CIE A-Level Physics

14 - Waves

Flashcards

Define the term ‘progressive wave’.

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A wave which transfers energy from one place to another with a wave front which travels through the material (in contrast to stationary waves which don’t appear to move).

What is a longitudinal wave?

What is a longitudinal wave?

Waves for which the particles oscillate in the same direction as energy propagation.

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

What is a transverse wave? Give examples.

What is a transverse wave? Give examples.

Waves for which the particle oscillations are perpendicular to the energy propagation.

For example electromagnetic waves.

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?

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

$$T = 1/f$$

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

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

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?

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

Vertical divisions = voltage / amplitude of the wave

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

How is intensity defined in terms of power?

How is intensity defined in terms of power?

Intensity is power / area

How are intensity and amplitude related?

How are intensity and amplitude related?

Intensity is proportional to amplitude^2

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

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

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?

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

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

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

What is the doppler effect?

What is the doppler effect?

It is an observed change in the frequency of any wave when the source of the wave is moving. When the source of a wave moves towards the observer, each disturbance reaches the observer in a time less than the previous disturbance.

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.

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

False.

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

How fast do electromagnetic waves travel in a vacuum?

How fast do electromagnetic waves travel in a vacuum?

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 at right angles 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

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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300-700 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 are ultrasound waves?

What are ultrasound waves?

Sound waves with a frequency greater than 20,000 Hz (above the range of human hearing).

What happens when an ultrasound wave meets a boundary between 2 different materials?

What happens when an ultrasound wave meets a boundary between 2 different materials?

Some of it is reflected and some is transmitted and will refract when the angle of incidence isn't 0°. The amount of reflection depends on the different in acoustic impedance (Z) between the materials.

The speed of sound in air is 340 ms^{-1} and air's density is 1.2 kgm^{-3}, calculate the acoustic impedance of air.

The speed of sound in air is 340 ms^{-1} and air's density is 1.20 kgm^{-3}, calculate the acoustic impedance of air.

$$Z = 1.2 \times 340 = 408\ kgm^{-2}s^{-1}$$

State the equation used to calculate the fraction of ultrasound wave intensity reflected.

State the equation used to calculate the fraction of ultrasound wave intensity reflected.

$$\frac{I_r}{I_i} = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$$

I_r= intensity of reflected wave, Wm^{-2}

I_i= intensity of incident wave, Wm^{-2}

Z_2=acoustic impedance of 2nd material, $kgm^{-2}s^{-1}$

Z_1=acoustic impedance of 1st material,$kgm^{-2}s^{-1}$

Complete the sentence: If 2 materials have the same impedance then ….. reflection occurs.

Complete the sentence: If 2 materials have the same impedance then ….. reflection occurs.

If 2 materials have the same impedance then no reflection occurs.

‘Ultrasound waves are attenuated when they travel through a material’
What is attenuation?

‘Ultrasound waves are attenuated when they travel through a material’ What is attenuation?

When the waves are absorbed and scattered.The higher the frequency of a wave or impedance of a material the more attenuation the wave undergoes.

What is a transducer?

What is a transducer?

A device which converts one form of energy into another.

What do piezoelectric crystals do when they are deformed?

What do piezoelectric crystals do when they are deformed?

Produce a potential difference (the piezoelectric effect), as the change in their structure moves the centres of symmetry of their electric charges.

What happens when you apply a voltage across a piezoelectric crystal?

What happens when you apply a voltage across a piezoelectric crystal?

The crystal deforms, if the voltage is alternating then it vibrates at the same frequency.

True or false? A piezoelectric crystal can only act as a transmitter of ultrasound.

True or false? A piezoelectric crystal can only act as a transmitter of ultrasound.

False.

It can act as both a receiver (converting ultrasound to alternating p.d) and a transmitter (converting alternating p.d into ultrasound).

What is the relationship between the thickness of the crystal and the wavelength it produces?

What is the relationship between the thickness of the crystal and the wavelength of the ultrasound it produces?

