Constitutive relationships for solids, incompressible fluids, ideal gases and pure substances

Model	Equation of State	Specific Internal Energy	Specific Enthalpy	Specific Entropy
Incompressible Liquid or Solid	$\rho = const$	$u = u_0 + c(T - T_0)$	$h = h_0 + c(T - T_0) + \frac{P - P_0}{\rho}$	$s = s_0 + c \ln \frac{T}{T_0}$
Ideal Gas*	$PV = mRT$ or $\rho = \frac{P}{RT}$	$u = u_0 + c_v(T - T_0)$	$h = h_0 + c_p(T - T_0)$	$s = s_0 + c_p \ln \frac{T}{T_0} - R \ln \frac{P}{P_0}$
Pure Substance**	$\rho = \rho(P,T)$ (single-phase) $\frac{1}{\rho} = \frac{1-x}{\rho_f(P)} + \frac{x}{\rho_g(P)}$ (two-phase)	$u = u(P,T)$ (single-phase) $u = u_f(P)(1-x) + u_g(P)x$ (two-phase)	$h = h(P,T)$ (single-phase) $h = h_f(P)(1-x) + h_g(P)x$ (two-phase)	$s = s(P,T)$ (single-phase) $s = s_f(P)(1-x) + s_g(P)x$ (two-phase)

***** Relation of universal gas constant ***R*** and specific ideal gas constant *R: R*=***R***/*A*, where *A* is the molecular weight; $c_p = c_v + R$

** Phases present to be determined from phase (*P*-*T*) diagram