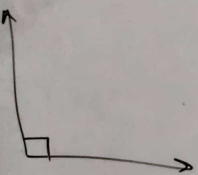
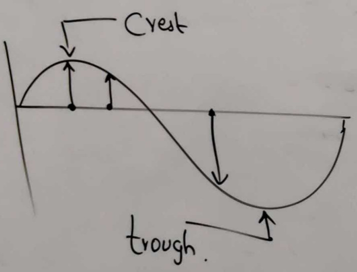
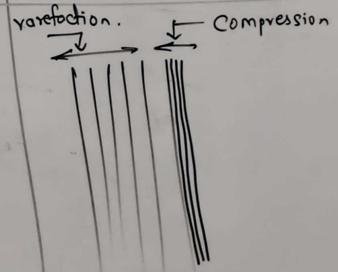
12. Study of Sound.

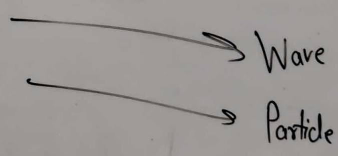
Types of waves.

Transverse Wave	Longitudinal wave.



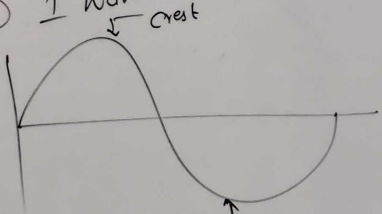






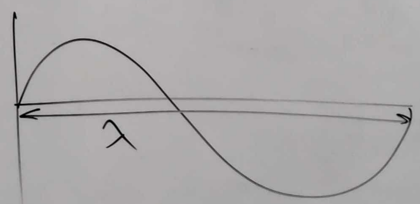
Basic terms related to waves.

① 1 wave.



1 crest + 1 trough = 1 wave

② Wavelength (λ) ↳ lambda

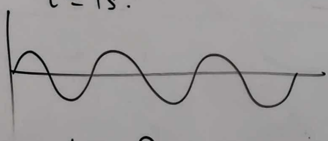


Length of 1 wave = Wavelength

③ Frequency (f or n)

Frequency = No. of waves generated in unit time

$t = 1s$.

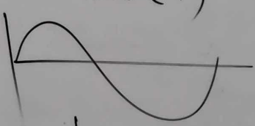


$1s = 3$ waves.

$n = 3$ Hertz

$n = 3$ Hz.

④ Time Period (T)



$t = 4s$.

1 wave = 4s

$\boxed{T = 4s}$

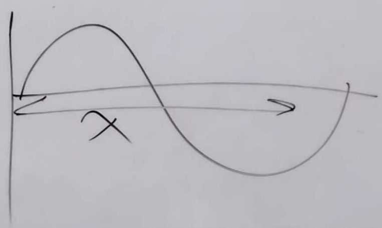
Time period = Time required to generate one wave.

$\boxed{n = \frac{1}{T}}$

Velocity of sound
(v)

$$\text{Velocity} = \frac{\text{distance}}{\text{time}}$$

For $\underline{1}$ wave:



$$\underset{(v)}{\text{Velocity}} = \frac{\text{Wavelength } (\lambda)}{\text{Time Period } (T)}$$

$$V = \frac{\lambda}{T}$$

$$V = \frac{1 \times \lambda}{T}$$

$$V = \frac{1}{T} \times \lambda$$

We know that,

$$\boxed{n = \frac{1}{T}}$$

$$V = n \times \lambda$$

$$\boxed{V = n\lambda}$$

Velocity of Sound in gaseous medium.

① Temperature (T)

$$V \propto \sqrt{T}.$$

$V = k \times \sqrt{T}.$

$\underline{V_1} = \underline{k \times \sqrt{T_1}}$ — ①

$T_2 = 4T_1$ — ②

$\therefore V_2 = k \times \sqrt{T_2}$

$V_2 = k \times \sqrt{4 \times T_1}$

$V_2 = 2 \times \underline{k \times \sqrt{T_1}}$

$\therefore \boxed{V_2 = 2 \times V_1}$

$T_1 = 10°c$

$T_2 = 40°c$

$V_1 = ?$

$V_2 = ?$

Velocity of Sound in gaseous medium.

2] Density (ρ) (घनता)

$\downarrow v \propto \frac{1}{\sqrt{\rho}} \uparrow$

$v = k \times \frac{1}{\sqrt{\rho}}$

$v_1 = k \times \frac{1}{\sqrt{\rho_1}}$ — ①

$\rho_2 = 4 \times \rho_1$ — ②

$V_2 = k \times \frac{1}{\sqrt{\rho_2}}$

$V_2 = k \times \frac{1}{\sqrt{4 \times \rho_1}}$ (From ②)

$V_2 = \frac{1}{2} \times k \times \frac{1}{\sqrt{\rho_1}}$

$V_2 = \frac{1}{2} \times v_1$ (From ①)

$V_2 = \frac{V_1}{2}$

ρ_1	V_1
ρ_2	V_2

Velocity of sound in gaseous medium.

