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# Exercise 3

**1)**
Two bodies A and B with temperature $T_A$ and $T_B$ ($T_A > T_B > T_0$) are brought into thermal contact such that after a while, they get the common temperature $T_{AB}$. The bodies have mass $m_A$ and $m_B$ and specific heat capacity $C_A$ and $C_B$.

a) Determine the minimum work required to bring the two bodies back to the initial state.
b) Determine the common final temperature when the separate bodies A and B are brought in contact through a reversible heat engine.
c) Sketch the processes in a T-s diagram

**2)**
An ideal gas with state 2 bar, 400 K is throttled to pressure 1 bar. The gas has constant specific heat capacity $C_p$ =1,0 kJ/(kgK) and $k= C_p/C_v$=1,4. The temperature in the surroundings is 300 K.

a) Determine the minimum work required to bring the gas back to the initial state. You can assume that the process first is an isentropic compression and subsequently an isobaric cooling.
b) Show that the total work required to bring the gas reversibly back to the initial state is independent of which reversible "path" that is chosen.

**3)**
The working medium in a vapour cycle is water/steam. Water from the condenser is saturated at 45 °C (state 4). It is pumped to 22 bar (state 5) and ducted into a boiler. There, it is evaporated and superheated to 380 °C (and 22 bar) (state 1).
a) how much energy is transferred to the water/steam per unit of mass during this heat transfer?
b) how much does the exergy content per unit of mass of the water/steam increase?
c) if all the steam is utilized in a steam turbine, what is the maximum thermal efficiency (theoretically) obtainable by the plant?

Data, change of state: $h_1 - h_4 = 3011{,}2$ kJ/kg, $s_1 - s_4 = 6{,}374$ kJ/(kg·K), $h_5 \approx h_4$, $s_5 \approx s_4$
The surroundings have temperature 10 °C.