TFY4115 Fysikk

Faseoverganger (smelte, fordampe)

Y&F kap.17.6+18.6 (8 sider)
H&S kap 10 (6 sider)
L&H&L Kap. 17.10 (1½ side)

Varme Q tilført et legeme kan:

1) Varme opp stoff: $Q = C \cdot n \cdot \Delta T$

der C = molar varmekapasitet

2) Smelte stoff: $Q = L_s \cdot \Delta m$

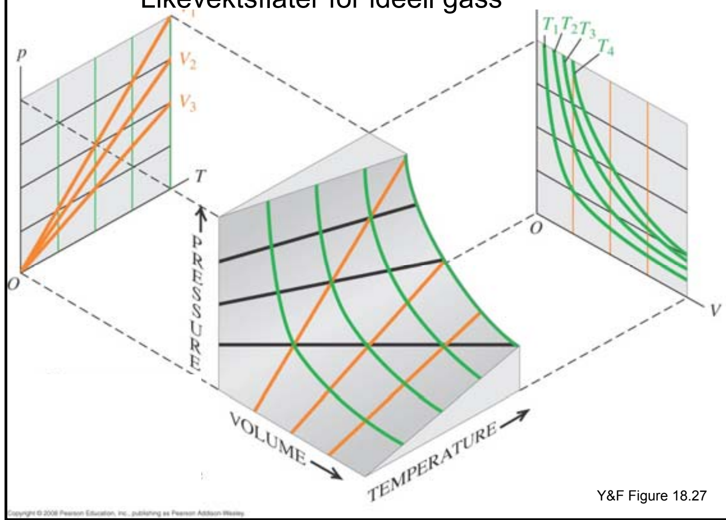
der L_s = spesifikk smeltevarme (J/kg)

3) Fordampe stoff: $Q = L_f \cdot \Delta m$

der L_f = spesifikk fordampingsvarme (J/kg)

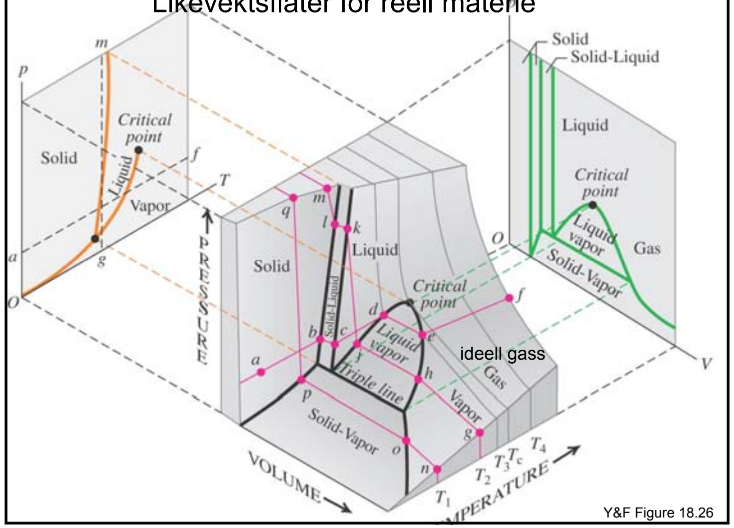
4) Utvide en gass isotermt $Q = \int p \, dV$

