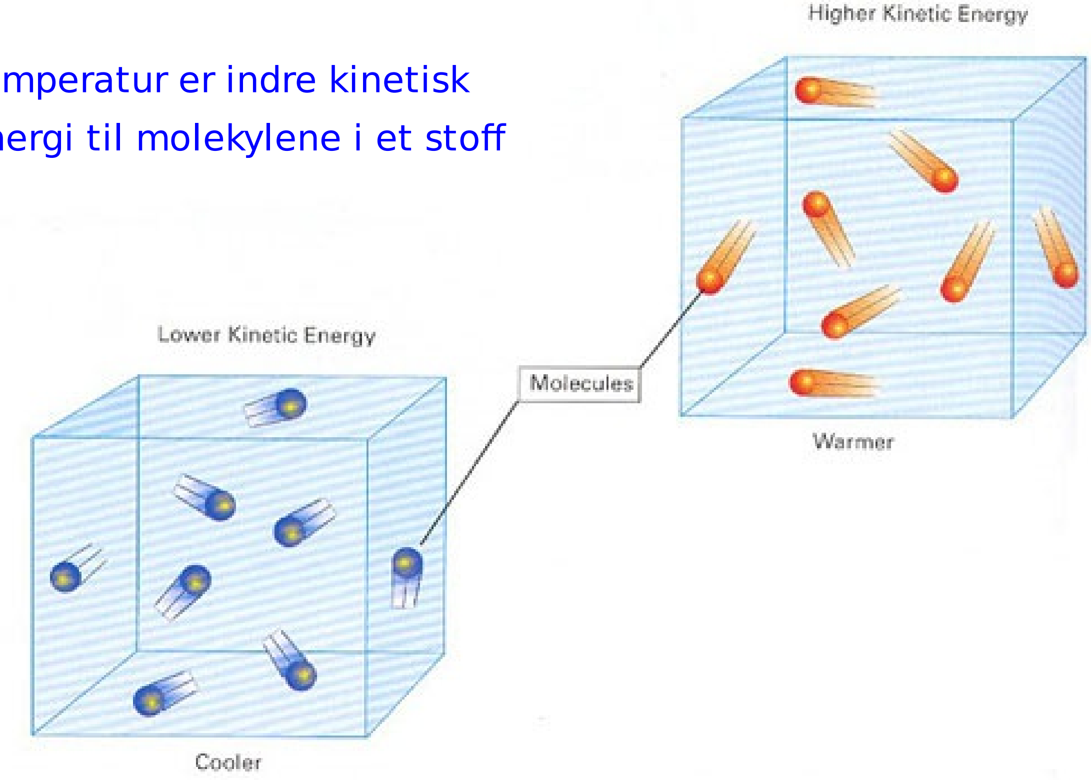
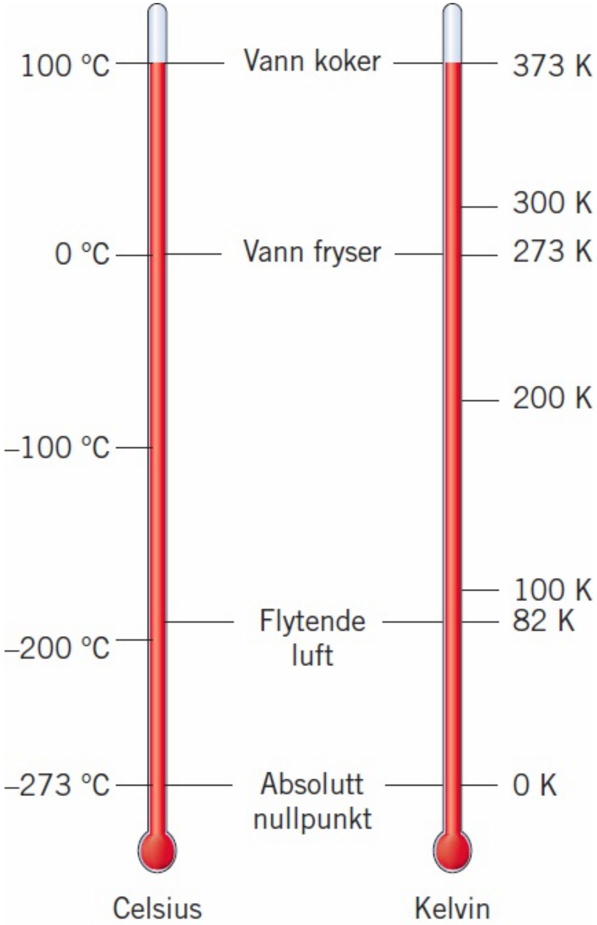
Termofysikk

