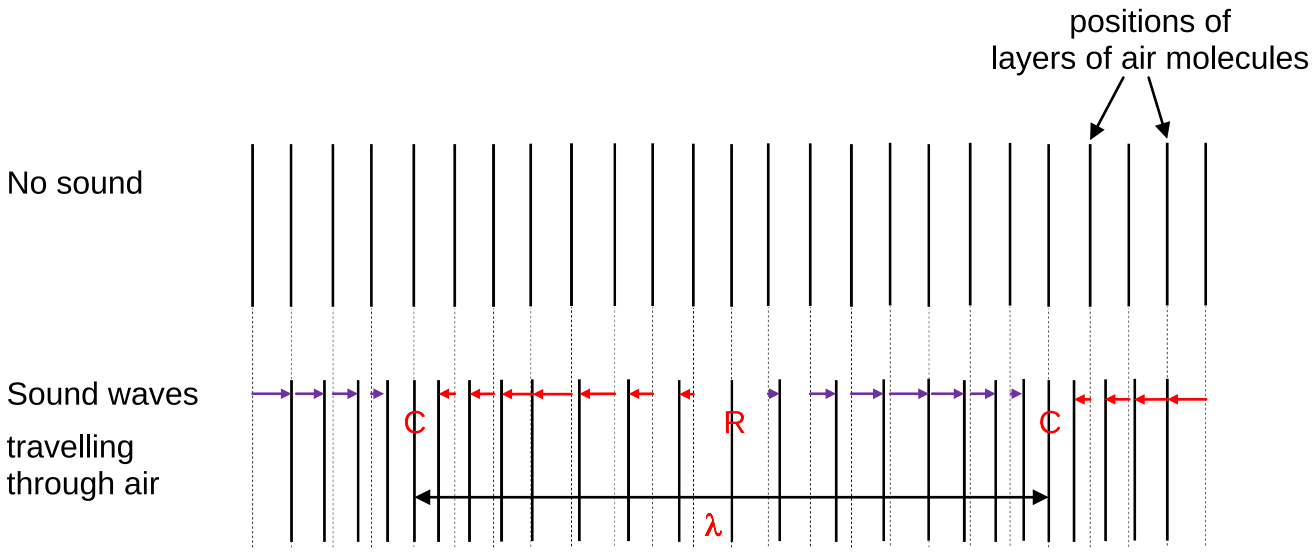
**2020 Sec 4 Physics Notes Answers**
**Chapter 12 Sound**

