

Waves

Question Paper

Level	Pre U
Subject	Physics
Exam Board	Cambridge International Examinations
Topic	Waves
Booklet	Question Paper

Time Allowed: 39 minutes

Score: /32

Percentage: /100

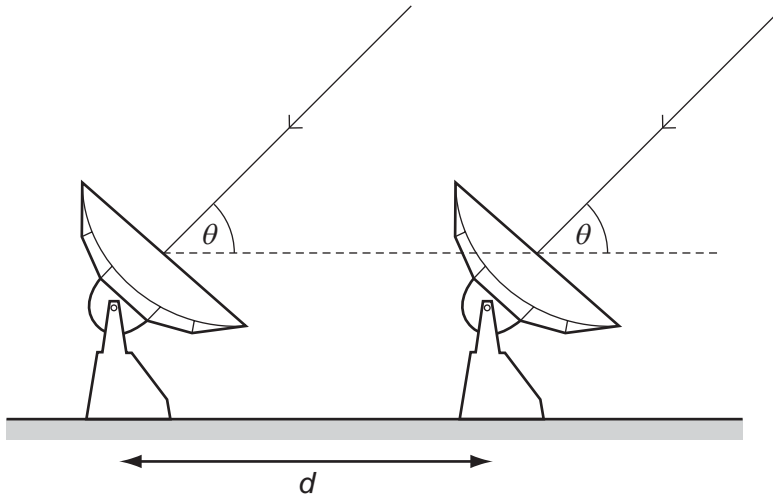
Grade Boundaries:

- 1 A wave has a frequency of 5 Hz. It travels through a medium at a speed of 8 km s^{-1} .

What is the phase difference, in radians, between two points 2 km apart?

- A 0 B $\frac{\pi}{4}$ C $\frac{\pi}{2}$ D π

- 2 Two radio telescopes separated by a distance d detect parallel waves of wavelength λ from the same distant radio source.



What is the correct expression for the path difference between the waves received at the telescopes?

- A $d \sin \theta$ B $d \cos \theta$ C $\frac{d \sin \theta}{\lambda}$ D $\frac{d \cos \theta}{\lambda}$

Space for working

- 3 Two sources of radio waves are at a distance of 1.0×10^{15} m from Earth. The sources are separated by 1.0×10^{12} m and emit radio waves of wavelength 0.030 m.

What is the estimate for the diameter of a dish of a radio telescope on Earth that will just resolve the two sources?

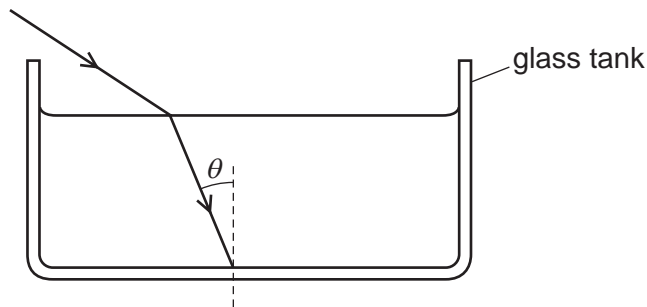
- A 3.0×10^{-5} m
- B 0.03 m
- C 30 m
- D 3.0×10^{-4} m

- 4 Early CD players used a laser with a wavelength of 950 nm. Modern DVD players use a laser with a wavelength of 650 nm.

Which statement is correct?

- A CD players used infra-red light, and DVD players use infra-red light of a higher frequency.
- B CD players used infra-red light, and DVD players use visible light.
- C CD players used red light, and DVD players use blue light.
- D CD players used visible light, and DVD players use ultra-violet light.

- 5 A light ray enters the water in a tank. The ray strikes the glass bottom of the tank at an angle of incidence θ .



speed of light in air = $3.00 \times 10^8 \text{ m s}^{-1}$
speed of light in water = $2.25 \times 10^8 \text{ m s}^{-1}$
speed of light in glass = $1.97 \times 10^8 \text{ m s}^{-1}$

What is the maximum value of θ at which the ray will emerge from the other side of the glass into the air below?

