

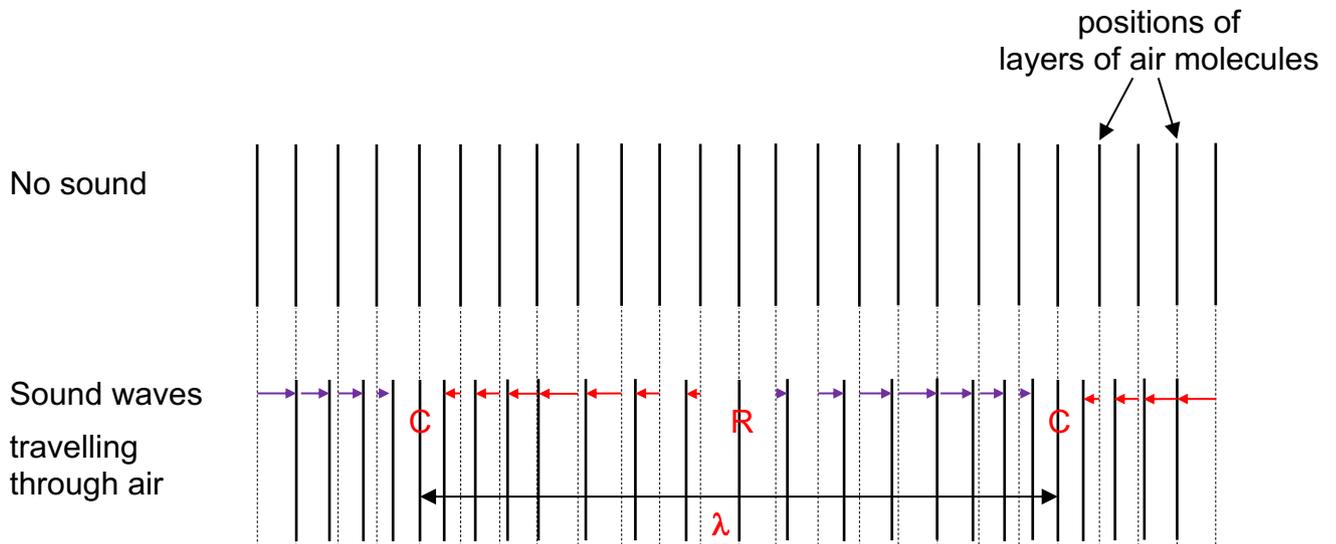


2021 Sec 4 Physics Notes Answers
Chapter 12 Sound

12.1 Sound waves

12.11 Production and transmission of sound waves

- vibration
- longitudinal
- medium, mechanical
- The diagram below shows the positions of layers of air molecules before and after sound waves travel through them from the left towards the right.



- pressure.
- higher, compression
- lower, rarefaction

Example 12.1

On the diagram above showing sound waves travelling through air, mark & label
(a) the middle of compressions (with letter “C”) and the middle of rarefactions (with letter “R”);
(b) a wavelength λ between 2 Cs and between 2 Rs.