3. Molecular Weight (M)

$$\downarrow V \propto \frac{1}{\sqrt{M}} \uparrow$$

$$V = k \times \frac{1}{\sqrt{M}}$$

$$V_1 = k \times \frac{1}{\sqrt{M_1}} \quad - (1)$$

$$\boxed{M_2 = 4 \times M_1} \quad - (2)$$

$$V_2 = k \times \frac{1}{\sqrt{M_2}}$$

$$V_2 = k \times \frac{1}{\sqrt{4 \times M_1}} \quad \text{(From (2))}$$

M_1

M_2

V_1

V_2

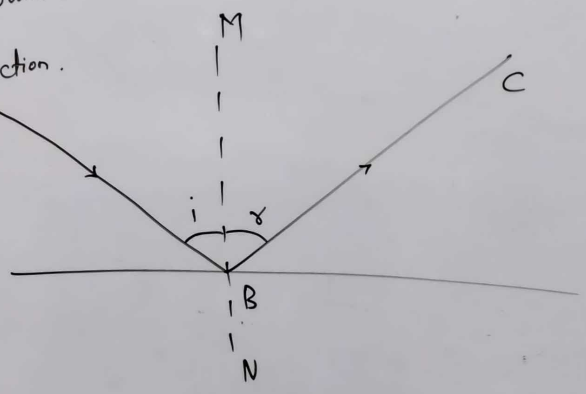
$$V_2 = \frac{1}{2} \times k \times \frac{1}{\sqrt{M_1}}$$

$$V_2 = \frac{1}{2} \times V_1 \quad \text{(From (1))}$$

$$\boxed{V_2 = \frac{V_1}{2}}$$

Reflection of Sound.

Laws of reflection.



MN = Normal.

AB = Incident ray.

BC = Reflected ray

i = Angle of incidence

r = Angle of reflection.

① Incident ray, normal and reflected ray lie in the same plane.

② $\angle i = \angle r$.

Echo.

At $22^\circ C$

$v = 344\ m/s.$

$t = 0.1\ s.$

$v = \dfrac{d}{t}$

$d = v \times t$

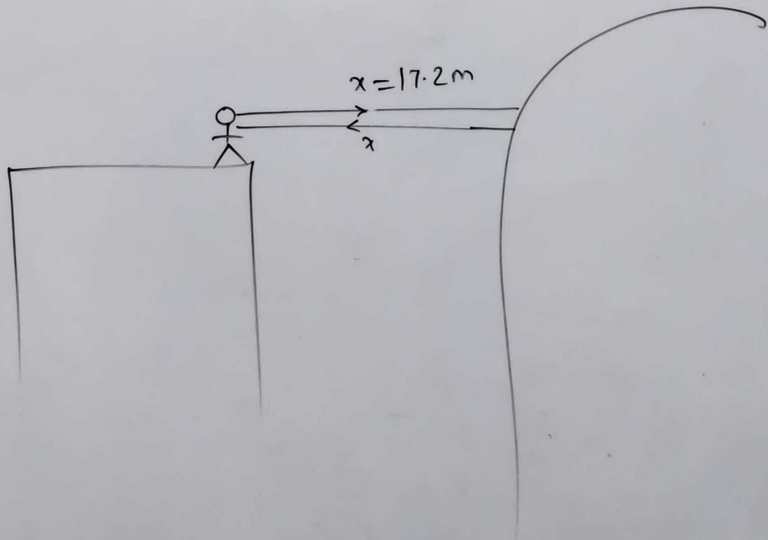
$= 344 \times 0.1$

$= 34.4\ m$

$x + x = 34.4$

$2 \times x = 34.4$

$x = \dfrac{34.4}{2} = \boxed{17.2m}$

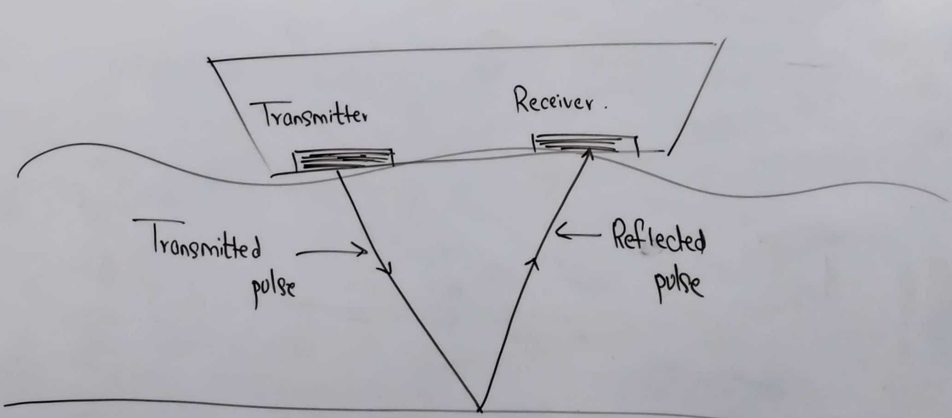


SONAR

Infra sound	20 Hz to 20,000 Hz (20 kHz)	Ultrasound.
Less than 20 Hz	Audible sound.	More than 20,000 Hz