- A 41.0°
- B 41.4°
- C 48.6°
- D 61.1°

Space for working

- 6 A beam of light goes through a polarising filter, then through a sugar solution, then through a second polarising filter. The polarising axes of the two filters are initially aligned.

The sugar solution has the effect of rotating the light's plane of polarisation clockwise by 45° .

Through which angle must the second filter be rotated to block the beam?

- A 45° clockwise
 - B 45° anticlockwise
 - C 90° clockwise
 - D 90° anticlockwise
- 7 A telescope on Earth receives radiation from two distant sources. The sources are 1.0×10^{15} m from Earth and are separated by 1.0×10^{12} m.

The telescope dish has a diameter 40.0 m and can just resolve the two sources.

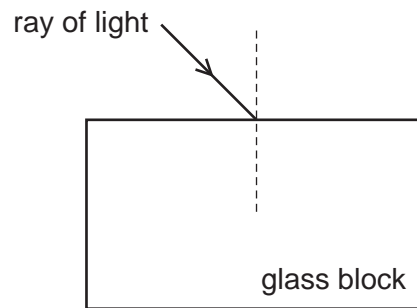
What is the wavelength of the radiation emitted by the sources?

- A 2.5×10^{-5} m B 4.0×10^{-2} m C 25 m D 4.0×10^4 m

8 Which of these parts of the electromagnetic spectrum has both frequency greater than infra-red and wavelength smaller than X-rays?

- A gamma rays
- B microwaves
- C radio waves
- D ultraviolet

9 Light passes from air into a glass block as shown.



Which features of the light **all** change as the light enters the block?

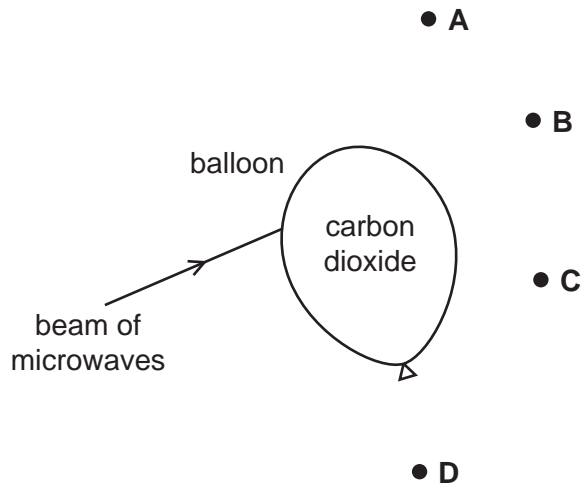
- A direction of travel, frequency and speed
- B direction of travel, frequency and wavelength
- C direction of travel, speed and wavelength
- D frequency, speed and wavelength

Space for working

- 10 Microwaves travel more slowly in carbon dioxide than in air.

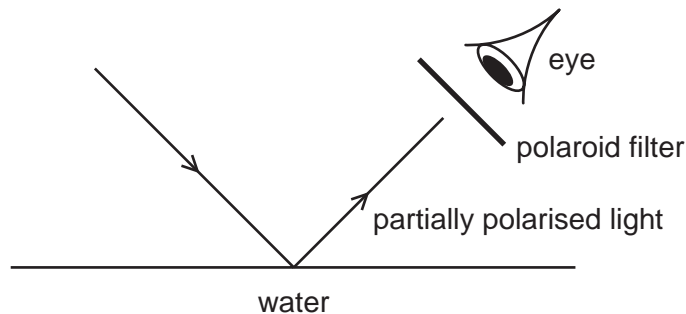
A beam of microwaves is directed towards a balloon filled with carbon dioxide as shown in the diagram.

At which point will the intensity of microwaves be greatest?



- 11 Light reflected from the surface of water is partially polarised.

A polaroid filter is used to view a water surface.