12.12 Properties of sound waves

Example 12.2

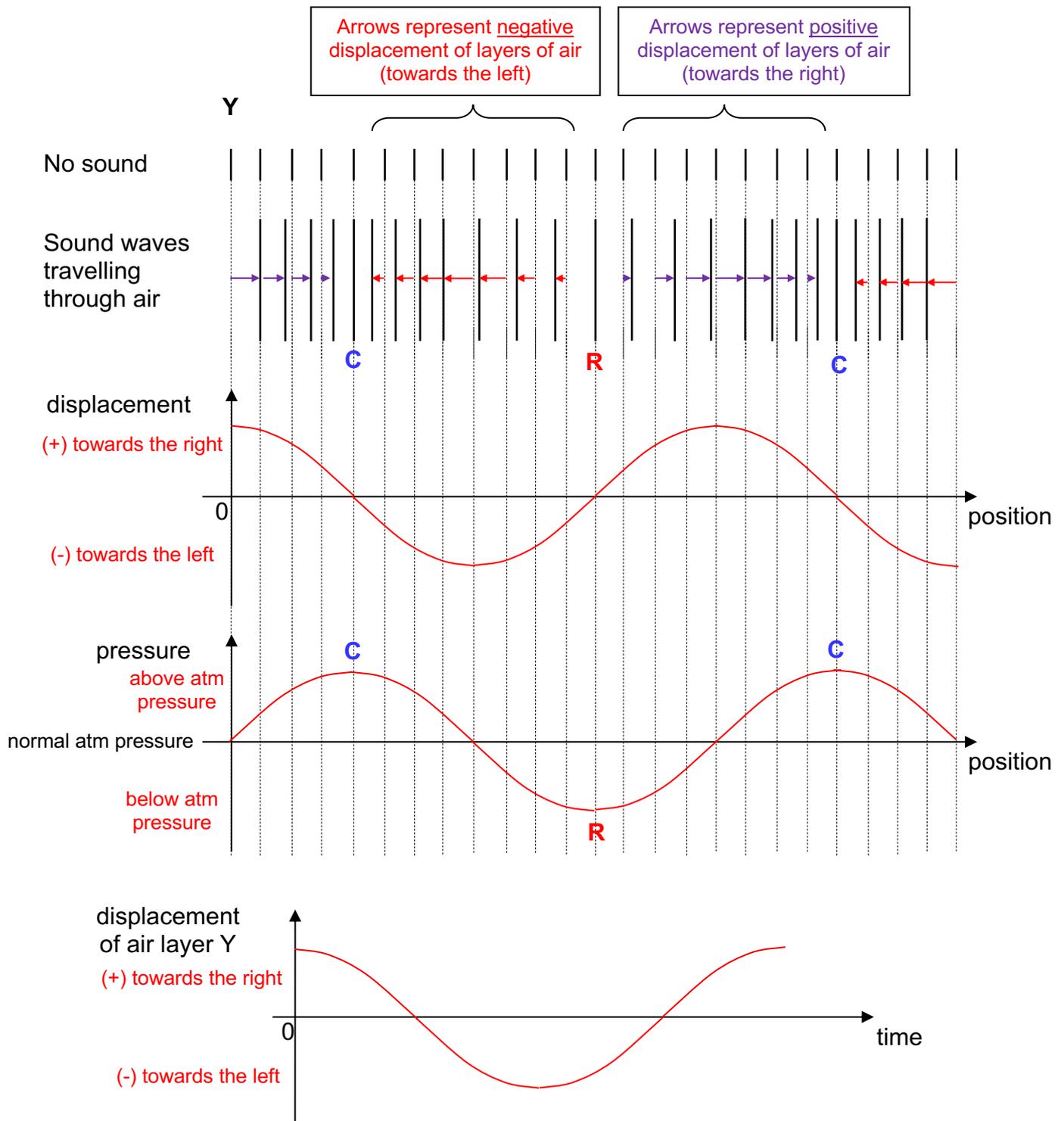
(a) Based on the positions of the layers of air when sound waves travel through it from left to right, as shown below, mark with arrows the displacements (if any) of each layer from its rest positions. (Convention: positive displacement towards the right.)

