

T-ds Relations

To find the relationship between δQ and T so that the integration of $\delta Q/T$ can be performed

- From the **1st Law** (neglecting KE & PE)

$$Q - W = U$$

$$\delta Q_{rev} - \delta W_{rev} = dU$$

$$\delta Q_{rev} = TdS$$

$$\delta W_{rev} = pdV$$

$$TdS - pdV = dU$$

$$TdS = dU + pdV$$

$$Tds = du + pdv$$

← (a)

- From the definition of **enthalpy**

$$h = u + pv$$

$$dh = du + pdv + vdp$$

$$du = dh - pdv - vdp$$

From (a) $Tds = du + pdv$

$$= dh - pdv - vdp + pdv$$

$$Tds = dh - vdp$$

← (b)

$$Tds = du + pdv$$

$$Tds = dh - vdp$$

→

$$ds = \frac{du}{T} + \frac{pdv}{T}$$

&

$$ds = \frac{dh}{T} - \frac{vdp}{T}$$

- Can be used for ΔS of any process (rev. & irrev.)
- Can be used for open & closed system