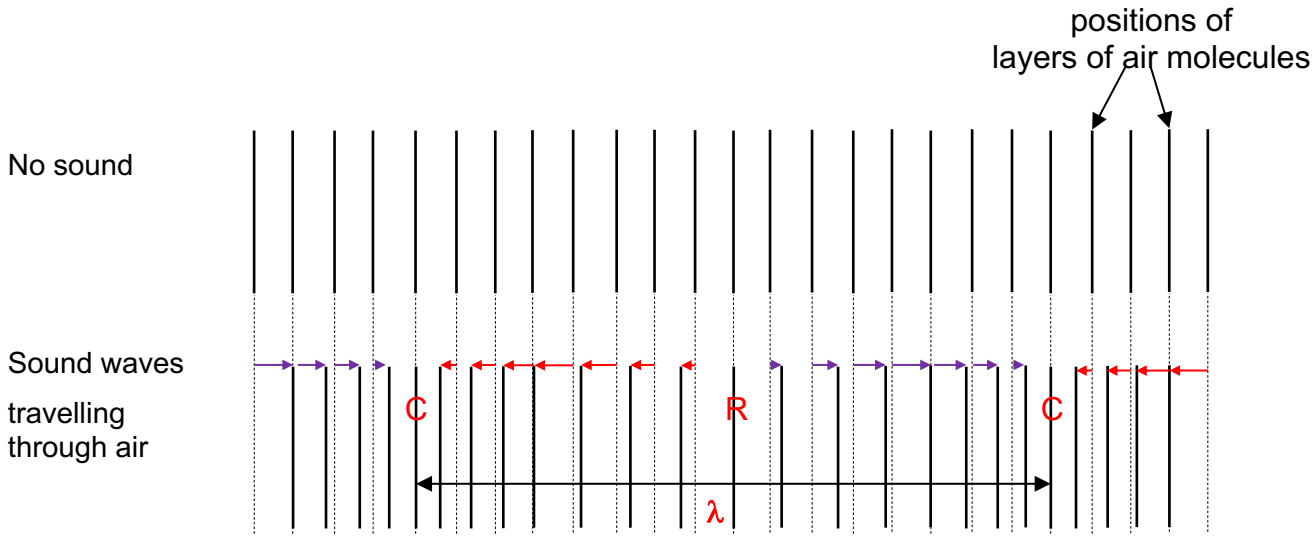
2024 Sec 4 Physics Notes Answers
Chapter 13 Sound

1 Sound waves

1.1 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.

