Lecture General Chemistry
Winter Term 2022/23

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- Website (Slides, Excercises):
- http://www.chemie.uni-siegen.de/pc/lehre/nanoscitec/

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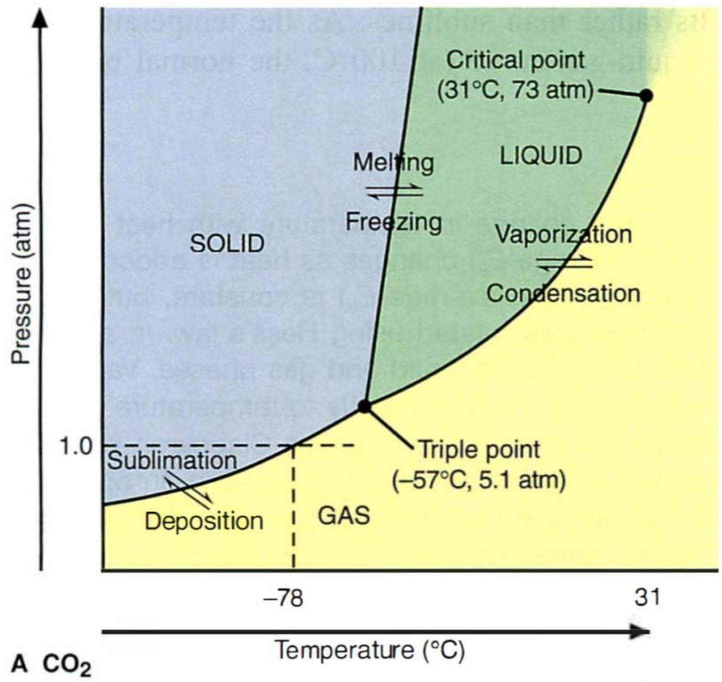
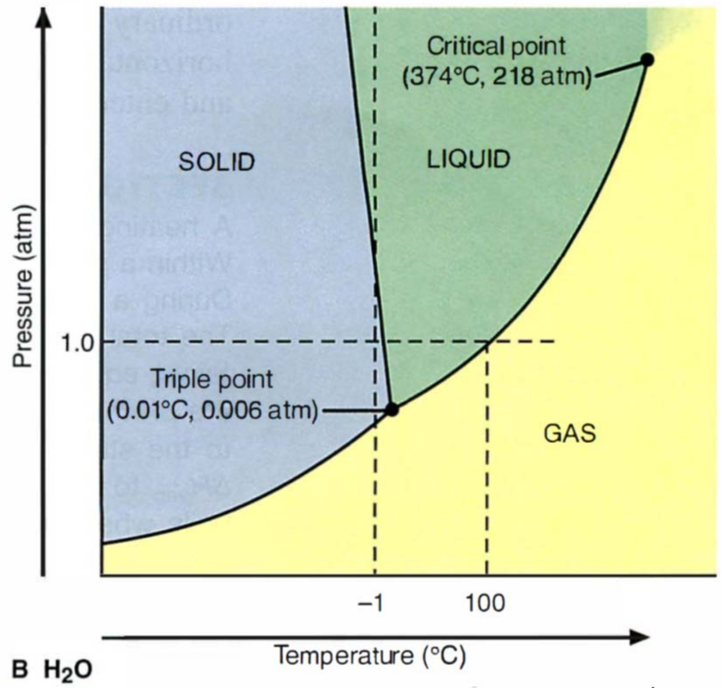
Properties of pure liquids and solutions

- Phase diagrams
- Liquid Crystals
- Vapour pressure of pure liquids
- Solubility of solids
- Solubility of gases
- Vapour pressure of solutions
- Distillation
- Elevation of boiling point
- Freezing point depression
- Stability of phases


Critical point
(31°C, 73 atm)
LIQUID
Melting
Freezing
SOLID
Vaporization
Condensation
Pressure (atm)
1.0
Sublimation
Deposition
Triple point
(–57°C, 5.1 atm)
GAS
–78
31
Temperature (°C)
A CO2