Temperatur er indre kinetisk energi til molekylene i et stoff



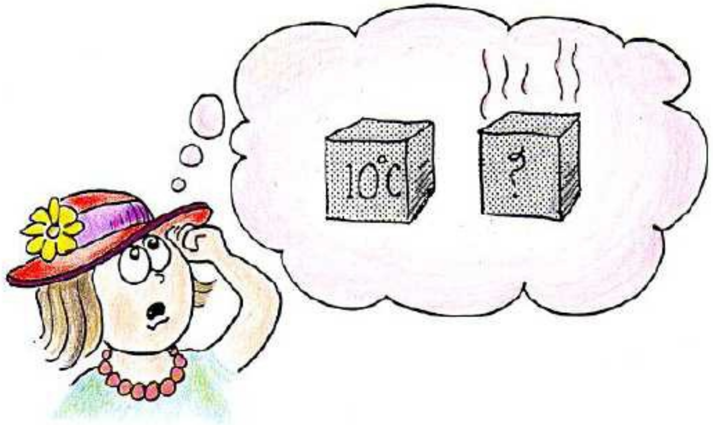
Kelvinskalaen



NEXT-TIME QUESTION

CONCEPTUAL Physics

A piece of iron has a temperature of 10°C. A second identical piece of iron is twice as hot. What is the temperature of the second piece of iron?



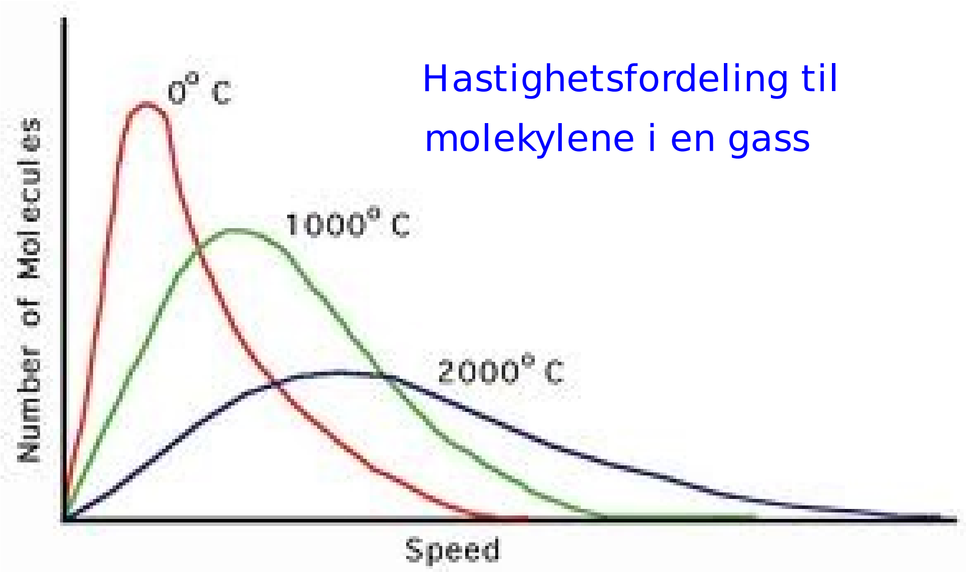
ARBOR SCIENTIFIC

Hewitt Drew it!

