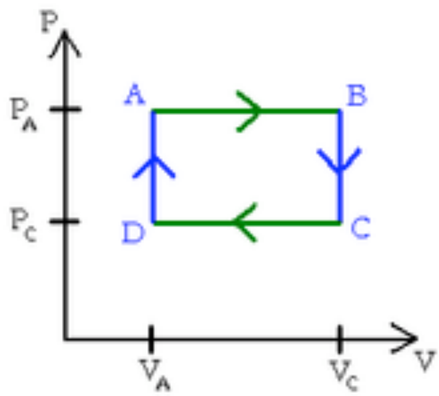
Thermodynamic Cycles

For each of these cycles, you should be able to fully characterise the system. You should be able to derive formulas for:

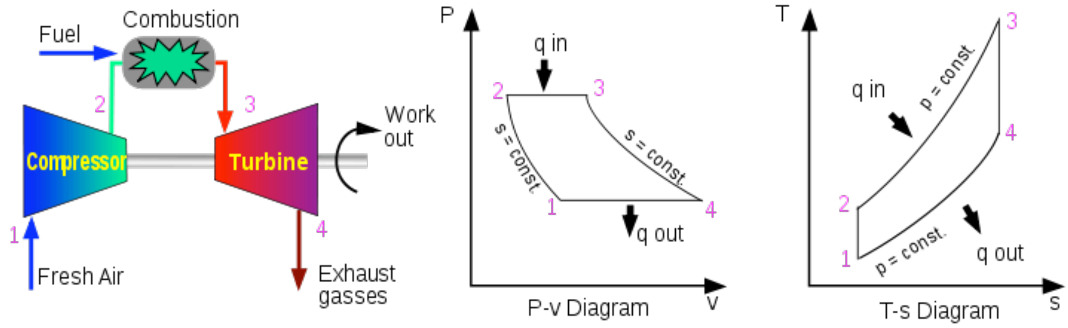
- (i) Work done per cycle
- (ii) Heat input to cycle
- (iii) Heat output from cycle
- (iv) Efficiency of the motor
- (v) Coefficient of performance for the refrigerator
- (vi) Coefficient of performance for the heat pump

(Nearly) all of the images have been taken from Wikipedia and you should read the articles on these (and other) Thermodynamic Cycles.

Ideal Cycle
Two isobaric processes plus two isochoric processes.



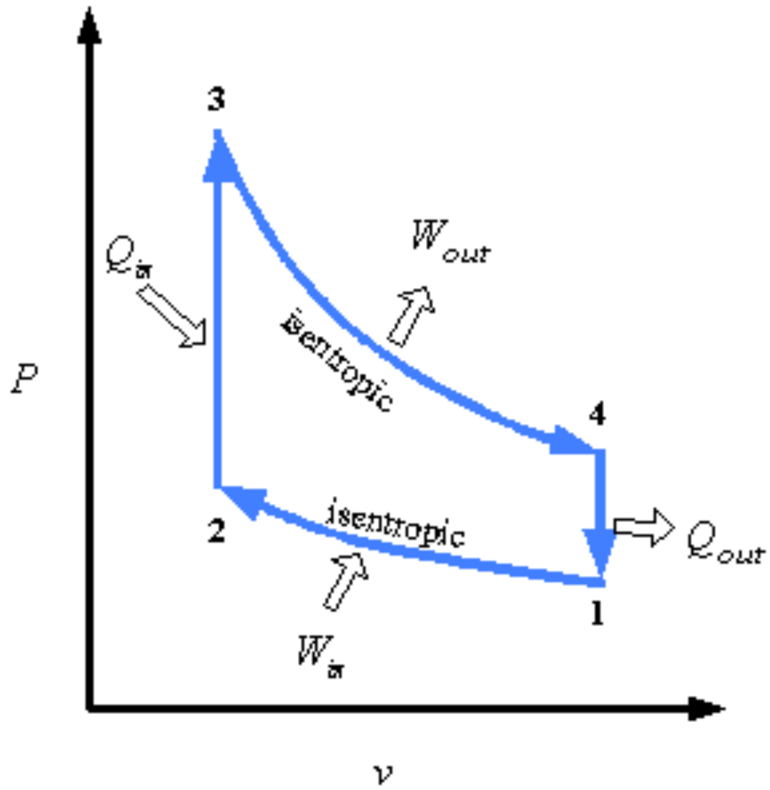
Brayton or Joule Cycle
Two isobaric processes linked by two adiabatic processes.