La 3

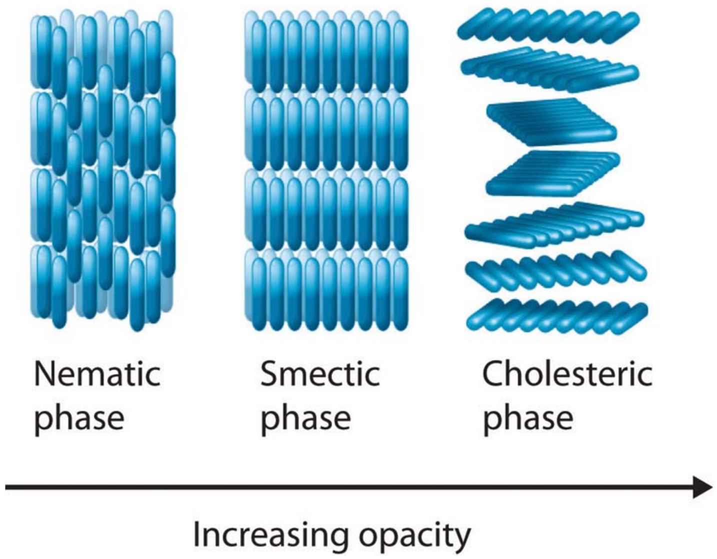

Critical point
(374°C, 218 atm)
SOLID
LIQUID
Pressure (atm)
1.0
Triple point
(0.01°C, 0.006 atm)
GAS
–1
100
Temperature (°C)
B H2O

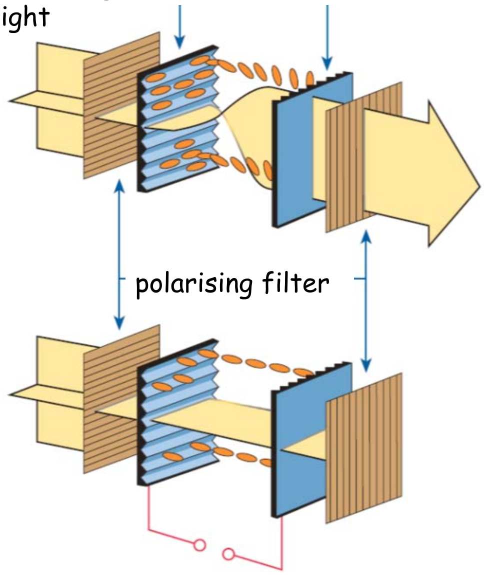
La 4

Tab. 17.5.1 triple points and critical points of some substances

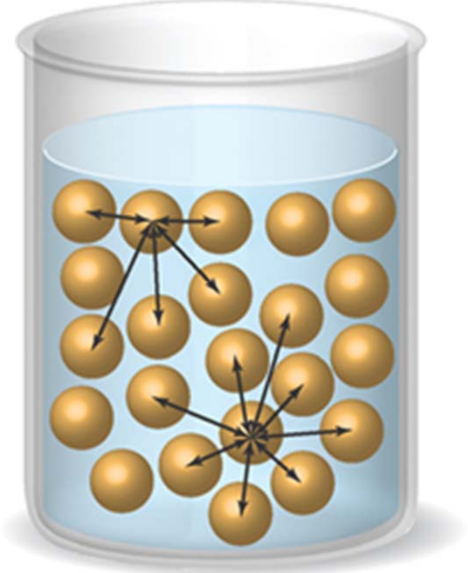
substance	triple point		critical point	
	T_T/K	p_T/bar	T_k/K	p_k/bar
He	–	–	5,3	2,26
Ne	24,563	0,4339	44,4	26,54
H_2	13,958	0,07193	33,24	12,96
N_2	63,146	0,12526	126,20	34,00
O_2	54,361	0,00147	154,576	50,43
H_2O	273,16	0,006	647,25	218,3
CO_2	216,579	5,185	304,25	73,825
CH_4	90,685	0,117	190,555	45,95

