FYS1001
Innføring i fysikk

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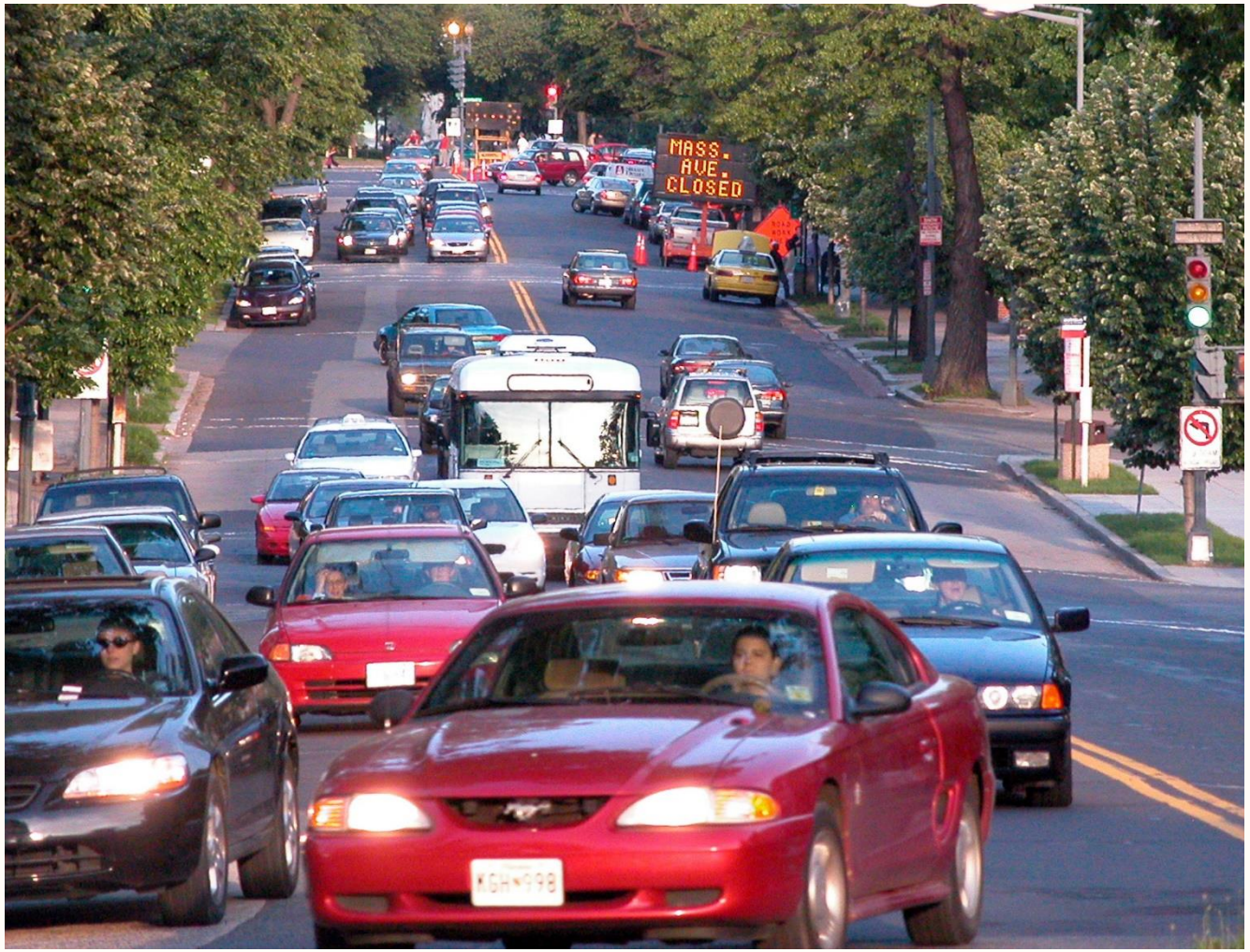
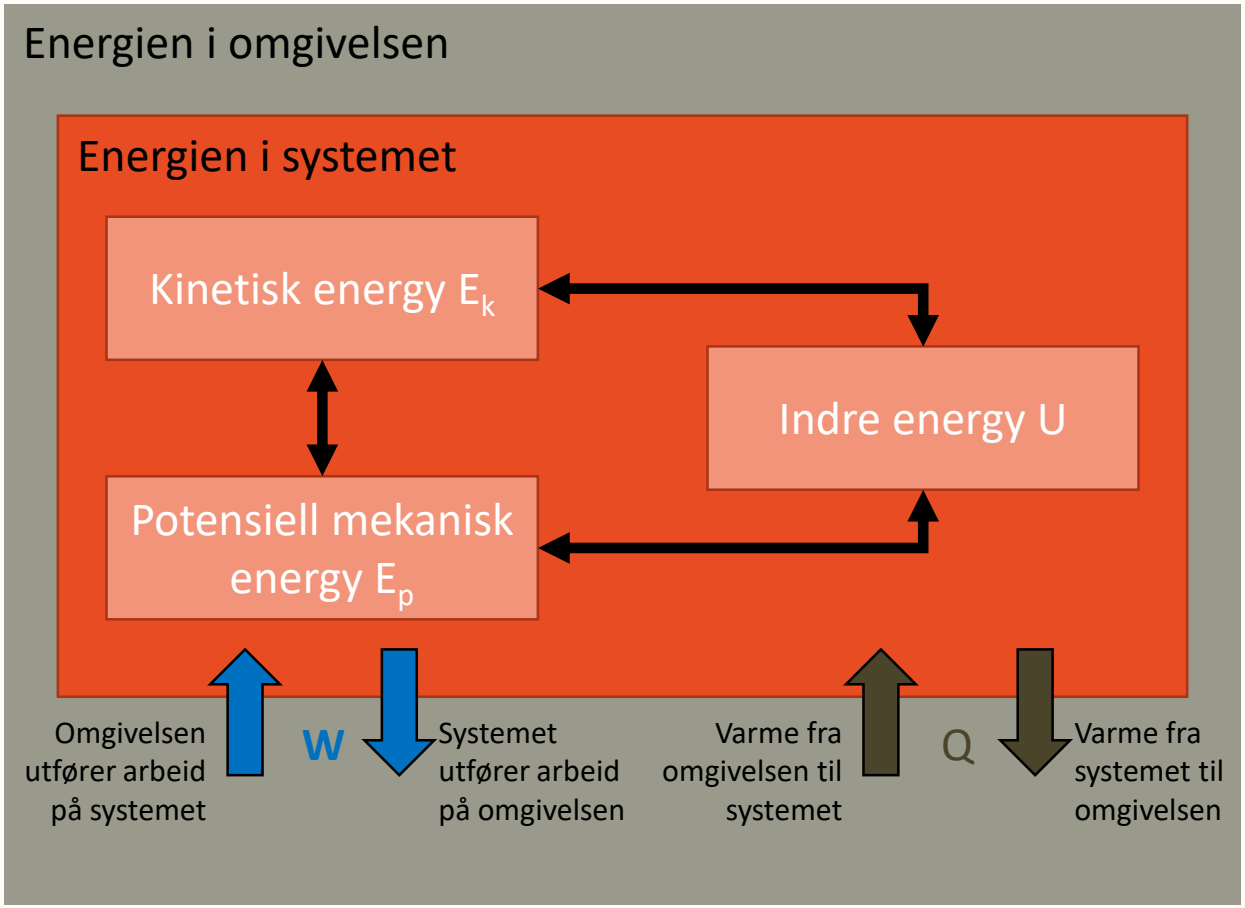
Hvordan blir bensin til bevelgelse?