Likevektsflater for ideell gass



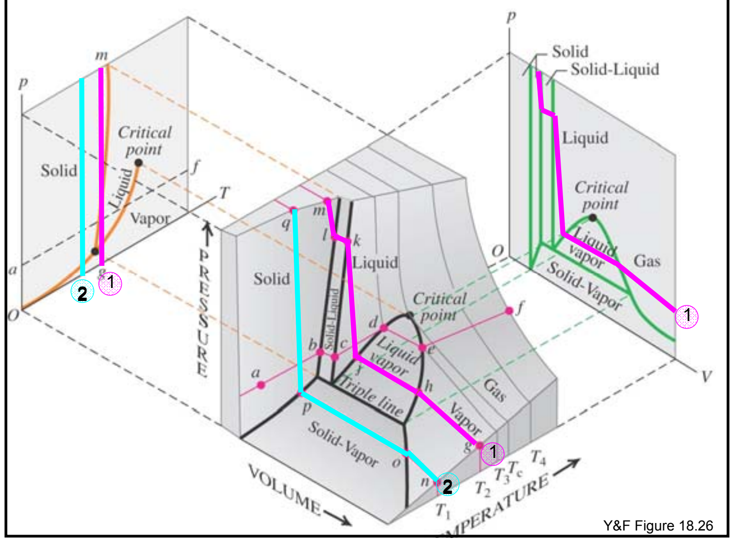
Y&F Figure 18.27

Likevektsflater for reell materie



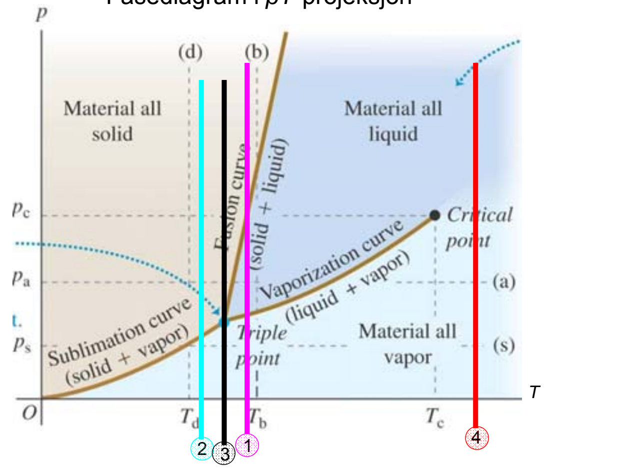
Y&F Figure 18.26

Faseoverganger



Y&F Figure 18.26

Fasediagram i *pT*-projeksjon



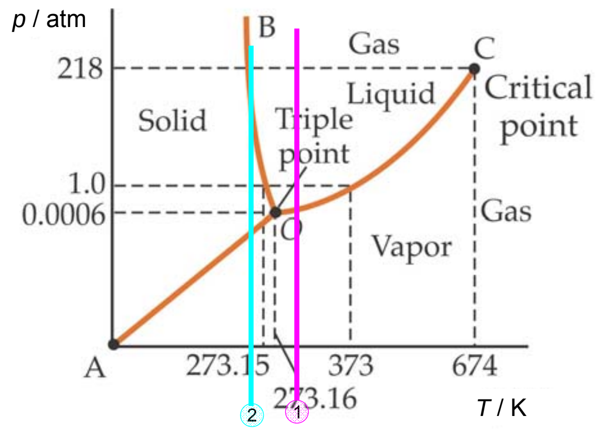
Y&F Figure 18.24

Table 18.3 Triple-Point Data

Substance	Temperature (K)	Pressure (Pa)
Hydrogen	13.80	0.0704×10^5
Deuterium	18.63	0.171×10^5
Neon	24.56	0.432×10^5
Nitrogen	63.18	0.125×10^5
Oxygen	54.36	0.00152×10^5
Ammonia	195.40	0.0607×10^5
Carbon dioxide	216.55 =-56,5 °C	5.17×10^5 = 5,1 atm
Sulfur dioxide	197.68	0.00167×10^5
Water	273.16 =0,01 °C	0.00610×10^5 = 0,006 atm

