AS Level Physics

Chapter 4 – Waves

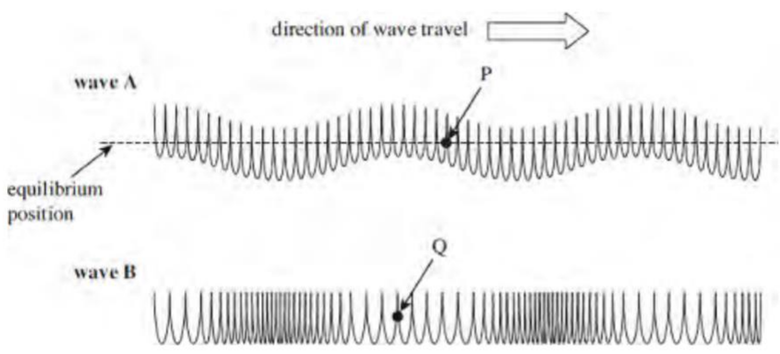
4.1.2 Wave Motion

Worked Examples

Waves

Exam Style Question 1

The figure below shows two ways in which a wave can travel along a slinky spring.



(a) State and explain which wave is longitudinal.

(b) On the figure above,

(i) clearly indicate and label the wavelength of wave B

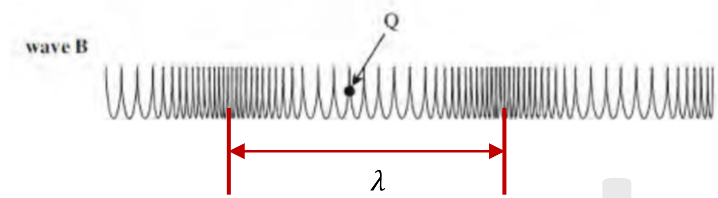
(ii) use arrows to show the direction in which the points P and Q are about to move as each wave moves to the right.

Waves

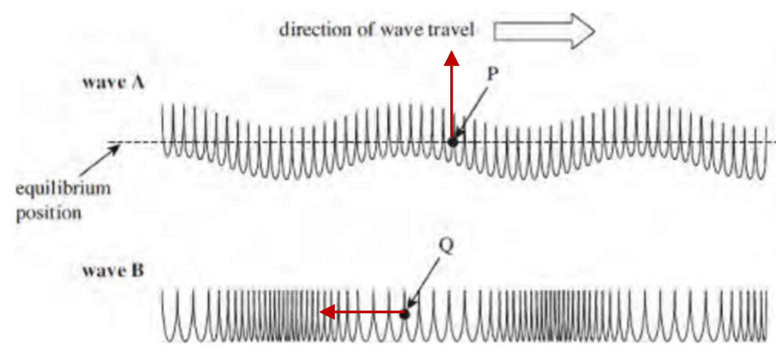
Exam Style Question 1

(a) State and explain which wave is longitudinal.
Wave B. The parts of the spring oscillate back and forth in the direction of wave travel.

(b) On the figure above,
(i) clearly indicate and label the wavelength of wave B.



(ii) use arrows to show the direction in which the points P and Q are about to move as each wave moves to the right.



Waves

Exam Style Question 2

(a) Define the terms wavelength, frequency and speed used to describe a progressive wave.

- wavelength, λ
- frequency, f
- speed, v

(b) Hence derive the wave equation $v = f\lambda$ which relates these terms together.

Waves

Exam Style Question 2

(a) Define the terms wavelength, frequency and speed used to describe a progressive wave.

- **wavelength, λ**

The wavelength of a wave is the distance between adjacent crests (or troughs).

- **frequency, f**

The number of complete waves passing a fixed point per second.

- **speed, v**

Speed is the distance travelled by the wave per unit time.

(b) Hence derive the wave equation $v = f\lambda$ which relates these terms together.

The speed on a particle on a wave is given by:

$$speed = \frac{distance}{time}$$

In one time period (T) the wave will travel a distance equal to a full wavelength (λ) therefore:

$$\text{Wave speed, } v = \frac{distance\ travelled}{time\ taken} = \frac{\lambda}{T}$$

And since, $T = \frac{1}{f}$, we get

$$v = \frac{\lambda}{1/f}$$

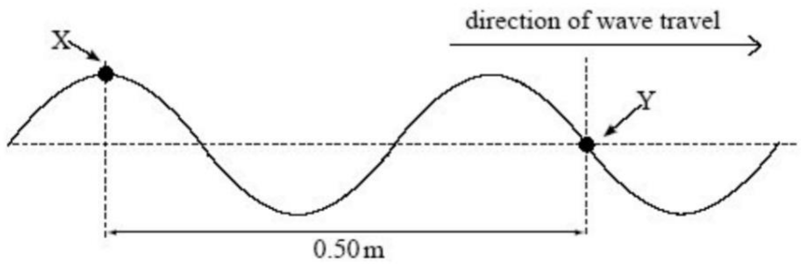
Therefore:

$$v = f\lambda$$

Waves

Exam Style Question 3

(a) The diagram below represents a progressive wave travelling from left to right on a stretched string.



