Equation of state for ideal gas:

$$p \;=\; \rho R T \;=\; \frac{\gamma-1}{\gamma}\,\rho h \qquad , \qquad h \;=\; c_p T$$

Isentropic relations:

$$\frac{\rho_2}{\rho_1} \;=\; \left(\frac{T_2}{T_1}\right)^{1/(\gamma-1)} \qquad\qquad \frac{p_2}{p_1} \;=\; \left(\frac{T_2}{T_1}\right)^{\gamma/(\gamma-1)} \;=\; \left(\frac{\rho_2}{\rho_1}\right)^{\gamma}$$

Total enthalpy definition:

$$h_o \;\equiv\; h + \frac{1}{2}V^2 \;=\; e + \frac{p}{\rho} + \frac{1}{2}V^2 \;=\; e_o + \frac{p}{\rho}$$

Integral Enthalpy Equation (steady):

$$\oiint \rho\left(\vec{V}\cdot\hat{n}\right) h_o \, dA \;=\; \iiint \rho\,\dot{q}\; d\mathcal{V} \;+\; \iiint \rho\,\vec{g}\cdot\vec{V}\; d\mathcal{V}$$

Convective form of enthalpy equation:

$$\frac{Dh_o}{Dt} \;=\; \frac{1}{\rho}\frac{\partial p}{\partial t} \;+\; \dot{q} \;+\; \vec{g}\cdot\vec{V}$$

$$h_o \;=\; \text{constant} \qquad\qquad \text{(steady, adiabatic, no gravity)}$$

Rankine-Hugoniot shock jump relations:

$$\rho_1 u_1 \;=\; \rho_2 u_2$$

$$\rho_1 u_1^2 \;+\; p_1 \;=\; \rho_2 u_2^2 \;+\; p_2$$

$$w_1 \;=\; w_2$$

$$h_1 \;+\; \frac{1}{2}u_1^2 \;=\; h_2 \;+\; \frac{1}{2}u_2^2$$

Speed of sound, Mach number:

$$a^2 \;=\; \gamma p/\rho \;=\; \gamma R T \;=\; (\gamma-1)\,h \qquad\qquad\qquad M \;\equiv\; V/a$$

Total pressure relation:

$$\frac{p_o}{p} \;=\; \left(1 \;+\; \frac{\gamma-1}{2}M^2\right)^{\gamma/(\gamma-1)} \;=\; \left(1 \;-\; \frac{V^2}{2h_o}\right)^{-\gamma/(\gamma-1)}$$

Shock jump functions:

$$M_{n_2}^2 \;=\; \frac{1 \;+\; \frac{\gamma-1}{2}M_{n_1}^2}{\gamma M_{n_1}^2 \;-\; \frac{\gamma-1}{2}}$$

$$\frac{\rho_2}{\rho_1} \;=\; \frac{(\gamma+1)M_{n_1}^2}{2 \;+\; (\gamma-1)M_{n_1}^2}$$

$$\frac{p_2}{p_1} \;=\; 1 \;+\; \frac{2\gamma}{\gamma+1}\left(M_{n_1}^2 - 1\right)$$

$$\frac{T_2}{T_1} \;=\; \frac{p_2}{p_1}\frac{\rho_1}{\rho_2}$$

$$\frac{p_{o_2}}{p_{o_1}} \;=\; \frac{p_2}{p_1}\left(\frac{1 \;+\; \frac{\gamma-1}{2}M_{n_2}^2}{1 \;+\; \frac{\gamma-1}{2}M_{n_1}^2}\right)^{\gamma/(\gamma-1)} \;=\; f(M_{n_1})$$

Rayleigh Pitot formula:

$$\frac{p_{o_2}}{p_1} = \frac{p_{o_2}}{p_2}\frac{p_2}{p_1} = \left(\frac{(\gamma+1)^2 M_1^2}{4\gamma M_1^2 - 2(\gamma-1)}\right)^{\gamma/(\gamma-1)} \frac{1-\gamma+2\gamma M_1^2}{\gamma+1}$$

Oblique-shock relations:

$$M_{n_1} = M_1 \sin\beta$$

$$M_{n_2} = M_2 \sin(\beta-\theta)$$

$$\tan\theta = \frac{2}{\tan\beta}\,\frac{M_1^2\sin^2\beta \,-\, 1}{M_1^2(\gamma+\cos 2\beta) \,+\, 2}$$

Prandtl-Meyer expansion-wave Mach/angle relation:

$$\theta_2 - \theta_1 = \nu(M_2) \,-\, \nu(M_1)$$

$$\nu(M) \equiv \sqrt{\frac{\gamma+1}{\gamma-1}}\,\arctan\sqrt{\frac{\gamma-1}{\gamma+1}\,(M^2-1)} \,-\, \arctan\sqrt{M^2-1}$$

Channel mass flow relations:

$$\dot{m} = \rho u A = \rho^* a^* A^* = \text{constant}$$

Sonic-flow quantities:

$$\rho^* = \rho_o\left(1+\frac{\gamma-1}{2}\right)^{-\frac{1}{\gamma-1}}$$

$$p^* = p_o\left(1+\frac{\gamma-1}{2}\right)^{-\frac{\gamma}{\gamma-1}}$$

$$u^* = a^* = a_o\left(1+\frac{\gamma-1}{2}\right)^{-\frac{1}{2}}$$

Area-Mach relation:

$$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1}\left(1+\frac{\gamma-1}{2}M^2\right)\right]^{\frac{\gamma+1}{2(\gamma-1)}}$$

Derived channel mass flow relations:

$$\dot{m} = \frac{\gamma\, p_o}{\sqrt{(\gamma-1)h_o}}\; M\left(1 \,+\, \frac{\gamma-1}{2}M^2\right)^{-\frac{\gamma+1}{2(\gamma-1)}} A$$

$$\dot{m} = \frac{\gamma\, p}{\sqrt{(\gamma-1)h_o}}\; M\left(1 \,+\, \frac{\gamma-1}{2}M^2\right)^{1/2} A$$