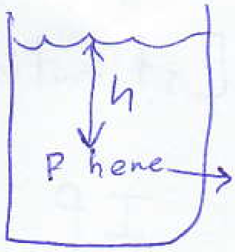
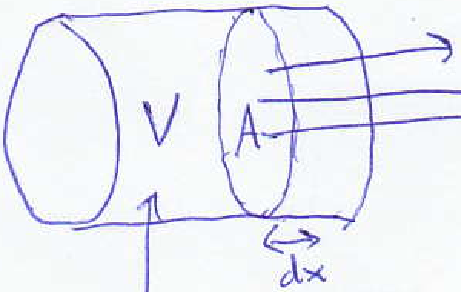
$$\text{Pressure} = \frac{\text{force}}{\text{area}} \qquad Pa = \frac{N}{m^2}$$



$\rightarrow P = \rho g h$

$$\rho = \frac{m}{V}$$



$\rightarrow F = PA \qquad P = \frac{F}{A}$

monoatomic ideal gas

energy in the random motion of the atoms

$$E = \frac{3}{2} nkT = \frac{3}{2} PV$$

$$\frac{\text{mass of gas}}{\text{mass of 1 atom}} = \text{\# particles} \rightarrow n$$

k → Boltzmann const.

T → temp. in °K

$$k = 1.38 \times 10^{-23} \; \frac{J}{°K}$$

The gas does work on the piston

$$dW = F\,dx = PA\,dx = P\,dV$$

ideal gases: $PV = nkT$

diatomic: $\frac{3}{2} \rightarrow \frac{5}{2}$

If the gas is being heated, then

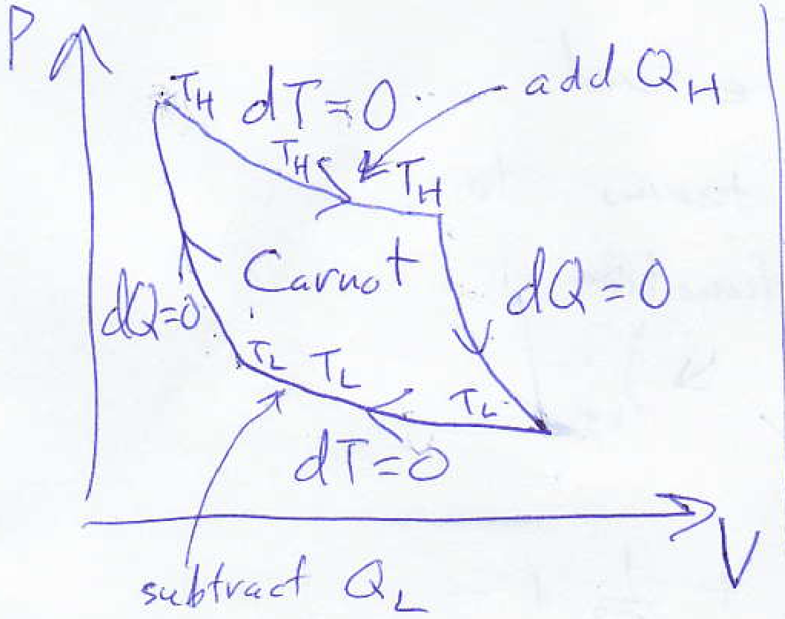
$$dE = dQ - dW \Rightarrow \frac{3}{2} d(PV) = dQ - P\,dV$$

$$\frac{3}{2}(V\,dP + P\,dV) = dQ - P\,dV$$

$$\frac{3}{2} V\,dP + \frac{5}{2} P\,dV = dQ \quad \leftarrow \text{(still monoatomic)}$$

$\left(\frac{5}{2} V\,dP + \frac{7}{2} P\,dV = dQ \quad \text{diatomic} \right)$

In heat engines there are different stages in the cycle.