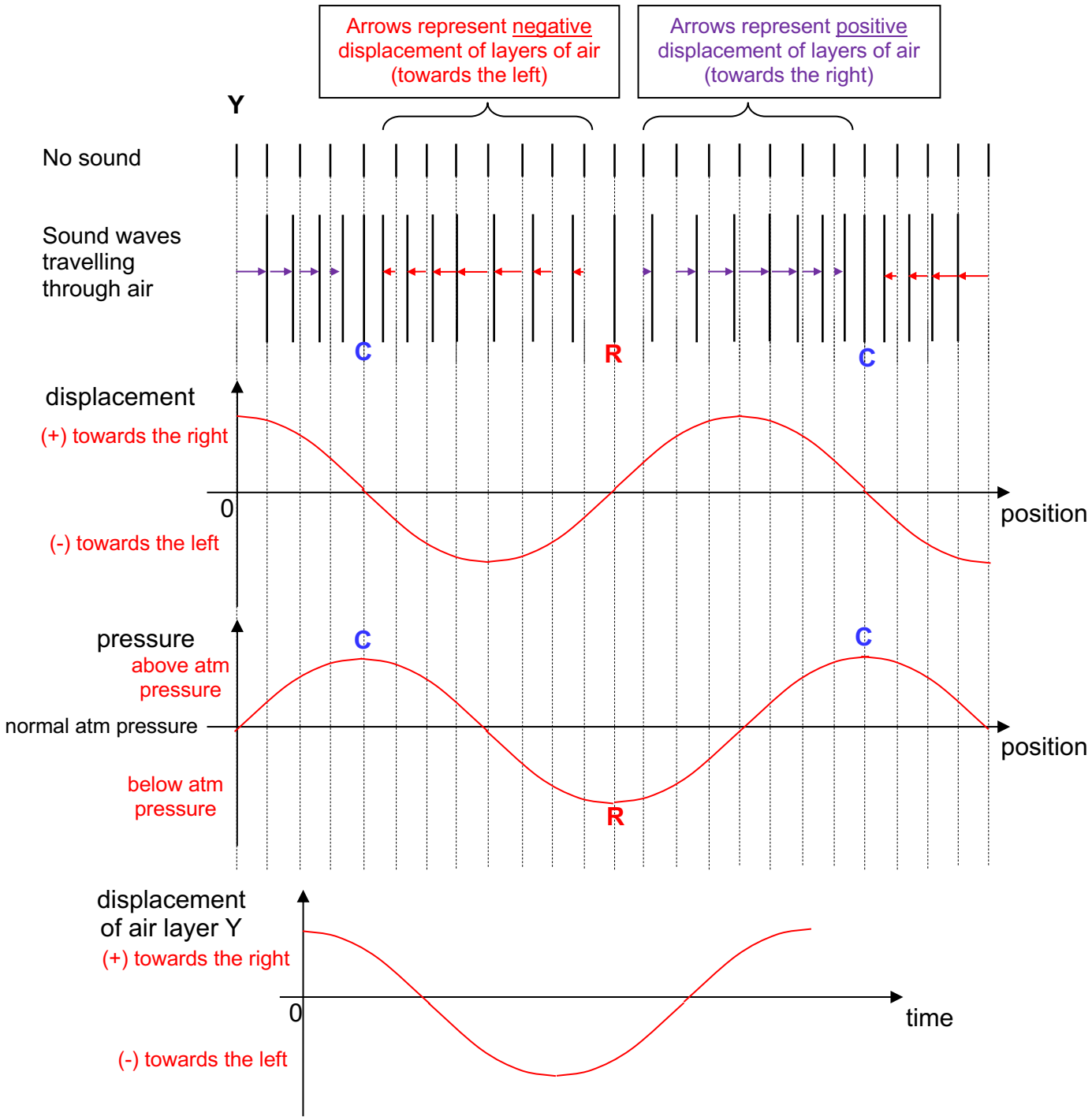


- pressure.
- higher, compression
- lower, rarefaction

Example 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.

1.2 Properties of sound waves

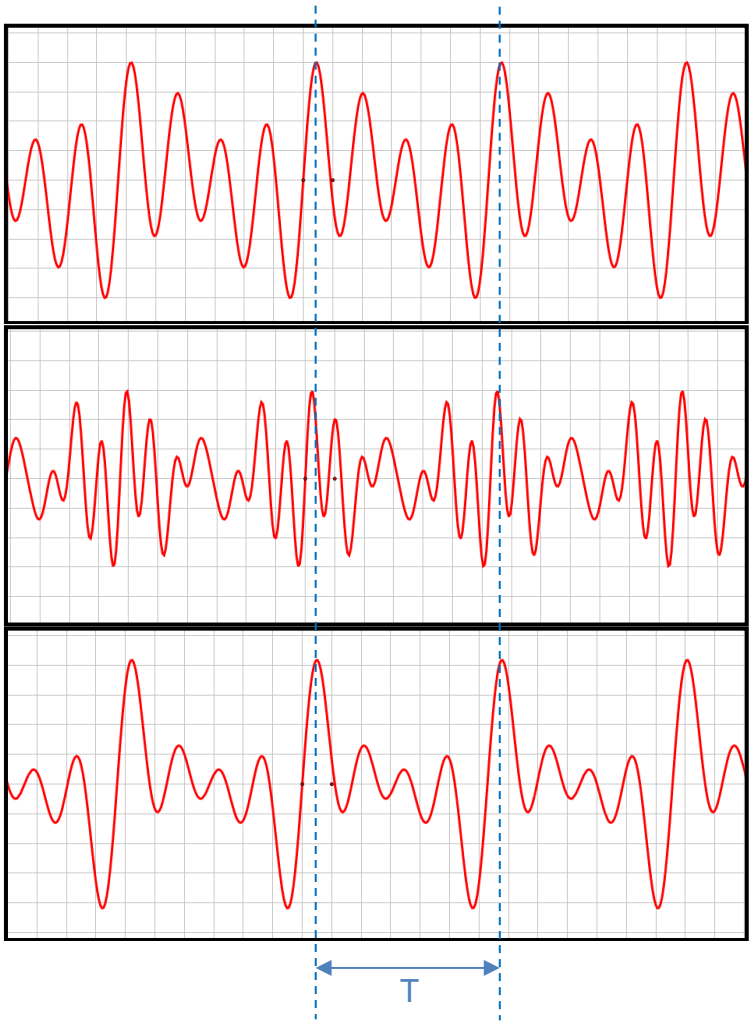
Example 2
Hence, sketch the corresponding
(a) displacement-position graph,
(b) pressure-position graph, and
(c) displacement-time graph of a layer of air, **Y**, starting from the position shown in the diagram.



