Nishant Jindal

Doppler Effect (Only in JEE Adv)

"When there is relative motion b/w Source and detector/observer then detector detects apparent frequency which is different from the real frequency emitted by source" this effect is Called Doppler effect

⇒ **Important points**

- In doppler effect v_s & v_o alway along the line joining Source & detector.
  v_s = velocity of source, v_o = velocity of observer/detector
- v_s & v_o always less then velocity of sound in air (v)

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FORMULA

$$f_{app} = \left(\frac{v \pm v_0}{v \mp v_s}\right) f$$

N → (+)
D → (−)

> When source & Observer moving towards each other

N ← (−)
D ← (+)

> when Source & observer moving away from each other

v = velocity of Sound in air

v_0 = velocity of observer or detector.

v_s = velocity of source.

f = Real frequency

v_0 & v_s → w.r.t earth.

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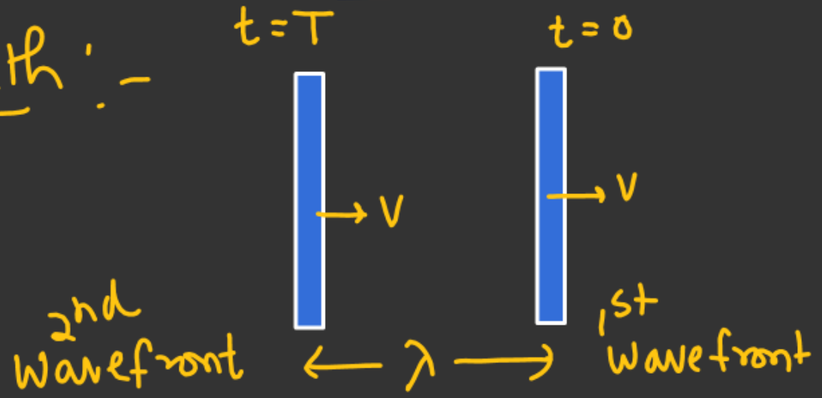
Wavelength :-



$\lambda = \left(\frac{V}{T}\right)$ $\quad \frac{1}{T} = f$

Time period :- Time interval b/w two consecutive wavefront

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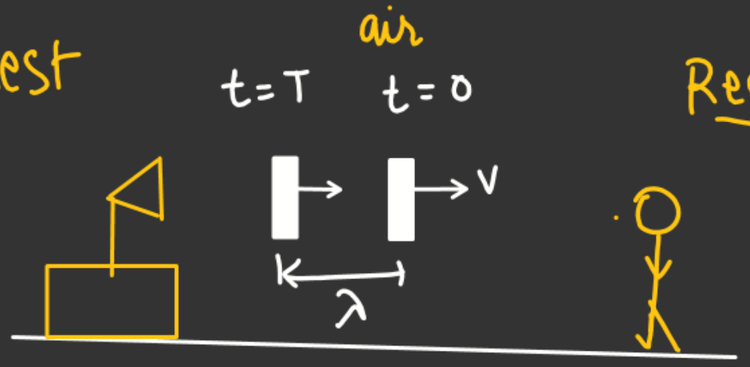
Source Stationary & observer in moving towards the source

