First Law of Thermodynamics

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Work & heat interactions in Thermodynamics

- W=p*dV-σ*d(A)-v*dq-μH*d(vM) -E*d(vP)...
- Generalized intensive forces & Generalized extensive displacements
- "Thermal" energy flows from regions of high to low temperature via conduction, convection & radiation
- "Reversible transformation": Infinitesimal...While undertaking Cyclic transformation both the system & surrounding should come to the same state...All *states* should be represented in the state diagram during the transformation
- Generalizing work-energy theorem and conservation of energy beyond mechanics

$$\Delta E = \Delta U + \Delta KE + \Delta PE$$

$\Delta U = Change\ in\ Internal\ Energy\ U = Heat\ \&\ work\ exchange = q - W$

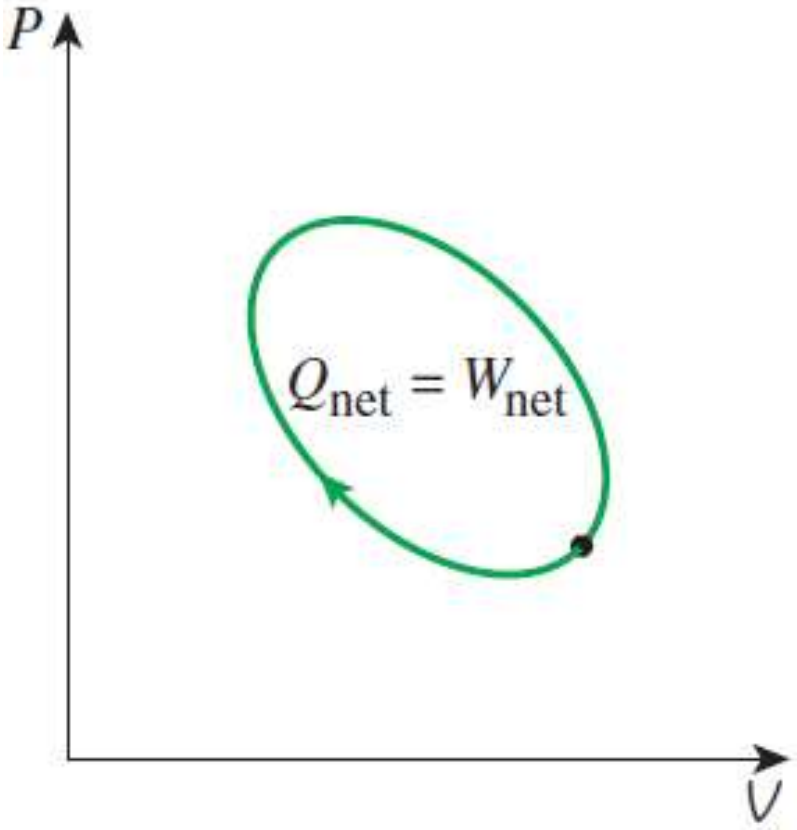
Sign Conventions: Work, heat & 1st law of TD

$$\textbf{Change in Internal Energy} = \textbf{Heat \& work exchange}$$
$$\Delta U = q - W$$

- $W > 0$: work *done by* the system
- $W < 0$: work *done on* the system

- $Q > 0$: heat transfer *to the* system
- $Q < 0$: heat transfer *from* the system

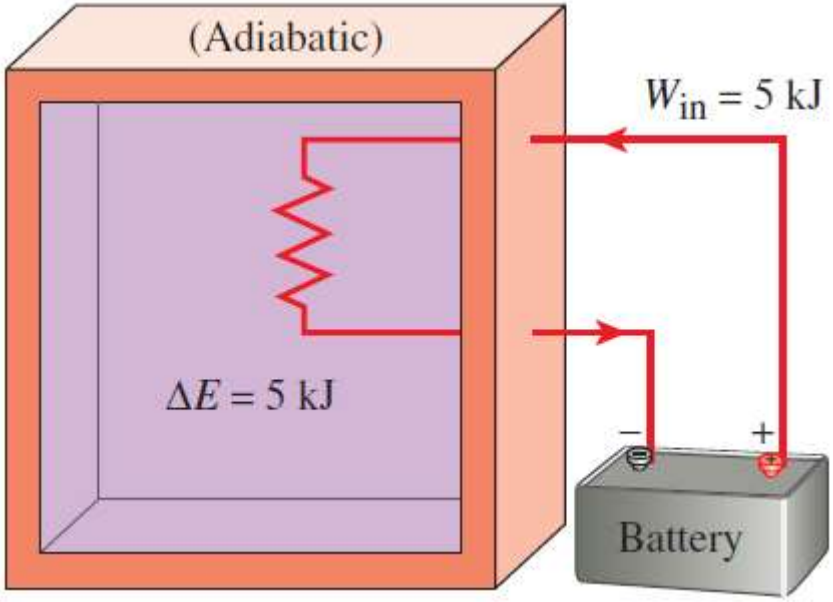
Perpetual motion machine is impossible!