$T = 10°C = (10 + 273)K = 283K$

$2 \cdot T = 2 \cdot 283K = 566K = 293°C$

Sammenhengen mellom temperatur og energi



Hastighetsfordeling til molekylene i en gass

$$\bar{E}_k = \frac{3}{2} k T$$

Boltzmanns konstant

$k = 1{,}38 \cdot 10^{-23}\ J/K$

gjennomsnitts

Hvilken fart har molekylene i

Sophus Lies auditorium i dag?

$$\bar{v} = v_{rms} = \sqrt{\overline{v^2}}$$

masse til et molekyl

$$E_k = \frac{1}{2} m v^2$$

$$\overline{E_k} = \frac{1}{2} m \overline{v^2} = \frac{1}{2} m \bar{v}^2 = \frac{3}{2} kT$$

$$\bar{v} = \sqrt{\frac{3kT}{m}}$$

N_2 : $m_{N_2} = 28u = 28 \cdot 1{,}66 \cdot 10^{-27}$ kg =

$T = 23\,°C = 296\,K$

$\bar{v} = 513$ m/s

O_2 : $m_{O_2} = 32u$ $\qquad \bar{v} = 480$ m/s

H_2 : $m_{H_2} = 2u$ $\qquad \bar{v} = 1921$ m/s

Tilstandslikningen for en idealgass

Antall molekyler

$$pV = NkT$$

temperatur

trykk Volum Boltzmann

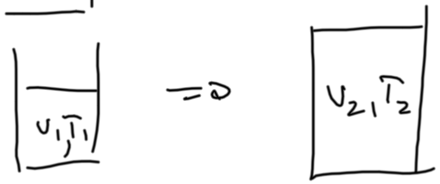
V konst. (isokor)

$$\frac{p}{T} = \frac{Nk}{V} = \text{konst.}$$

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

p konstant (isobar)

$$\frac{V}{T} = \frac{Nk}{p} = \text{konstant}$$



$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

T konst. (isoterm)

$$pV = NkT = \text{konst} \qquad p_1V_1 = p_2V_2$$

$$pV = NkT = n\underbrace{N_A k}_{R} T$$

$$= nRT$$

antall mol

$$N = n N_A$$

$6{,}023 \cdot 10^{23}$

Fra Din Side:

Årstidene påvirker lufttrykket

Den som fyller luft i et oppvarmet lokale må være spesielt oppmerksom på temperatur-problemstillingen. Hvis bilen har stått lenge i en oppvarmet garasje, vil nemlig luften inni dekkene oppnå omtrent samme temperatur som garasjeluften. Hvis du fyller 250 kPa i et lokale som holder 20 varmegrader - og deretter kjører ut i 20 minusgrader, vil lufttrykket snart synke til rundt 210 kPa.

Men dette problemet kan altså løses ved overfylling. I dette tilfellet ville du oppnådd korrekt lufttrykk ved å fylle 290 kPa.

Stemmer dette?

$$pV = NkT \qquad \frac{p}{T} = \frac{Nk}{V}$$

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$p_1 = 250\ \text{kPa}$

$T_1 = 20\,^\circ C = 293\ K$

$p_2 = ??$

$T_2 = -20\,^\circ C = 253\ K$

$$p_2 = p_1 \cdot \frac{T_2}{T_1} = 250\ \text{kPa} \cdot \frac{253\ K}{293\ K} = 210\ \text{kPa}$$

