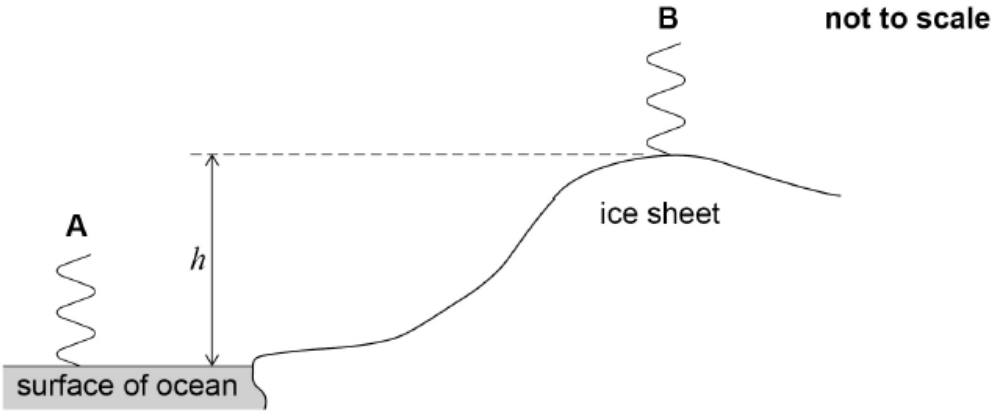
Waves – 2022 AS Physics

1. June /2022/Paper_ 7407/1/No.3

0 3 A satellite system is used to measure the height h of the top of an ice sheet above the surface of the ocean.
The satellite emits two pulses **A** and **B** of infrared radiation. **A** is incident on the surface of the ocean and **B** is incident on the top of the ice sheet as shown in **Figure 2**.

Figure 2



0 3 . 1 The frequency of the infrared radiation is 3.8×10^{14} Hz.
Each pulse has a duration of 6.0 ns.

Calculate the number of cycles in each pulse.

[2 marks]

number of cycles = _____

0 3 . 2 **A** and **B** reflect and return to the satellite. The travel time is the time between the emission of a pulse and its return to the satellite.

The difference in the travel times of **A** and **B** is $10.7\ \mu s$.

Calculate h.

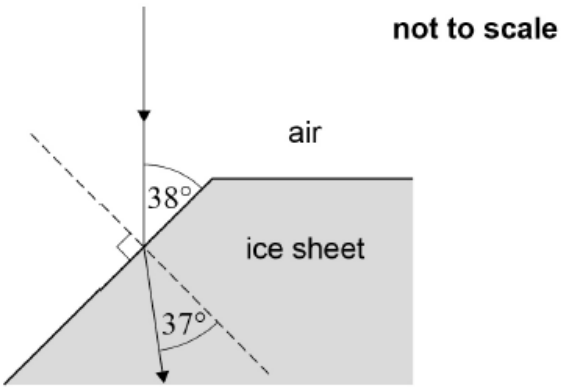
[2 marks]

$h =$ _____ m

Some of the infrared radiation enters the ice sheet.

Figure 3 shows the path of infrared radiation that refracts at a sloping part of the ice sheet.

Figure 3



0 3 . 3 Calculate the refractive index of the ice.

[2 marks]

refractive index = _____

0 3 . 4 Calculate the wavelength of the infrared radiation when it is inside the ice sheet.

[2 marks]

wavelength = _____ m

2. June /2022/Paper_ 7407/2/No.3

0 3 A student buys a portable loudspeaker that is powered by its own internal battery. The battery in the loudspeaker is initially uncharged.

0 3 . 1 The battery is connected to a charger that maintains a constant potential difference of 5.0 V across the battery. It takes 2.6 hours for the battery to become fully charged. The average current in the battery during this time is 2.0 A.

The battery is disconnected from the charger.
The fully-charged battery operates the loudspeaker for 12 hours before it is completely discharged.

Calculate the average output power of the battery during these 12 hours.

[2 marks]

average output power = _____ W

0 3 . 2 A mobile phone transmits data to the loudspeaker using microwaves. The data are processed at the loudspeaker to produce sound waves.

Microwaves and sound waves travel at different speeds.

Describe **two** other differences between microwaves and sound waves.

[2 marks]

1 _____

_____

2 _____

_____

0 3 . 3 A second loudspeaker receives the same data from the mobile phone. The two loudspeakers act as coherent sources of sound waves.

State the **two** conditions required for the sources to be coherent.

