



AS Level Physics

Chapter 5 – Waves and Particle Nature of Light

5.9.2 Pulse-Echo Technique (Edexcel Only)

Worked Examples

Pulse-Echo Technique

Exam Style Question 1

- (a) Ultrasound scanning can be used by doctors to obtain information about the internal structures of the human body without the need for surgery. Pulses of ultrasound are sent into the body from a transmitter placed on the skin.
- (i) The ultrasound used has a frequency of 4.5 MHz . State why waves of this frequency are called ultrasound.
- (ii) A pulse of ultrasound enters the body and its reflection returns to the transmitter after a total time of $1.6 \times 10^{-4} \text{ s}$. Calculate how far the reflecting surface is below the skin. average speed of ultrasound in the body 1500 m s^{-1}
- (iii) State why the ultrasound is transmitted in pulses.
- (b) Another way of obtaining information about the internal structures of the human body is by the use of X-rays.
- (i) Give one property of X-rays which makes them more hazardous to use than ultrasound.
- (ii) State two other differences between X-rays and ultrasound.



Pulse-Echo Technique

Exam Style Question 1

- (a) (i) The ultrasound used has a frequency of 4.5 MHz . State why waves of this frequency are called ultrasound.**

They are called ultrasound because they are above the audible range and frequency.

- (a) (ii) Calculate how far the reflecting surface is below the skin. average speed of ultrasound in the body 1500 m s^{-1} .**

$$\begin{aligned} \text{distance} &= \text{speed} \times \text{time}^* \\ \text{distance} &= (1500 \text{ m s}^{-1})(0.8 \times 10^{-4} \text{ s}) \\ \text{distance} &= 0.12 \text{ m} \end{aligned}$$

- (a) (iii) State why the ultrasound is transmitted in pulses.**

Ultrasound is transmitted in pulses because one pulse must return before the next is sent.

- (b) Another way of obtaining information about the internal structures of the human body is by the use of X-rays.**

- (i) Give one property of X-rays which makes them more hazardous to use than ultrasound.**

X-rays cause ionisation which can damage cells and/or cause mutation.

- (ii) State two other differences between X-rays and ultrasound.**

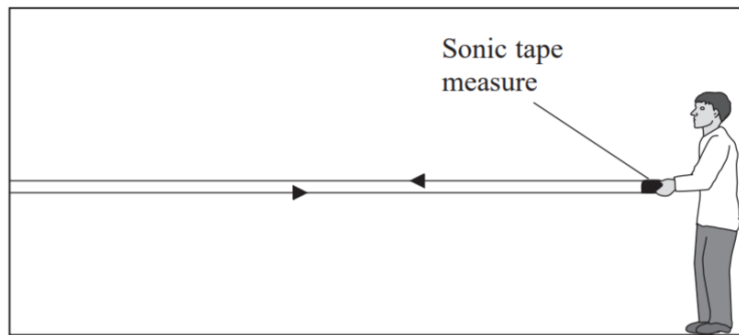
- X-rays are transverse, Ultrasound is longitudinal.
- X-rays travel in a vacuum, Ultrasound does not.
- X-rays have a much higher frequency and shorter wavelength and greater speed.

*Remember the total time is the time taken for the ultrasound to be transmitted and received. To calculate the distance, we only need half the time, which is the time transmitted; otherwise, the distance would be doubled.

Pulse-Echo Technique

Exam Style Question 2

A sonic tape measure uses ultrasound to measure distances in buildings. It sends out pulses of ultrasound towards a distant wall and records the time interval between a pulse being sent and its return.



- (a) For one particular measurement the time interval was 25 ms . Calculate the distance from the sonic tape measure to the wall. Speed of sound = 330 m s^{-1} .
- (b) Why is the ultrasound transmitted in pulses?

Pulse-Echo Technique

Exam Style Question 2

(a) For one particular measurement the time interval was 25 ms . Calculate the distance from the sonic tape measure to the wall. Speed of sound = 330 m s^{-1} .

$$\begin{aligned} \text{distance} &= \text{speed} \times \text{time} \\ \text{distance} &= (330 \text{ m s}^{-1}) \left(\frac{25 \times 10^{-3} \text{ s}}{2} \right) \\ \text{distance} &= 4.125 \text{ m} \end{aligned}$$

- (b) Why is the ultrasound transmitted in pulses?
- One pulse must return before the next one is sent.
 - So that the time interval between transmitted and received pulses can be measured.
 - No overlap between pulses.
 - No interference between pulses.



Please see '**5.9.1 Pulse-Echo Technique (Edexcel Only) notes**' pack for revision notes.

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