$dE = \frac{3}{2} nk\,dT$

$dT = 0 \Rightarrow dE = 0$

$dQ = dW$

$\hookrightarrow = P\,dV$

$dQ = 0 \Rightarrow dE = -dW$

$\frac{3}{2} nk\,dT = -dW$

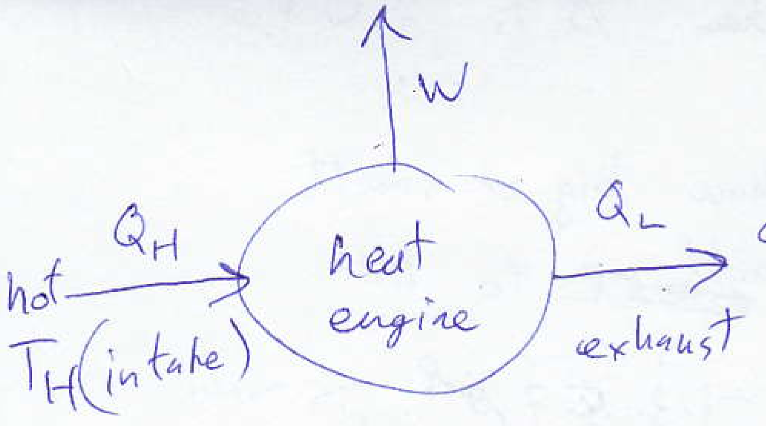
$e = \frac{W}{Q_H}$ for heat engines

$e_{Carnot} = 1 - \frac{T_L}{T_H}$ & $\frac{Q_H}{Q_L} = \frac{T_H}{T_L}$

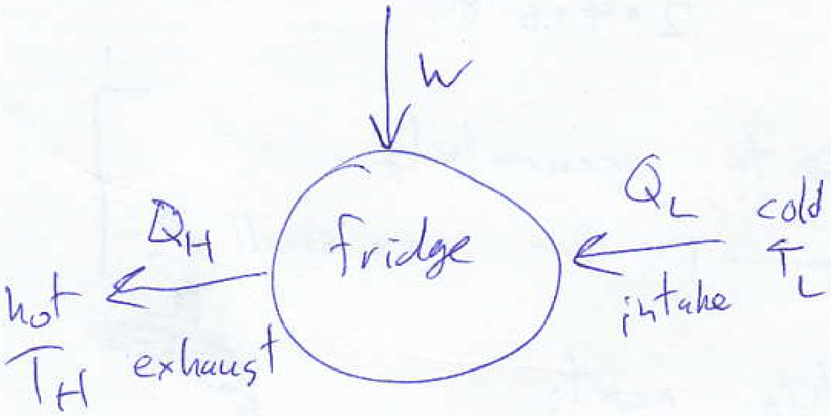
$e = \frac{Q_L}{W}$ for fridges (heat engine backwards)

$e_{Carnot} = \frac{Q_L}{W} = \frac{Q_L}{Q_H - Q_L} = \frac{T_L}{T_H - T_L}$

$\uparrow$ $Q_L + W = Q_H$



$$Q_H = W + Q_L$$



$$Q_H = W + Q_L$$

Carnot: $\frac{Q_H}{Q_L} = \frac{T_H}{T_L}$

everything else: $\frac{Q_H}{Q_L} \neq \frac{T_H}{T_L}$

$$\frac{Q_{intake}}{Q_{exhaust}} \leq \frac{T_{intake}}{T_{exhaust}}$$

2nd Law

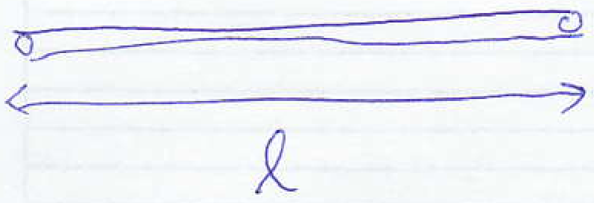
entropy: $dS = \frac{dQ}{T} \geq 0$

$$\frac{Q_{exhaust}}{T_{exhaust}} - \frac{Q_{intake}}{T_{intake}} = \Delta S_{universe} \geq 0$$

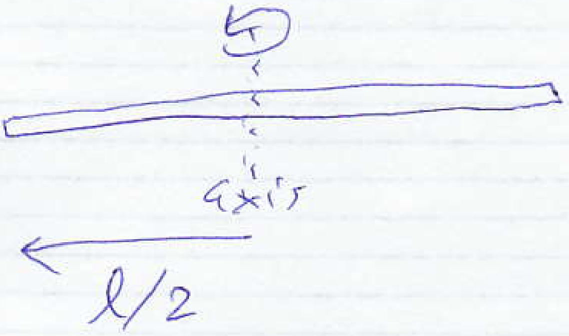
microscopically, $S = k \ln M$

M = # microscopic states available at the current energy

$$dS = \frac{dQ}{T} \iff \frac{dS}{dQ} = \frac{1}{T}$$



thin rod mass m



$$I_{cm} = \frac{1}{12} m l^2$$

$$\left(I = \int r^2 \, dm \right)$$

$$I_{end} = \frac{1}{12} m l^2 + m \left(\frac{l}{2}\right)^2$$

$$= \frac{1}{12} m l^2 + \frac{1}{4} m l^2$$

$$= \frac{1}{3} m l^2$$

$$K_{rot} = \frac{1}{2} I \omega^2$$

Chapter 0	x, v, a, t unit conversion etc.
Chapter 1	conservation of mass
" 2	" " energy
" 3	" " momentum
" 4	" " angular momentum
" 5	entropy is increasing

Chapter summaries start on p. 876.