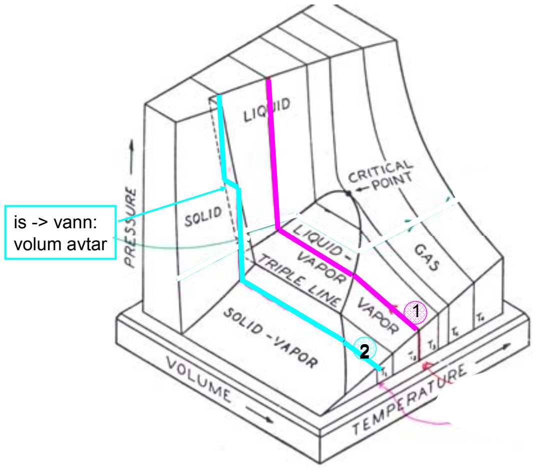
Y&F Table 18.3

Fasediagram i *pT*-projeksjon **for H_2O**

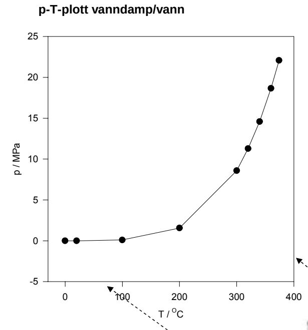


Faseoverganger

Fasediagram H_2O

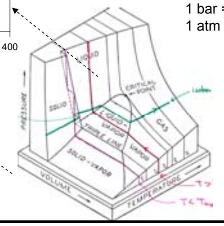


Vanndamptrykk *p* sfa. temp. *T* (kokepunkt)

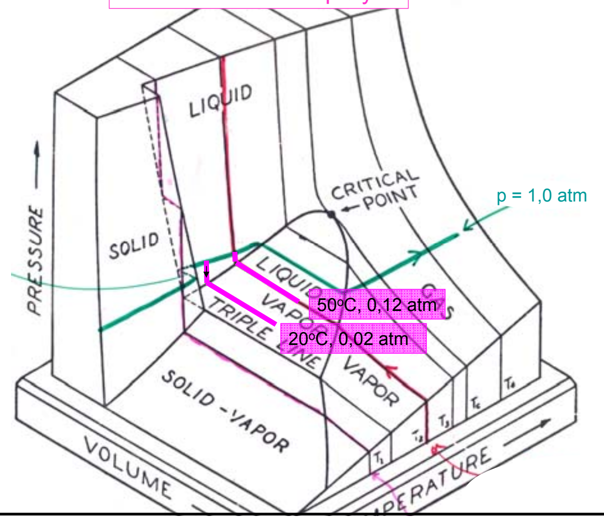


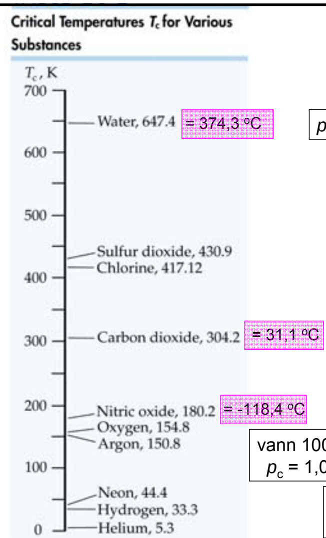
T / °C	p / bar
0,01	0,006
20	0,023
50	0,123
100	1,013
200	15,5
300	85,8
320	113
340	146
360	187
374,14	220,9

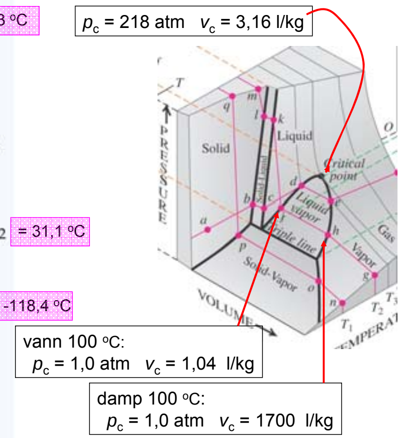
1 bar = 100 kPa = 0,1 MPa
1 atm = 1,013 bar



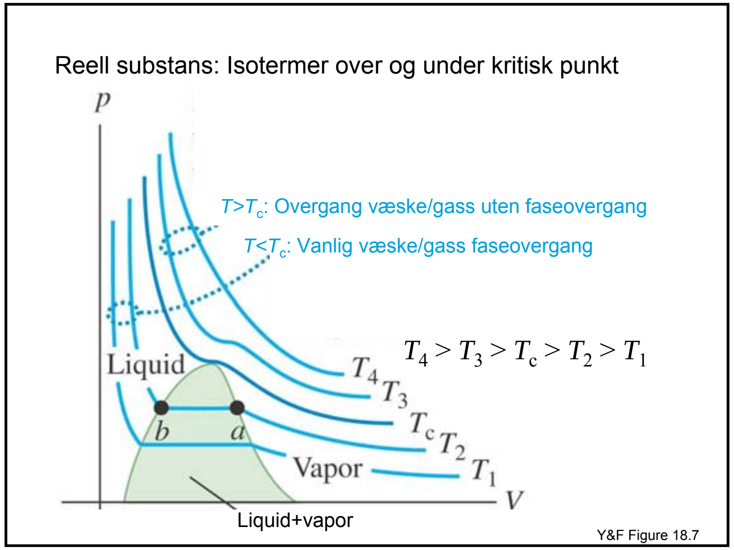
"Håndkokt" vann i sprøyte.