(b) Hence, sketch the corresponding

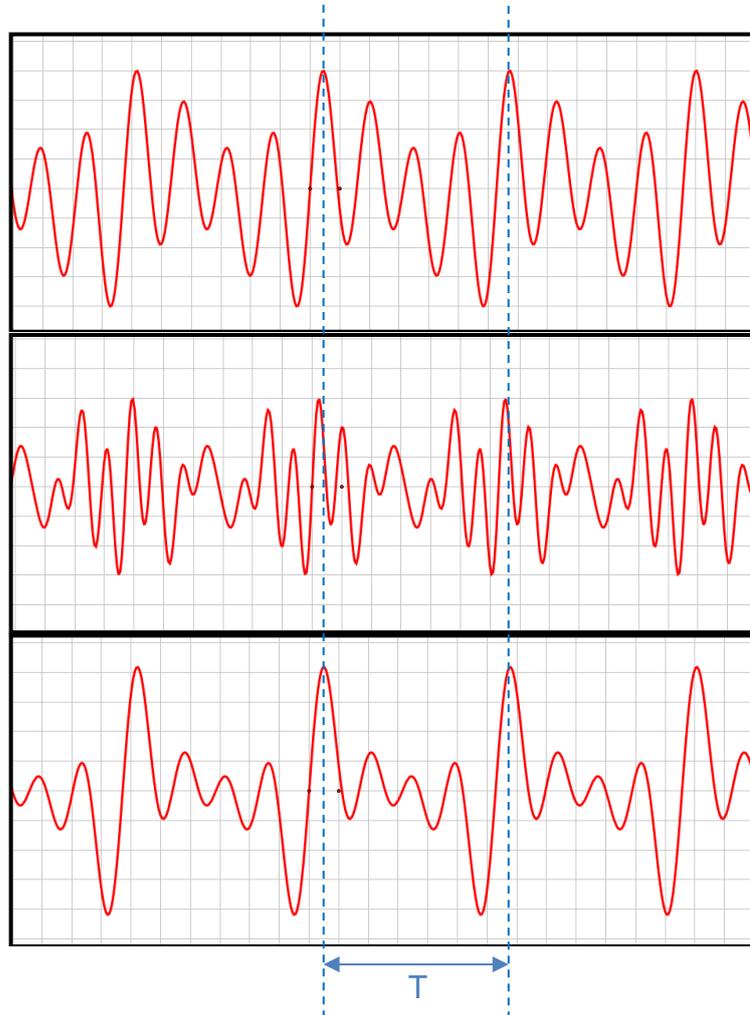
(i) displacement-position graph,

(ii) pressure-position graph, and

(iii) displacement-time graph of a layer of air, **Y**, starting from the position shown in the diagram.



- amplitude, energy
- frequency.
- quality



Example 12.3

Draw and label the period T on the diagrams above.

12.2 Speed of sound & echo

- medium

	Direct method	Indirect method	Indirect method
Method	<ul style="list-style-type: none"> • Observer A fires a starting pistol. • Observer B (at least 200 m away) starts a stopwatch on seeing the flash of the gun and stops the stopwatch on hearing the sound 	<ul style="list-style-type: none"> • Observer A faces a high smooth wall at least 50 m away and claps regularly to coincide with echoes. • Observer B times 50 claps. 	<ul style="list-style-type: none"> • Place a microphone at one end of a long hollow tube and a smooth flat surface at the other end. • Connect the microphone (sound sensor) to a laptop (installed with Addestation software with "Scope" simulator). • Snap your finger next to microphone, and click to capture the image of sound and its echo.
Physical quantities to measure	<ol style="list-style-type: none"> 1. distance (d) between A and B 2. time (t) between seeing the flash and hearing the sound 	<ol style="list-style-type: none"> 1. perpendicular distance (d) between A and the wall 2. time (t) between 0th clap and the 50th clap (time interval of 50 claps) 	<ol style="list-style-type: none"> 1. distance (d) between microphone and smooth surface = length of tube 2. time (t) between snap sound (incident pulse) and its echo (reflected pulse) - (between 2 peaks on the C.R.O. display)
Formula to use	$\text{Speed} = \frac{d}{t}$	$\text{Speed} = \frac{2d}{(t / 50)}$	$\text{Speed} = \frac{2d}{t}$
Possible sources of error	<ol style="list-style-type: none"> 1. Wind 2. Human reaction time (in starting & stopping stopwatch) 	<ol style="list-style-type: none"> 1. Wind 2. Human reaction time (in starting & stopping stopwatch) 	<ol style="list-style-type: none"> 1. Error in locating exact positions of the microphone and where the snap sound is produced 2. Noise from surrounding

12.3 Ultrasound

- 20 kHz, 20 Hz
- time
- List and describe some common applications of ultrasound in the table below.

Use of ultrasound	Description of use
Ultrasonic scanning in medicine: To examine internal tissues, organs of a patient, development of unborn baby (foetus)	Computer constructs images of tissues/organs/foetuses from reflected ultrasonic signals
SONAR (Sound Navigation and Ranging): To measure distances in air or water	Detector calculates the distances from the reflected ultrasonic pulse.
For quality control in manufacturing	Detector monitors the strength of the ultrasonic signals passing through a product. Flaws or inconsistency in the product will affect the strength of the signals.