Example 3

λ = 90 cm / 3 = 30 cm = 0.30 m
Speed v = $f \times \lambda$ ➔ f = v / λ = 330 m s^{-1} / 0.30 m = 1100 Hz

- amplitude, energy
- frequency.
- quality



Example 4
Draw and label the period T on the diagrams above.

2 Speed of sound

- medium

	[Enrichment] Direct method	Indirect method	Indirect method
Method	• *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*	• Observer A faces a high smooth wall at least 100 m away and claps regularly to coincide with **echoes**. • Observer B times 50 claps.	• 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	*1. distance (d) between A and B* *2. time (t) between seeing the flash and hearing the sound*	1. perpendicular distance (d) between A and the wall 2. time (t) between 0^{th} clap and the 15^{th} clap (time interval of 15 claps)	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	*Speed* = $\frac{d}{t}$	Speed = $\frac{2d}{(t / 15)}$ d = 100 m	Speed = $\frac{2d}{t}$
Possible sources of error	*1. Wind* *2. Human reaction time (in starting & stopping stopwatch)*	1. Wind 2. Human reaction time (in starting & stopping stopwatch)	1. Error in locating exact positions of the microphone and where the snap sound is produced 2. Noise from surrounding

Example 5

Taking speed of sound, v =330 ms^{-1}
Using v = 2d / t ➔ d = vt / 2 = (330 ms^{-1} x 4.0 s) / 2 = 660 m

Example 6

t = 8 × 10 ms = 80 ms = 0.080 s
v = 2d / t ➔ d = vt / 2 = (300 ms^{-1} × 0.080 s) / 2 = 12 m

3 Ultrasound

- 20 kHz, 20 Hz
- time

Common applications of ultrasound	*Description of how ultrasound is used
Sonar technologies • SONAR (**So**und **Na**vigation and **R**anging): • To measure distances in air or water	• Commercial fishing boats use sonar, which emits an ultrasound pulse into the water and listens for the reflected pulse. The reflected pulses may be reflected from a shoal of fish and the sea floor. • The strength of the reflected pulses will differ according to distance and characteristics of the reflecting objects. The reflected signals are processed by a computer and the location is shown on the screen.
For imaging internal organs • Medical application • To examine internal tissues, organs of a patient, development of unborn baby (foetus)	• By detecting the strength, direction and timing of reflected pulses of ultrasound, a computer can process the data very quickly to generate an image of the internal organs. • Ultrasound is commonly used in prenatal scanning, where pulses of ultrasound are sent into the womb of a pregnant woman via a transmitter. A computer processes the data quickly to form an image of the unborn baby.
For breaking up kidney stones & cancer treatment • Medical application • **Advantage**: safe and non-invasive compared to surgery and other methods	• When focused onto a kidney stone, high intensity vibrations of ultrasound can break the stone into smaller pieces so that they can be naturally expelled through urination. • High intensity focused ultrasound can also be used to kill cancer or tumour cells.
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.

Example 7: D

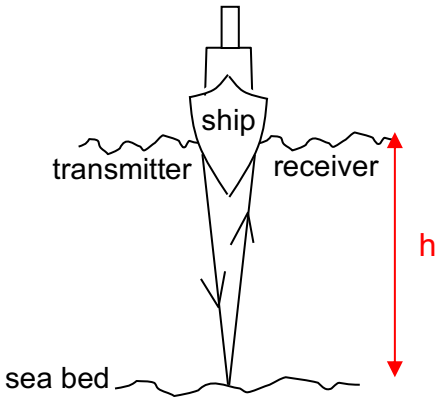
Exercises

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

2 **(a)** $v = d / t$ ➔ $d = v \times t$

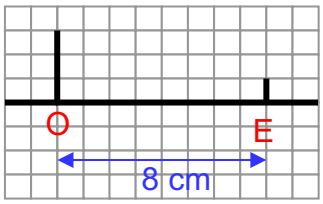
$d = 2\ h$

depth = 1500 m s^{-1} × 0.40 s = 600 m



(b)

(i)



CRO display

(ii) Assume each division (square) has length of 1 cm

time t = length x time base

time base = t / length = 0.8 s / 8 cm = 0.1 s / cm