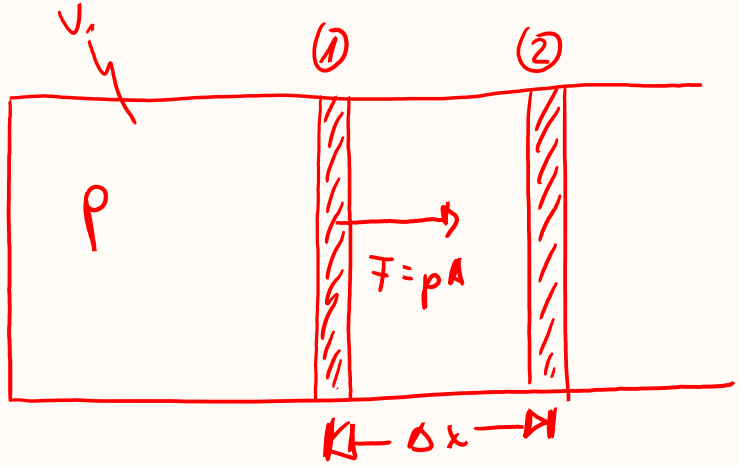
Energibevaring



$$Q = \Delta U + W$$

hvis systemet utfører arbeid: $W > 0$

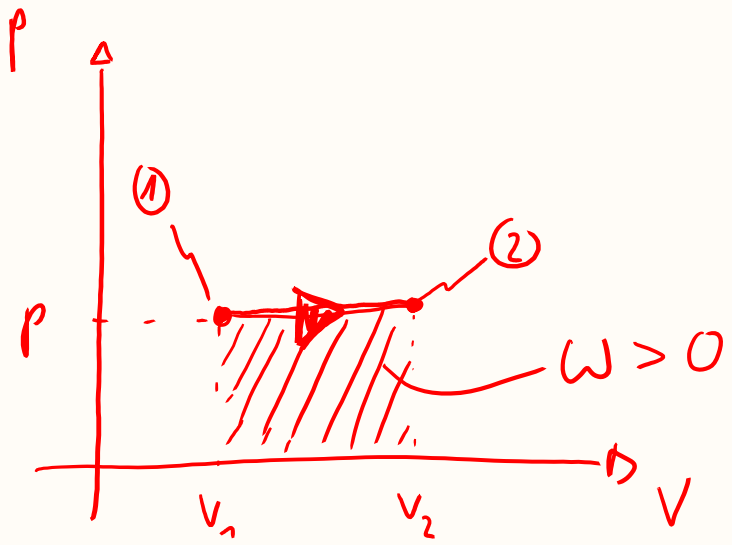
Termodynamisk arbeid

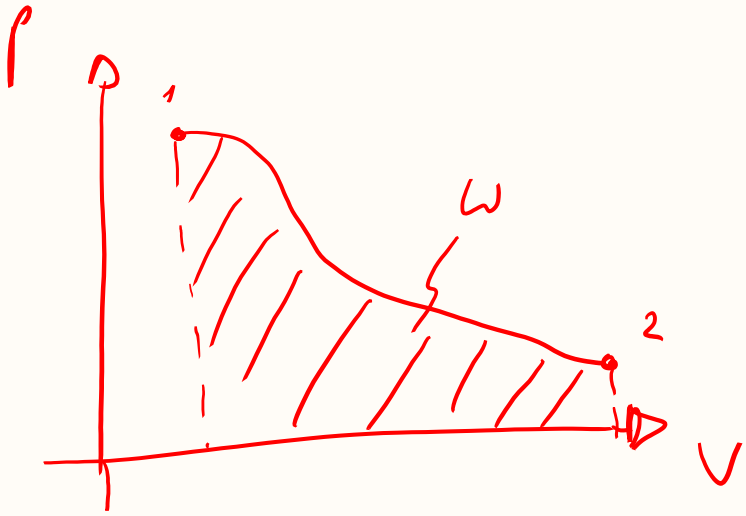


$$W = F\Delta x = pA\Delta x$$

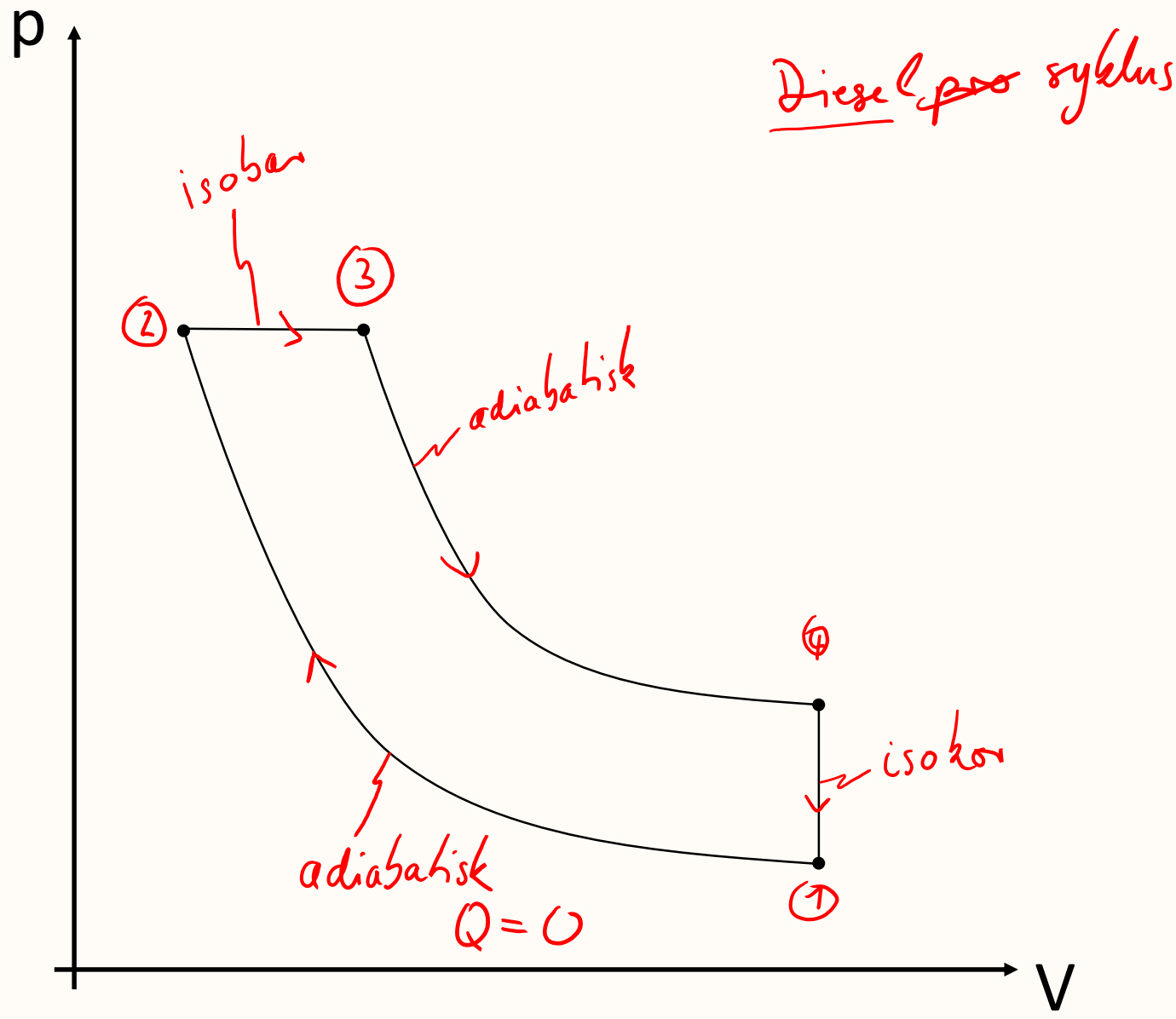
$$W = p\Delta V$$

↑ volumendring





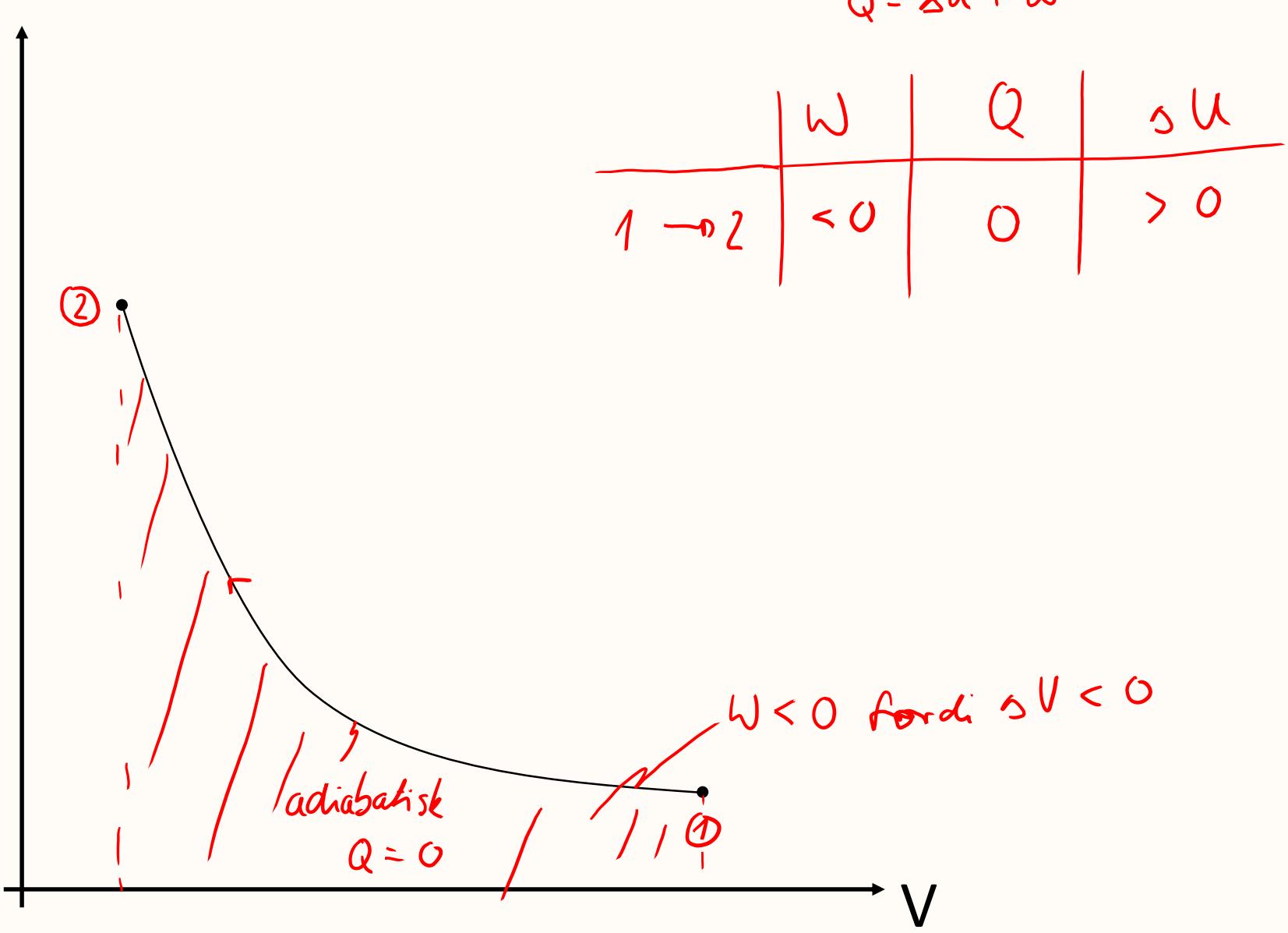
