Formula Sheet

Speed of sound $v_{solid} = \sqrt{\frac{Y}{\rho}}$ (Y is the Young modulus and ρ the density of the solid).

$v_{air} = 343 m/s$

Displacement of a mass element $s(x,t) = s_m \cos(kx - \omega t)$

The pressure change from equilibrium pressure is

$\Delta p = \Delta p_m \sin(kx - \omega t)$; $\Delta p_m = (\rho v \omega) s_m$

Sound intensity $I = \frac{P}{A} = \frac{1}{2}\rho v \omega^2 s_m^2$ Sound level $= SL = \beta = 10 \log \frac{I}{I_o}$ (dB)

Threshold of hearing: $I_o = 10^{-12} W/m^2$; threshold of pain: $I = 1 W/m^2$

Standing wave pattern in pipes:

Open at both ends $f_n = \frac{v}{\lambda_n} = \frac{nv}{2L}$, $n = 1, 2, 3...$

Closed at one end and open at the other $f_n = \frac{v}{\lambda_n} = \frac{nv}{4L}$, $n = 1, 3, 5, ...$

Doppler effect : $f = f_o \frac{v \pm v_O}{v \mp v_S}$

Where v_O is the speed of the detector (observer) and v_S is the speed of the emitter (source) and v is the speed of sound in the medium.

An electromagnetic wave traveling along an x axis, is a transverse wave, with $\vec{E} \perp \vec{B} \perp \vec{k} // x$.

Energy flow is given by the Poynting vector $\vec{S} = \frac{1}{\mu_o} \vec{E} \times \vec{B}$; $I = \frac{E_m^2}{2\mu_0 c}$;

The intensity of the waves at distance r from an isotropic point source of power P_s is given by $I = \frac{P_s}{4\pi r^2}$

Radiation pressure:

1- Total absorption : $P_{rad} = \frac{I}{c}$, 2- Total reflection : $P_{rad} = \frac{2I}{c}$

Polarization:

If the original light is initially unpolarized, the transmitted intensity is half the original intensity. If the original light is initially polarized, the transmitted intensity depends on the angle θ between the polarization direction of the original light and the polarizing direction of the sheet : $I = I_o \cos^2 \theta$

Polarization by reflection: Brewster angle: $\theta_B = \tan^{-1} \frac{n_2}{n_1}$

$c = 3 \times 10^8 m/s$, $\mu_o = 4\pi \times 10^{-7}$ (SI)