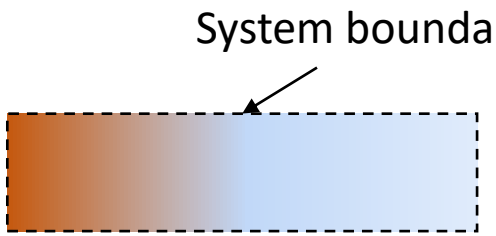
Challenge

irreversible



$$\frac{kA}{l} = 1 \text{ W/K}$$

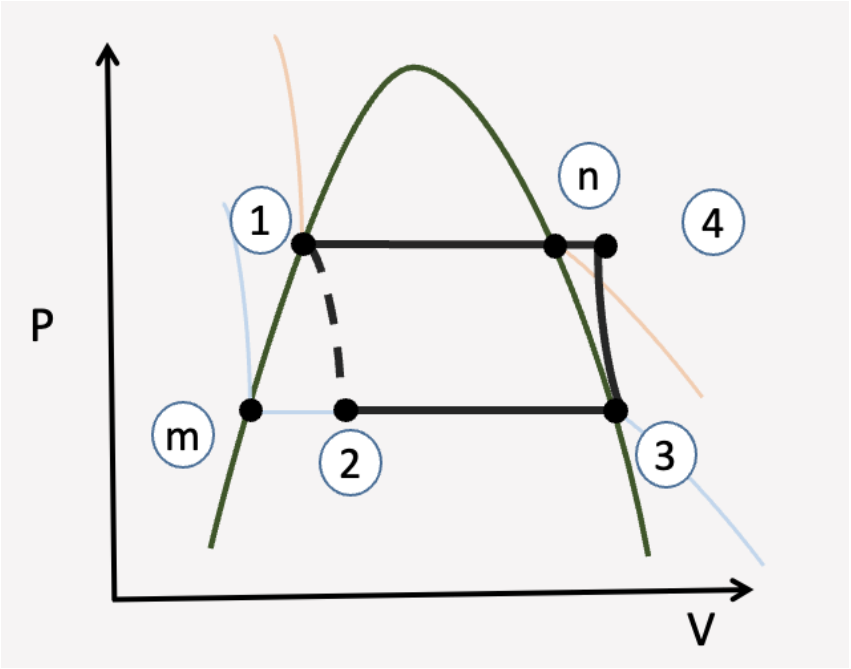
Estimate entropy generation rate

System	$\Delta S =$
Surroundings	$\Delta S' =$
Total	$\Delta S_{total} = \Delta S + \Delta S' =$

reversible

Think of an ideal concept in which heat transfer over a finite difference will not increase total entropy

Exercise I: Vapor compression (Freezer)



Fill the table with +, - or 0 (zero)

