Table 4.2-1
SOME USEFUL DEFINITIONS AND THERMODYNAMIC IDENTITIES

Definitions

$$\text{Constant-volume heat capacity} = C_V = \left(\frac{\partial \underline{U}}{\partial T}\right)_{\underline{V}} = T\left(\frac{\partial \underline{S}}{\partial T}\right)_{\underline{V}}$$

$$\text{Constant-pressure heat capacity} = C_P = \left(\frac{\partial \underline{H}}{\partial T}\right)_{P} = T\left(\frac{\partial \underline{S}}{\partial T}\right)_{P}$$

$$\text{Isothermal compressibility} = \kappa_T = -\frac{1}{\underline{V}}\left(\frac{\partial \underline{V}}{\partial P}\right)_{T}$$

$$\text{Coefficient of thermal expansion} = \alpha = \frac{1}{\underline{V}}\left(\frac{\partial \underline{V}}{\partial T}\right)_{P}$$

Maxwell relations

$$\left(\frac{\partial T}{\partial \underline{V}}\right)_{\underline{S}} = -\left(\frac{\partial P}{\partial \underline{S}}\right)_{\underline{V}} \qquad \left(\frac{\partial T}{\partial P}\right)_{\underline{S}} = \left(\frac{\partial \underline{V}}{\partial \underline{S}}\right)_{P}$$

$$\left(\frac{\partial P}{\partial T}\right)_{\underline{V}} = \left(\frac{\partial \underline{S}}{\partial \underline{V}}\right)_{T} \qquad \left(\frac{\partial \underline{V}}{\partial T}\right)_{P} = -\left(\frac{\partial \underline{S}}{\partial P}\right)_{T}$$

Thermodynamic identities

$$\left(\frac{\partial \underline{H}}{\partial \underline{S}}\right)_{P} = \left(\frac{\partial \underline{U}}{\partial \underline{S}}\right)_{\underline{V}} = T \qquad \left(\frac{\partial \underline{G}}{\partial P}\right)_{T} = \left(\frac{\partial \underline{H}}{\partial P}\right)_{\underline{S}} = \underline{V}$$

$$\left(\frac{\partial \underline{U}}{\partial \underline{V}}\right)_{\underline{S}} = \left(\frac{\partial \underline{A}}{\partial \underline{V}}\right)_{T} = -P \qquad \left(\frac{\partial \underline{A}}{\partial T}\right)_{\underline{V}} = \left(\frac{\partial \underline{G}}{\partial T}\right)_{P} = -\underline{S}$$

Thermodynamic functions

$$d\underline{U} = T\,d\underline{S} - P\,d\underline{V} = C_V\,dT + \left[T\left(\frac{\partial P}{\partial T}\right)_{\underline{V}} - P\right]d\underline{V}$$

$$d\underline{H} = T\,d\underline{S} + \underline{V}\,dP = C_P\,dT + \left[\underline{V} - T\left(\frac{\partial \underline{V}}{\partial T}\right)_{P}\right]dP$$

$$d\underline{A} = -P\,d\underline{V} - \underline{S}\,dT$$

$$d\underline{G} = \underline{V}\,dP - \underline{S}\,dT$$

Miscellaneous

$$\left(\frac{\partial \underline{U}}{\partial \underline{V}}\right)_{T} = T\left(\frac{\partial P}{\partial T}\right)_{\underline{V}} - P = \frac{T\alpha}{\kappa_T} - P$$

$$\left(\frac{\partial \underline{H}}{\partial P}\right)_{T} = \underline{V} - T\left(\frac{\partial \underline{V}}{\partial T}\right)_{P} = \underline{V}(1 - T\alpha)$$