SONAR = Sound Navigation and Ranging.

t [illegible] 0 s
$v = 340$ m/s
$d = ?$



Q 5

a] Given : At $0^\circ C$

$v_1 = 332$ m/s

Rate of increase = 0.6 m/s per degree.

$V_2 = 344$ m/s

To find : Change in temperature = ?

Solution : Increase in temperature $= \frac{\text{Change in velocity}}{\text{Rate of change}}$

$$= \frac{344 - 332}{0.6}$$

$$= \frac{12}{0.6}$$

$$= \frac{12 \times 10}{0.6 \times 10} = \frac{120}{6} = 20^\circ C$$

New temperature = $0 + 20 = 20^\circ C$.

Q 5

b] Given : $t = 4s$

$v = 340\ m/s$

To find : $d = ?$

Solution : $v = \frac{d}{t}$

$d = v \times t$

$= 340 \times 4$

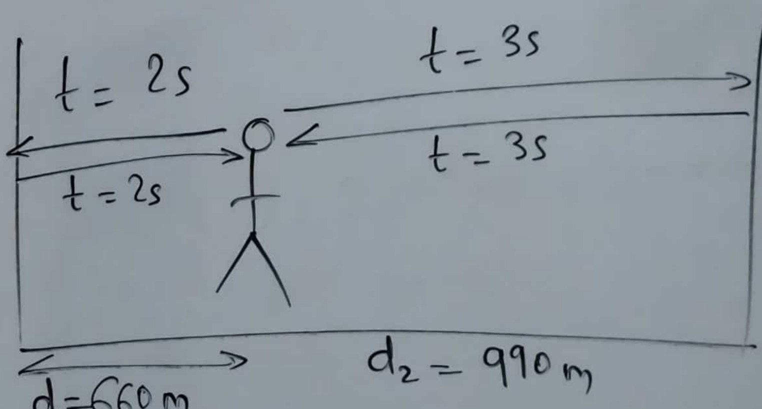
$d = \boxed{1360\ m}$

Q 5

c)

To find: ① $v = ?$

② Distance = ?



Solution: For closest wall

$$v = \frac{d}{t}$$

$$= \frac{660}{2}$$

$$\boxed{v = 330 \text{ m/s}}$$

For farther wall.

$$v = \frac{d_2}{t}$$

$$d_2 = v \times t$$

$$d_2 = 330 \times 3$$

$$\boxed{d_2 = 990 \text{ m}}$$

Total distance $= 660 + 990$

$$= \boxed{1650 \text{ m}}$$

$\frac{v_A}{v_B} = \frac{2}{1}$ $v_A = 2 \times v_B$

Sub:-

d] Given : $V_A = V_B$.

$T_A = T_B$.

$M_A = 12$ gm

$M_B = 48$ gm.

To find : $v_A = ?$

$v_B = ?$

Solution : $v \propto \frac{1}{\sqrt{\rho}}$

$\rho = \frac{M}{V}$.

$v \propto \frac{1}{\sqrt{M}}$

$v \propto \sqrt{T}$

$v \propto \frac{\sqrt{T}}{\sqrt{M}}$

$v \propto \sqrt{\frac{T}{M}}$

$v = k \times \sqrt{\frac{T}{M}}$

$v_A = k \times \sqrt{\frac{T_A}{M_A}}$ — (1)

$v_B = k \times \sqrt{\frac{T_B}{M_B}}$ - (2)

Dividing eq. (1) by (2).

$\frac{v_A}{v_B} = \frac{\cancel{k} \times \sqrt{\frac{T_A}{M_A}}}{\cancel{k} \times \sqrt{\frac{T_B}{M_B}}}$

$\frac{v_A}{v_B} = \sqrt{\frac{T_A}{M_A}} \div \sqrt{\frac{T_B}{M_B}}$

$\frac{v_A}{v_B} = \sqrt{\frac{T_A}{M_A}} \times \sqrt{\frac{M_B}{T_B}}$

$\frac{v_A}{v_B} = \sqrt{\frac{T_A}{T_B} \times \frac{M_B}{M_A}}$

$\frac{v_A}{v_B} = \sqrt{\frac{\cancel{T_B}}{\cancel{T_B}} \times \frac{M_B}{M_A}}$

$\frac{v_A}{v_B} = \sqrt{\frac{48}{12}} = \sqrt{4}$