Waves

Harmonic Progression	$y(x,t) = A\sin(kx - \omega t + \phi)$
Speed of Wave	$v = \frac{\omega}{k} = \frac{\lambda}{T} = \lambda f$
Speed of Particle	$V_P = A\omega\cos(\omega t + kx)$ $(V_P)_{max} = Akv$ v = speed of wave
Speed of Longitudinal Wave in gas $T = Temperature$ $\rho = Density$	$v = \sqrt{\frac{\gamma p}{\rho}} = \sqrt{\frac{RT}{M}}$
Speed of Transverse Wave $T = Tension\ in\ String$ $\mu = mass\ per\ unit\ length$ $\eta = modulus\ of\ Rigidity$	$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{\eta}{\rho}}$
Speed of Transverse Wave at a point x	$v_x = \sqrt{gx}$
Acceleration of a Transverse Wave going up Vertical Plane	$a_{wave} = \frac{g}{2}$
Relation between Phase difference, Path differnece and Time difference	$\frac{2\pi}{\Delta\phi} = \frac{\lambda}{\Delta x} = \frac{T}{\Delta t}$

Speed of Sound			
Newton's Formula	$v = \sqrt{\frac{P}{\rho}}$	Laplace's Correction (Longitutdinal)	$v = \sqrt{\frac{\gamma P}{\rho}}$

Effect of Temperature on Speed of Sound	$v_t = v_0 + 0.61t$
Principle of Superposition of Wave	Two or more progressive waves can travel simultaneously in the medium without effecting the motion of one another
Equation of Stationary Wave	$y = 2a \sin\frac{2\pi t}{T} \cos\frac{2\pi x}{\lambda}$
Position of Nodes	$x = \frac{n\lambda}{2}$

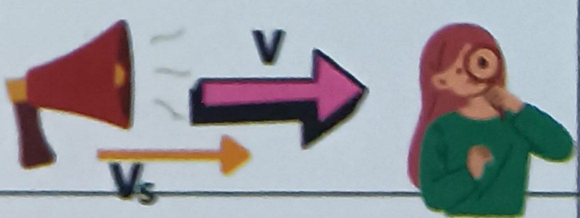
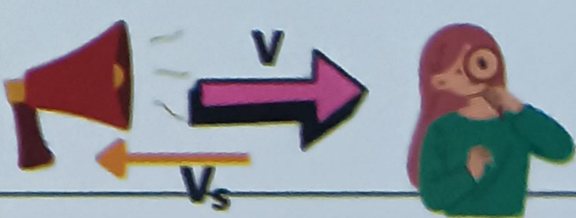
Properties	Reflected	Refracted/Transmitted
Velocity	Same always	from Rarer → Denser (speed ↓)
Frequency	Same	Same
Wavelength	Same	$V = \lambda f$ (f is same)
Phase	from Denser there is phase difference of π	No change

Sonometer Wire/Open Organpipe	$f = \frac{nV}{2L} = \frac{n}{2L}\sqrt{\frac{T}{\mu}} = \frac{n}{2L}\sqrt{\frac{\gamma P}{\rho}}$	
1st Harmonic Fundamental Frequency	2nd Harmonic 1st Overtone	3rd Harmonic 2nd Overtone
$f_1 = \frac{V}{2L}$	$f_1 = \frac{V}{L}$	$f_1 = \frac{3V}{2L}$

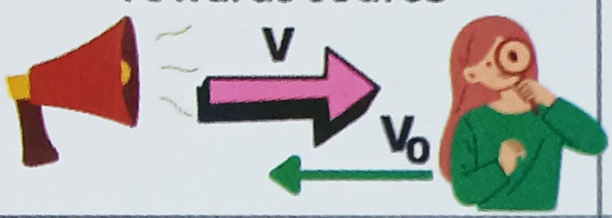
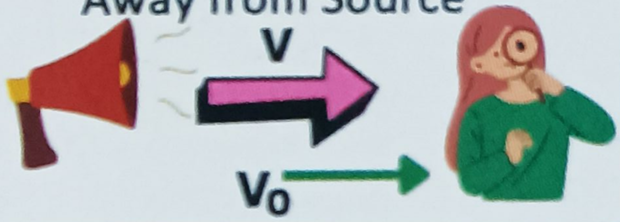
Closed Organpipe	$f = \frac{(2n-1)V}{4L}$		
n=1 1st Harmonic	Fundamental Frequency $f = \frac{V}{4L}$	n=2 3rd Harmonic	1st Overtone $f = \frac{3V}{4L}$
End Correction	$e = \frac{l_2 - 3l_1}{2}$		
Resonance Tube	If, $l_1 = l$; Then, $l_2 = 3l$		

Doppler Effect

When Source is moving, Observer at rest

Towards observer	Away from Observer
	
$f' = f\left(\frac{v}{v - v_s}\right)$	$f' = f\left(\frac{v}{v + v_s}\right)$

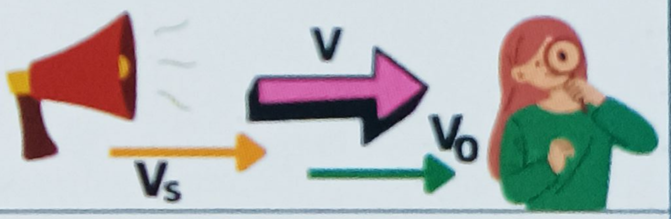
When Source is at rest, Observer is moving

Towards source	Away from Source
	
$f' = f\left(\frac{v + v_o}{v}\right)$	$f' = f\left(\frac{v - v_o}{v}\right)$

When Source and Observer both are moving

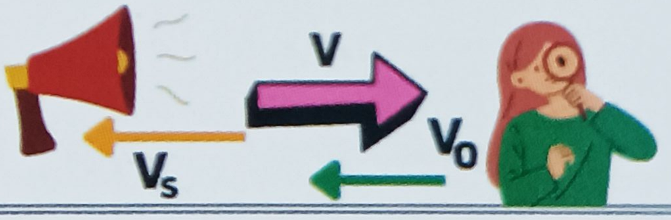
a. Both moving in direction of sound

$$f' = f\left(\frac{v - v_o}{v - v_s}\right)$$



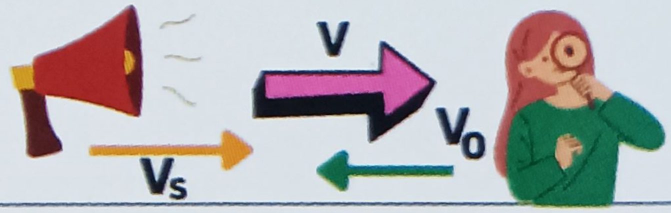
b. Both moving oppsite to direction of sound

$$f' = f\left(\frac{v + v_o}{v + v_s}\right)$$



c. Both moving towards each other

$$f' = f\left(\frac{v + v_o}{v - v_s}\right)$$



a. Both moving opposite to each other

$$f' = f\left(\frac{v - v_o}{v + v_s}\right)$$