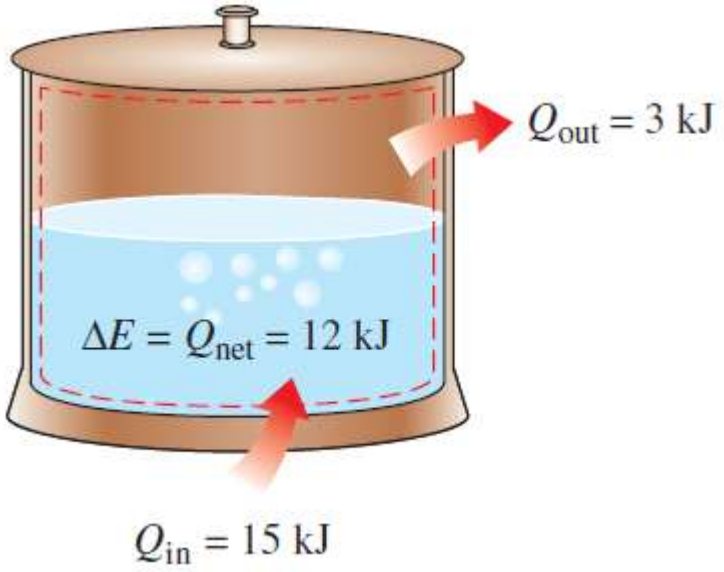


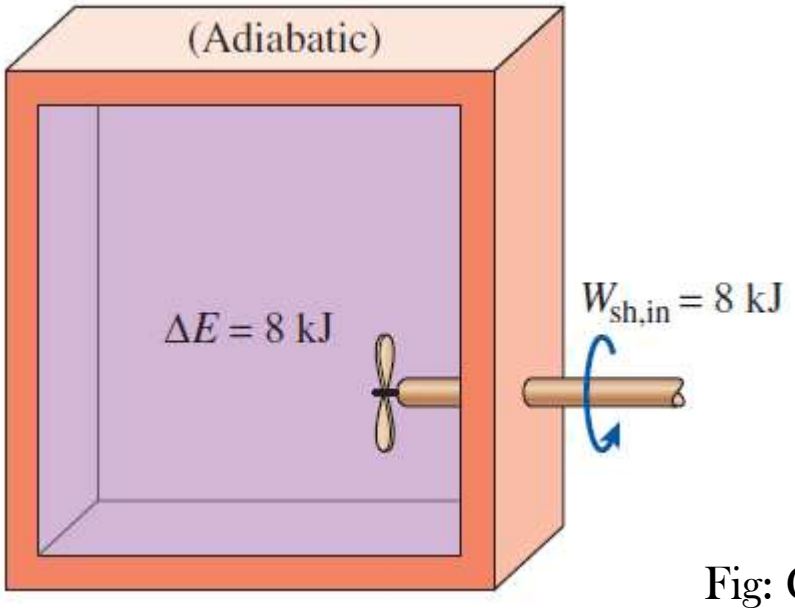
Cycle: $\oint \Delta U = 0; W = Q = 0$

Fig: Cengel & Boles: TD

Work & Heat interactions







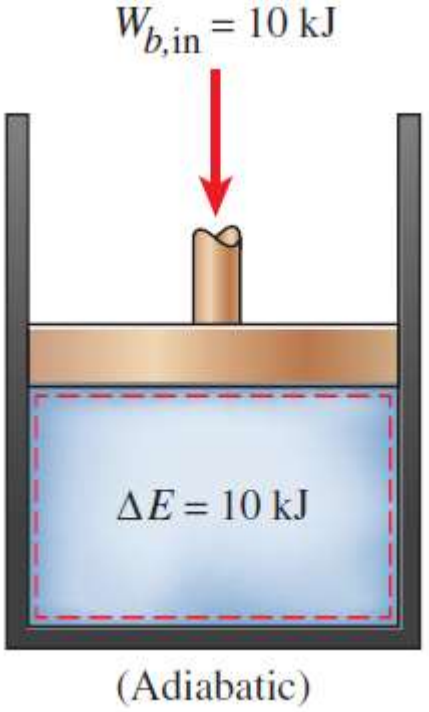


Fig: Cengel & Boles: TD

(Work+heat) exchange=Increase in thermal energy

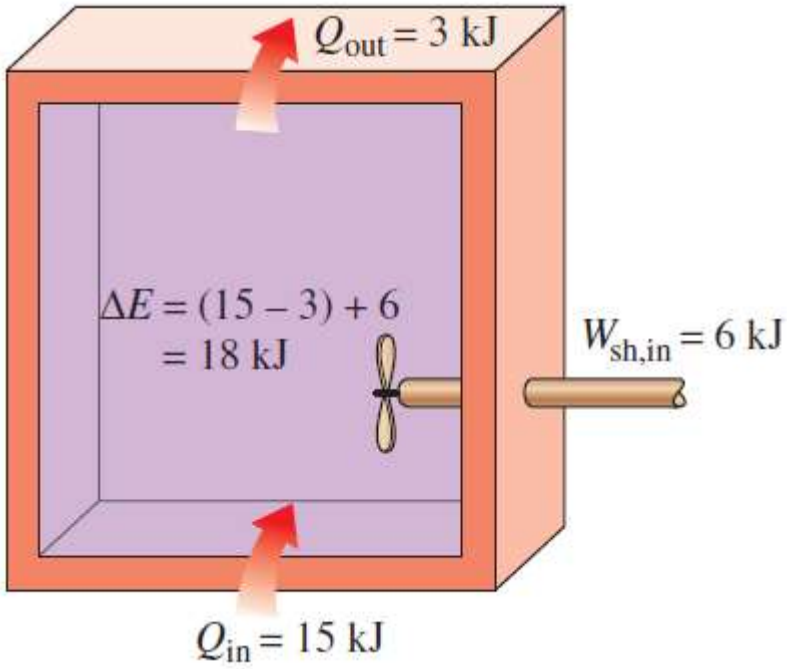
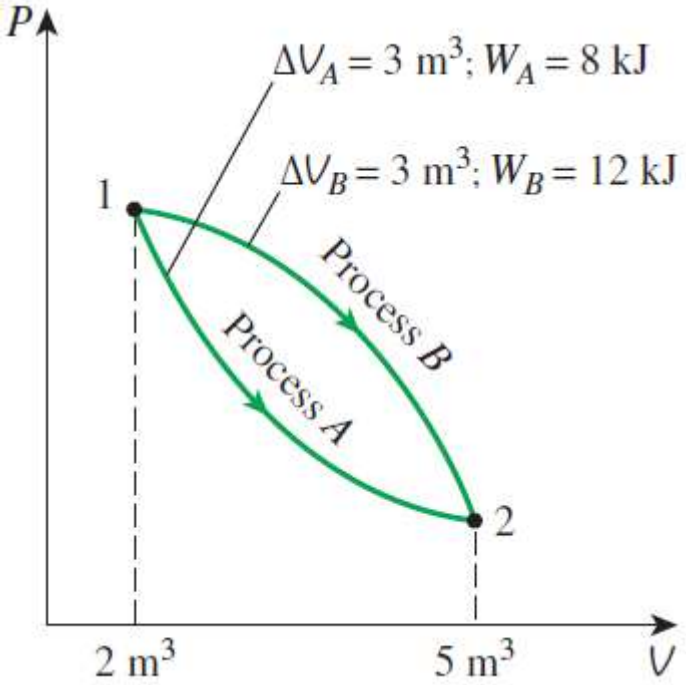


Fig: Cengel & Boles: TD

Exact & inexact differentials & Path Function



$$\int_1^2 dV = V_2 - V_1 = \Delta V$$

