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SESSION 4: TRANSVERSE PULSES

KEY CONCEPTS:

In this session we will consider:

- How to define and describe a transverse pulse and its properties and characteristics as well transverse waves.
- Important calculations with waves and some phenomena which are specific to transverse waves.

TERMINOLOGY:

Medium: A medium is the substance or material in which a wave will move.

Pulse: A pulse is a single disturbance that moves through a medium

Transverse pulse: A pulse where all the particles disturbed by the pulse move perpendicular (at right angles) to the direction in which the pulse is moving.

Pulse Speed: Pulse speed is the distance a pulse travels per unit time.

Constructive interference: Constructive interference is when two pulses meet, resulting in a bigger pulse.

Destructive interference: Destructive interference is when two pulses meet, resulting in a smaller pulse.

Wave: A wave is periodic, continuous disturbance that consists of a train (series) of pulses

Transverse wave: A transverse wave is a wave where the movement of the particles of the medium is perpendicular (at a right angle) to the direction of propagation of the wave.

Crest: A crest is a point on the wave where the displacement of the medium is at a maximum.

Troughs: A point on the wave is a trough if the displacement of the medium is at a minimum.

Amplitude: The amplitude is the maximum displacement of a particle from its equilibrium position

Wavelength: The wavelength (λ) of a wave is the distance between any two adjacent points that are in phase.

Period (T): The period (T) is the time for two successive crests (or troughs) to pass a fixed point.

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Frequency (f): The frequency is the number of successive crests (or troughs) passing a given point in 1 second.

X-PLANATION

Calculations for Transverse pulses

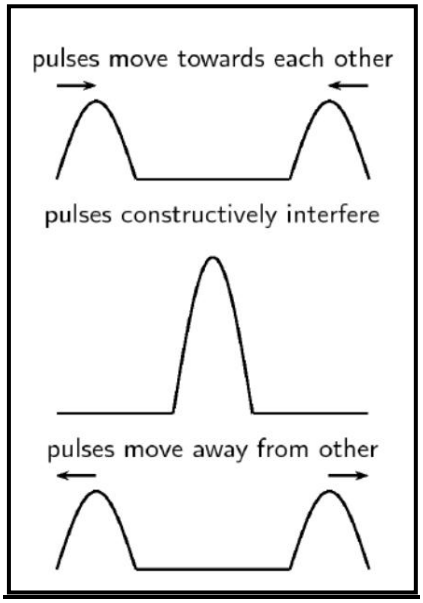
To calculate the speed of the pulse, we can use a very simple equation:

$$v = \frac{D}{t}$$

Where: v = speed measured in $m.s^{-1}$
D = distance travelled measured in m
t = time taken measured in s

Superposition of Two Pulses

1. Constructive Interference



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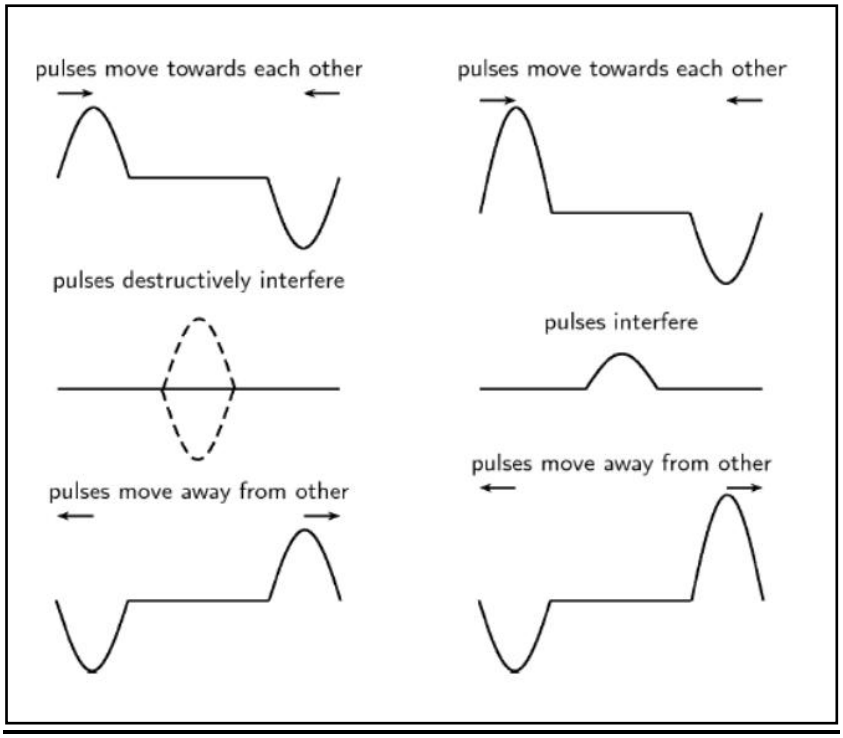
2. Destructive interference



TRANSVERSE WAVES

When series of pulses are produced, in a regular, repetitive manner, a wave is formed. If the pulses are transverse pulses, then the wave formed in a transverse wave.