(i) Calculate the wavelength of the wave.

(ii) The frequency of the wave is $22\ Hz$. Calculate the speed of the wave.

(iii) State the phase difference between points X and Y on the string, giving an appropriate unit.

(b) Describe how the displacement of point Y on the string varies in the next half-period.

Waves

Exam Style Question 3

(a) (i) Calculate the wavelength of the wave.

Between X and Y there are five $one - quarter\ (1/4)$ waves.

Therefore each quarter wave is $\frac{0.50\ m}{5} = 0.10\ m.$

One complete wave is made up of 4 quarters therefore:

$$wavelength = 0.10\ m \times 4 = 0.40\ m$$

So wavelength is 0.40 m.

(a) (ii) The frequency of the wave is $22\ Hz$. Calculate the speed of the wave.

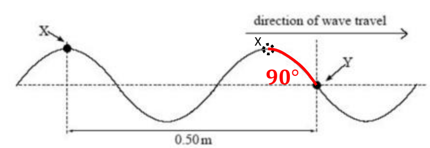
Use $v = f\lambda$

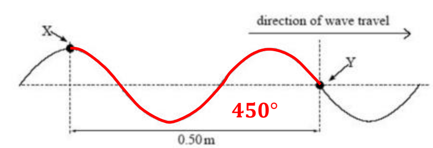
$$v = (22\ Hz)(0.40\ m) = 8.8\ m\ s^{-1}$$

(a) (iii) State the phase difference between points X and Y on the string, giving an appropriate unit.

Point Y lags behind X by:

$$90° \ or\ 450°$$





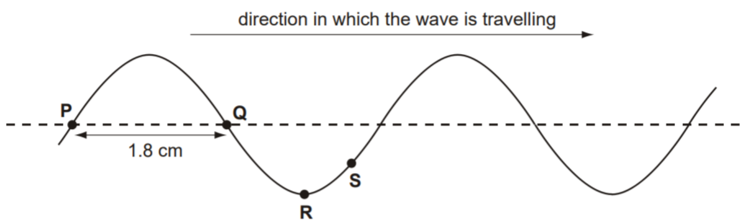
(b) Describe how the displacement of point Y on the string varies in the next half-period.

Displacement of Y will be a positive (or up) at $\frac{1}{4}$ of a cycle. At $\frac{1}{2}$ cycle Y returns to original position.

Waves

Exam Style Question 4

The figure below shows, at a given instant, the surface of the water in a ripple tank when plane water waves are travelling from left to right.



(a) Show on the figure

(i) the amplitude of the wave – label this A.

(ii) the wavelength – label this λ.

(b) On the figure above draw the position of the wave a short time, about one-tenth of a period, later.

(c) State the phase difference between the movement of particles at P and Q.

(d) The frequency of the wave is 25 Hz and the distance between P and Q is 1.8 cm. Calculate

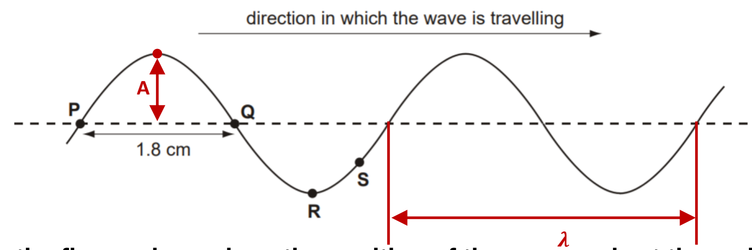
(i) the period of the wave,

(ii) the speed of the wave.

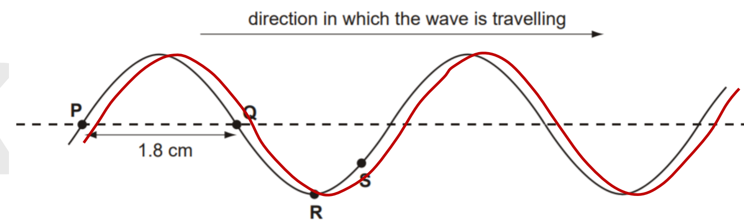
Waves

Exam Style Question 4

(a)Show on the figure
(i) the amplitude of the wave – label this A.
(ii) the wavelength – label this λ.



(b) On the figure above draw the position of the wave a short time, about one-tenth of a period, later.