[2 marks]

1 _____

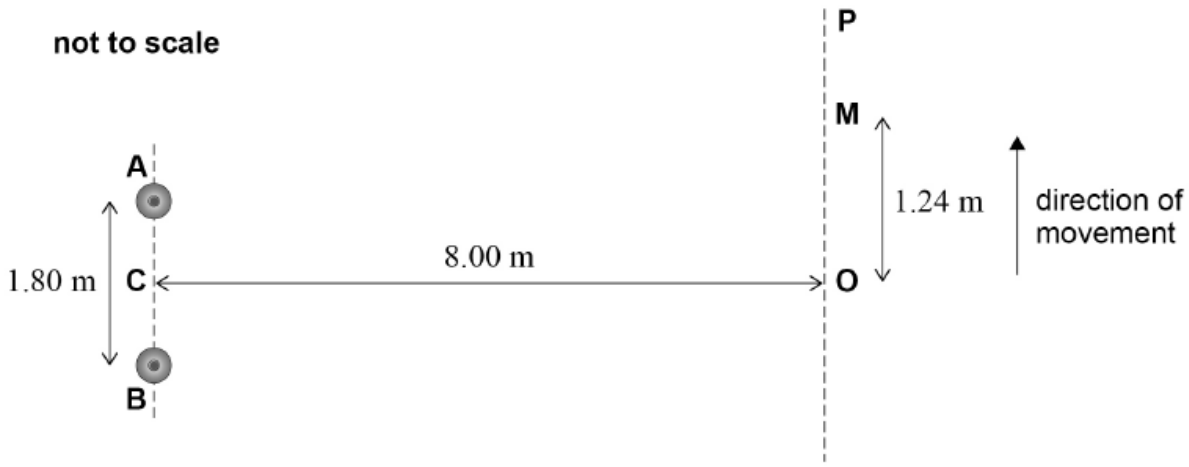
_____

2 _____

_____

Figure 5 shows two loudspeakers **A** and **B** that act as coherent point sources of sound of a single frequency.

Figure 5



C is the midpoint between **A** and **B**.
Distances **OA** and **OB** are equal.
OP is perpendicular to **CO**.

The student uses a sound-level meter to measure the intensity of the sound. The meter detects a maximum intensity at **O**.
The student moves the meter along **OP**. The intensity decreases and reaches a first minimum at **M**. The intensity then increases as the meter moves towards **P**.

The student records the following distances:

AB = 1.80 m
CO = 8.00 m
OM = 1.24 m.

0 3 . 4 Show that the difference between the path lengths **AM** and **BM** is approximately $0.3\ \text{m}$.

[2 marks]

0 3 . 5 The speed of sound is $340\ \text{m s}^{-1}$.

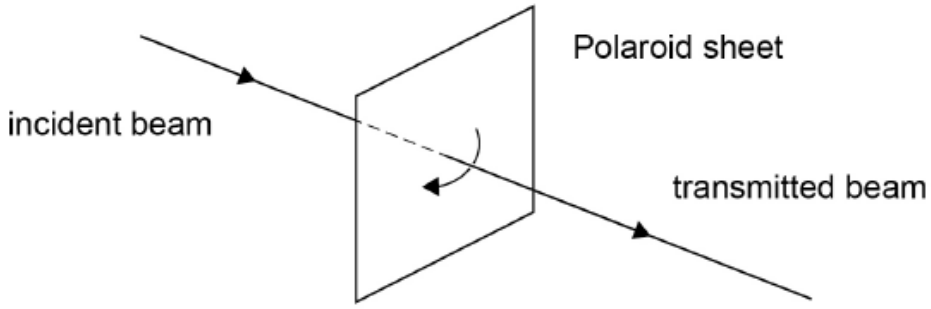
Determine the frequency of the sound waves.

[2 marks]

frequency = _____ Hz

3. June /2022/Paper_ 7407/2/No.11

A narrow beam of light is incident on a sheet of Polaroid material. The intensity of the transmitted beam is a maximum.



The Polaroid sheet is rotated about the beam by $90°$ and the intensity of the transmitted beam decreases to zero.

Which row explains this observation?

[1 mark]

	Nature of incident beam	Action of Polaroid material as it is rotated	
A	unpolarised	polarises the incident beam	⬭
B	unpolarised	absorbs the incident beam	⬭
C	polarised	absorbs the incident beam	⬭
D	polarised	changes the plane of polarisation of the incident beam	⬭

4. June /2022/Paper_ 7407/2/No.14

A mass **M** hangs in equilibrium from a vertical spring that obeys Hooke's law.
M is pulled down by 10 cm and then released to oscillate about the equilibrium position.
M returns to the equilibrium position for the first time 0.50 s after release.

