Cyclic rule

$$\frac{\partial x}{\partial y}\frac{\partial y}{\partial z}\frac{\partial z}{\partial x} = -1 \tag{1}$$

Definition of volumetric thermal expansion coefficient and the isothermal compressibility

$$\alpha = \frac{1}{V}\frac{\partial V}{\partial T} \qquad \kappa_T = -\frac{1}{V}\frac{\partial V}{\partial P} \tag{2}$$

Definition of heat capacity at constant volume

$$\frac{dq}{dT} = \frac{\partial U}{\partial T} = C_V \tag{3}$$

ΔU can be measured by measuring heat flow at constant volume

$$\int_a^b dq_V = \int_a^b \frac{\partial U}{\partial T} dT \qquad q_V = \Delta U \tag{4}$$

Under most conditions, $U = U(T)$ alone

$$U(T_2, V_2) - U(T_1, V_1) = \Delta U = \int_{T_1}^{T_2} C_V dT = n\int_{T_1}^{T_2} C_{V,m} dT \tag{5}$$

Changes in enthalpy can be measured by determining heat flow at constant pressure

$$(U_2 + P_2V_2) - (U_1 + P_1V_1) = q_P \qquad \Delta H = q_P \tag{6}$$

Definition of heat capacity at constant pressure

$$C_P = \frac{dq_P}{dT} = \frac{\partial H}{\partial T} \tag{7}$$

Relation between C_P and C_V for any substance

$$C_P = C_V + TV\frac{\alpha^2}{\kappa_T} \qquad C_{P,m} = C_{V,m} + TV_m\frac{\alpha^2}{\kappa_T} \tag{8}$$

Under most conditions, $H = H(T)$ alone

$$H(T_2, P_2) - H(T_1, P_1) = \Delta H = \int_{T_1}^{T_2} C_P dT = n\int_{T_1}^{T_2} C_{P,m} dT \tag{9}$$

Definition of Joule-Thomson Coefficient

$$\mu_{JT} = \lim_{\Delta P \to 0}\frac{\Delta T}{\Delta P} = \frac{\partial T}{\partial P} \tag{10}$$