The crystal thickness is half the wavelength of the ultrasound.

Why is the piezoelectric crystal in ultrasound devices heavily damped?

Why is the piezoelectric crystal in ultrasound devices heavily damped?

To produce short pulses and increase the resolution of the device.

Why is a coupling medium needed between the ultrasound transducer and the body?

Why is a coupling medium needed between the ultrasound transducer and the body?

The acoustic impedance of the body is very different to air so most ultrasound energy is reflected. The coupling medium (oil or gel) has an impedance closer to body tissue (impedance matching) so more ultrasound is transmitted.

How are the uses for amplitude (A) scans and brightness (B) scans different?

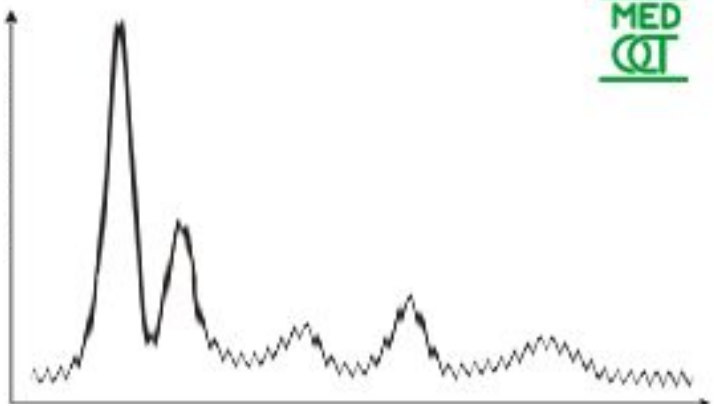
How are the uses for amplitude (A) scans and brightness (B) scans different?

Both are ultrasound scans but B scans are used to create images and A scans are used to measure distances e.g. the depth of an eyeball.

In an A-scan how do reflected ultrasound pulses appear on the cathode ray oscilloscope (CRO) screen?

In an A-scan how do reflected ultrasound pulses appear on the cathode ray oscilloscope screen?

As vertical deflections.



https://upload.wikimedia.org/wikipedia/commons/archive/b/b3/20051211134709%21A-mode_scan.png

What is the process of amplifying weaker pulses that have travelled further called?

What is the process of amplifying weaker pulses that have travelled further called?

Time gain compensation.

What do the horizontal positions of the reflected pulses on the CRO indicate?

What do the horizontal positions of the reflected pulses on the CRO indicate?

The time taken for the reflection to return. They can be used to work out distances since the speed of the ultrasound is known.

In which direction does the electron beam sweep across the CRO screen in an A-scan? What direction is it for a B scan?

In what direction does the electron beam sweep across the CRO screen in an A-scan?

Horizontally for A scans, vertically down for B scans.

State a use of A scans and uses of B scans.

State a use of A scans and uses of B scans.

A: Monitoring a baby's growth in the uterus by measuring its head diameter.

B: Prenatal fetus scanning and echocardiograms to see how the heart is functioning in real time.

How is the amplitude of the reflected pulses displayed in a B scan?

How is the amplitude of the reflected pulses displayed in a B scan?

As the brightness of a spot.

What array of transducers can be used to produce a 2D image in a B scan?

What array of transducers can be used to produce a 2D image in a B scan?

Linear array.

State 5 advantages of ultrasound scans.

State 5 advantages of ultrasound scans.

1. No known hazards or side effects.
2. No exposure to ionising radiation.
3. Can obtain real-time images of soft tissues.
4. Ultrasound devices are portable and cheap.
5. Scan is quick, non invasive and patient can move.

State 3 disadvantages of ultrasound scans.

State 3 disadvantages of ultrasound scans.

1. Ultrasound can't penetrate bone so the brain can't be imaged (skull in the way) and fractures can't be detected.
2. Ultrasound can't pass through air spaces in body (mismatched impedance) so can't produce images from behind the lungs.
3. Low resolution.