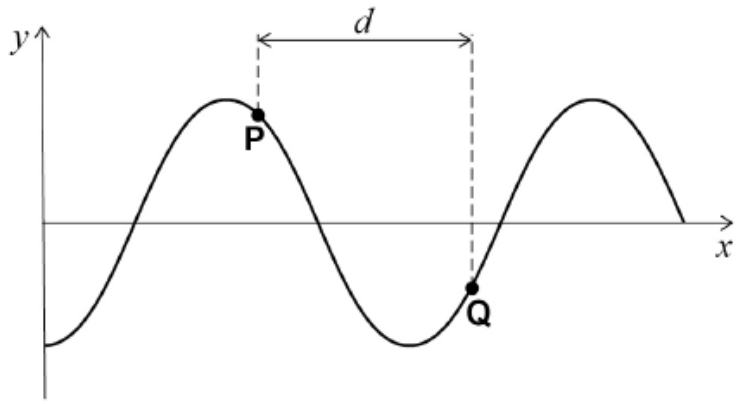
Which row gives the amplitude and the period of the oscillations?

[1 mark]

	Amplitude / cm	Period / s	
A	10	1.0	⬭
B	10	2.0	⬭
C	20	2.0	⬭
D	20	1.0	⬭

5. June /2022/Paper_ 7407/2/No.15

Two points **P** and **Q** on a progressive wave are separated by distance d.



The phase difference between **P** and **Q** is θ rad.

What is the wavelength?

[1 mark]

A $\frac{\theta d}{2\pi}$ ⬭

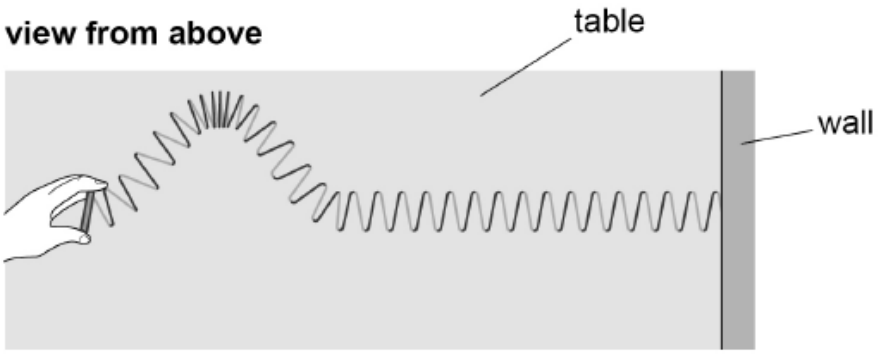
B θd ⬭

C $\frac{2\pi d}{\theta}$ ⬭

D $\frac{d}{\theta}$ ⬭

6. June /2022/Paper_ 7407/2/No.16

A long spring is used to demonstrate wave motion. The spring lies horizontally on a table. One end of the spring is attached to a wall.



The free end of the spring is quickly moved to one side and then back to the centre, creating a pulse.
This movement takes 0.40 s.
The pulse travels 4.0 m along the spring in a time of 2.0 s.

What is the length of the pulse?

[1 mark]

A 0.8 m ⬭

B 1.6 m ⬭

C 2.0 m ⬭

D 10.0 m ⬭

7. June /2022/Paper_ 7407/2/No.17

A stretched wire vibrates between two fixed points.
The frequency of the first harmonic of the vibrating wire is 300 Hz.
Without making any other change, the tension in the wire is doubled.

What is the frequency of the new first harmonic of the wire?

[1 mark]

A 150 Hz ⬭

B 420 Hz ⬭

C 600 Hz ⬭

D 1200 Hz ⬭

8. June /2022/Paper_ 7407/2/No.18

A stationary wave forms on a uniform string.

Which statement is correct?

[1 mark]

A The amplitude of oscillations is a maximum at the nodes. ⬭

B The distance between two adjacent nodes equals one wavelength. ⬭

C The oscillations at two adjacent antinodes are in antiphase. ⬭

D The time period of oscillating sections varies along the string. ⬭

9. June /2022/Paper_ 7407/2/No.19

Monochromatic visible light is incident normally on a plane transmission diffraction grating that has 4.8×10^5 lines m^{-1}.
First-order maxima are observed at angles of $16°$ to the central maximum.

How many maxima in total can be observed?

[1 mark]

A 3 ⬭

B 4 ⬭

C 5 ⬭

D 7 ⬭

10. June /2022/Paper_ 7407/2/No.20

Which combination produces the smallest modal dispersion in an optical fibre?

[1 ma

	Refractive index of core	Refractive index of cladding	
A	1.5	1.4	⬭
B	1.4	1.5	⬭
C	1.5	1.3	⬭
D	1.3	1.5	⬭