(c) State the phase difference between the movement of particles at P and Q.

$$phase\ difference = 180° \ or\ \pi$$

(d) Calculate
(i) the period of the wave,
Use $T = \frac{1}{f}$

$$T = \frac{1}{25\ Hz} = 0.04\ s$$

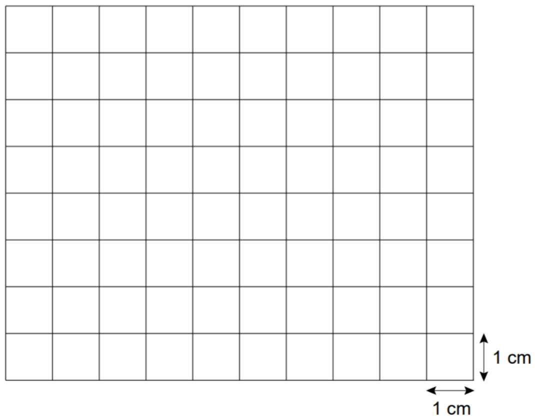
(ii) the speed of the wave.
Use $v = f\lambda$

$$\lambda = 1.8\ cm \times 2 = 3.6\ cm = 0.036\ m$$
$$v = (25\ Hz)(0.036\ m) = 0.90\ m\ s^{-1}$$

Oscilloscope

Exam Style Question 5

The diagram below represents the screen of a cathode ray oscilloscope (c.r.o.).



The time-base setting is $0.50\ ms\ cm^{-1}$ and the voltage (y-gain) setting is $2.0\ mV\ cm^{-1}$. A microphone connected to the c.r.o. detects a pure (sinusoidal) sound wave note of frequency $500\ Hz$.

(i) Calculate the period of the note.

(ii) The amplitude of the signal from the microphone produced by the note is $6.0\ mV$.

Draw on the diagram above the trace produced on the c.r.o. screen when the microphone detects the sound wave. Draw at least two full cycles of the wave on the diagram.

(iii) The speed of sound in air is $330\ m\ s^{-1}$. Calculate the wavelength of the sound received by the microphone.

Oscilloscope

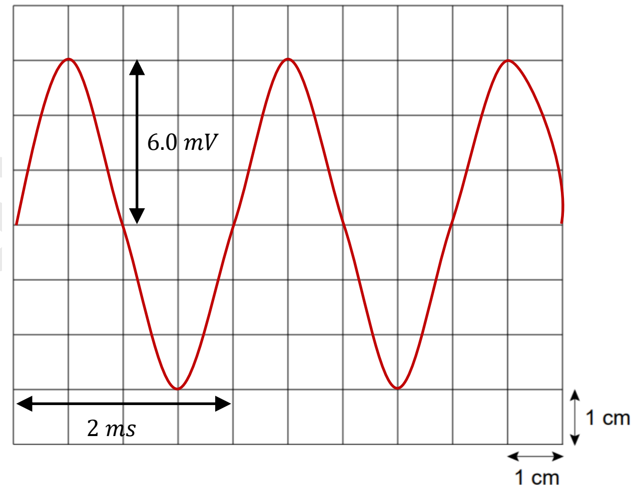
Exam Style Question 5

(i) Calculate the period of the note.

Use $T = \frac{I}{f}$

$$T = \frac{1}{500\ Hz} = 2 \times 10^{-3}\ s = 2\ ms$$

(ii) Draw on the diagram above the trace produced on the c.r.o. screen when the microphone detects the sound wave. Draw at least two full cycles of the wave on the diagram.



(iii) Calculate the wavelength of the sound received by the microphone.

Use $v = f\lambda$ and rearrange for λ:

$$\lambda = \frac{v}{f} = \frac{330\ m\ s^{-1}}{500\ Hz} = 0.66\ m$$

Polarisation

Exam Style Question 6

(a) State two properties which distinguish electromagnetic waves from other transverse waves.

(b) Describe what is meant by a plane polarised wave.

(c) Light from a filament lamp is viewed through two polarising filters, shown in Fig. 6.1. The arrow beside each filter indicates the transmission axis of that polarising filter.

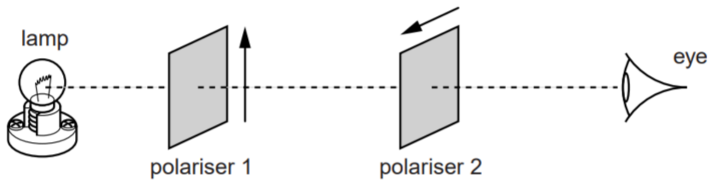


Fig. 6.1

Explain why the lamp cannot be seen by the eye.

Polarisation

Exam Style Question 6

(a) State two properties which distinguish electromagnetic waves from other transverse waves.

- All EM waves travel at the speed of light through a vacuum.
- EM waves are made up of oscillating electric fields and magnetic fields.

(b) Describe what is meant by a plane polarised wave.

Oscillations of particles/EM fields along the wave are in one direction only and are perpendicular to the direction in which the waves travels.

(c) Explain why the lamp cannot be seen by the eye.

- Ordinary light waves are made up of a variety of vibrations in different directions.
- When the light passes through polariser 1 it is vertically polarised.
- Polariser 2 is in the horizontal plane and will only allow horizontally polarised light to get through.
- So when our vertically polarised light reaches polariser 2, no light will pass through and therefore no light reaches the eye.

Please see **'4.1.1 Wave Motion notes'** pack for revision notes.

For more revision notes, tutorials and worked examples please visit **www.tutorpacks.co.uk.**

tutorpacks.co.uk