There is more than solid, liquid, gas: Liquid Crystals

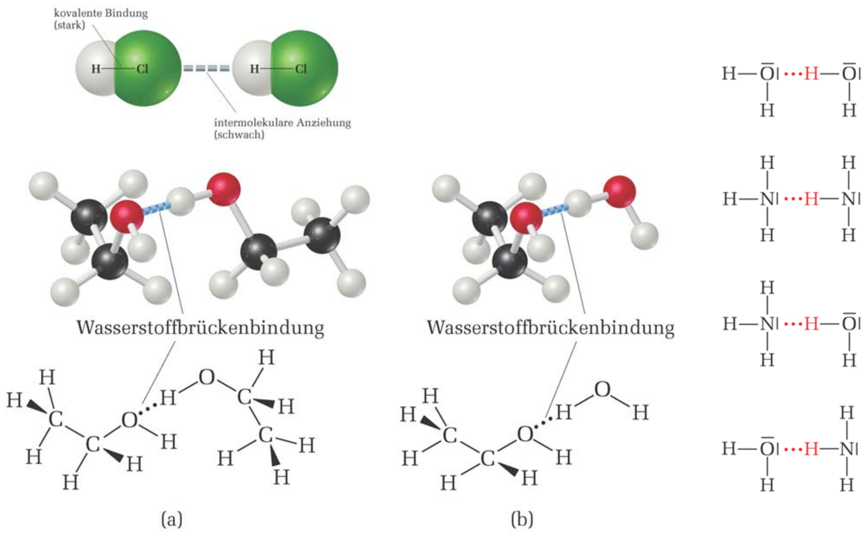


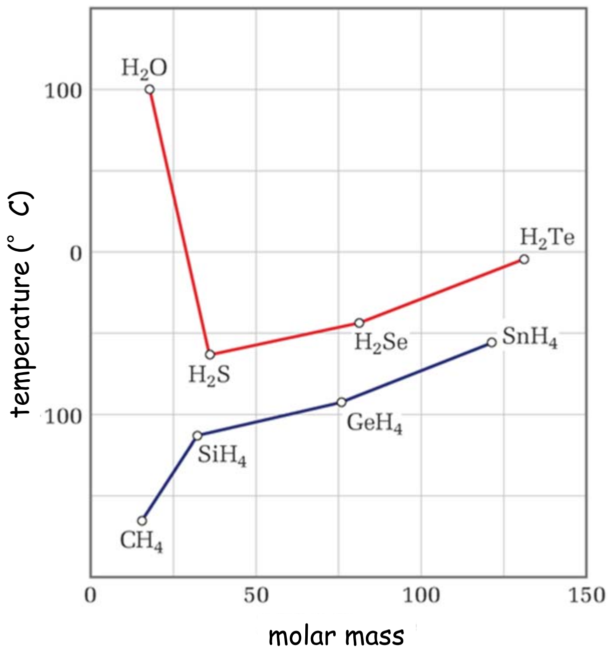


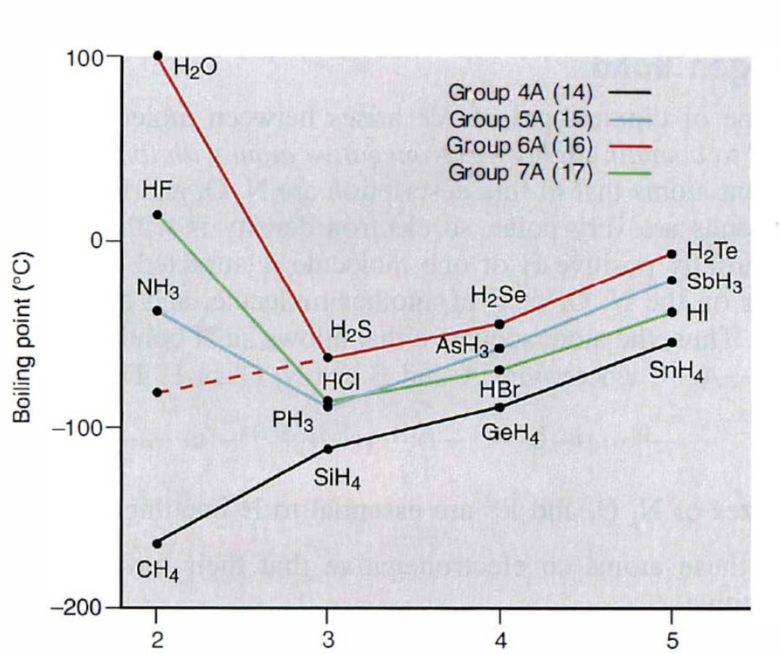
Forces in solutions



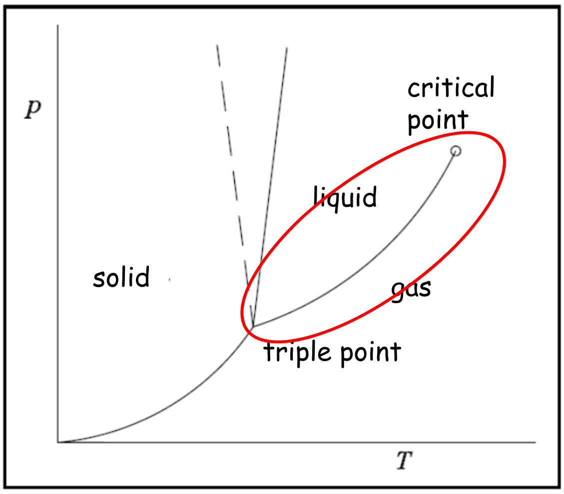
hydrogen bonds



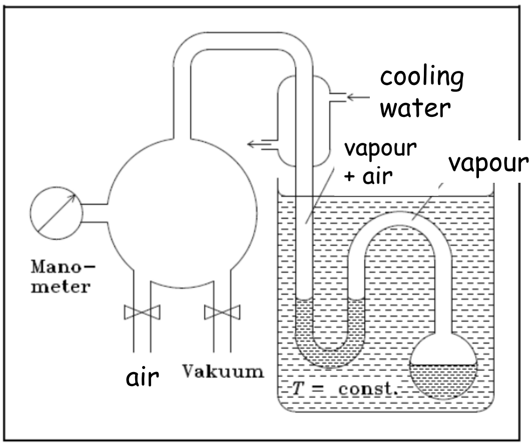




vapour pressure of liquids

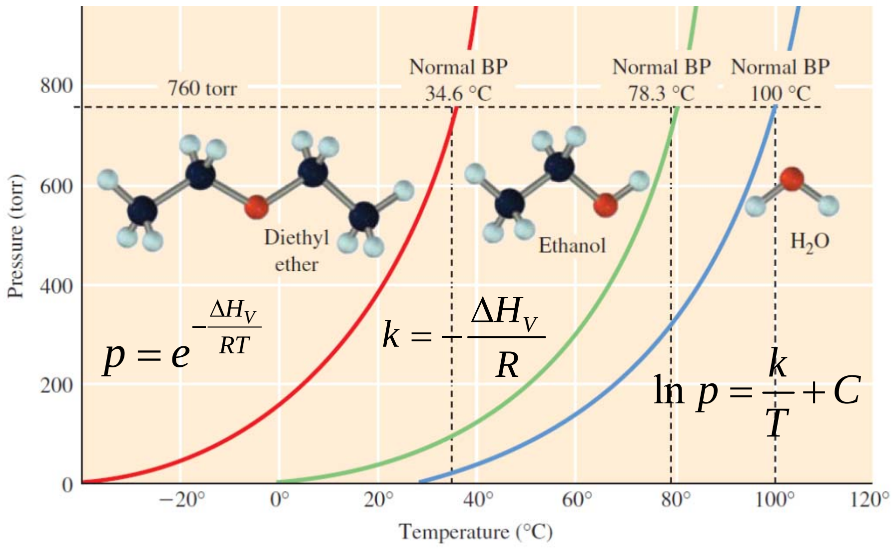


measuring the vapour pressure

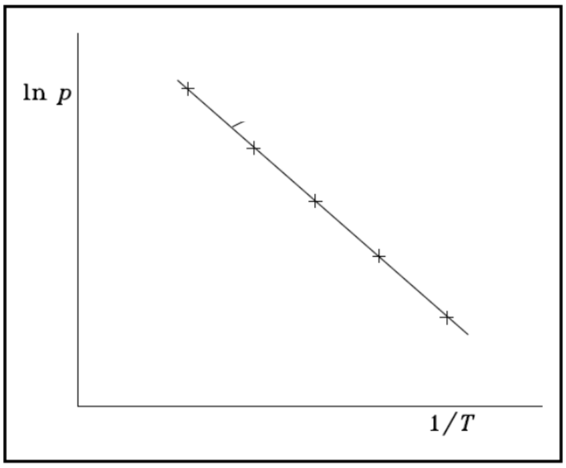


measuring device for vapour pressure

vapour pressure as f(T)



making the vapour pressure curve linear



$$\ln p = \frac{k}{T} + C$$ elimination of integration constant: $$\ln p_0 = \frac{k}{T_S} + C$$

$$\ln \frac{p}{p_0} = k\left(\frac{1}{T} - \frac{1}{T_S}\right)$$ Clausius-Clapeyron's law

