(1.12)
Doppler effect for sound with speed v_S, object moves with v_o

$a)\lambda' = \lambda\left(1 - \frac{v_o}{v_S}\right)$ object approaching with speed v_o

$b)\lambda' = \lambda\left(1 + \frac{v_o}{v_S}\right)$ object receding with speed v_o

To get from wavelengths λ to frequencies f, we just remember the general relationship $\lambda f = v_S$ and $\lambda' f' = v_S$; where v_S is the speed of the wave.
General formula, including moving receiver with speed v_R:

$f' = f\left(\frac{v_S + v_R}{v_S - v_O}\right)$; v_R=speed of the receiver, and v_O speed of the object, are positive numbers for approaching, negative for receding.

(1.13) Doppler effect for light (relativistic):

$a)\lambda' = \lambda\sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}};\ f' = f\sqrt{\frac{1+\frac{v}{c}}{1-\frac{v}{c}}}$ $b)\lambda' = \lambda\sqrt{\frac{1+\frac{v}{c}}{1-\frac{v}{c}}};\ f' = f\sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}}$

a)for a star approaching with the speed v; blue shift
b)for a star receding with the speed v; red shift
Hubble constant:
H=0.017m/(s ltyrs)

(1.14)
Wave particle relationships:(1.15)
$a)E = \hbar\omega = \sqrt{p^2c^2 + m_0^2c^4}$

Every material particle with mass m_0 has a frequency f_0, a wavelength λ_0,

and a momentum (c) p=$\frac{m_0 v}{\sqrt{1-\frac{v^2}{c^2}}}$ $(d)p = \hbar k = \frac{h}{\lambda}$

The subscript 0 refers to the quantity of the object with reference to its own system, for example rest-mass.

5. (1.16) Group velocity: $v_g = \frac{d\omega}{dk} = \frac{dE}{dp}$ Phase velocity: $v_p = \frac{\omega}{k} = \frac{E}{p}$

Formulas:

1. (1.1)

$$I = \sum_{i=1}^{N} m_i r_i^2 \Rightarrow \int_{total\ mass} r^2 dm$$ for the rotation of objects with mass m_i or dm around a fixed axis.

2. (1.2)The buoyant force B equals the weight of the displaced liquid.

(1.3) $\frac{\rho}{\rho_{liquid}} = \frac{V_{liquid}}{V}; m = \rho V$

Continuity equation;

3. (1.4) $A_1 v_1 = A_2 v_2$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

(1.5)

$$\frac{\partial^2 \Delta P}{\partial x^2} = \frac{\rho}{B}\frac{\partial^2 \Delta P}{\partial t^2} = \frac{1}{v^2}\frac{\partial^2 \Delta P}{\partial t^2};$$

$$\Delta P(x,t) = \Delta P_{max}\sin(kx - \omega t + \varphi);\ v = \sqrt{\frac{B}{\rho}} = \frac{\omega}{k};\ v = \text{(for a solid metal bar)} = \sqrt{\frac{Y}{\rho}}$$

$a) s(x,t) = s_{max}\cos(kx - \omega t); \Delta P(x,t)$ and s(x,t) are out of phase by $\frac{\pi}{2}$

(1.6) $b) \Delta P(x,t) = \Delta P_{max}\sin(kx - \omega t) = -B\frac{\partial s(x,t)}{\partial x}$

ΔP is the excess pressure created by the sound wave.

(1.7) $P_{max} = \rho v \omega s_{max} = Bk s_{max}$, where we put $v = \omega / k$

(1.8) Intensity $= \frac{\text{Power}}{\text{cross sectional area A}} = I = \frac{1}{2}\rho(\omega s_{max})^2 v$

(1.9) $I = \frac{P^2_{max}}{2\rho v}$ Sound intensity:

(1.10) $\beta = 10\log\left(\frac{I}{I_0}\right)$ decibels, dB, with $I_0 = 10^{-12}\frac{W}{m^2}$

Superposition of two sine waves with amplitude A and different phases :

4. (1.11) $y_1 + y_2 = 2A\cos\frac{(\theta_2 - \theta_1)}{2}\sin\left(\frac{\theta_2 + \theta_1}{2}\right)$