Termodynamiske prosesser



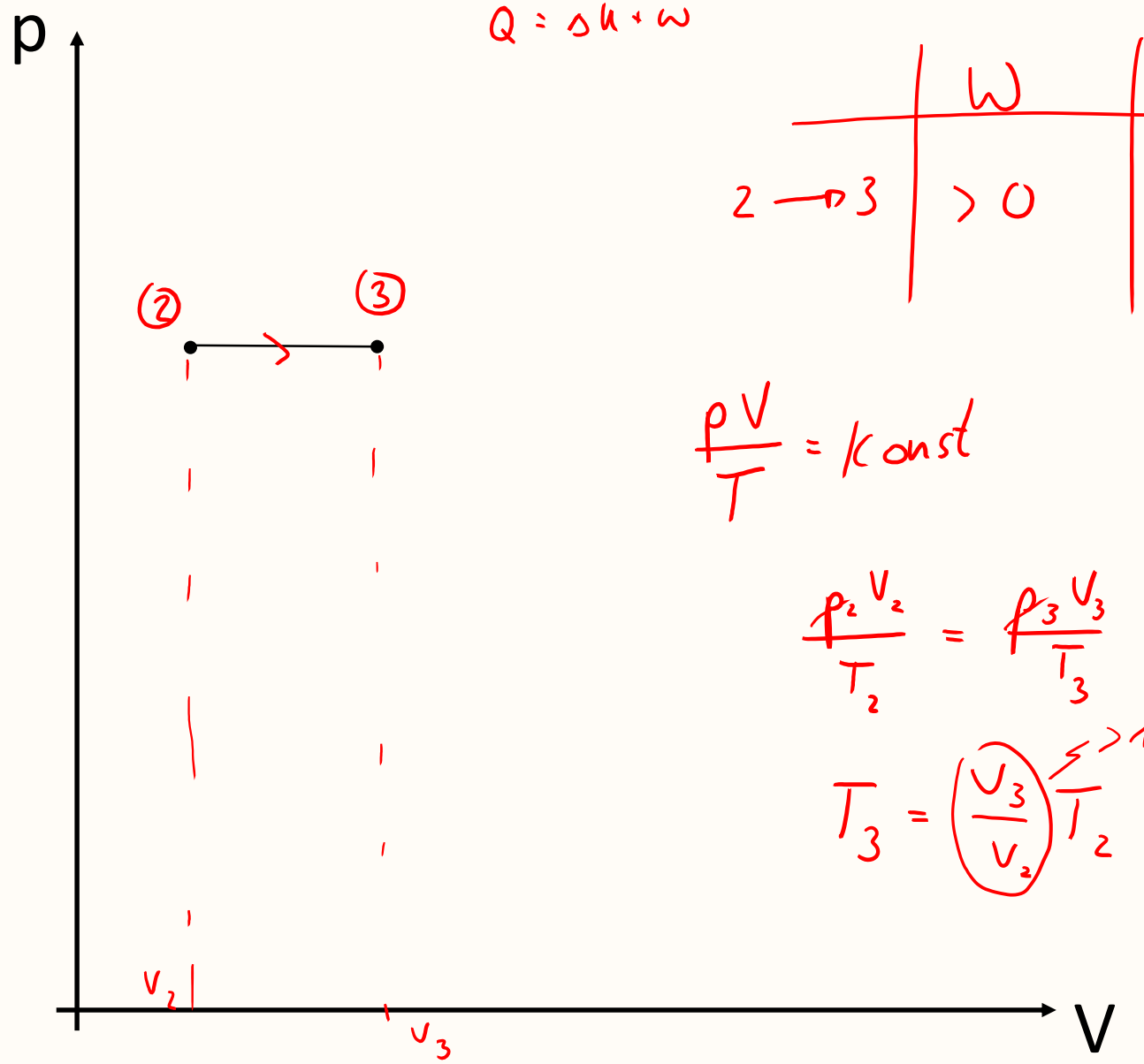
Termodynamiske prosesser

$Q = \Delta U + W$

	W	Q	ΔU
$1 \to 2$	< 0	0	> 0



Termodynamiske prosesser



$Q = \Delta U + W$

	W	Q	ΔU
2 → 3	> 0	> 0	> 0

$$\frac{pV}{T} = \text{konst}$$

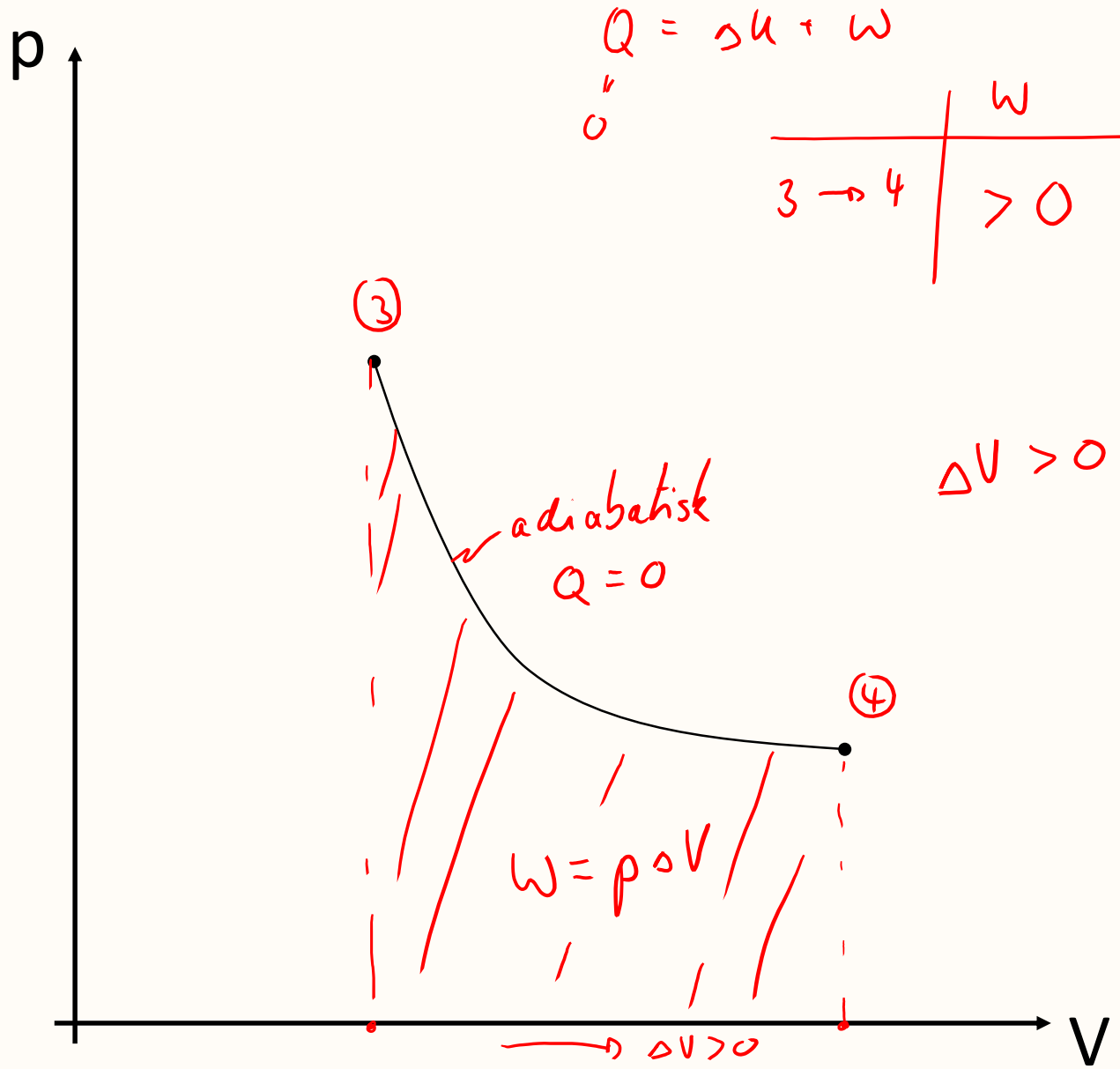
$$\frac{p_2 V_2}{T_2} = \frac{p_3 V_3}{T_3} \quad \text{i} \quad p_2 = p_3$$

