Thermodynamics Formulae to remember.

1st law: $dU = dq + dw$ ← work done on system

(dU: internal energy change of system; dq: heat input to system)

U is a state function
q, w are path functions

$dU = C_v dT$
$dw = -pdV$

$\left[C_v = \frac{\partial q}{\partial T} \right|_V$

Entropy $dS = dq_{rev}/T$

S is a state function

$S = k \ln g$
$U_f = F = U - TS$
↑ free energy. useful in stat mech.

⇒ rewrite 1st law: $C_v dT = TdS - pdV$ ← pick reversible paths

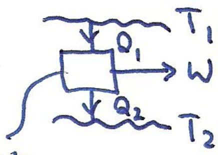
Also: $C_p = \frac{\partial q}{\partial T} \Big|_p$ ⇒ for ideal gas $(PV = nRT)$

$C_p = C_v + Rn.$

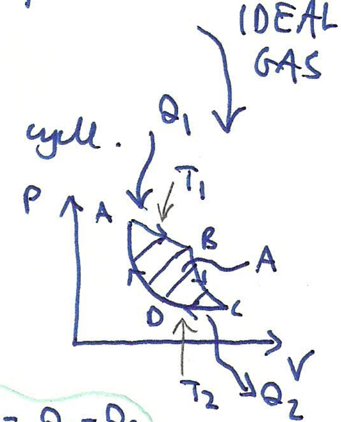
Carnot cycle is reversible and most efficient heat cycle.

Efficiency (general) $= \eta = W/Q_1$

$= 1 - T_2/T_1$ for carnot cycle.



carnot heat engine



A–B : Isothermal expansion @ T_1
B–C : Adiabatic expansion
C–D : Isothermal compression
D–A : Adiabatic compression

π $\left[\begin{array}{l} PV^\gamma = \text{constant} \\ P^{1-\gamma} T^\gamma = \text{constant} \\ TV^{\gamma-1} = \text{constant} \end{array} \right]$

Find Q_1, Q_2 in terms of T_1, T_2 only. Then find $\eta = \frac{Q_1 - Q_2}{Q_1}$

$\text{Work} = Q_1 - Q_2 = \int_A dPdV$ ← No dU overall in process A→A.

Kelvin's statement : " No process whose sole purpose is heat → work" ↕
Clausius " : " No process can transfer heat from hot to cold body"

2nd law: $dS_{universe} \geq 0$ for any spontaneous process.