The frequency of the wave tells us how many waves pass a point in one second. Frequency has the unit Hertz, which means per second.

Period and frequency are closely related to each other.
$f = \frac{1}{T}$ and $T = \frac{1}{f}$

Where: f = frequency of the wave measured in Hertz (Hz)
T = period measured in seconds (s)

With a pulse, we were able to calculate the speed of the pulse by using the equation: $v = \frac{D}{t}$

The speed of a transverse wave can also be calculated using this equation. But we can use more specific values.

The distance (D) is the wavelength (λ) of the transverse wave (the distance between two points in phase), the time taken for the wave to move this distance is the period of the wave. (Remember period is the time taken for the one wavelength to move pass a point)

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So the equation changes as follows:

$$v = \frac{D}{t}$$
$$v = \frac{\lambda}{T}$$

But we know that: $T = \frac{1}{f}$

So this means that

$$v = \frac{\lambda}{\frac{1}{f}}$$
$$\therefore \quad v = \lambda \times \left(\frac{f}{1}\right)$$
$$\boxed{v = \lambda \cdot f}$$

Where: v = speed measured in $m.s^{-1}$
λ = wavelength measured in m
f = frequency measured in Hz

X-AMPLE QUESTIONS

Question 1:

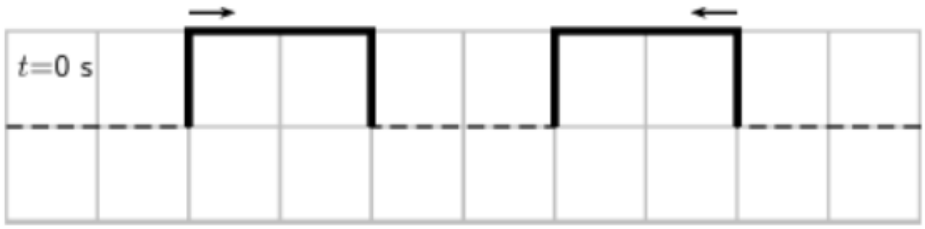
A pulse covers a distance of 5 m in 15s. Calculate the speed of the pulse.

Question 2:

A pulse has a speed of $0,5m.s^{-1}$. How long does it take to cover a distance of 25cm?

Question 3:

For the following pulse, draw the resulting wave forms after 1 s, 2 s, 3 s, 4 s and 5 s. Each pulse is travelling at $1m \cdot s^{-1}$. Each block represents 1m. The pulses are shown as thick black lines and the undisplaced medium as dashed lines.



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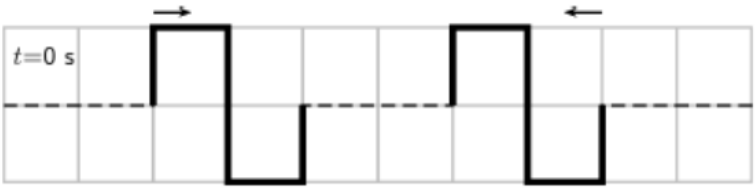
Question 4:

For the following pulse, draw the resulting wave forms after 1 s, 2 s, 3 s, 4 s and 5 s. Each pulse is travelling at $1m \cdot s^{-1}$. Each block represents 1m. The pulses are shown as thick black lines and the undisplaced medium as dashed lines.



Question 5:

A heavy rope is flicked upwards, creating a single pulse in the rope. Make a drawing of the rope and indicate the following in your drawing:

a. The direction of motion of the pulse
b. Amplitude
c. Pulse length
d. Position of rest

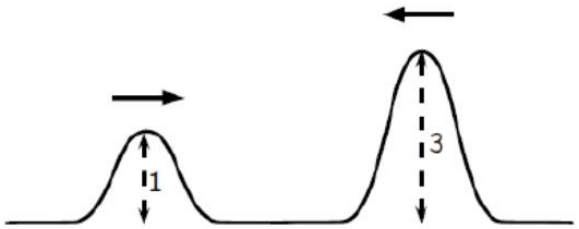
Question 6:

A pulse has a speed of 2, $5m \cdot s^{-1}$. How far will it have travelled in 6 s?

