This question required students to work out the wavelength of the sound wave, and then calculate the phase difference of two parts a certain distance apart. 45% of students correctly identified the correct answer. Approximately 35% thought A was correct, using π, rather than 2π, as the phase difference for two points a whole wavelength apart, perhaps.

21 This proved to be one of the more demanding questions on the paper, with 39% of students being correct, despite the equation being in the data booklet. The most popular distractor was C, chosen by students having difficulty dividing $\sqrt{2}$ by 2 perhaps. Unsurprisingly B was also popular, the answer obtained if the two changes cancelled out.

22 57% of students correctly identified D as the appropriate answer. The other students were split almost evenly between the distractors, with A being slightly more popular.

23 It was pleasing to note that 74% of students were sufficiently familiar with white light single slit diffraction to give the correct answer here. Approximately 10% of students gave the answer D, suggesting that they were unaware that any effect would occur.

24 This question proved to be quite demanding, with 40% of the students giving the correct answer. Nearly 30% chose D, confusing angles of reflection and refraction perhaps.

25 This straightforward calculation proved to be very accessible with 85% of the answers correct. It is worth pointing out that only about 2% of students chose D, an answer greater than the speed of light in a vacuum.