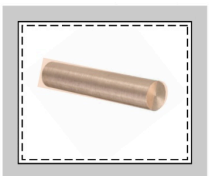
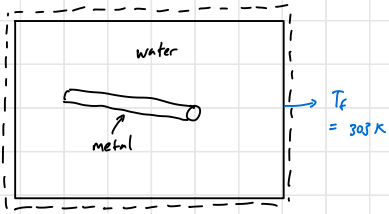
Example

A 0.3 kg metal bar initially at 1200K is removed from an oven and quenched by immersing it in a closed tank containing 9 kg of water initially at 300K. The final temperature of both the metal bar and water is 303 K. Find the entropy produced during quenching.

- Assume constant specific heat values:
  - c_{water} = 4.2 kJ/kgK
  - c_{metal} = 0.42 kJ/kgK
- Neglect heat transfer from the tank to surroundings
- Each substance can be modelled as incompressible





$c_w = 4.2\ kJ/kg \cdot K$

$m_w = 9\ kg$

$T_{wi} = 300\ K$

$c_m = 0.42\ kJ/kg \cdot K$

$m_m = 0.3\ kg$

$T_{mi} = 1200\ K$

neglect heat transfer from system

$$\Delta S_{sys} = \sum \frac{Q_k}{T_k} + S_{gen}$$

$$S_{gen} = \Delta S_{sys}$$

$$= \Delta S_{water} + \Delta S_{metal}$$

$$= m_w c_w \ln\left(\frac{T_f}{T_{wi}}\right) + m_m c_m \ln\left(\frac{T_f}{T_{mi}}\right)$$

$$= 9[kg]\ 4.2\left[kJ/kg\,K\right] \ln\left(\frac{303\ K}{300\ K}\right) + 0.3[kg]\ 0.42\left[kJ/kg \cdot K\right] \ln\left(\frac{303\ K}{1200\ K}\right)$$

$$= 0.3761\ [kJ/K] - 0.1734\ [kJ/K]$$

$$= \boxed{0.203\ kJ/K}$$

- Net increase in entropy of system
- Irreversible process