4.2 Travelling Waves

Question Paper

Course	DP IB Physics
Section	4. Waves
Topic	4.2 Travelling Waves
Difficulty	Hard

Time allowed: 50

Score: /41

Percentage: /100

Question 1a

Waves can be described as either transverse or longitudinal.

(a)
Illustrate and explain the terms transverse and longitudinal, giving examples of each.

[6]

[6 marks]

Question 1b

A satellite passing Neptune communicates with Earth using a microwave transmitter with an output power of 24.0 W and wavelength 78 900 μm.

The satellite's controller is located on Earth, at a distance of 4.40×10^{12} m when the signal is transmitted.

(b)
For this communication

(i)
Calculate the time taken for the signal to be detected by the controller.

[1]

(ii)
Calculate the energy of a microwave photon.

[2]

[3 marks]

Question 1c

The controller dish aerial has an effective area of 258 m^2.

(c)
For the communication from part (b)

(i)
Determine the power received by the controller dish aerial. You may assume that the power transmitted by the satellite radiates uniformly in all directions.

[2]

(ii)
The actual power received by the controller dish aerial is 1.4×10^{-15} W. Suggest why this is different to the calculated power received.

[2]

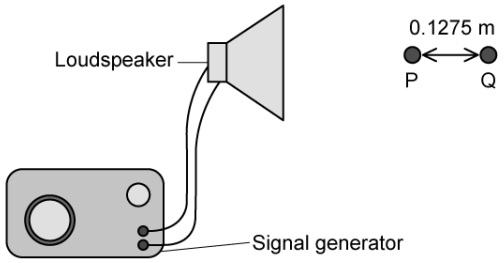
(iii)
Calculate the rate at which microwave photons arrive at the controller dish aerial.

[2]

[6 marks]

Question 2a

A signal generator is connected to a loudspeaker and produces an output signal with 6.70×10^2 oscillations per second.



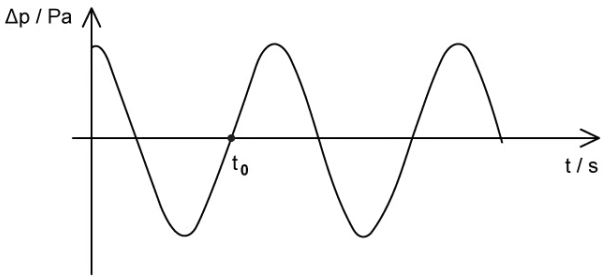
(a)
Determine the wavelength, λ, of the sound wave.

[2]

[2 marks]

Question 2b

The graph shows the change in pressure, Δp, at point P as a function of time, t, as the sound wave passes.



(b)
Deduce the value of t_0.

[1]

[1 mark]

Question 2c

(c)
State the phase of the oscillation at point Q relative to point P and justify your answer.

[2]

[2 marks]

Question 2d

(d)
Suggest and explain one **other** feature of the Δp-t graph that would be different at point Q in relation to point P.

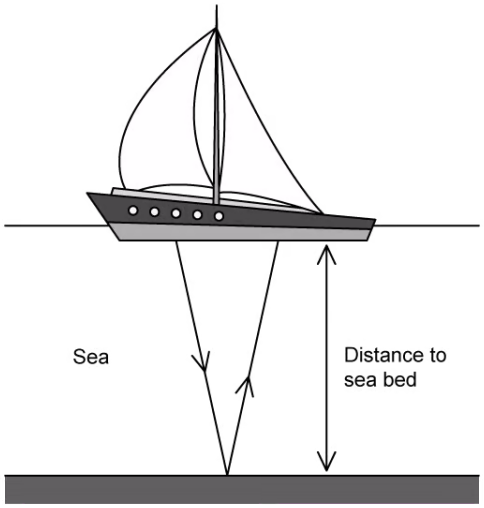
[2]

[2 marks]

Question 3a

Ultrasound is used to measure the depth of oceans, seas and lakes.

The diagram shows a pulse of ultrasound being emitted from the boat, travelling down to the sea bed and being reflected back to the boat.



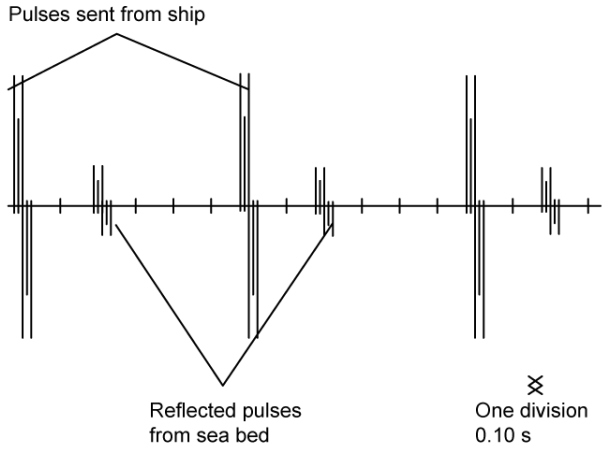
(a)
Outline the term ultrasound

[2]

[2 marks]

Question 3b

A cathode-ray oscilloscope (C.R.O.) is used to trace the ultrasound pulses sent from the boat and the reflected pulses returning to the boat.



The ultrasound travels through water at 1 452 m s^{-1}, and the wavelength of the pulse is 0.023 m.

(b)
For the ultrasound pulses:

(i)
Calculate the frequency

[1]

(ii)
Calculate the distance to the sea bed

[2]

[3 marks]

Question 3c

(c)
The boat moves out to an area where the sea is deeper.

(i)
State and explain two changes that would occur on the cathode-ray oscilloscope trace. You may include diagrams in your answer.

[4]

(ii)
When the sea is over 450 m deep, the pulses must be transmitted less frequently. Explain why this is the case.

[4]

[8 marks]

Question 4a

A boulder falls into a lake and ripples propagate radially outwards. Two boats on the surface of the water are in line with the source and perform the simple harmonic motion, bobbing up and down as the ripples pass by. The boats are separated by a distance of 45 m.

Two observations were recorded; the first ripple took 3.8 s to travel between the boats; the boats are completely out of phase.

(a)
Calculate the speed of the water wave.

[2]

[2 marks]

Question 4b

(b)
Explain why the amplitude of the wave will decrease with increasing distance from the source.

[4]

[4 marks]