NEXT-TIME QUESTION

CONCEPTUAL PHYSICS

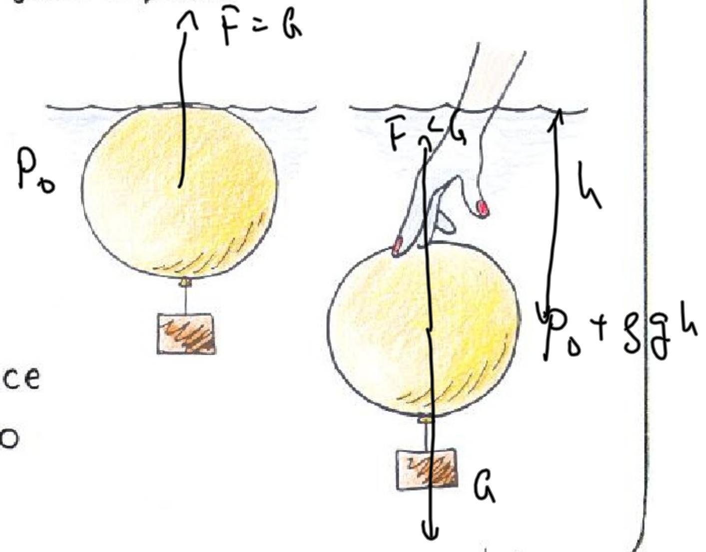
Consider an air-filled balloon weighted so that it is on the verge of sinking— that is, its overall density just equals that of water.

Now if you push it beneath the surface, it will

a) sink.

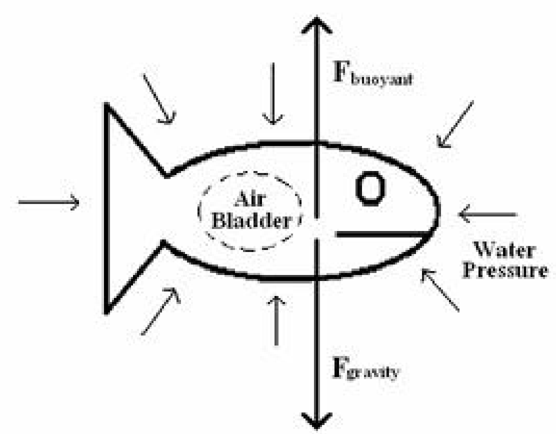
b) return to the surface

c) stay at the depth to which it is pushed.

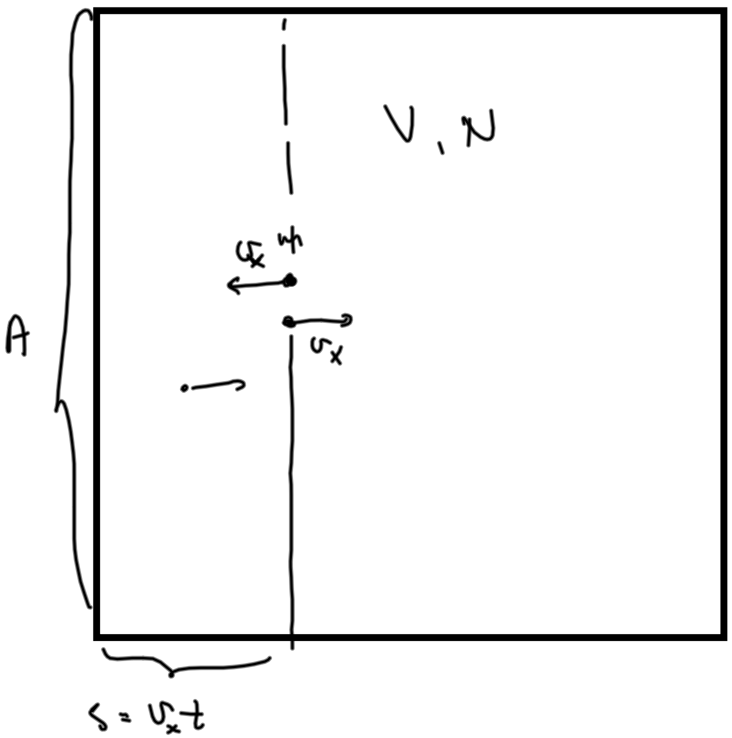


ARBOR SCIENTIFIC

Hewitt Drew it!