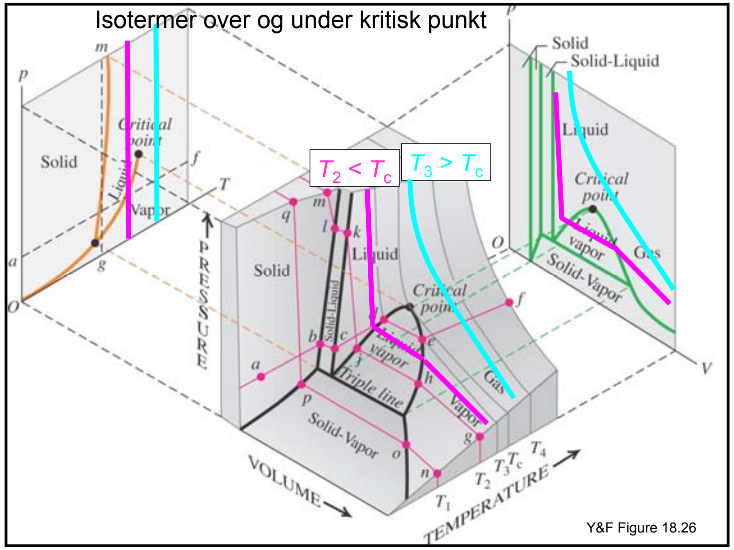


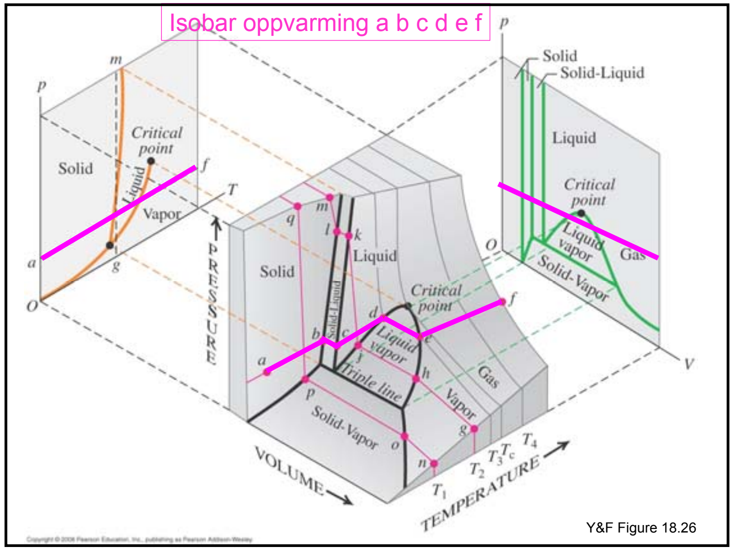


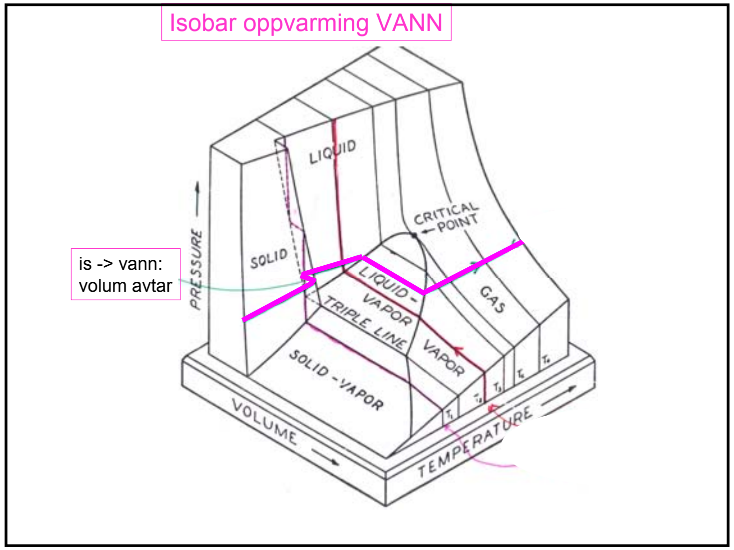


Faseoverganger



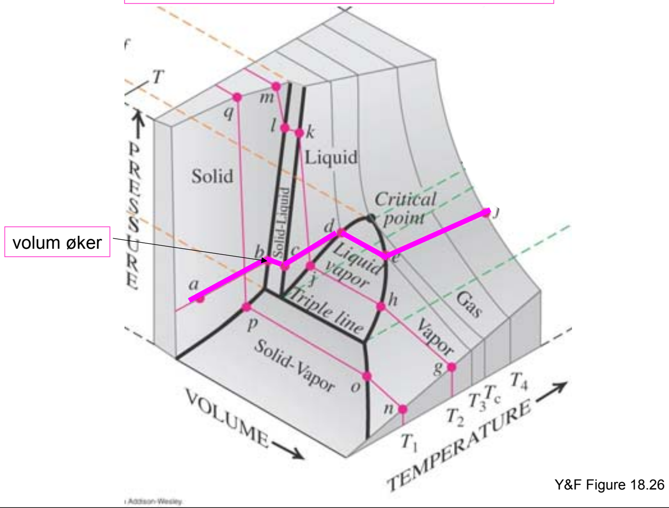






Faseoverganger

Isobar oppvarming STOFFER ≠ VANN



Y&F Figure 18.26

Y&F Table 17.4

Table 17.4 Heats of Fusion and Vaporization at 1 atm

Substance	Normal Melting Point K	Normal Melting Point °C	Heat of Fusion, L_f (J/kg)	Normal Boiling Point K	Normal Boiling Point °C	Heat of Vaporization, L_v (J/kg)
Helium	*	*	*	4.216	−268.93	20.9×10^3
Hydrogen	13.84	−259.31	58.6×10^3	20.26	−252.89	452×10^3
Nitrogen } Luft	63.18	−209.97	25.5×10^3	77.34	−195.8	201×10^3
Oxygen } Luft	54.36	−218.79	13.8×10^3	90.18	−183.0	213×10^3
Ethanol	159	−114	104.2×10^3	351	78	854×10^3
Mercury	234	−39	11.8×10^3	630	357	272×10^3
Water	273.15	0.00	334×10^3	373.15	100.00	2256×10^3
Sulfur	392	119	38.1×10^3	717.75	444.60	326×10^3
Lead	600.5	327.3	24.5×10^3	2023	1750	871×10^3
Antimony	903.65	630.50	165×10^3	1713	1440	561×10^3
Silver	1233.95	960.80	88.3×10^3	2466	2193	2336×10^3