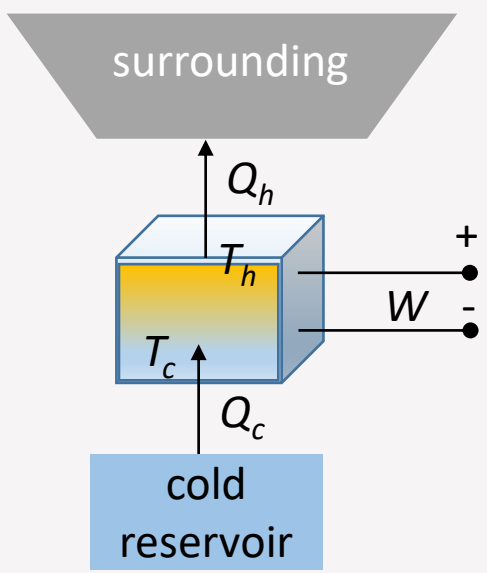
Counter clockwise

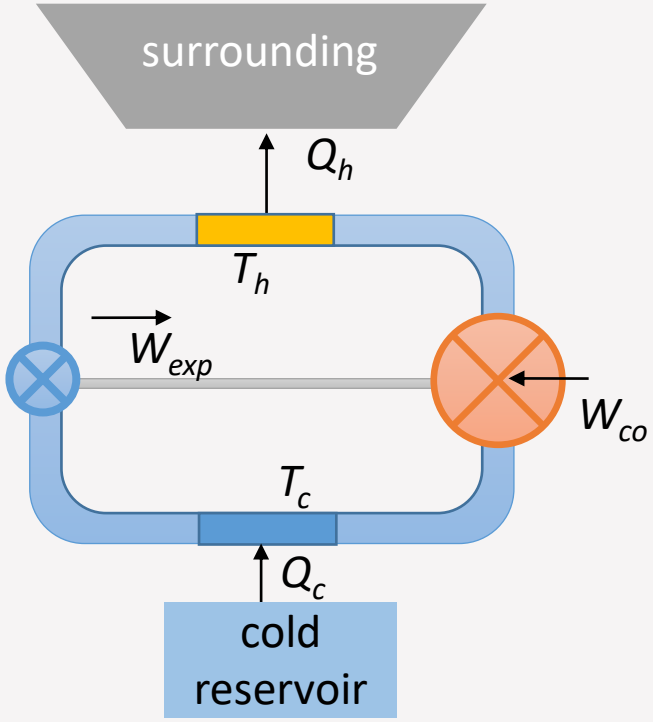
AB (**compressor**): adiabatic process
BC (**condenser**): heat from system to surroundings
constant pressure; **don't use $Q = mc_p\Delta T$**
CX (**throttle**): constant enthalpy process, why?
XA (**evaporator**): heat from surroundings to system (cooling)

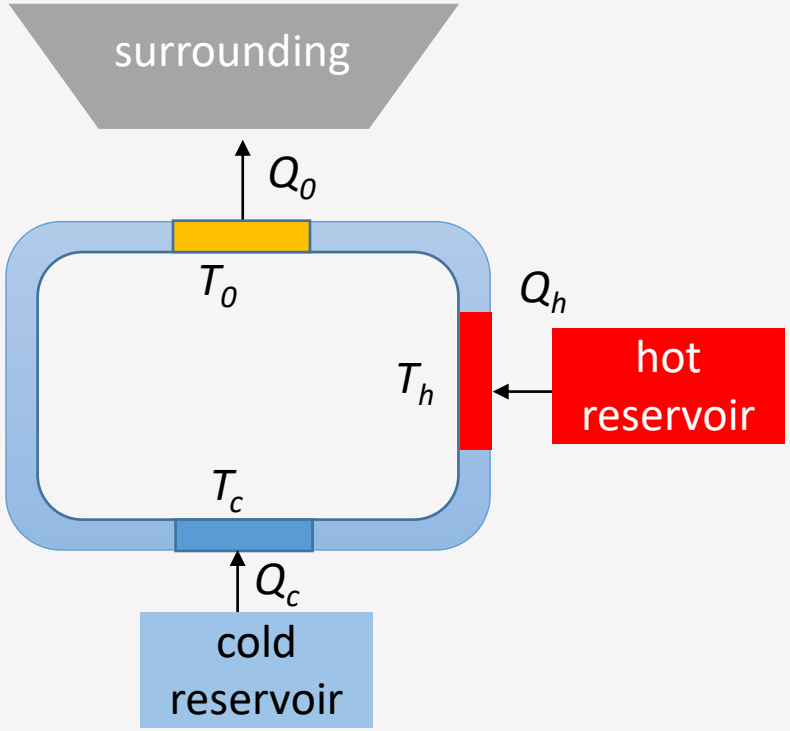
[Steady operation; Sign convention: energy transfer to the system is positive]

Process	**W (J) {external work}**	**Q(J)**	**ΔH(J)**	**ΔS_{sys}(J/K)**
1-> 2				
2-> 3				
3-> 4				
4-> 1				
Cycle				

Apply first and second laws







Note: absolute quantities

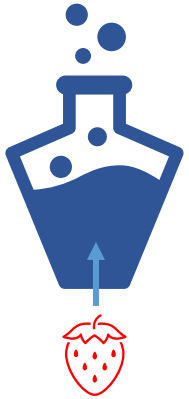
$\lvert Q_c\rvert + \lvert W\rvert - \lvert Q_h\rvert = 0$		
$\frac{\lvert Q_c\rvert}{T_c} - \frac{\lvert Q_h\rvert}{T_h} = 0$		

Examples of heat transfer and entropy change

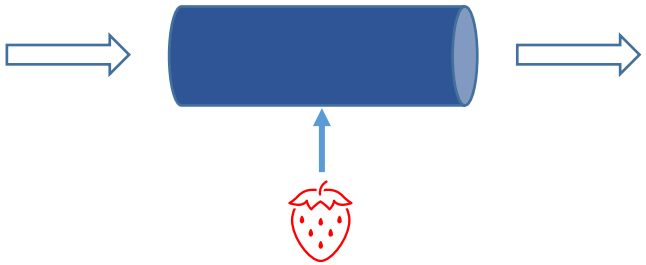
Energy change

Entropy change

Boiling liquid



Cold gas flow



Gas expansion