The polaroid filter is rotated through 180° in the plane perpendicular to the reflected light.

Which statement could describe the observations?

- A The brightness changes from a maximum to a minimum.
- B The brightness changes from a minimum to a maximum.
- C The brightness changes from a maximum to a minimum to a maximum.
- D The brightness changes from a minimum to a maximum to a minimum to a maximum.

Space for working

12 The table lists some properties of longitudinal waves.

Which row is correct?

	direction of vibrations	polarisation
A	parallel to velocity of wave	can be polarised
B	parallel to velocity of wave	cannot be polarised
C	perpendicular to velocity of wave	can be polarised
D	perpendicular to velocity of wave	cannot be polarised

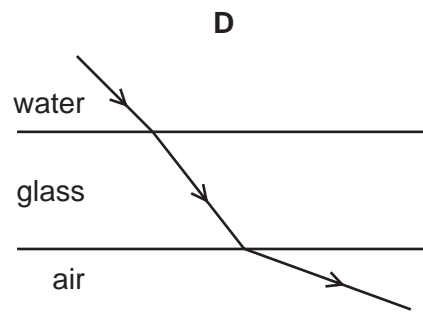
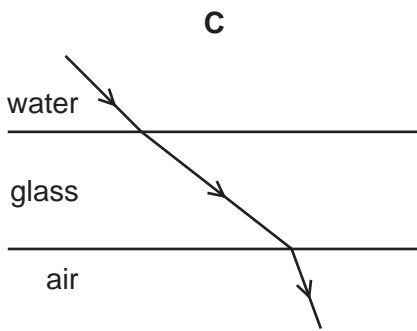
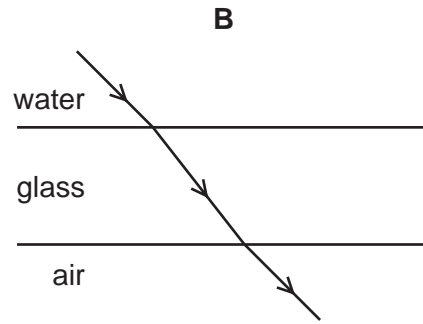
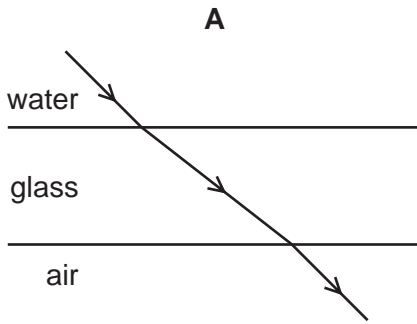
Space for working

13 Which row correctly lists the electromagnetic waves that correspond to wavelengths of 250 nm, 450 nm and 650 nm?

	wavelength 250 nm	wavelength 450 nm	wavelength 650 nm
A	infra-red	red light	blue light
B	infra-red	red light	ultraviolet
C	ultraviolet	blue light	infra-red
D	ultraviolet	blue light	red light

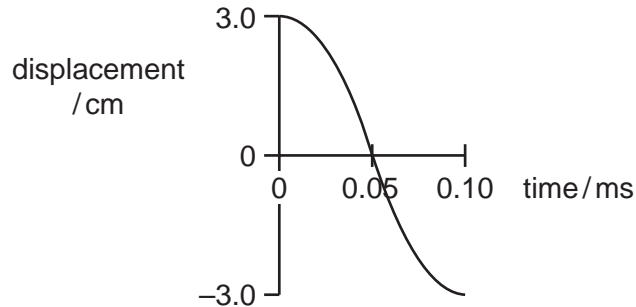
14 A glass table top has a small pool of spilled water on its surface.

Which diagram shows the path of the light beam from a laser pen as it passes through the water, the glass and into the air below?



Space for working

- 15 The graph below shows the variation in the displacement of a particle in a progressive wave with respect to time.



