

$$Q = \Delta U - W$$

$$\delta Q = dU - \delta W$$

$$\delta Q = dU + p dV$$

① $\delta Q \rightarrow \delta Q(\theta, V)$

$$\delta Q = c_v d\theta + \frac{p - c_v}{V\alpha} dV$$

② $\delta Q \rightarrow \delta Q(P, V)$

$$\delta Q = \frac{p}{V\alpha} dV + \frac{\kappa_T}{\alpha} c_v dP$$

③ $\delta Q \rightarrow \delta Q(\theta, P)$

$$\delta Q = c_p d\theta + \frac{\kappa_T}{\alpha} (c_v - c_p) dP$$

④ $U = U(V, \theta)$

$$\left(\frac{\partial U}{\partial \theta}\right)_V = c_v$$

$$\left(\frac{\partial U}{\partial V}\right)_\theta = \frac{c_p - c_v}{V\alpha} - p$$

⑤ $U = U(V, P)$

$$\left(\frac{\partial U}{\partial P}\right)_V = \frac{\kappa_T}{\alpha} c_v$$

$$\left(\frac{\partial U}{\partial V}\right)_P = \frac{c_p}{V\alpha} - p$$

⑥ $U = U(\theta, P)$

$$\left(\frac{\partial U}{\partial \theta}\right)_P = c_p - p V \alpha$$

$$\left(\frac{\partial U}{\partial P}\right)_\theta = -\frac{\kappa_T}{\alpha} (c_p - c_v) + p V \kappa_T$$

⑦

$$c_p - c_v = -T \left(\frac{\partial V}{\partial T}\right)_P^2 \left(\frac{\partial P}{\partial V}\right)_T$$