Specific heat of liquids & solids

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Specific heat of ideal and real gases

- U(T) & H(T) for ideal gas; Degrees of freedom of ideal gas
- Specific heat at constant P > Specific heat at constant V
- Specific heat variation with T for real gases

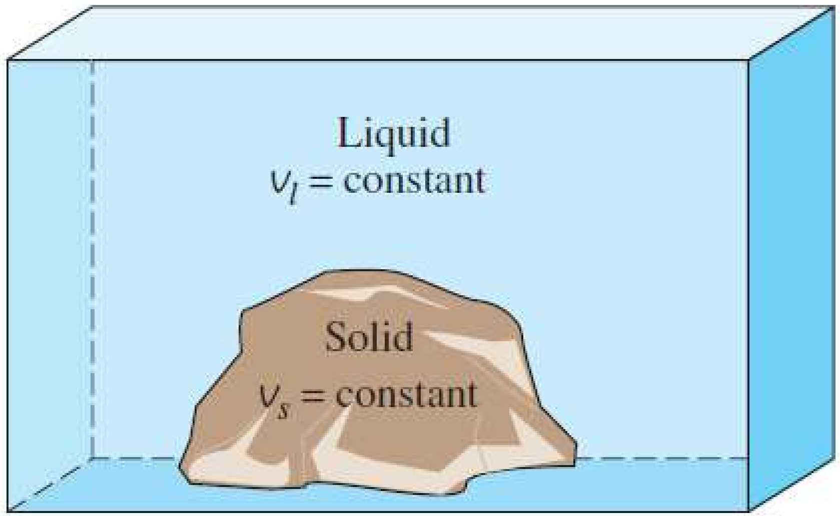
$$\Delta u = u_2 - u_1 \text{ (table)}$$

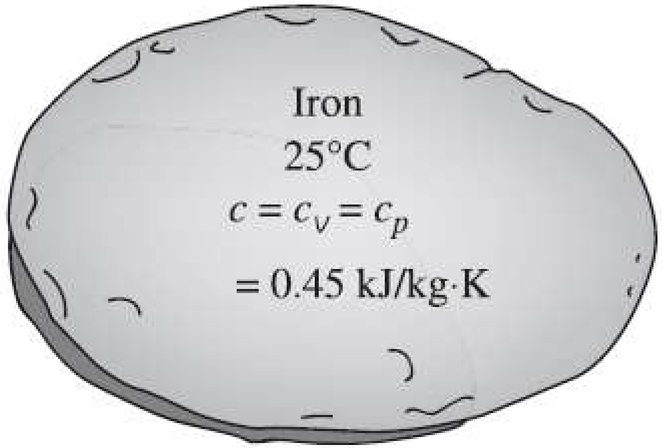
$$\Delta u = \int_1^2 c_v(T)\, dT$$

$$\Delta u \cong c_{v,\text{avg}}\, \Delta T$$

Incompressible approximation & its consequence

- Specific volume of a particular phase is a constant during TD process transformations





Figs: Cengel & Boles: TD

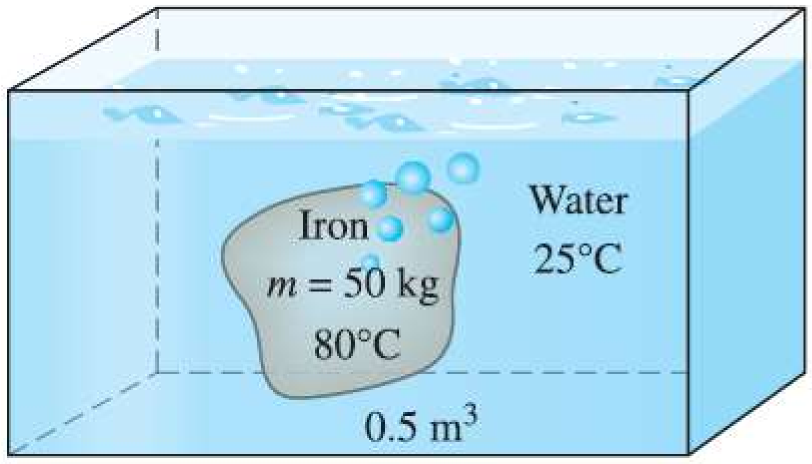
$\mathcal{H}$ within Incompressible approximation

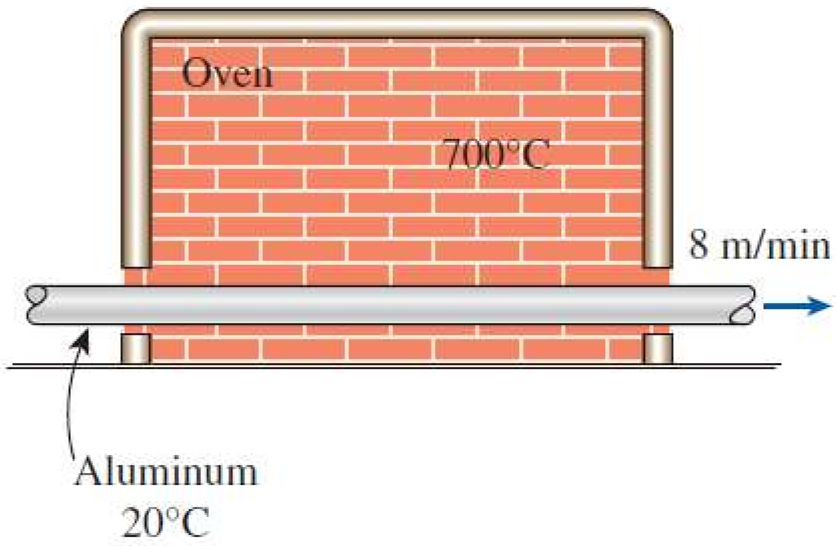
$$h = u + P\mathrm{v}$$

$$dh = du + \mathrm{v}\,dP + \overset{\nearrow 0}{P\,d\mathrm{v}} = du + \mathrm{v}\,dP$$

- Solids: As vdP is negligible, Δh= Δu$\cong$ $\boldsymbol{c_{avg}}\Delta\boldsymbol{T}$
- Constant-P process for liquids (e.g. heaters): Δh= Δu$\cong$ $\boldsymbol{c_{avg}}\Delta\boldsymbol{T}$
- Constant-T process for liquids (e.g. pumps): Δh=vdP

Application of heat capacities in 1st Law of TD





$$\underbrace{E_{in} - E_{out}}_{\substack{\text{Net energy transfer}\\ \text{by heat, work, and mass}}} = \underbrace{\Delta E_{system}}_{\substack{\text{Change in internal, kinetic,}\\ \text{potential, etc., energies}}}$$

$$0 = \Delta U$$

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$$Q_{in} = \Delta U_{rod} = m(u_2 - u_1)$$

$$Q_{in} = mc(T_2 - T_1)$$

$$\Delta U_{sys} = \Delta U_{iron} + \Delta U_{water} = 0$$

$$[mc(T_2 - T_1)]_{iron} + [mc(T_2 - T_1)]_{water} = 0$$

$$\dot{Q}_{in} = Q_{in} / \Delta t$$

Figs: Cengel & Boles: TD