## 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.

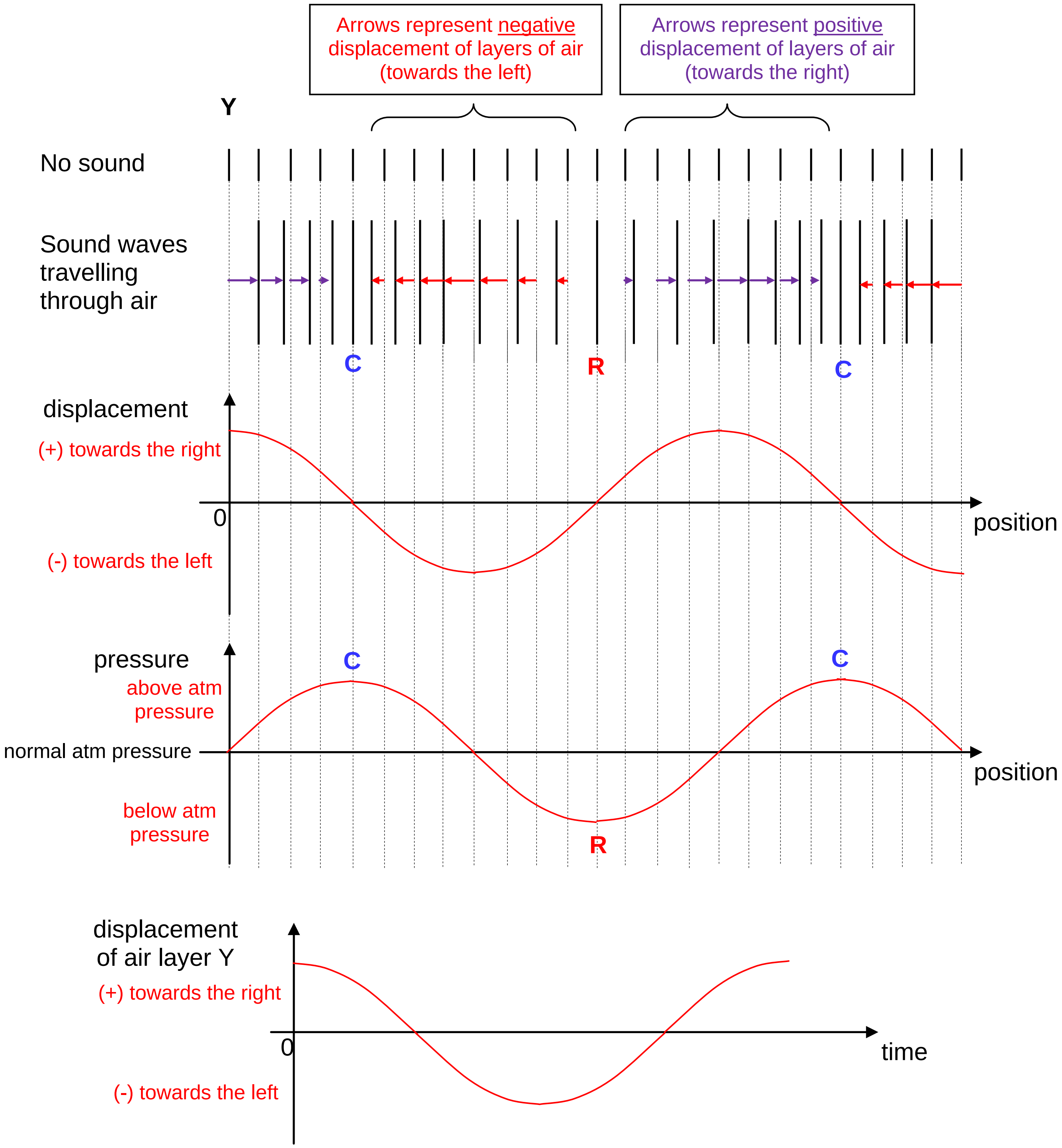



- pressure.
- higher, compression
- lower, rarefaction

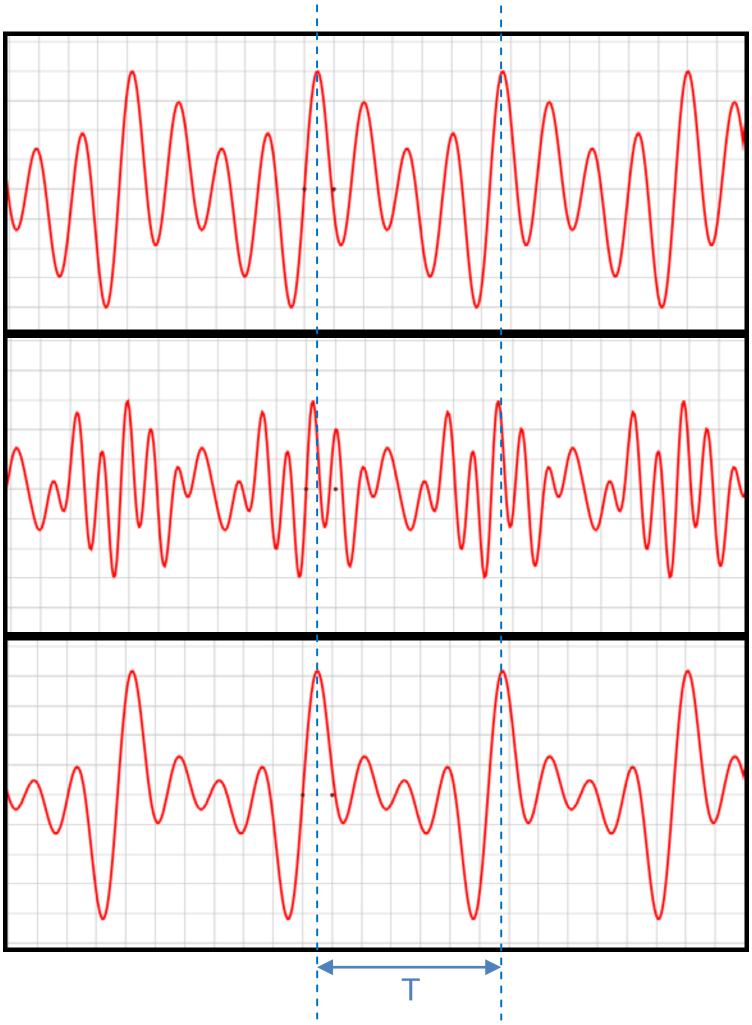
**Example 12.1**
On the diagram above showing sound waves travelling through air, mark & label
(a) the middle of compressions (with letter "C") and the middle of rarefactions (with letter "R");
(b) a wavelength λ between 2 Cs and between 2 Rs.