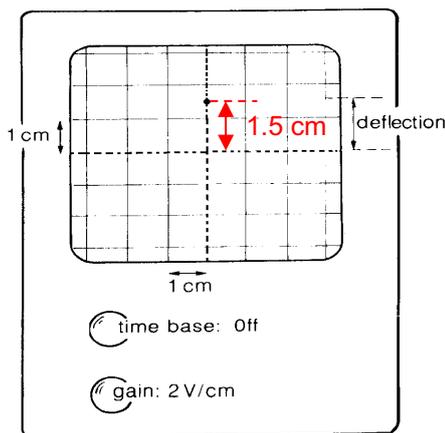
12.4 Use of cathode ray oscilloscope (refer to textbook pages 444 to 447)

12.41 Displaying waveforms

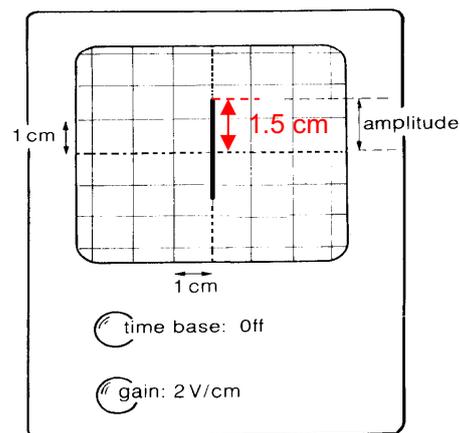
- time base

12.42 Measuring voltages

- The figures below show the screen of an oscilloscope displaying different types of voltages when the time base is switched off. The **gain control** is set at 2 V/cm
- voltage $V = \text{height} \times \text{gain}$ (gain: or gain control, Y gain or Y setting)



a constant d.c. voltage source
e.g. a battery



an a.c. voltage source
e.g. an a.c. generator

In both cases, the magnitude of the input is 3.0 V.

Working:

$$\begin{aligned}
 V &= \text{height} \times \text{gain} \\
 &= 1.5 \text{ cm} \times 2 \text{ V/cm} \\
 &= 3.0 \text{ V}
 \end{aligned}$$

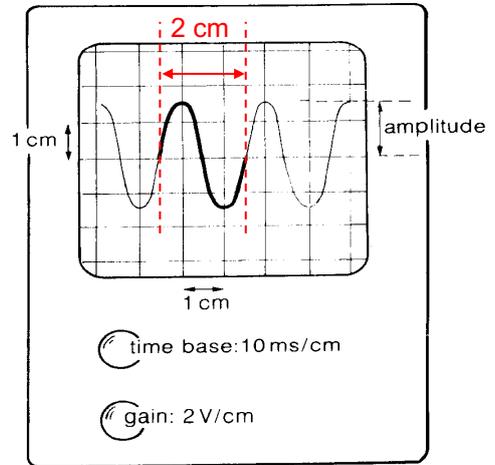
Example 12.4

voltage = height × gain
 amplitude = 2 div × 5 V / div = 10 V

12.33 Measuring Short Intervals of Time and Frequencies

- cm
- 20 ms (or 0.020 s), 50 Hz

Working:
 $t = \text{length of 1 wave} \times \text{time base}$
 $= 2 \text{ cm} \times 10 \text{ ms/cm}$
 $= 20 \text{ ms}$



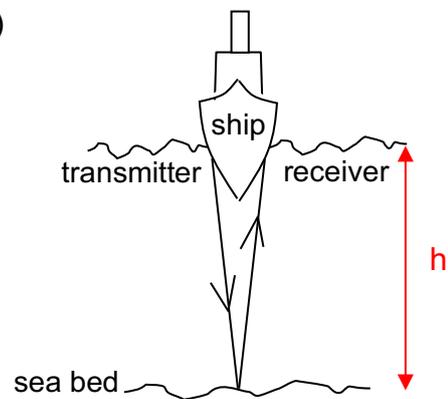
Example 12.5

period $T = \text{length (of 1 wave)} \times \text{time-base}$
 $= 8.0 \text{ cm} \times 5 \text{ ms cm}^{-1}$
 $= 40 \text{ ms} = 40 \times 10^{-3} \text{ s}$
 frequency $f = 1 / T = 1 / (40 \times 10^{-3})$
 $= 25 \text{ Hz}$

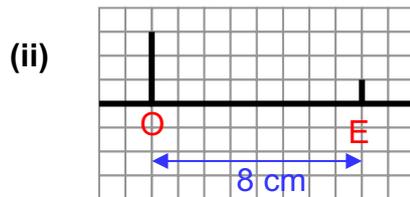
Exercises

1 $v = f \times \lambda \rightarrow f = v / \lambda$ (λ in metres)

2 (a) $v = d / t \rightarrow d = v \times t$
 $d = 2 \text{ h}$
 $\text{depth} = 1500 \text{ m s}^{-1} \times 0.40 \text{ s} = 600 \text{ m}$