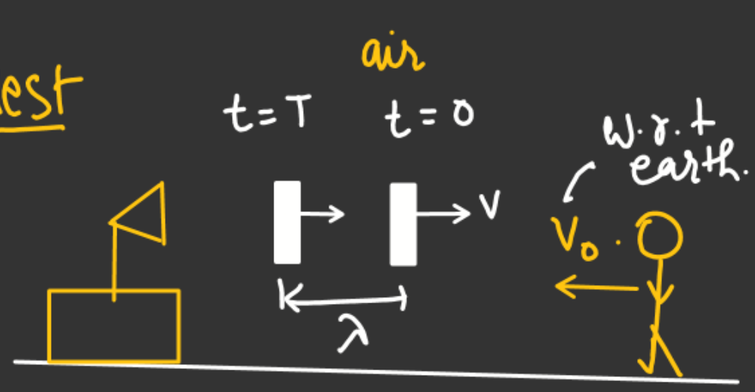


$$\lambda = VT$$

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

$$f = \left(\frac{V}{\lambda}\right)$$

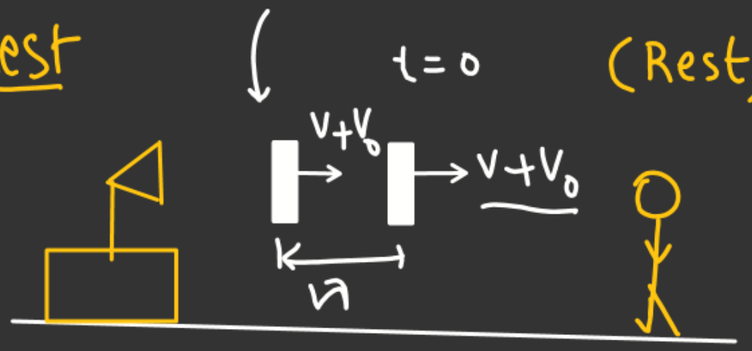
Real frequency.



$$T_{app} = \frac{\lambda}{V+V_0}$$

$$f_{app} = \frac{V+V_0}{\lambda}$$

$t = T_{app} = ??$



$$f_{app} = \left(\frac{V+V_0}{V}\right)\frac{1}{T}$$

$$\boxed{f_{app} = \left(\frac{V+V_0}{V}\right)\cdot f}$$

Due to T_{app} we have f_{app}

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When Observe moving away from Source & Source is Stationary

$$f_{app} = \left(\frac{V - V_0}{V}\right) f$$

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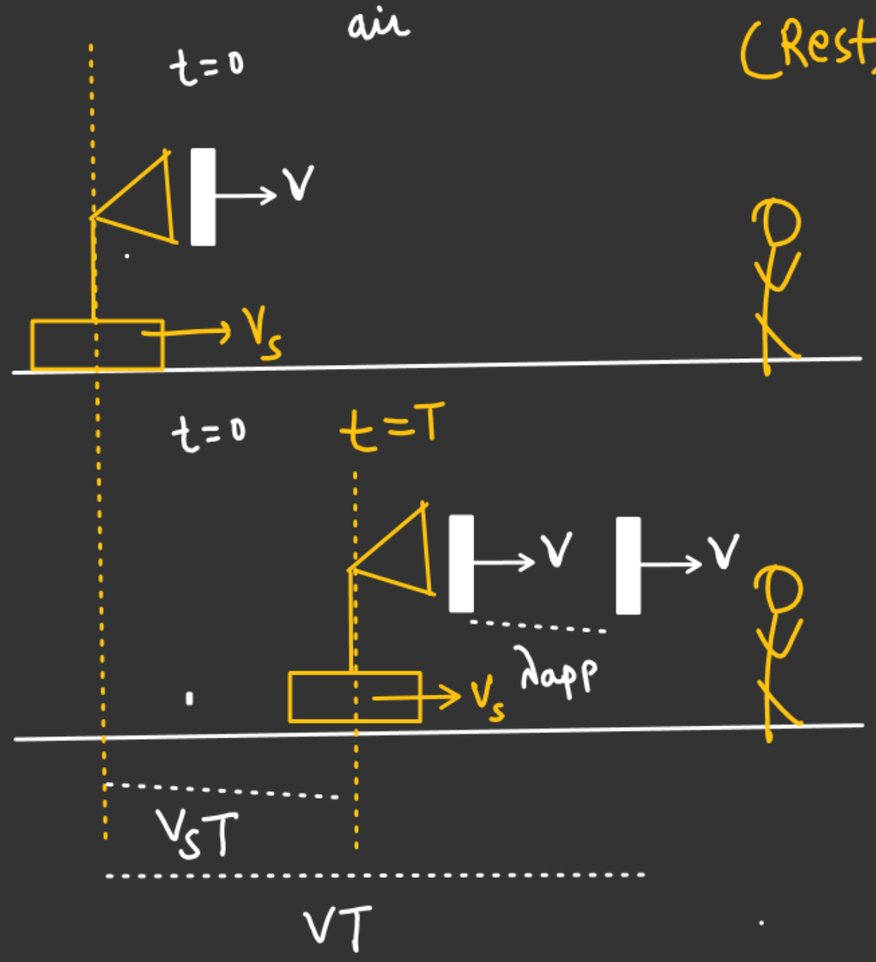
Source Moving observer Stationary