Gold	1336.15	1063.00	64.5×10^3	2933	2660	1578×10^3
Copper	1356	1083	134×10^3	1460	1187	5069×10^3

*A pressure in excess of 25 atmospheres is required to make helium solidify. At 1 atmosphere pressure, helium remains a liquid down to absolute zero.

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Faseoverganger. Oppsummering

- Fasediagram i *pVT*-rommet viser hvilke områder de tre faser fast, væske, gass kan eksistere hver for seg og sammen. Gjelder kun reine faser (én type stoff).
- I fasediagram i *pT*-projeksjon er sameksistensflatene kurver. Fasediagram i *pV*-projeksjon også ofte brukes.
- Smelting (fast -> væske): L_s = spesifikk smeltevarme (J/kg)
- Fordamping (væske -> gass) : L_f = spesifikk fordampingsvarme (J/kg)
- I *pT*-plott har sameksistenskurve væske/gass $dp/dT>0$. Sameksistenskurve fast/væske har $dp/dT>0$ for alle stoff unntatt H_2O fordi is har større volum enn vann.
- Sameksistenskurve væske/gass har et maksimalt (kritisk) punkt (p_{krit}, T_{krit}). For $p>p_{krit}$ og/eller $T > T_{krit}$ har væske og gass samme egenskaper.