$$T_3 = \left(\frac{V_3}{V_2}\right) T_2 \qquad \frac{V_3}{V_2} > 1$$

$\rightsquigarrow T_3 > T_2$

$\rightsquigarrow \Delta U > 0$

Termodynamiske prosesser



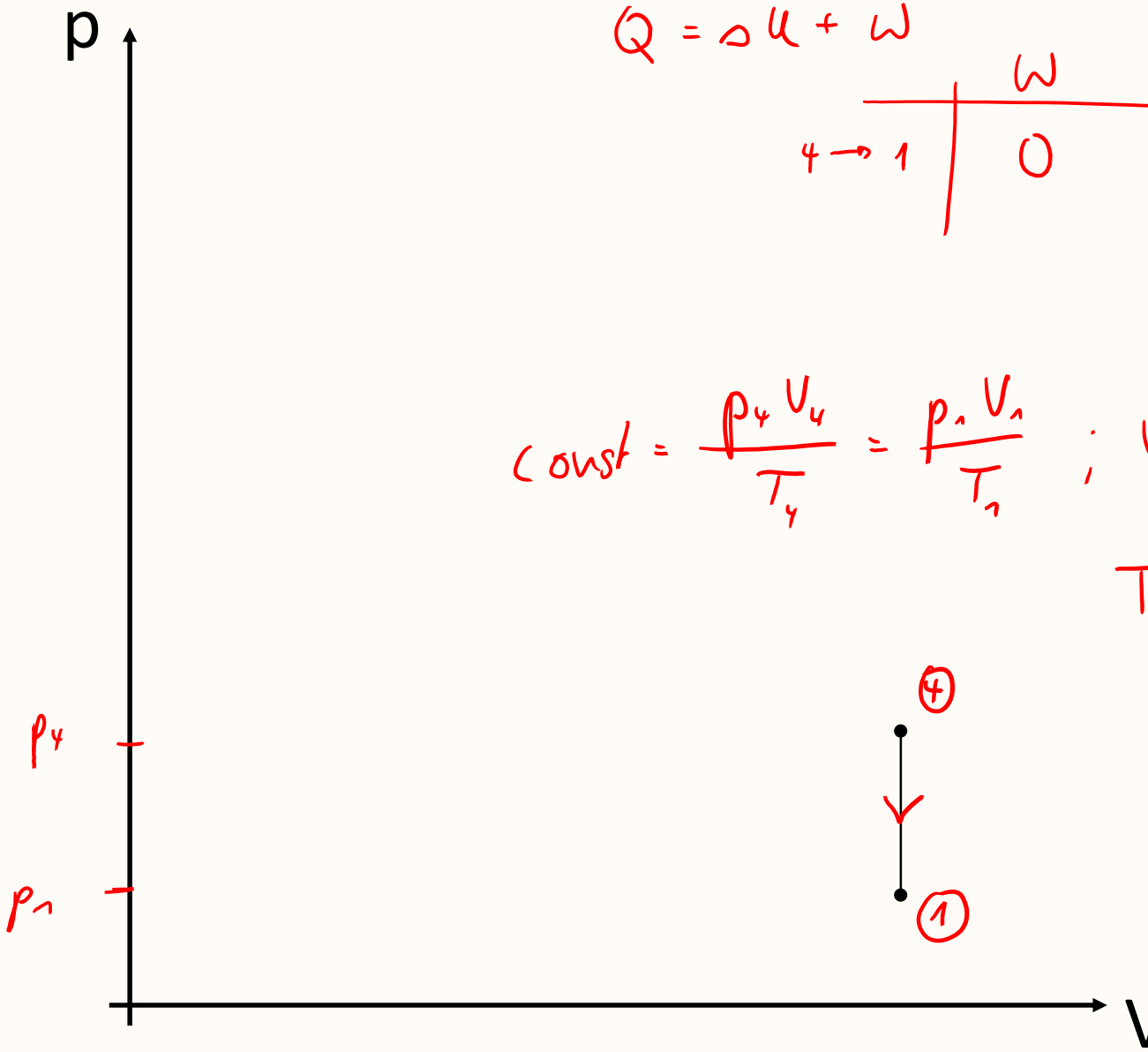
$Q = \Delta U + W$

"0"

	W	Q	ΔU
3 → 4	> 0	0	< 0

$\Delta V > 0 \rightsquigarrow W > 0$

Termodynamiske prosesser



$Q = \Delta U + W$

	W	Q	ΔU
$4 \to 1$	0	$< Q$	< 0

$$\text{const} = \frac{p_4 V_4}{T_4} = \frac{p_1 V_1}{T_1} \quad ; \quad V_4 = V_1 \quad < 1$$

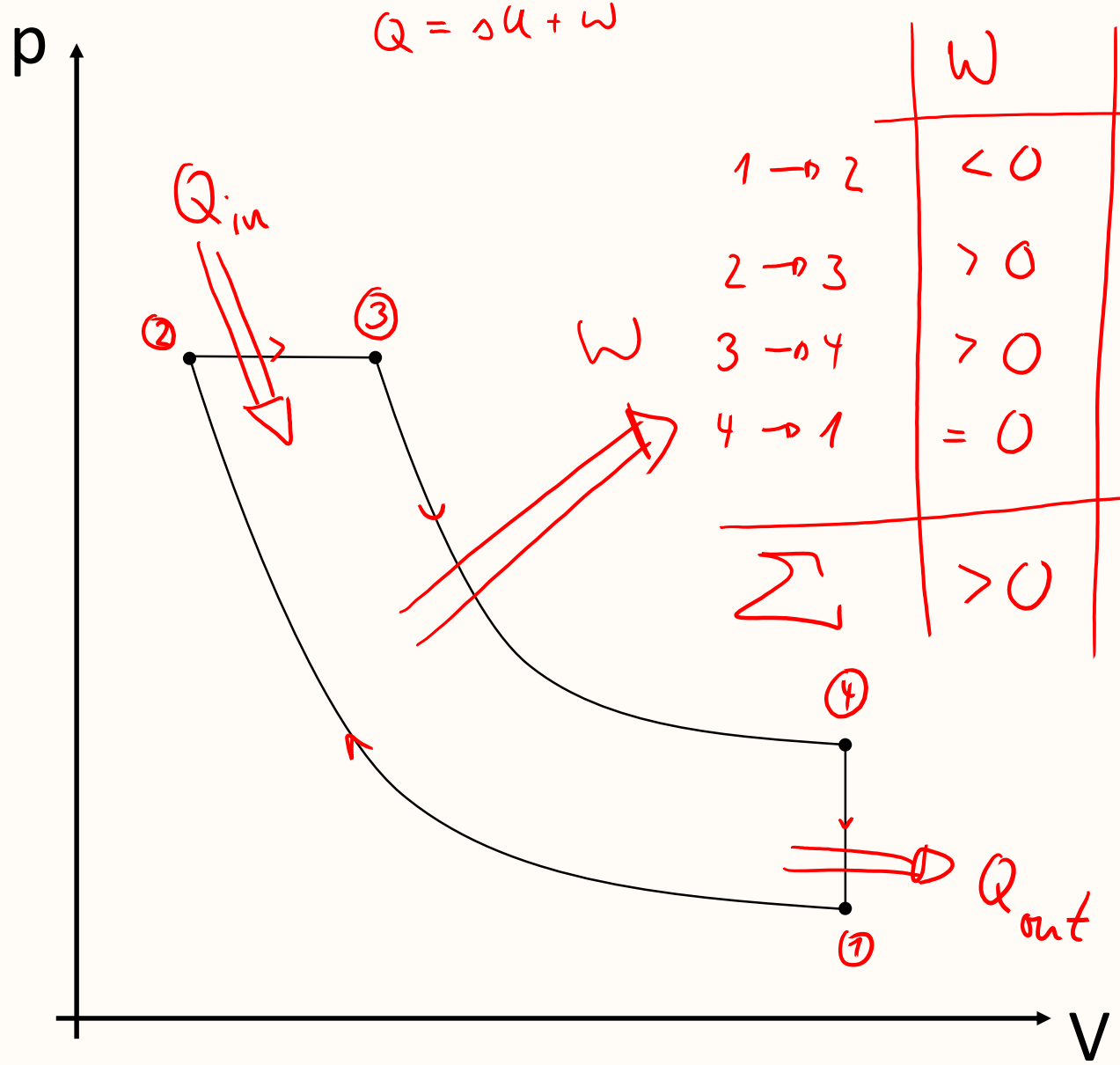
$$T_1 = \left(\frac{p_1}{p_4}\right) T_4$$