$v = f\lambda$.



$$\lambda_{app} = (V - V_s) \times T$$

$$\frac{v}{f_{app}} = \frac{v - v_s}{} \times \frac{1}{f}$$

$$f_{app} = \frac{v}{v - v_s} \times f$$

when source moving away from detector or observer.

$$f_{app} = \frac{v}{v + v_s} \times f \longrightarrow 1$$

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Different Cases

When Source & observer velocity not along the line joing

$$\left(f_{app} = \frac{V \pm V_o}{V \mp V_s} \times f \right)$$

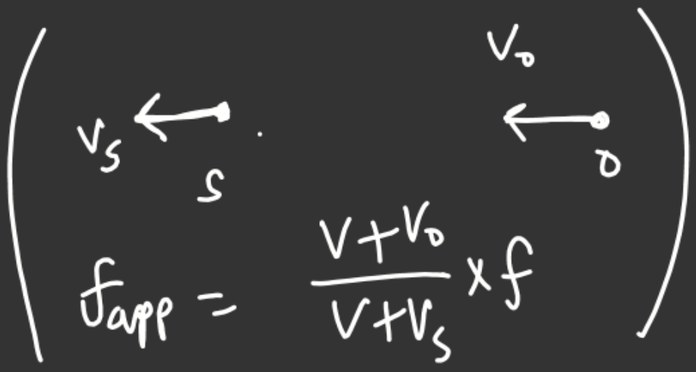
$V_o \rightarrow V_o \cos\beta$

$V_s \rightarrow V_s \cos\alpha$

for towards
(+)
(−)

$$f_{app} = \left(\frac{V + V_o \cos\beta}{V - V_s \cos\alpha} \right) f$$

#



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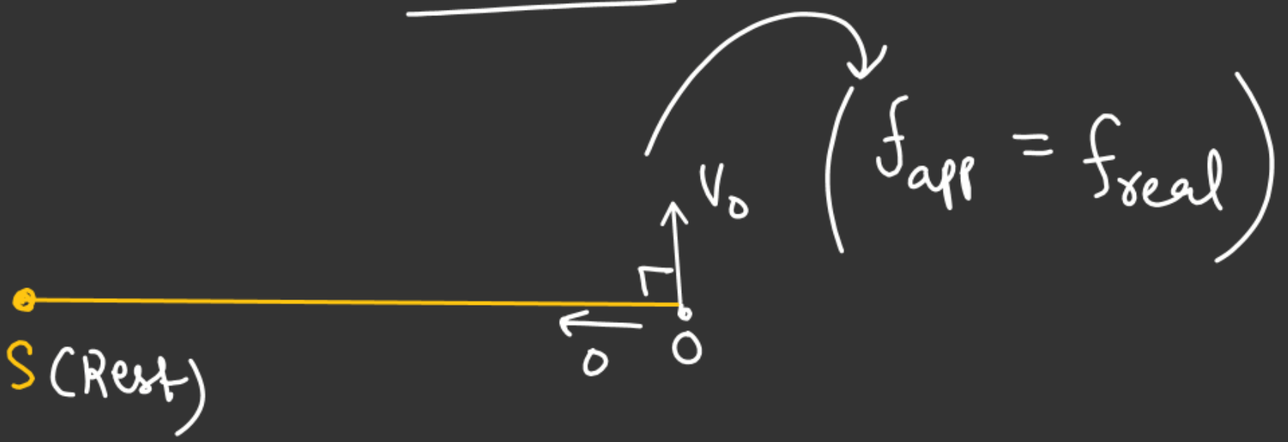
$$f_{app} = \left(\frac{V}{V - V_s}\right) \times f$$

$V_o \cos 90^\circ = 0$



$f_{app} = f_{real}$