Which row gives the correct values of the frequency and amplitude of the vibration of the particle?

	frequency / kHz	amplitude / cm
A	5.0	6.0
B	10.0	6.0
C	5.0	3.0
D	10.0	3.0

- 16 Pre-natal scanners use ultrasound to create detailed images of developing babies while they are still inside their mother's womb. The finest details that can be resolved are about the same size as the wavelength of the ultrasound.

The speed of ultrasound in human flesh is about 1500 m s^{-1} .

Which frequency of ultrasound has a wavelength closest to 1.0 mm ?

- A** 2 Hz **B** 2 kHz **C** 2 MHz **D** 2 GHz

Space for working

- 17 A vertically polarised beam of light of intensity I_0 enters a polarising filter whose plane of polarisation is at 45° to the vertical.

What is the intensity of the transmitted beam?

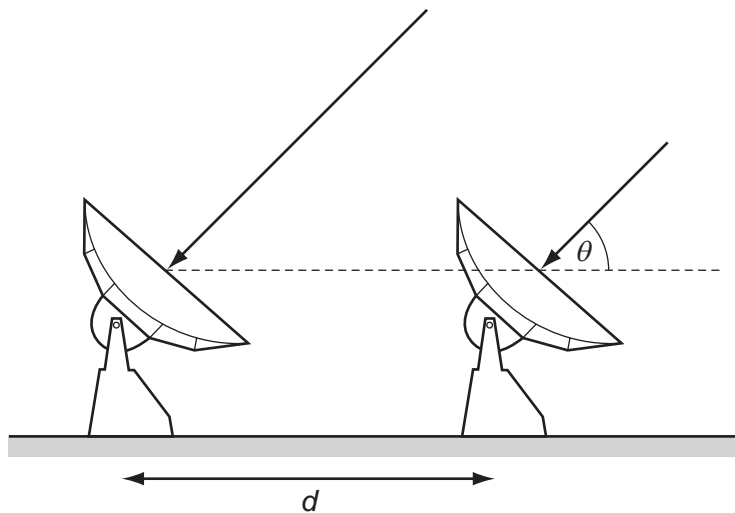
- A zero B $\frac{I_0}{\sqrt{2}}$ C $\frac{I_0}{2}$ D I_0

- 18 A wave has a frequency of 5 Hz. It travels through a medium at a speed of 8 km s^{-1} .

What is the phase difference, in radians, between two points 2 km apart?

- A 0 B $\frac{\pi}{4}$ C $\frac{\pi}{2}$ D π

- 19 Two radio telescopes separated by a distance d detect parallel waves of wavelength λ from the same distant radio source.



What is the correct expression for the path difference between the waves received at the telescopes?

- A $d \sin \theta$ B $d \cos \theta$ C $\frac{d \sin \theta}{\lambda}$ D $\frac{d \cos \theta}{\lambda}$

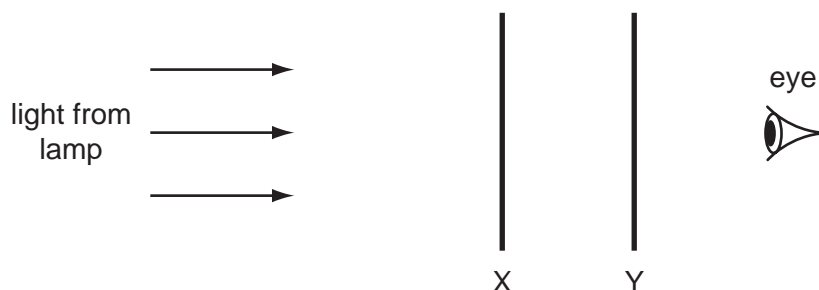
Space for working

- 20 The Rayleigh criterion for resolving power is $\theta \approx \lambda/b$. Two sources of radio waves are at a distance of 1×10^{15} m from Earth. The sources are separated by 1×10^{12} m and emit radio waves of wavelength 0.030 m.

What is the estimate for the diameter of a dish of a radio telescope on Earth that will just resolve the two sources?