$$\rightsquigarrow T_1 < T_4$$

$$\rightsquigarrow \Delta U < 0$$

Termodynamiske prosesser

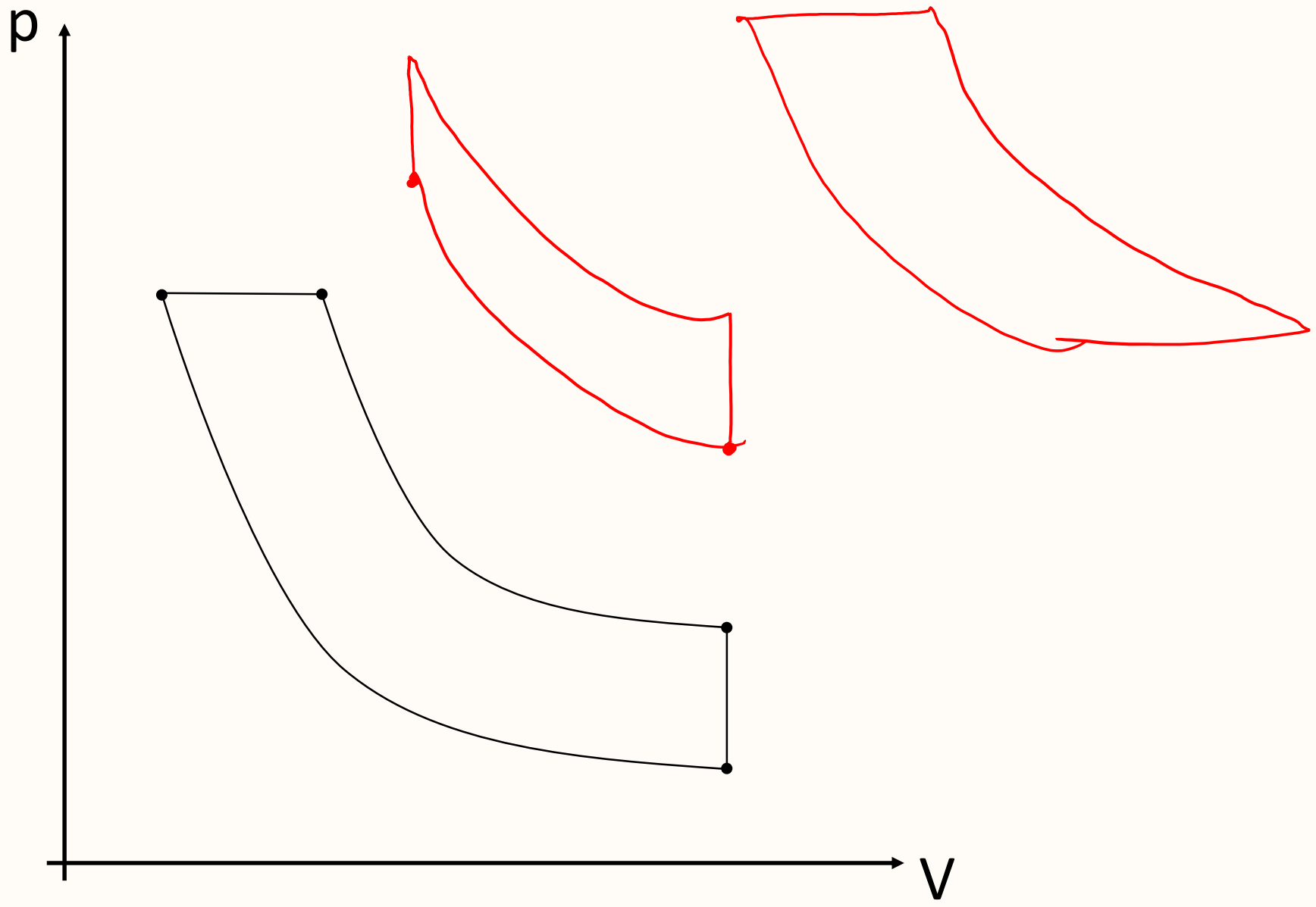
$Q = \Delta U + W$



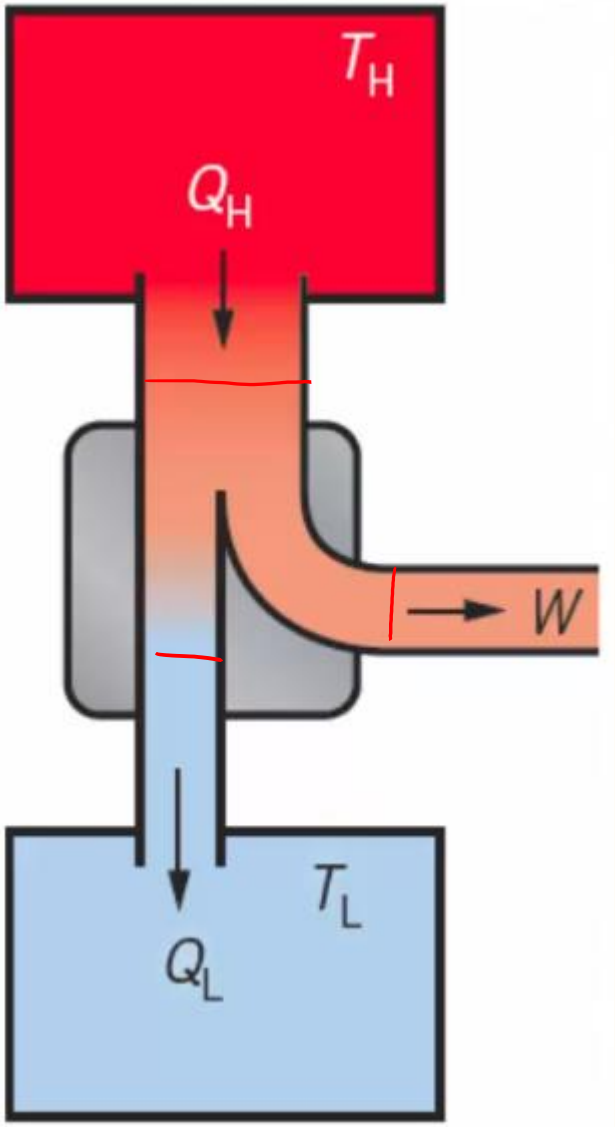
	W	Q	ΔU
1 → 2	< 0	0	> 0
2 → 3	> 0	> 0	> 0
3 → 4	> 0	0	< 0
4 → 1	= 0	< 0	< 0
$\sum$	> 0	> 0	0