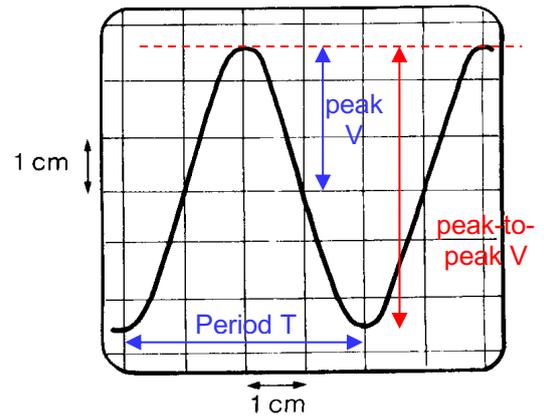
(b) (i) Cathode ray oscilloscope



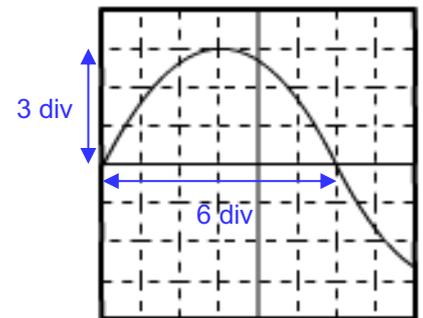
CRO display

(iii) Assume each division (square) has length of 1 cm
 $\text{time } t = \text{length} \times \text{time base}$
 $\text{time base} = t / \text{length} = 0.8 \text{ s} / 8 \text{ cm} = 0.1 \text{ s / cm}$

- 3 (a) peak voltage $V = \text{height} \times \text{gain}$
 $= 2.5 \text{ cm} \times 50 \text{ mV / cm} = 125 \text{ mV}$
- (b) peak-to-peak voltage = $\text{height} \times \text{gain}$
 $= 5.0 \text{ cm} \times 50 \text{ mV / cm} = 250 \text{ mV}$
 Or $125 \text{ mV} \times 2 = 250 \text{ mV}$
- (c) $\text{time} = \text{length} \times \text{time base}$
 period $T = 4 \text{ cm} \times 10 \text{ ms / cm} = 40 \text{ ms}$
 frequency $= 1/T = 1 \div 40 \text{ ms} = 1 \div (40/1000)\text{s}$
 $= 25 \text{ Hz}$



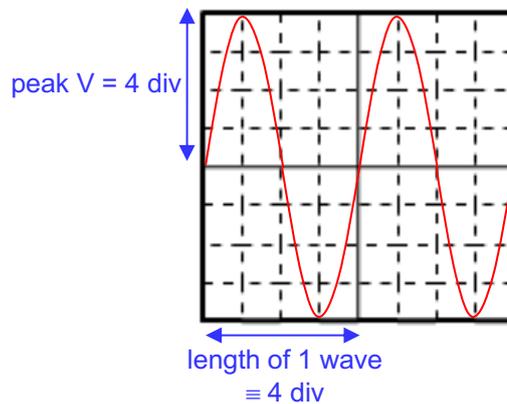
- 4 (a) $\text{time} = \text{length} \times \text{time base}$
 period $T = (6 \text{ div} \times 2) \times 1 \text{ ms / div} = 12 \text{ ms}$
 frequency $= 1/T = 1 \div 0.012 \text{ s} = 83 \text{ Hz}$



- (b) Need to calculate the new amplitude and new length first.
 peak voltage $V = \text{amplitude} \times \text{gain} = 3 \text{ div} \times 2 \text{ V/div} = 6 \text{ V}$
new amplitude $= V \div \text{gain} = 6 \text{ V} \div 1.5 \text{ V/div} = 4 \text{ div}$

$\text{period } T = \text{length} \times \text{time base}$

new length (of 1 wave) $= T \div \text{time base} = 12 \text{ ms} \div 3 \text{ ms/div} = 4 \text{ div}$



Answers:	1. 3.1 MHz	2(a) 600 m	(b)(iii) 0.10 s/cm		
	3(a) 125 mV	(b) 250 mV	(c) 25 Hz	4(a) 83 Hz	(b) 2 full waves

Discussion

- 3 This is a test done during pregnancy that uses reflected ultrasound waves to produce an image of a foetus for the doctor to monitor the growth and development of the foetus.