Tilstandslikningen for en idealgass



$$p_x = m v_x \qquad \Delta p_x = 2 m v_x = F_1 t$$

$$F_1 = \frac{2 m v_x}{t}$$

$$N_t = \frac{1}{2}\,\frac{v_x t \cdot A}{V}\,N$$

$$F = N_t \cdot F_1 = \frac{1}{\cancel{2}}\,\frac{v_x \cancel{t} A}{V}\,N \cdot \frac{\cancel{2} m v_x}{\cancel{t}} = A\, m v_x^2 \cdot \frac{N}{V}$$

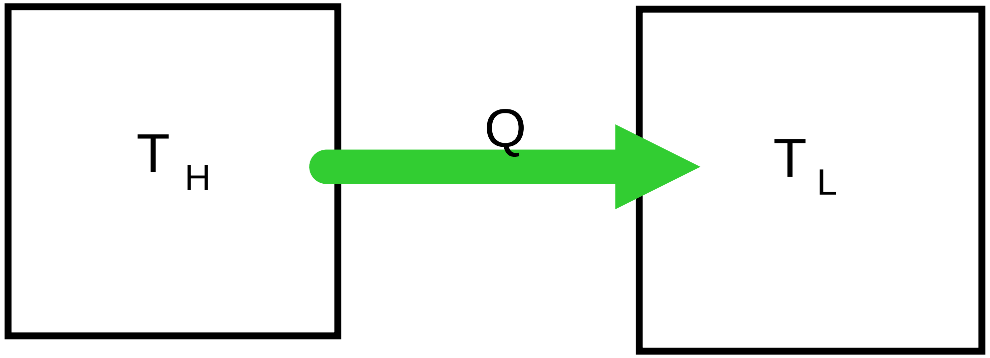
$$p = \frac{F}{A} = \underbrace{m v_x^2}_{\to \frac{2}{3}\bar{E}_k}\,\frac{N}{V}$$

$$\bar{E}_k = \frac{1}{2} m \overline{|\vec{v}|^2} = \frac{1}{2} m \left(\overline{v_x^2} + \overline{v_y^2} + \overline{v_z^2}\right) = \frac{3}{2} m \overline{v_x^2}$$

$$p = \frac{2}{3}\underbrace{\bar{E}_k}_{\to \frac{3}{2}kT} \cdot \frac{N}{V} = kT \cdot \frac{N}{V}$$

$$\boxed{pV = NkT}$$

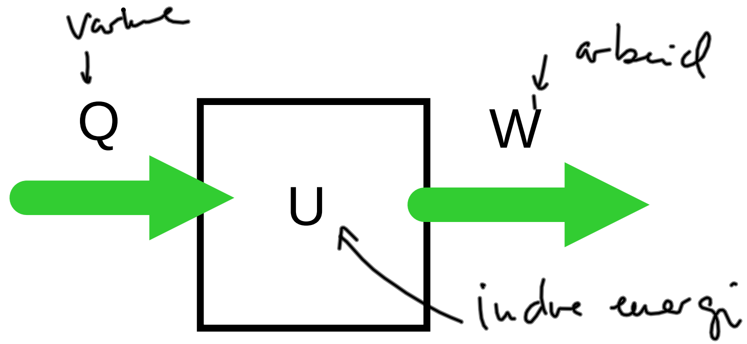
Temperatur og varme



Temperatur er en egenskap (indre kinetisk energi) til et legeme.

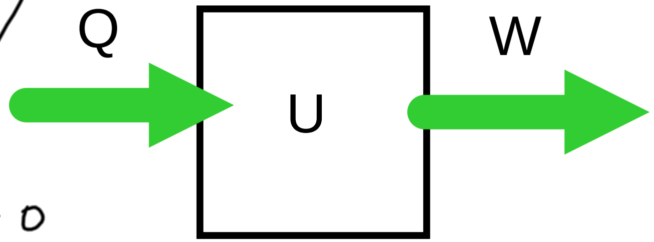
Varme er energi som strømmer fra et varmt til et kaldt legeme.