$\frac{pV}{T} = \text{const}$

Termodynamiske prosesser



Varmemaskin



$$Q_H = W + Q_L$$

virkningsgrad

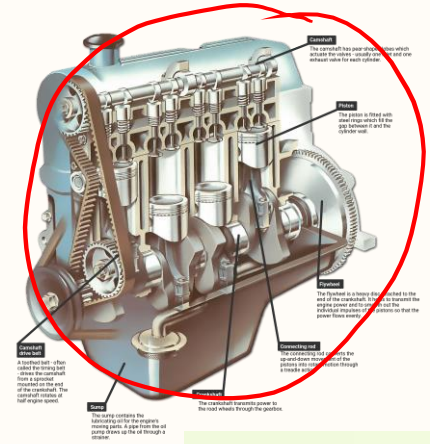
$$\eta = \frac{W}{Q_H}$$

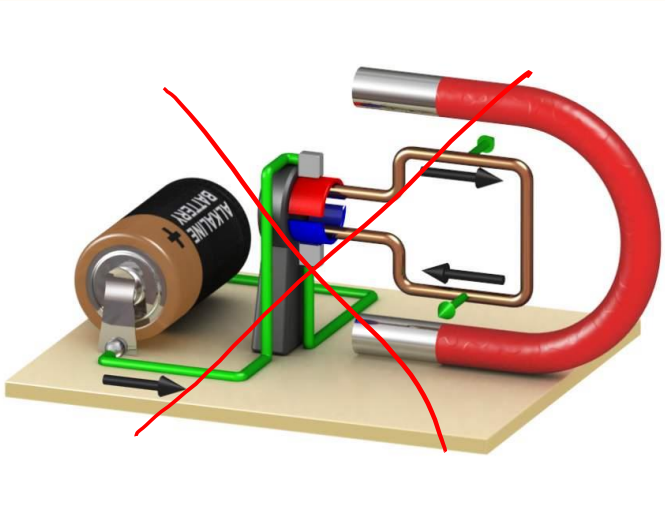
$\eta_{diesel} \sim 35-40\%$

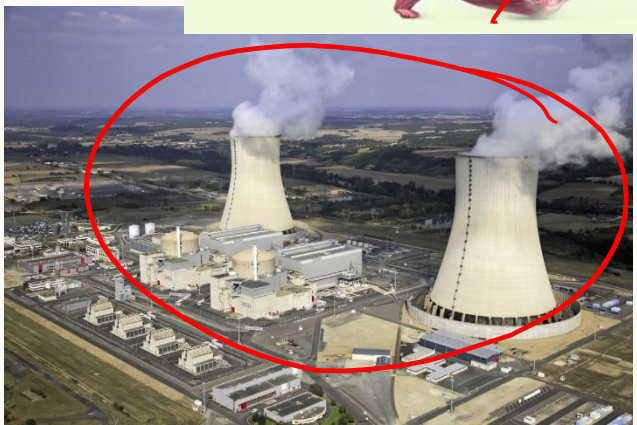
$\eta_{bensin} \sim 20-30\%$

$\eta_{elektromotor} \sim 90-99\%$

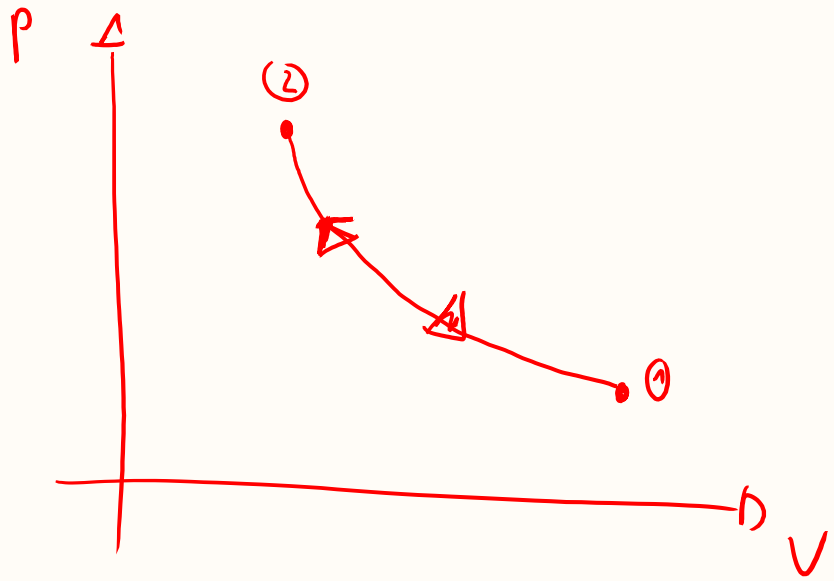
Varmemaskin?