Idealized Brayton Cycle

$$\eta = 1 - \left(\frac{P_L}{P_H}\right)^{\frac{\gamma-1}{\gamma}}$$

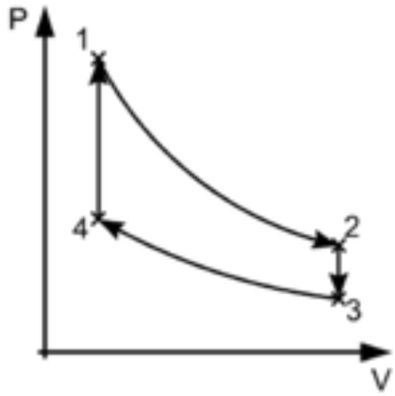
Otto cycle
Two adiabatic (isentropic) processes linked by two isochoric (isometric) processes.



$$\eta = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$
$$= 1 - \frac{1}{r^{\gamma-1}}$$

Stirling cycle

Two isothermal processes linked by two isochoric (isometric) processes.

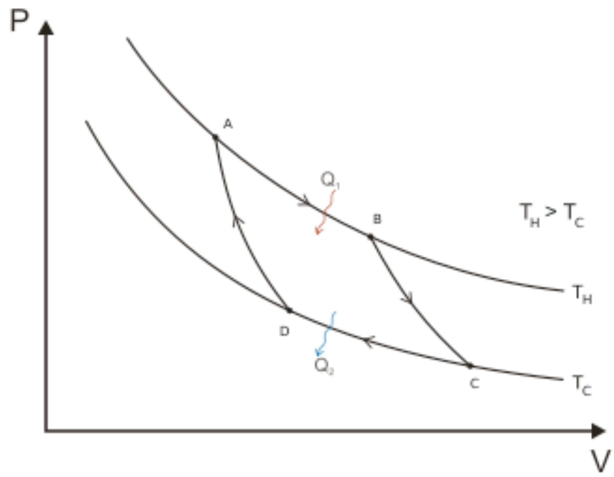


$$\eta = \frac{[1-\frac{T_H}{T_C}]}{1+\frac{1}{(\gamma-1)\ln\left(\frac{V_H}{V_L}\right)}[1-\frac{T_H}{T_C}]}$$

$$= \frac{\eta_C}{1+\frac{1}{(\gamma-1)\ln(r)}\eta_C}$$

Carnot cycle

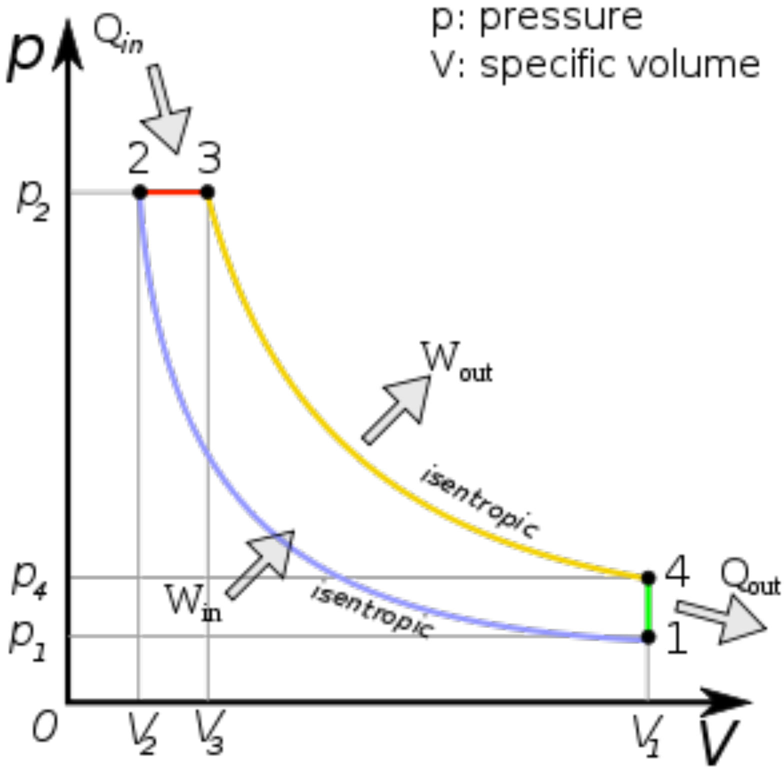
Two isothermal processes linked by adiabatic processes.



$$\eta_C = 1-\frac{T_C}{T_H}$$

Diesel cycle

Two adiabatic (isentropic) processes linked by an isochoric process and an isobaric process.