Exact differential

$$\int_1^2 \delta W = W_{12} \qquad (not\ \Delta W)$$

Inexact differential; Path function

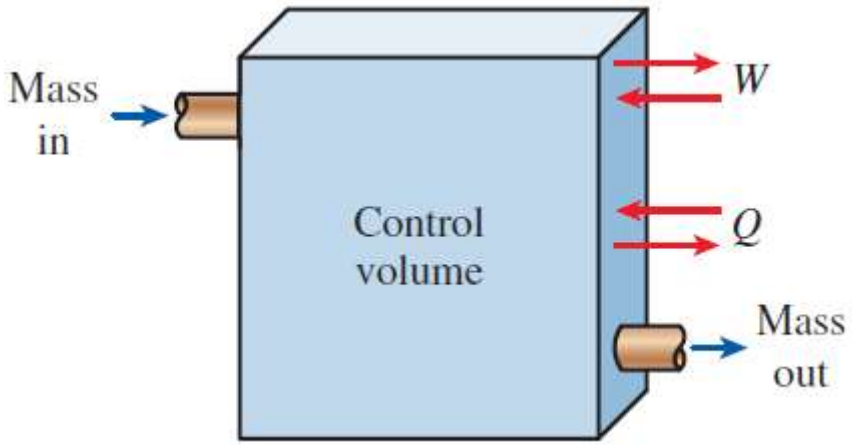
Fig: Cengel & Boles: TD

Forms of energy balance: Time & per unit mass

$$\frac{dE}{dt} = \dot{Q} - \dot{W}$$

$$e_{\text{in}} - e_{\text{out}} = \Delta e_{\text{system}} \qquad \text{(kJ/kg)}$$

Balances in flow system



$$E_{in} - E_{out} = (Q_{in} - Q_{out}) + (W_{in} - W_{out}) + (E_{mass,in} - E_{mass,out}) = \Delta E_{system}$$