Termofysikkens 1.lov: Energien er bevart

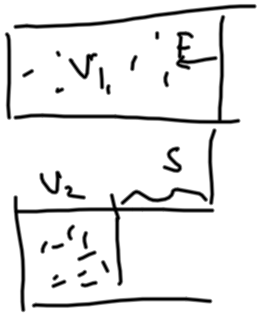


$$\Delta U = Q - W$$

Adiabatisk kompresjon



$Q = 0$



$W = Fs < 0$

$\Delta U = \underbrace{Q}_{0} - W = -W > 0$

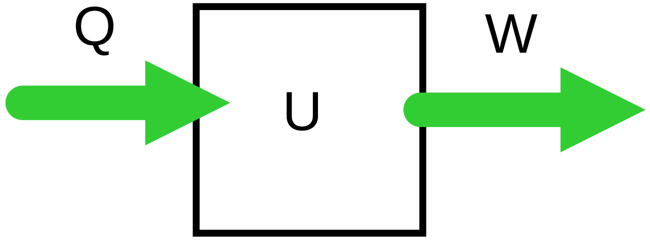
T øker.

Isoterm kompresjon

T konst.

$\Downarrow$

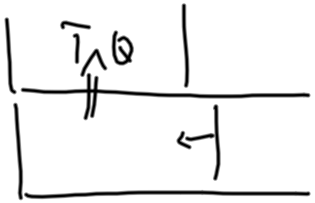
U = konst



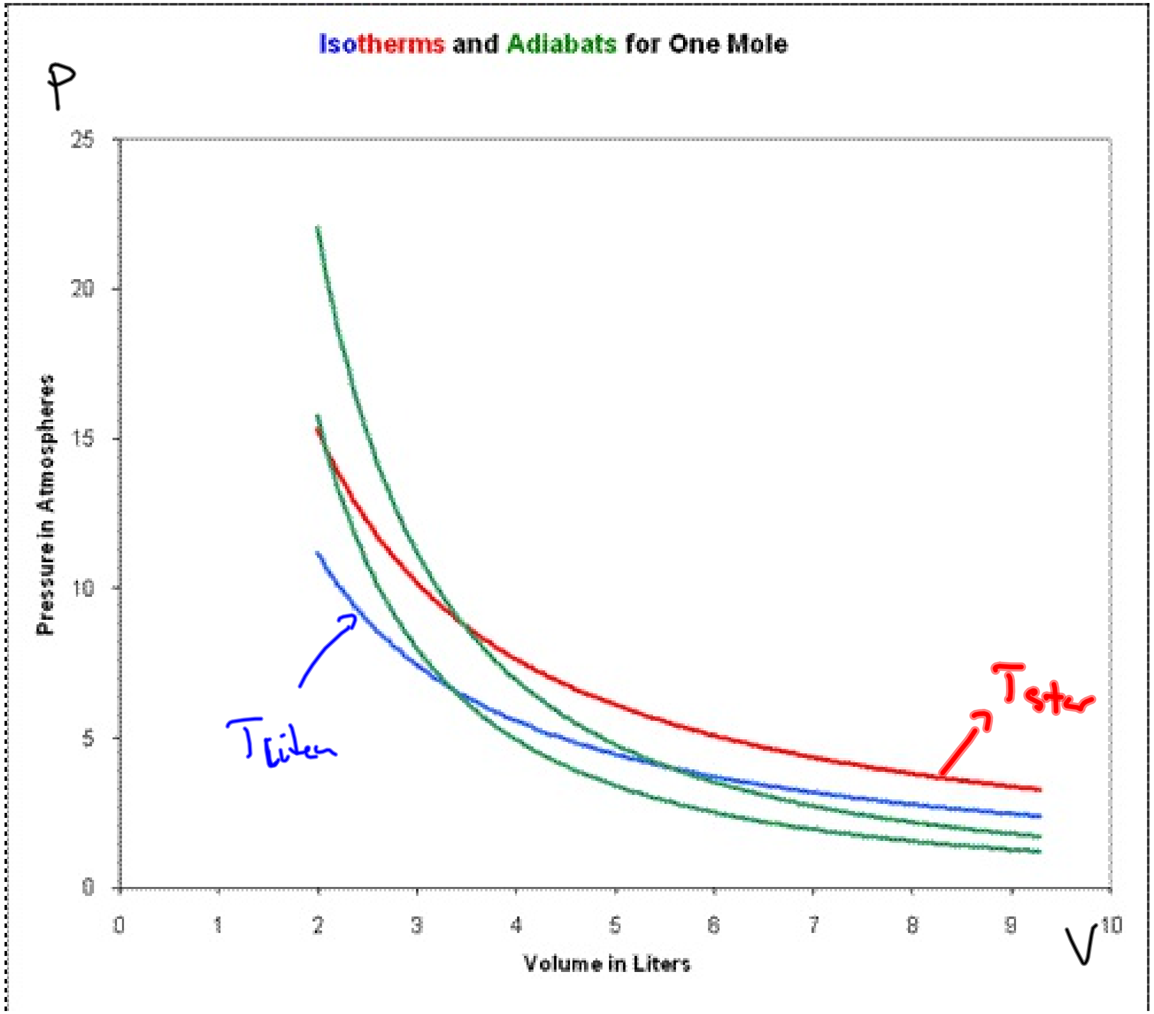
$W < 0$

$\Delta U = Q - W = 0$

$Q = W < 0$



p-V diagram. Isoterme og adiabatiske kurver



$pV = NkT$

Isoterm: T konst.