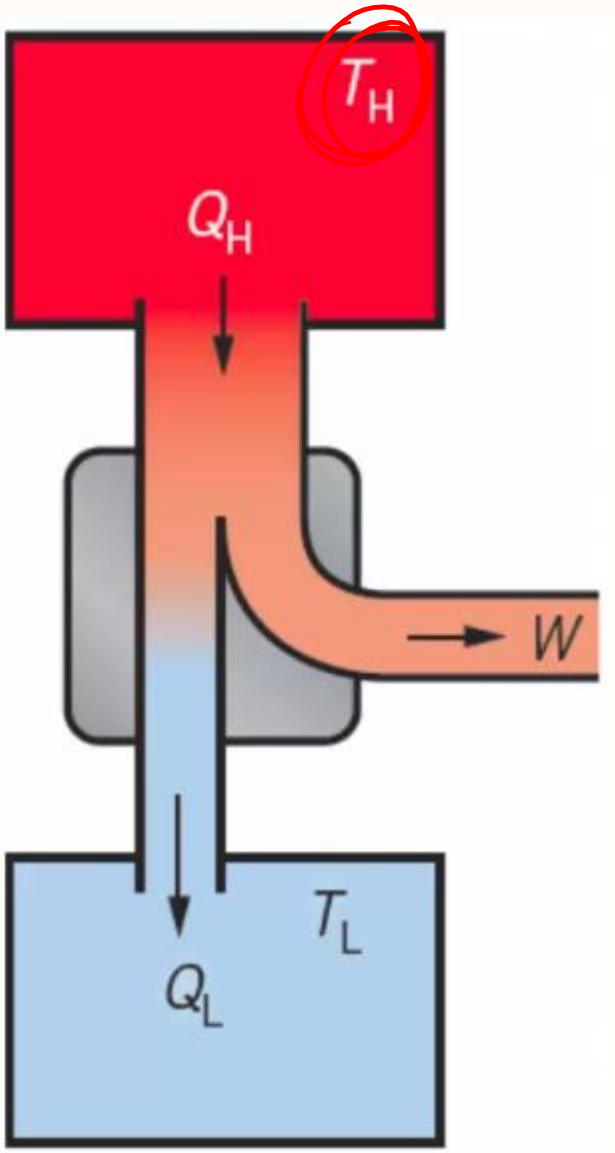




Reversibilitet



Virkningsgrad av Carnot-prosesser



Carnot prosess består kun av reversible prosesser

$$\eta_c = 1 - \frac{T_L}{T_H} \left(= \frac{W}{Q_H} \right)$$

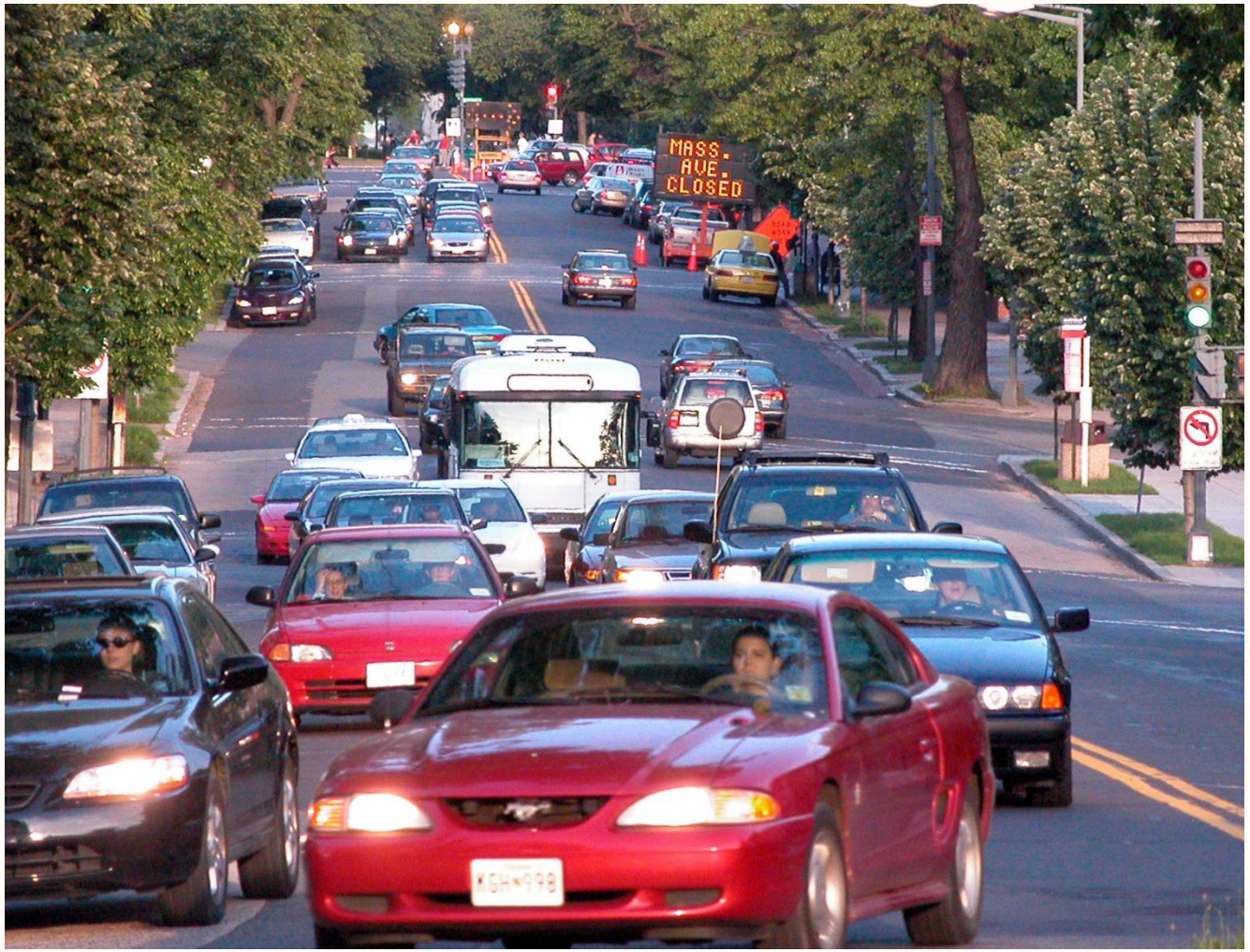
↑ i Kelvin

diesel: $T_H \sim 700°C$

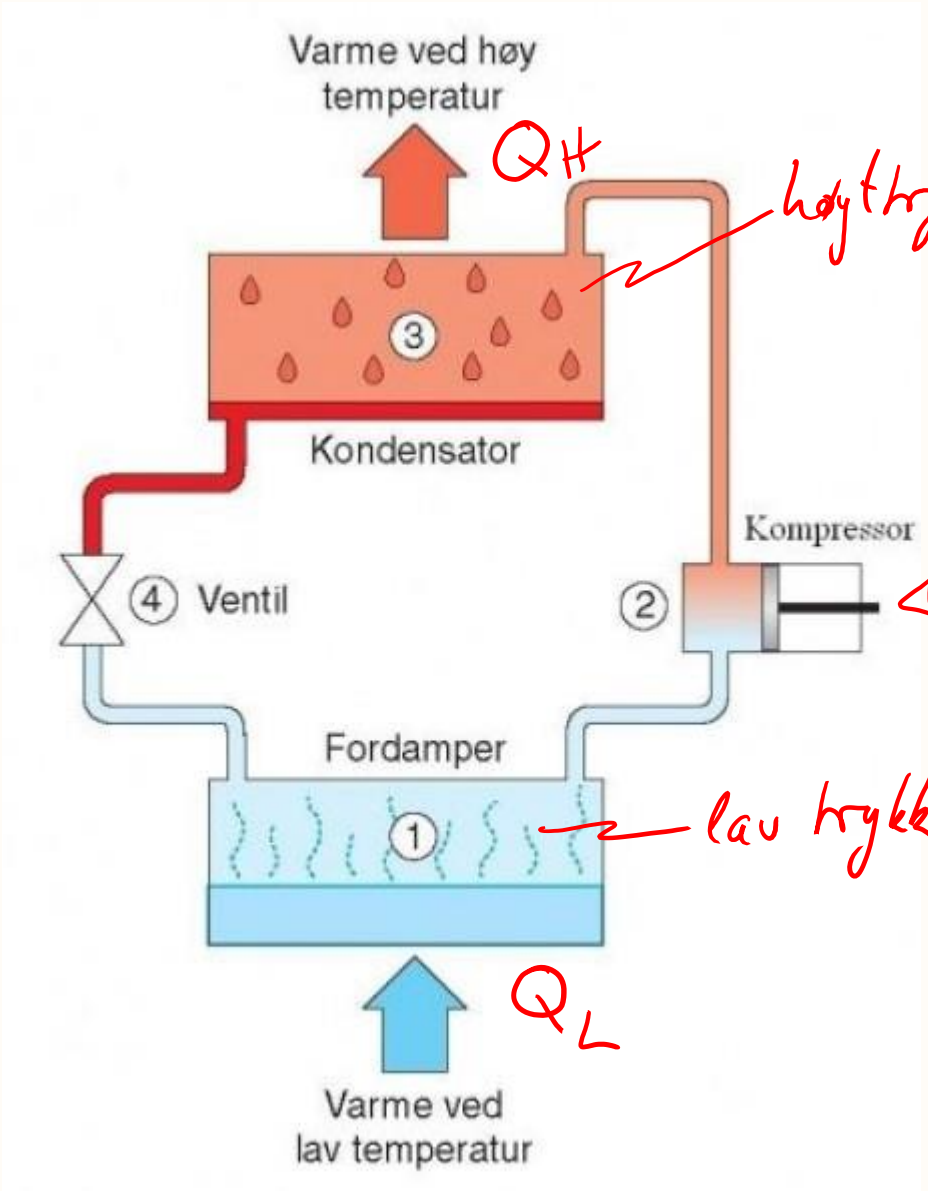
$T_L \sim 20°C$

$$\eta_c = 1 - \frac{293°K}{973°K} \approx 0{,}70$$

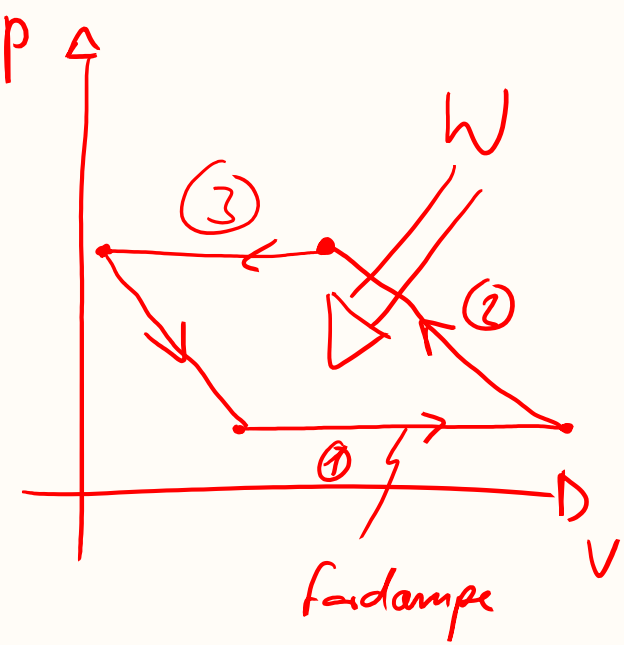
Varmemaskin!