$$k = -\frac{\Delta H_V}{R}$$

important equation:
determine ΔH_V, if $p = f(T)$ is known
determine p for any T, if ΔH_V is known

boiling point

(def. bp: vapour pressure = ambient pressure)

Substance	boiling point
He	4K
H_2O	373K
W	≈6000K

Big differences!

Reason: Forces between particles

London, Dipol-Dipol, Coulomb, hydrogen bonds, metallic bond

another difference: molar mass

noble gas	He	Ne	Ar	Kr	Xe	Rn
T_S / K	4	27	87	120	166	208

Alkane	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}
T_S / K	112	184	231	273	309	342

Why?

$$E_{kin} = \frac{mv^2}{2} = \frac{3kT}{2}$$

heavy particles are slower

Intermolecular forces between heavy (big) particles are stronger

stronger forces: higher boiling point

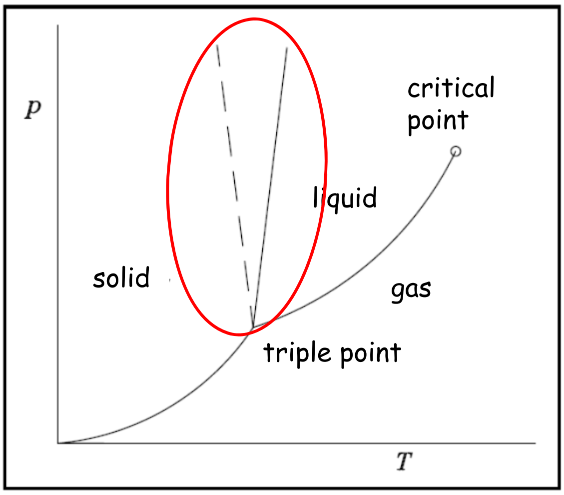
relation between boiling point and boiling enthalpy?

Pictet-Trouton's rule

$$\frac{\Delta H_V}{T_S} \approx \text{const.} \quad (= \Delta S_V)$$

	Diethyl ether	Chloroform	Benzene	Water
T_S [K]	308	335	353	373
ΔH_V [kJ mol^{-1}]	26,0	29,4	30,8	40,7
$\Delta H_V / T_S$ [J mol^{-1}K^{-1}]	85	88	87	109

Melting or Freezing point



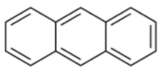
Melting or Freezing point

same here: strong forces -> high melting point

- type of lattice — Fp
  - Molecular lattice — low
  - Ionic lattice — medium
  - 3-dim Molecular crystal — high

- molcular structur of particles
  - rigid- flexible
  - symmetric - unsymmetric

Benzene	Toluene
5 °C	-95 °C



Anthracen
Smp: 217 °C
see Diesel:
C_{14}- Molecules
start to freeze
at 0 °C