- A 3×10^{-5} m
- B 0.03 m
- C 30 m
- D 3×10^{-4} m

- 21 A lamp is viewed through two polarising filters, X and Y.



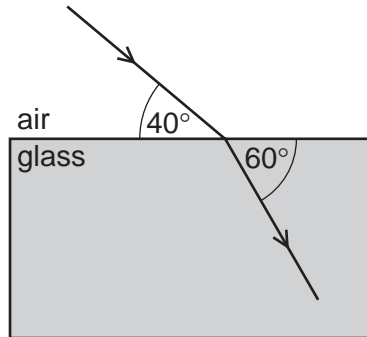
The filters are initially orientated so that the lamp appears with maximum brightness.

Which change in the orientation of the filters will again make the lamp appear with maximum brightness?

	X	Y
A	not turned	turned 90° anticlockwise
B	turned 45° clockwise	turned 45° anticlockwise
C	turned 45° clockwise	turned 90° anticlockwise
D	turned 90° clockwise	turned 90° anticlockwise

Space for working

22 The diagram shows a ray of light passing from air into a glass block.



The angle between the ray and the edge of the glass block is 40° in the air and 60° in the glass.

What is the speed of light in the glass block?

- A $2.0 \times 10^8 \text{ m s}^{-1}$
- B $2.2 \times 10^8 \text{ m s}^{-1}$
- C $4.0 \times 10^8 \text{ m s}^{-1}$
- D $4.6 \times 10^8 \text{ m s}^{-1}$

Space for working

23 Light from distant stars passes through the Earth's atmosphere before it reaches an observer on the surface of the Earth.

Which statement is correct?

- A Refraction causes the apparent star positions to move around the pole star.
- B Refraction causes the stars to appear closer to the horizon than they actually are.
- C Refraction causes the stars to appear higher in the sky than they actually are.
- D Refraction does not affect the apparent positions of stars in the sky.

Space for working

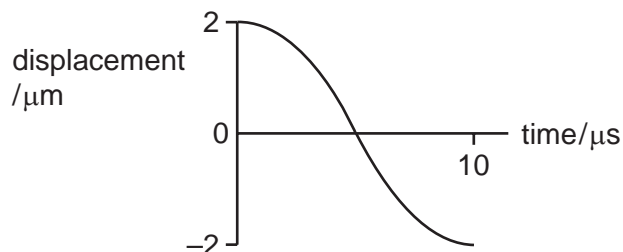
24 A student writes a list of statements about sound waves and radio waves.

Which statement is correct?

- A Radio waves are pressure waves.
- B Radio waves can be plane polarised.
- C Sound waves cannot be refracted.
- D Sound waves travel faster in air than in solids.

Space for working

- 25 The graph shows the variation in the displacement of a particle in a progressive wave with respect to time.



Which row gives the correct values of the frequency and amplitude of the vibration of the particle?

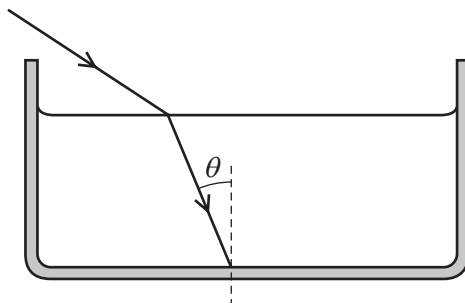
	frequency / kHz	amplitude / μm
A	25	2
B	25	4
C	50	2
D	50	4

- 26 The number of wavelengths of visible light in one metre is of the order of

A 10^4 . **B** 10^6 . **C** 10^8 . **D** 10^{10} .

Space for working

- 27 A light ray enters the water in a tank. The ray strikes the glass bottom of the tank at an angle of incidence θ .