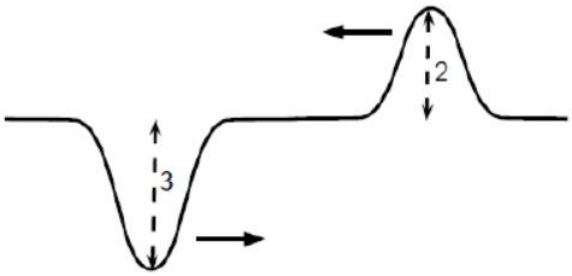
Question 7:

The following diagrams each show two approaching pulses. Redraw the diagrams to show what type of interference takes place, and label the type of interference.

a)

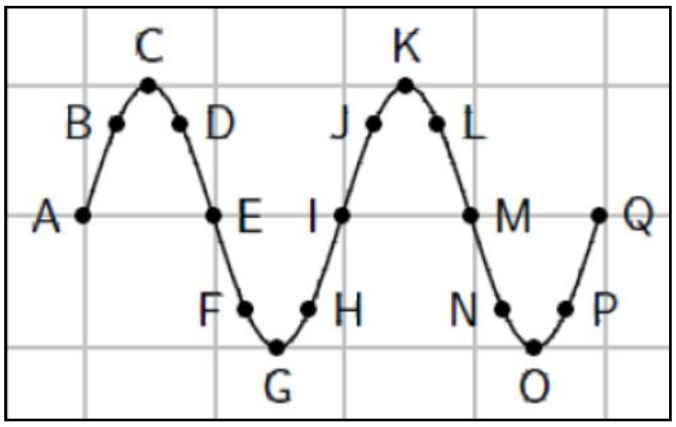


b)



Question 8:

Study the following diagram and answer the questions:



a) Identify two sets of points that are in phase.
b) Identify two sets of points that are out of phase.
c) Identify any two points that would indicate a wavelength.

Question 9:

A fly flaps its wings back and forth 200 times each second. Calculate the period of a wing flap.

Question 10:

Microwave ovens produce radiation with a frequency of 2 450 MHz (1 MHz = 10^6 Hz) and a wavelength of 0,122 m. What is the wave speed of the radiation?

Question 11:

A wave travels along a string at a speed of 1, 5m $\cdot$ s^{-1}. If the frequency of the source of the wave is 7,5 Hz, calculate:

a) the wavelength of the wave
b) the period of the wave

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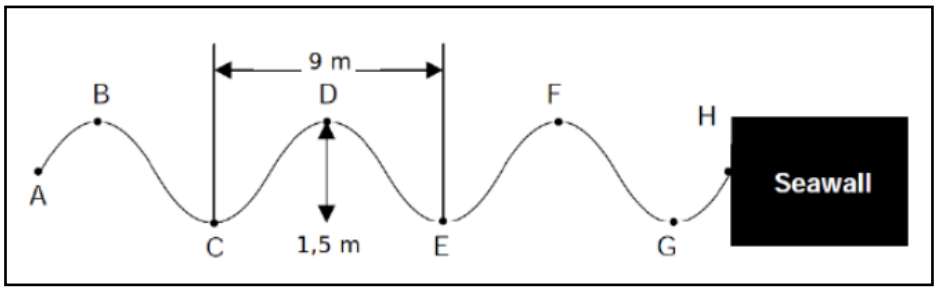
Question 12:

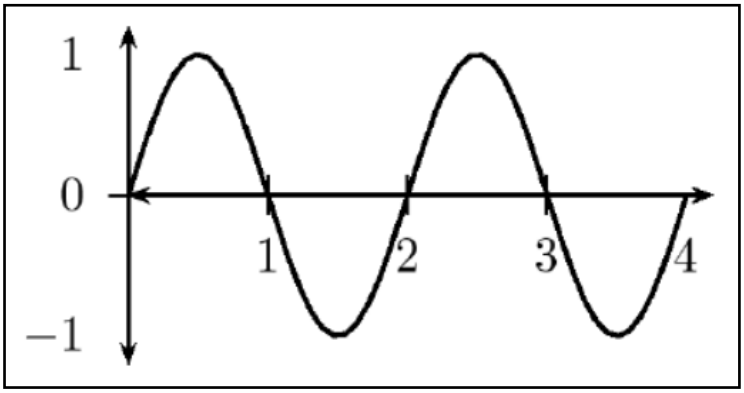
Water waves crash against a seawall around the harbour. Eight waves hit the seawall in 5 s. The distance between successive troughs is 9 m. The height of the wave from trough to crest is 1,5 m.



a) How many complete waves are indicated in the sketch?
b) Write down the letters that indicate any TWO points that are:
   i. in phase
   ii. out of phase
   iii. Represent ONE wavelength.
c) Calculate the amplitude of the wave.
d) Show that the period of the wave is 0,67 s.
e) Calculate the frequency of the waves.
f) Calculate the velocity of the waves.

Question 13:

You are given the transverse wave below:



Draw the following:
a. A wave with twice the amplitude of the given wave.
b. A wave with half the amplitude of the given wave.
c. A wave travelling at the same speed with twice the frequency of the given wave.
d. A wave travelling at the same speed with half the frequency of the given wave.
e. A wave with twice the wavelength of the given wave.
f. A wave with half the wavelength of the given wave.
g. A wave travelling at the same speed with twice the period of the given wave.
h. A wave travelling at the same speed with half the period of the given wave.