

---

$\exists$  Work done or received  $W \neq 0 \Rightarrow \exists$  Change of State (“Displacement”, “Deformation”)  
 $r \neq 0$ :

$$\begin{aligned} r &= r(t) = r_x(t_x) - r_0(t_0) = \Delta r(\Delta t) \\ &\stackrel{Path}{=} State(arrival) - State(start) = Trajectory(Change) \end{aligned} \quad (1)$$

$$v = \dot{r} = \frac{d}{dt}r \quad p = \frac{1}{v}\sqrt{E^2 - (mv^2)^2} \quad F = \dot{p} = \frac{d}{dt}p \quad (2)$$

$$E = E_{kin} + E_{pot} \quad E_{kin} = \frac{f}{n}pv = f \cdot T \cdot b_0 \quad E_{pot} = \mathcal{V} + \mathcal{Z} \quad (3)$$

$$W = \partial_t A = \partial_t(E \cdot t) = \partial_t(p \cdot r) = F_1 \cdot r_1 + p_2 \cdot v_2 = \begin{cases} F \cdot r \\ p \cdot v \end{cases} \quad (4)$$

Geometrical:

$$W = F \cdot r = mr \cdot a = I \cdot \frac{v}{t} = \frac{p}{t} \cdot tv = Ft \cdot v = pv = mv^2 \quad (5)$$

Analytical:

$$\mathcal{L} = \mathcal{L}(r, \dot{r}, t) = E_{kin} - E_{pot} \quad (6)$$

$$\mathcal{H} = \mathcal{H}(r, p, t) = \sum_i^f \dot{r}_i p_i - \mathcal{L} \stackrel{konsev.}{=} E_{kin} + E_{pot} = const. \quad (7)$$

$$\begin{aligned} W &= p \cdot v = \mathcal{L} + \mathcal{H} = (\mathcal{K} - \mathcal{U}) + \mathcal{H} \\ &\stackrel{konsev.}{=} (\mathcal{K} - \mathcal{U}) + (\mathcal{K} + \mathcal{U}) = (\mathcal{K} - \mathcal{U}) + E \end{aligned} \quad (8)$$

Electro Magnetic:

$$W = \mathcal{L} + \mathcal{H} = \left( \frac{1}{2}mv^2 - q(\Phi - \vec{\mathcal{A}} \cdot \vec{v}) \right) + \left( \frac{1}{2} \frac{1}{m} (\vec{p} - q\vec{\mathcal{A}})^2 + q\Phi \right) \quad (9)$$

Relativistic:

$$W = p \cdot v = \frac{v}{c} \sqrt{E^2 - (mc^2)^2} \quad (10)$$

Thermal:

$$W = F \cdot r = PV^\iota = T \cdot V^{\frac{f+2}{f}} = T \cdot V^{(\frac{c_P}{c_V}-1)} = T \cdot V^{\kappa-1} = T \cdot l \cdot g_0 = T \cdot n \cdot b_0 = T \cdot m \cdot c_0 \quad (11)$$

---

Thermo Statistical:

$$W = \mathcal{L} + \mathcal{H} = \Delta U - \Delta H = \Delta(T \cdot \Delta S - P \cdot \Delta V) - \Delta(T \cdot S) \quad (12)$$

Quantistic:

$$W = p \cdot v = k \cdot \omega = h\nu k = Ek \quad (13)$$

$$\Delta A = \Delta p \cdot \Delta r = \Delta E \cdot \Delta t \geq \frac{1}{2}\hbar \quad (14)$$

see description of “movement” Equation [2](#)

acronyms see **?@sec-acroworkenergy**