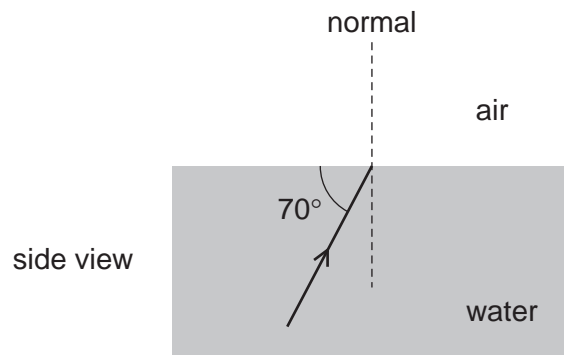
What is the maximum value of θ at which the ray will emerge from the other side of the glass into the air below?

(speed of light in air = $3.00 \times 10^8 \text{ m s}^{-1}$, speed of light in water = $2.25 \times 10^8 \text{ m s}^{-1}$, speed of light in glass = $1.97 \times 10^8 \text{ m s}^{-1}$)

- A** 41.0° **B** 41.4° **C** 48.6° **D** 61.1°

Space for working

- 28 The speed of light in air is $3.0 \times 10^8 \text{ m s}^{-1}$ and the speed of light in water is $2.3 \times 10^8 \text{ m s}^{-1}$. A laser beam strikes a water/air boundary at an angle of 70° to the boundary.



At which angle to the normal does the beam leave the surface?

- A** 15° **B** 20° **C** 26° **D** 46°
- 29 Why does white light passing through a glass prism split into a spectrum of colours?
- A** The frequency of the light changes as it passes into the prism.
B The light is refracted both on entering and leaving the prism.
C The refractive index of the glass depends on its density.
D The refractive index of the glass depends on the wavelength of the light.

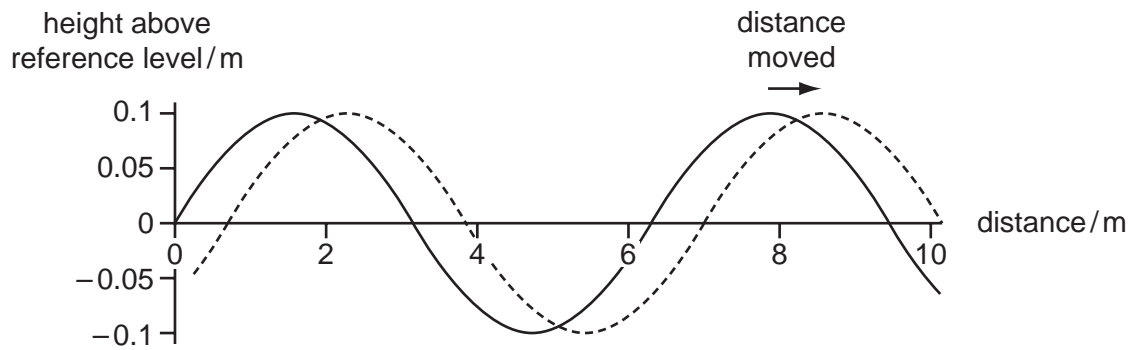
Space for working

30 Which statements are correct for **all** transverse waves?

- 1 The waves are electromagnetic.
- 2 The waves can be polarised.
- 3 The waves can travel through a vacuum.

A 1 only **B** 2 only **C** 1 and 3 only **D** 1, 2 and 3

31 The solid line shows a diagram of a rope on which there is a progressive wave travelling to the right. The dotted line shows the same rope 0.2 s later.



Which statement is correct?

- A** The amplitude of the wave is about 0.2 m.
- B** The frequency of the wave is about 0.6 Hz.
- C** The speed of the wave is about 30 m s^{-1} .
- D** The wavelength of the portion shown is about 10 m.

Space for working

- 32 Which correctly shows regions of the electromagnetic spectrum in order of increasing wavelength?
- A gamma → infra-red → visible → radio
 - B microwave → ultraviolet → visible → infra-red
 - C radio → microwave → infra-red → visible
 - D ultraviolet → visible → infra-red → microwave