

# First Law of Thermodynamics

## 1. Mathematical Formulations of Thermodynamics.

$$y = y(x_1, x_2, \dots, x_n)$$

then differential  $dy$  is said to be exact and one can write

$$dy = \sum_i c_i dx_i$$

$$dy = c_1 dx_1 + c_2 dx_2 + \dots$$

$$dy = \left( \frac{\partial y}{\partial x_1} \right) dx_1 + \left( \frac{\partial y}{\partial x_2} \right) dx_2 + \dots = \sum_i \left( \frac{\partial y}{\partial x_i} \right) dx_i$$

and its corresponding  $c_i$   $x_i$  are said to be conjugate to each other.

## Some Important Formulas

$$1. \frac{\partial^2 y}{\partial x_k \partial x_l} = \frac{\partial^2 y}{\partial x_l \partial x_k}$$

$$2. \left( \frac{\partial x}{\partial y} \right)_z = \left( \frac{\partial y}{\partial x} \right)_z$$

$$3. \left( \frac{\partial x}{\partial z} \right)_y = \left( \frac{\partial x}{\partial y} \right)_z \left( \frac{\partial y}{\partial z} \right)_x$$

$$4. \left( \frac{\partial x}{\partial y} \right)_z = - \left( \frac{\partial x}{\partial z} \right)_y \left( \frac{\partial z}{\partial y} \right)_x$$

$$5. \left( \frac{\partial x}{\partial y} \right)_z = \left( \frac{\partial x}{\partial w} \right)_z \left( \frac{\partial w}{\partial y} \right)_z$$

$$6. dx = \left( \frac{\partial x}{\partial y} \right)_w dy + \left( \frac{\partial x}{\partial w} \right)_y dw$$

$$\left( \frac{\partial x}{\partial y} \right)_z = \left( \frac{\partial x}{\partial y} \right)_w + \left( \frac{\partial x}{\partial w} \right)_y \left( \frac{\partial w}{\partial y} \right)_z$$