$$pV = \text{konst}$$

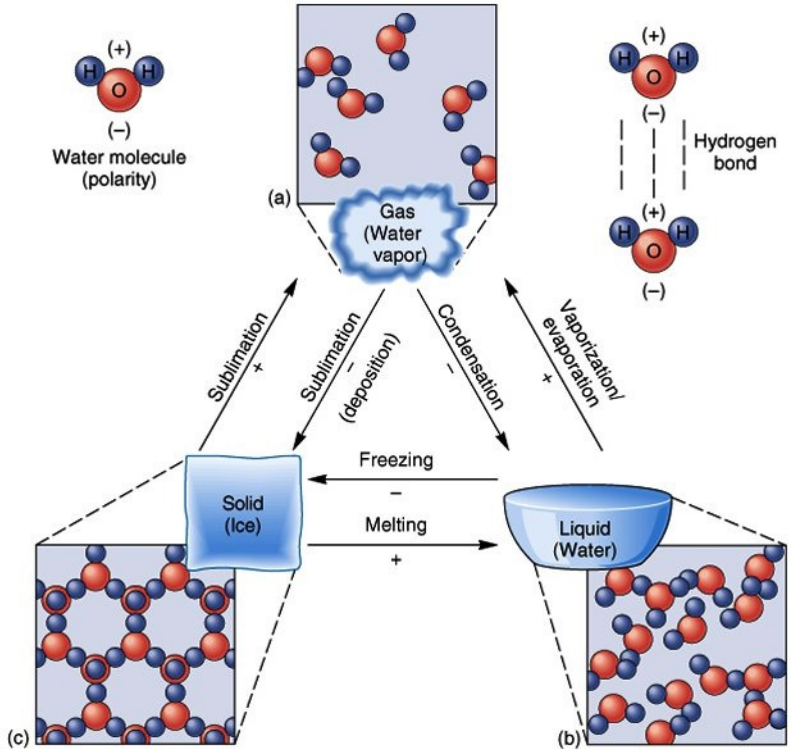
$$p = \frac{\text{konst}}{V}$$

Adiabatisk

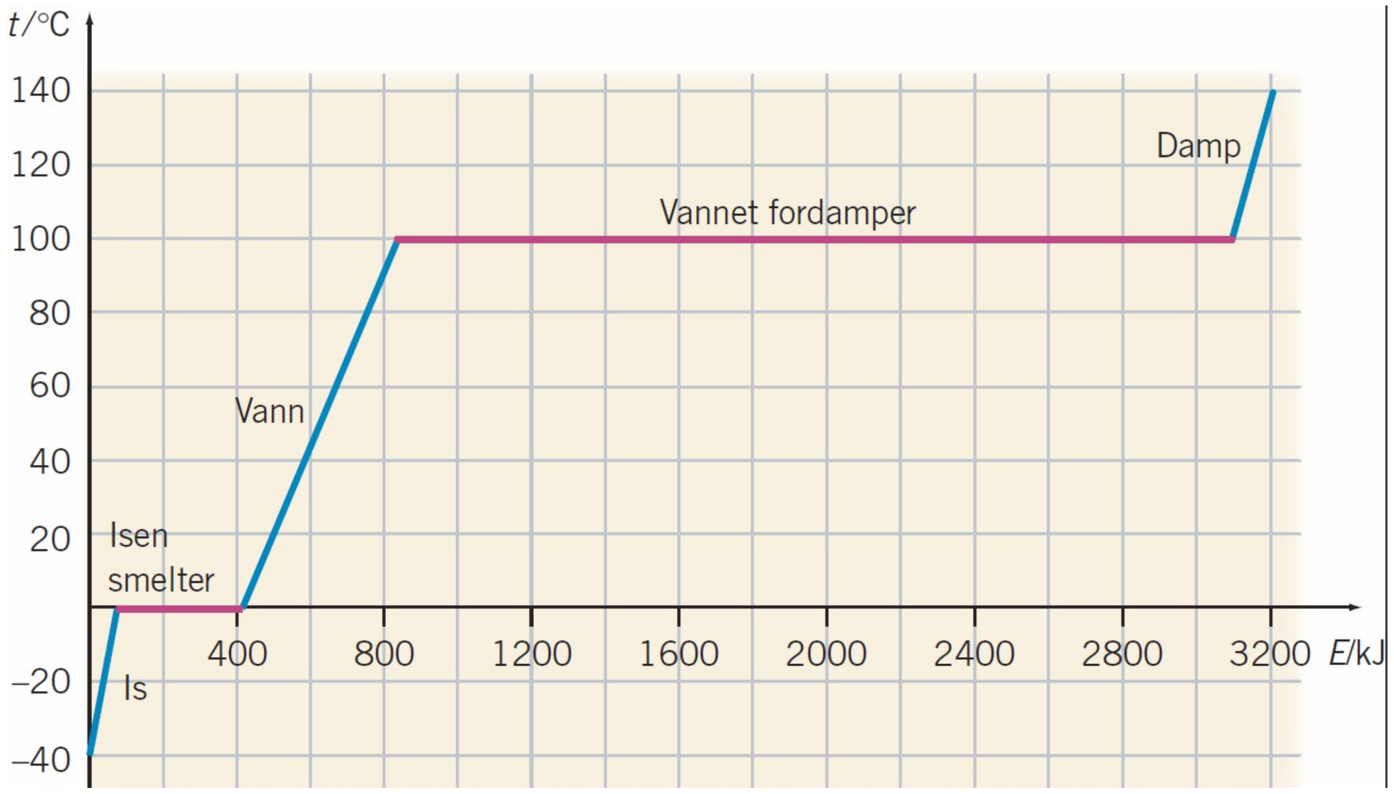
$$pV^{\gamma} = \text{konst}$$

$$\gamma = \begin{cases} 1{,}67 \quad (5/3) & \text{enatomig} \\ 1{,}40 \quad (7/5) & \text{toatomig} \end{cases}$$

Faser og faseoverganger



Varmekapasitet, faseoverganger og fasevarme



Spesifikk varmekapasitet: $Q = \underline{c} \cdot m \cdot \Delta T$ $c = \frac{Q}{m \Delta T}$ $\frac{J}{kg\,K}$

Fasevarme
- Smeltevarme $Q = \underline{l_s}\, m$
- Fordampningsvarme $Q = \underline{l_f}\, m$