Varmepumper

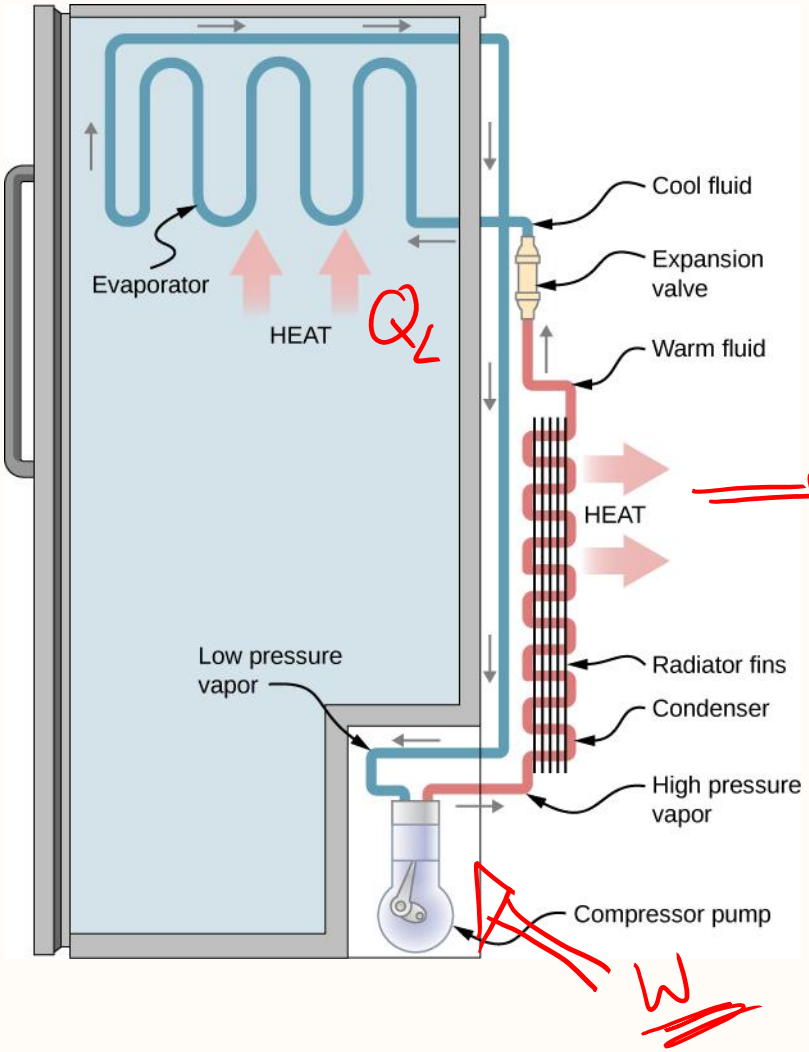


$Q_H = W + Q_L$

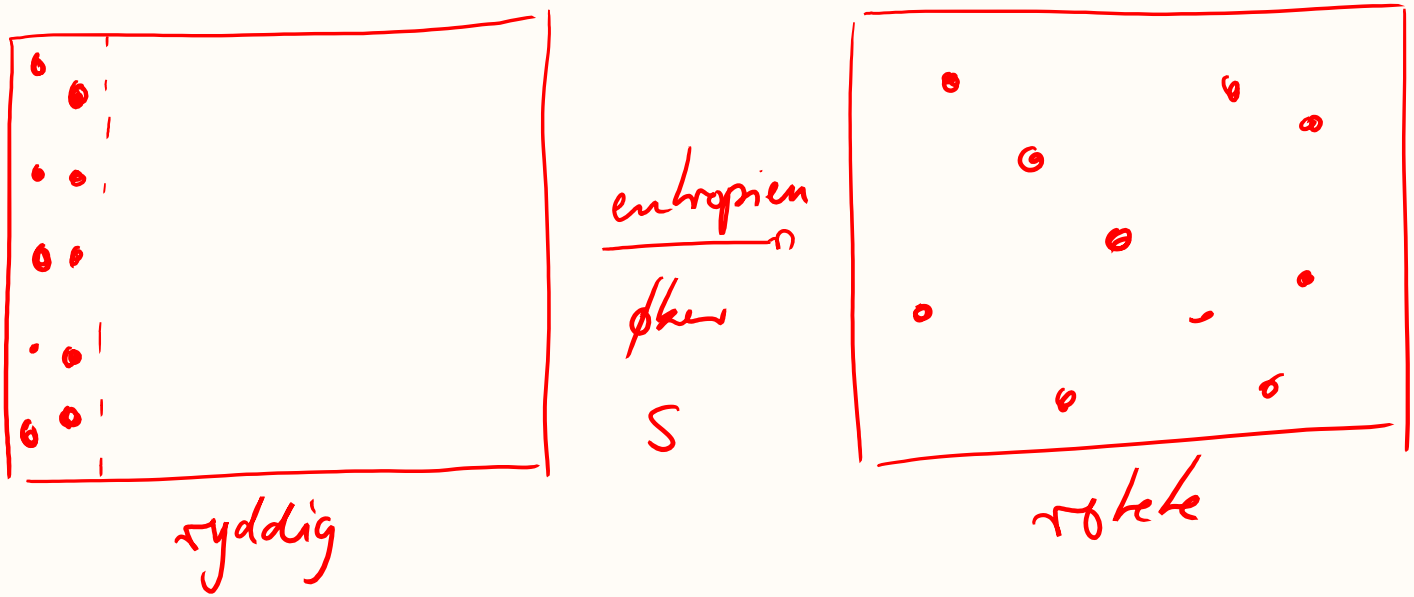


Kjøleskap

$Q_H = W + Q_L$



Entropi



Termofysikkens 2. lov

Den samlede entropien til et system og dets omgivelser øker i alle naturlige (irreversible) prosesser.

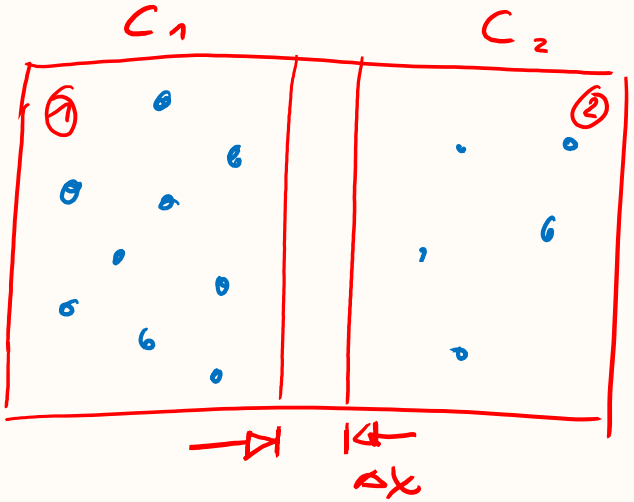
Varme går ikke av seg selv fra et legeme med lav temperature til et legeme med høy temperature.

Ingen syklisk varmemaskin kan ha som eneste resultat at varme blir fullstendig omformet til arbeid.

I alle prosesser blir den samlede energikvaliteten lavere.

$$\eta_c = 1 - \frac{T_L}{T_H}$$

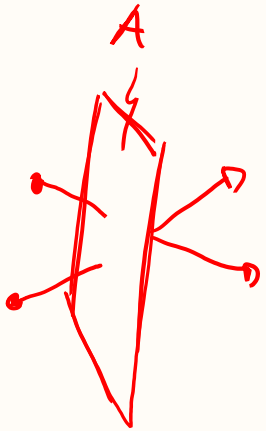
Diffusjon



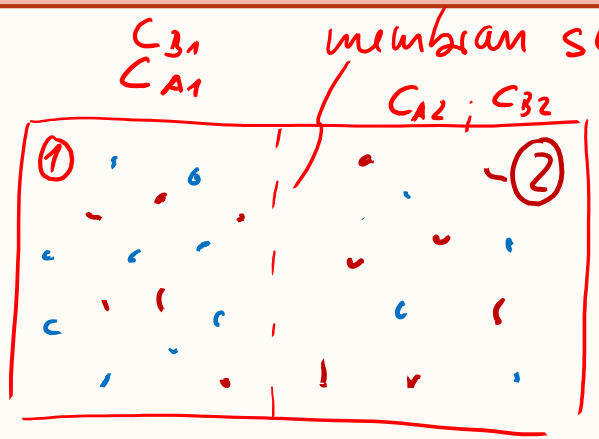
$$J = -D \frac{\Delta c}{\Delta x}$$

partikkelfluks

per areal per tid



Osmose



- A
- B

$$pV = nRT$$

$$p = \frac{n}{V}RT$$

$$p = cRT$$

① $p_1 = p_{A1} + p_{B1} = (c_{A1} + c_{B1})RT$

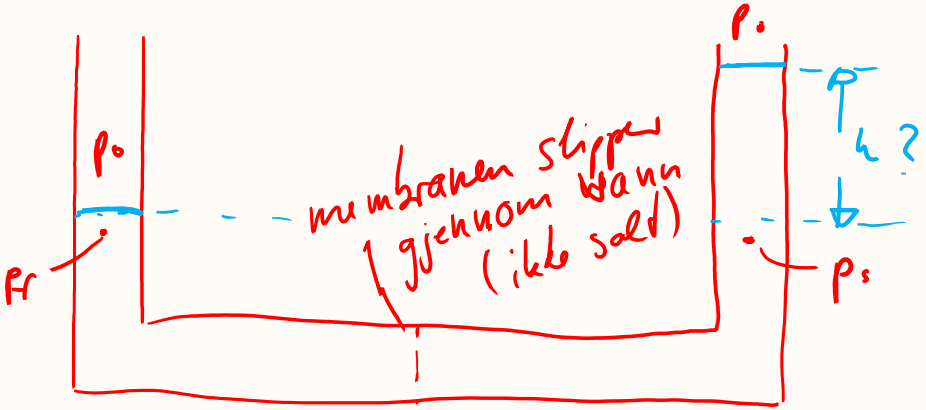
② $p_2 = p_{A2} + p_{B2} = (c_{A2} + c_{B2})RT$

pga membranen: $p_{A1} = p_{A2}$

$$\Delta\Pi = p_2 - p_1 = p_{B2} - p_{B1} = (c_{B2} - c_{B1})RT$$

$\Delta\Pi$: osmotisk trykk

Osmotisk trykk



ferskvann

$c_s = 0$

saltvann

$c_s = 1{,}13\ \text{mol/L}$

$= 1{,}13 \cdot 10^3\ \text{mol/m}^3$

$\Delta\pi = p_s - p_f = c_s RT = \rho g h$

$h = \dfrac{c_s RT}{\rho g}$

$= 273\,\text{m}$

$R = 8{,}31\ \text{J/K mol}$

$\rho_s = 1029\ \text{kg/m}^3$

$T = 293\ \text{K}$

$g = 10\ \text{m/s}^2$