## 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 | • Observer A fires a starting pistol.<br><br>• 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 50 m away and claps regularly to coincide with **echoes**.<br>• 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.<br>• Connect the microphone (sound sensor) to a laptop (installed with Addestation software with "Scope" simulator).<br>• 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<br><br>2. time (t) between seeing the flash and hearing the sound | 1. perpendicular distance (d) between A and the wall<br><br>2. time (t) between 0$^{th}$ clap and the 50$^{th}$ clap (time interval of 50 claps) | 1. distance (d) between microphone and smooth surface = length of tube<br><br>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 = $\frac{2d}{(t / 50)}$ | Speed = $\frac{2d}{t}$ |
| Possible sources of error | 1. Wind<br><br>2. Human reaction time (in starting & stopping stopwatch) | 1. Wind<br><br>2. Human reaction time (in starting & stopping stopwatch) | 1. Error in locating exact positions of the microphone and where the snap sound is produced<br><br>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:<br>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 (**So**und **Na**vigation and **R**anging): 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. |

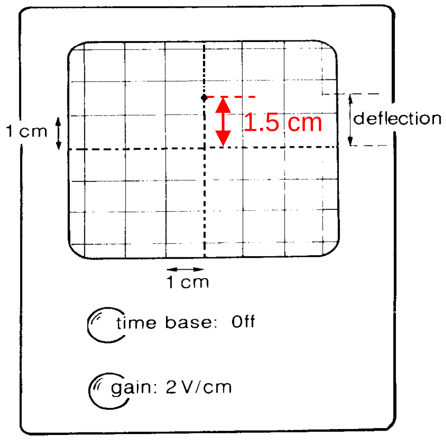
### 12.4 Use of cathode ray oscilloscope (refer to textbook pages 444 to 447)