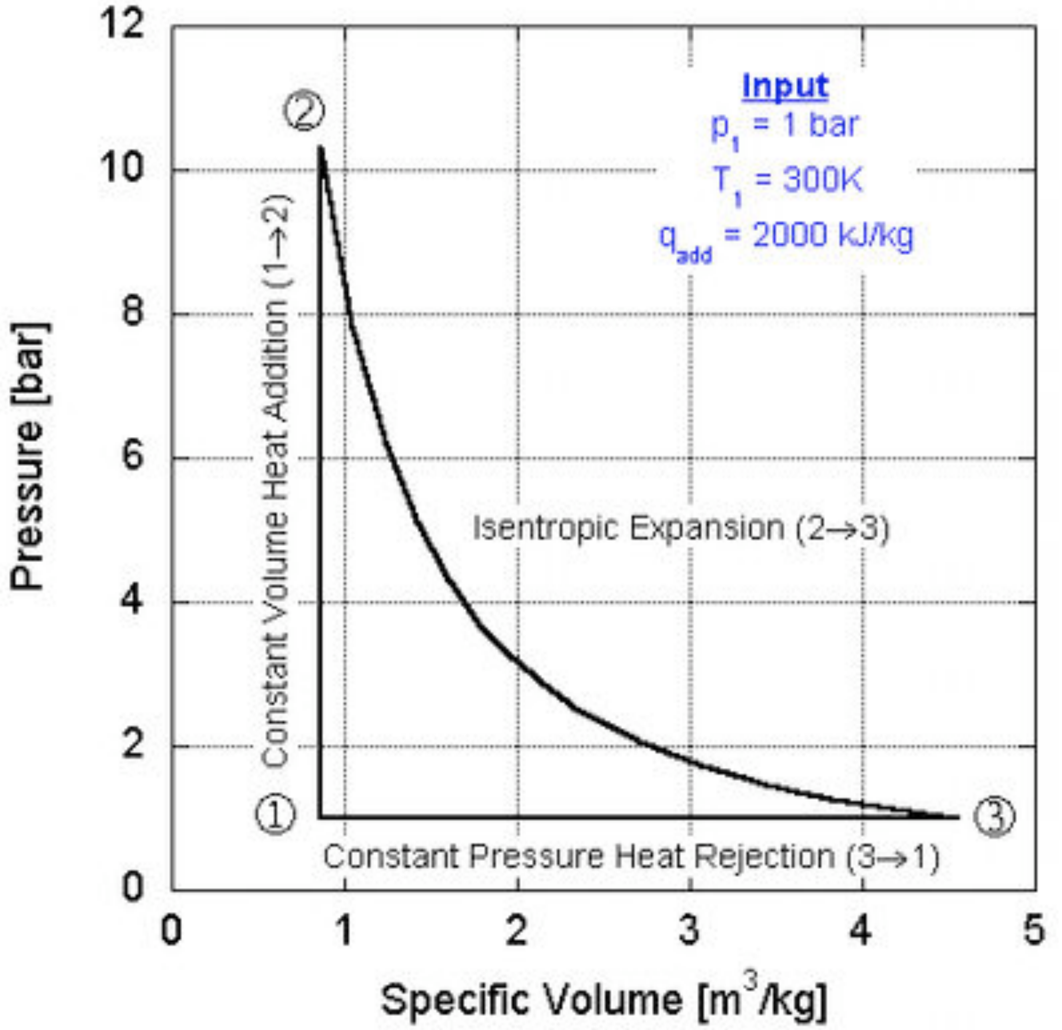
$$\eta = 1 - \frac{1}{r^{\gamma-1}}\left(\frac{\alpha^{\gamma}-1}{\gamma(\alpha-1)}\right)$$

where

$\alpha = \frac{V_3}{V_2}$ the cut off ratio

$r = \frac{V_1}{V_2}$ the compression ratio

Lenoir (pulse jet) cycle
Isobaric compression, isochoric pressurisation and adiabatic (isentropic) expansion.



$$\eta = 1 - \gamma\left(\frac{r-1}{r^{\gamma}-1}\right)$$

Unnamed Triangular cycle
Isobaric compression, isochoric pressurisation and isothermal expansion – differs from Lenoir by replacing the adiabat with an isotherm.

$$\eta = \frac{\ln(r) + \left[\frac{1}{r} - 1\right]}{\ln(r) - \frac{1}{(\gamma-1)}\left[\frac{1}{r} - 1\right]}$$