CAIE Physics A-level

7 - Waves

Flashcards

Define the term ‘progressive wave’.

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A wave which transfers energy from one place to another in a wave front, which travels through material (in contrast to stationary waves, which don’t purvey a net transfer of energy).

What is a longitudinal wave?

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Longitudinal waves are those in which particles oscillate in the same direction as the direction of energy propagation.

They comprise rarefactions (areas of low pressure) and compressions (areas of high pressure).

What is a transverse wave? Give examples.

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Transverse waves are those in which particle oscillations are oriented perpendicularly to the direction of energy propagation.

For example electromagnetic waves.

Describe the motion of a rope if you move it up and down but your partner at the other end of the rope holds it still. Classify this wave.

Describe the motion of a rope if you move it up and down but your partner at the other end of the rope holds it still. Classify this wave.

The rope will form a vertically oscillating wave that travels towards your partner and decreases in amplitude as it moves away from you. This is a transverse progressive wave.

Describe the motion of a spring if you suddenly hang a mass from the end of it. Classify the wave produced.

Describe the motion of a spring if you suddenly hang a mass from the end of it. Classify the wave produced.

The spring will begin to oscillate up and down around a central position of equilibrium. It will eventually come to rest at this point of equilibrium. The wave produced is longitudinal and standing.

Describe the motion of water particles in a ripple tank. Classify the wave produced.

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The particles will oscillate up and down but the wave will travel across the surface of the water linearly. The wave produced is progressive and transverse.

Define frequency and give its units.

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The number of waves passing through a point per second.

Units of Hertz (Hz) or s^{-1}

Define wavelength.

Define wavelength.

The distance between two adjacent corresponding points (eg. peaks) on a wave.

Define amplitude.

Define amplitude.

The maximum displacement of the wave from its equilibrium position.

How can you calculate the time period of a wave using its frequency?

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$$T = 1/f$$

How can you determine the velocity of a progressive wave from its frequency and its wavelength?

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Frequency is the number of oscillations to pass a point per second and the wavelength is the length of one oscillation. Therefore, since velocity is displacement/time, the velocity of the wave must be the product of these quantities: $v = f\lambda$

What is the phase difference of a wave and what is it measured in?

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The amount one wave lags behind another as a proportion of the wavelength. Measured in radians or degrees.

What do each of the ‘axes’ on an oscilloscope measure?

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Vertical divisions = voltage / amplitude of the wave

Horizontal divisions = time (can be used to find time period and frequency)

What is the y-gain and the time-base setting on the oscilloscope?

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They are calibration factors that allow us to view the wave on the oscilloscope, but also to figure out the amplitude and frequency of the wave. The y-gain determines the number of volts ‘per division’ (amplitude) on the vertical scale. The time-base setting dictates the time ‘per division’ on the horizontal scale.

How is intensity defined in terms of power?

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Intensity is power / area

How are intensity and amplitude related?

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Intensity is proportional to amplitude^2

How do you determine the frequency of sound with a CRO?

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First you find the time period of the wave using the CRO. This involves counting the squares for one wave period and multiplying by the time for each square. Then using f=1/T find the inverse of this to find the frequency of the wave.

How do you calculate the wavelength of sound using a stationary wave?

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Find the distance D between the nodes and antinodes and then use:

$$\frac{1}{2}\lambda = D$$

What is the doppler effect?

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It is an observed change in the frequency of any wave caused by the movement of the wave source relative to the observer. When the source moves towards the observer, each vibration reaches the observer in a time less than the previous vibration.

What is the frequency change in the doppler effect dependent on?
State the equation for the observed frequency.

What is the frequency change in the doppler effect dependent on? State the equation for the observed frequency.

The frequency (and wavelength) change in dependent on the velocity of the source relative to the observer.

$$f_o = \frac{f_s v}{(v \pm v_s)}$$

True or false? All electromagnetic waves have the same time period.

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False.

They all travel at the same speed - but their wavelengths, frequencies and hence periods vary.

How fast do electromagnetic waves travel in a vacuum?

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3×10^8 m/s ('the speed of light')

True or False? The magnetic field and electric field in an electromagnetic wave are parallel to each other.

True or False? The magnetic field and electric field in an electromagnetic wave are parallel to each other.

False.

The electric and magnetic field are perpendicular to each other.

Put the following in order from highest to lowest frequency:
X-rays, Radio, Microwaves, UV, Visible

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Highest: X-rays

UV

Visible

Microwaves

Lowest: Radio

What is the highest frequency form of EM radiation?

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Gamma radiation $>10^{19}$Hz

Which type of EM radiation has a wavelength of approximately 1μm?

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Infra-red is between ~700nm and 1mm

What is the range of wavelengths commonly known as ‘visible light’?

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400-700 nm

True or false? Microwaves can be polarised using a metal grid rather than a polarising filter.

True or false? Microwaves can be polarised using a metal grid rather than a polarising filter.

True - this is because the wavelength of microwaves is sufficiently large that the grid works as a polarising filter.

What is polarisation?

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Polarisation is the process of blocking all but one plane of vibration of a transverse wave. For example a light polarising filter blocks light oscillating at all but one orientation.

What is the difference between a polarised and unpolarised wave?

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Polarised waves only contain waves oscillating along one axis.

Unpolarised waves can be oscillating in any direction perpendicular to the axis of propagation.

Why can't longitudinal waves be polarised?

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Since particles in a longitudinal wave oscillate parallel to the direction of propagation of the wave, polarisation can have no effect. Either the wave is blocked completely or not at all.

How is the intensity of a transverse wave affected by polarisation?

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When passing through a polarising filter, the intensity of the wave either reduces or remains unchanged. This behaviour is defined by Malus's law: $I = I_0\cos^2\theta$. Where I is the intensity after passing through the filter, I_0 is the intensity before passing through the filter and θ is the angle of entry from the angle at which $I = I_0$

Polarised light is being passed through a rotating polarisation filter. What would happen to the intensity of the light passing through?

Polarised light is being passed through a rotating polarisation filter. What would happen to the intensity of the light passing through?

It would vary from a maximum (all light passes through) when the axis of polarisation and the axis of the filter line up, to a minimum (no light passes through) when the axes are perpendicular.