#### 12.41 Displaying waveforms

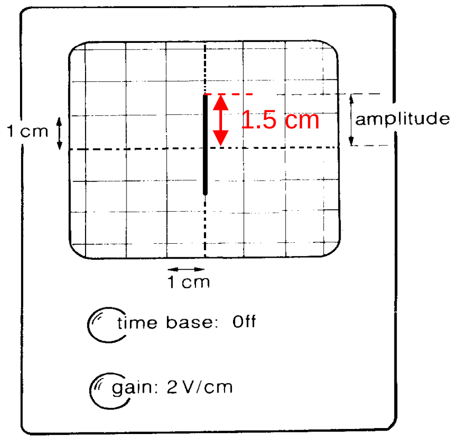
- time base

#### 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 = height x gain (gain: or gain control, Y gain or Y setting)




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



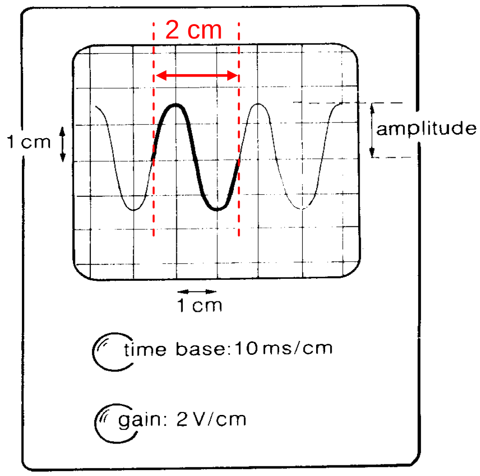

an a.c. voltage source
e.g. an a.c. generator

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

Working:
V = height x gain
= 1.5 cm x 2 V/cm
= 3.0 V

**Example 12.4**
voltage = height × gain
amplitude = 2 div × 5 V / div = 10 V

### 12.33 Measuring Short Intervals of Time and Frequencies



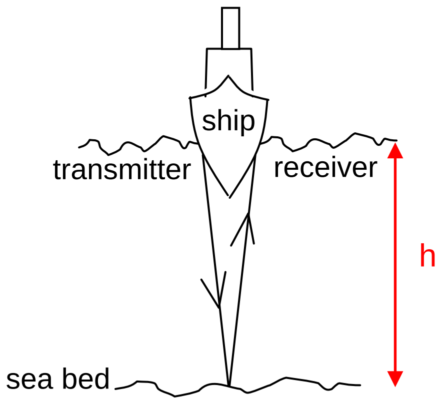

- cm
- 20 m s (or 0.020 s), 50 Hz

Working:
t = length of 1 wave x time base
= 2 cm x 10 m s/cm
= 20 m s

**Example 12.5**
period T = length (of 1 wave) × time-base
= 8.0 cm × 5 ms $cm^{-1}$
= 40 ms = 40 × $10^{-3}$ s
frequency $f$ = 1 / T = 1 / (40 × $10^{-3}$)
= 25 Hz

## Exercises

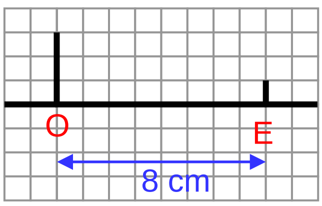
**1** v = $f$ x λ ➔ $f$ = v / λ (λ in metres)




**2** **(a)** v = d / t ➔ d = v x t
d = 2 h
depth = 1500 m $s^{-1}$ × 0.40 s = 600 m

**(b)** **(i)** Cathode ray oscilloscope

**(ii)**

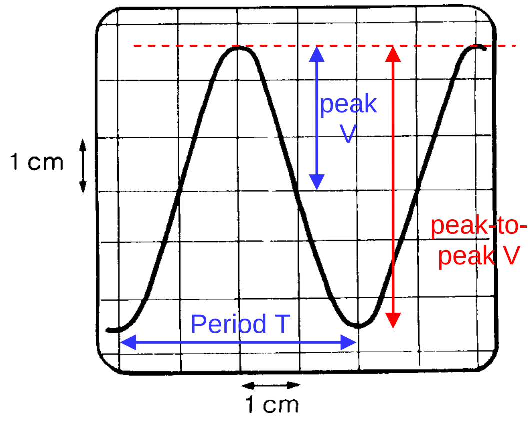



CRO display

**(iii)** 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

3 **(a)** peak voltage V = height x gain

= 2.5 cm x 50 mV / cm = 125 mV




**(b)** peak-to-peak voltage = height x gain

= 5.0 cm x 50 mV / cm = 250 mV

Or 125 mV x 2 = 250 mV

**(c)** time = length x time base

period T = 4 cm × 10 ms / cm = 40 ms

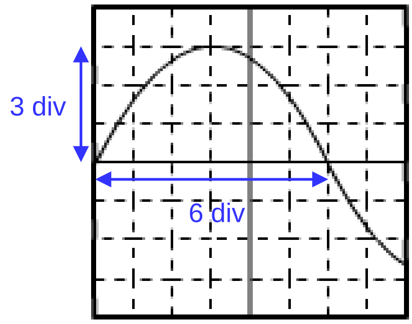
frequency = 1/T = 1 ÷ 40 ms = 1 ÷ (40/1000)s

= 25 Hz

4 **(a)** time = length x time base

period T = (6 div x 2) x 1 ms / div = 12 ms

frequency = 1/T = 1 ÷ 0.012 s = 83 Hz



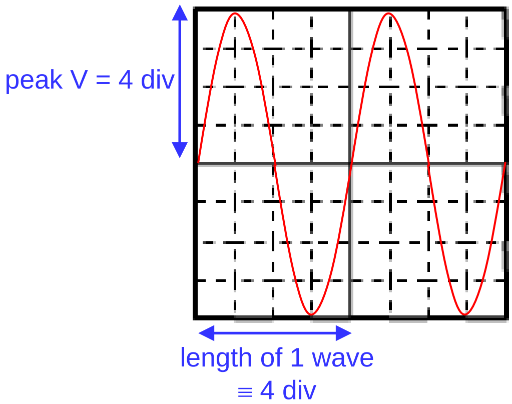

**(b)** Need to calculate the <u>new amplitude</u> and <u>new length</u> first.

peak voltage V = amplitude x gain = 3 div x 2 V/div = 6 V

<u>new amplitude</u> = V ÷ gain = 6 V ÷ 1.5 V/div = 4 div

period T = length x time base

<u>new length</u> (of 1 wave) = T ÷ time base = 12 ms ÷ 3 ms/div = 4 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.