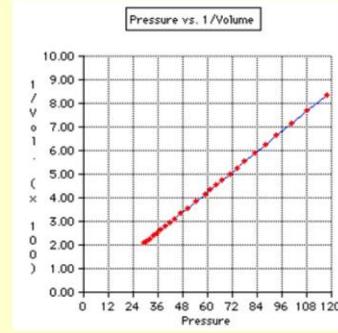
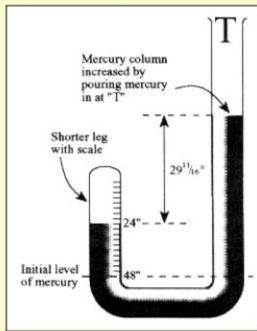




Gassen

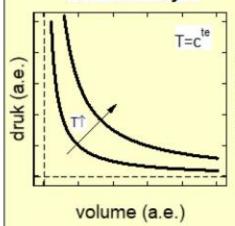
het experiment van Boyle



Gassen

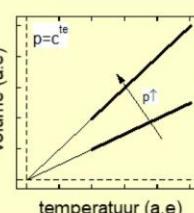
Fenomenologische gaswetten

Wet van Boyle



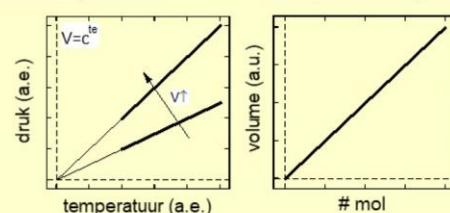
$$p \propto \frac{1}{V}$$

Wetten van Charles en Guy-Lussac



$$V \propto T$$

Principe van Avogadro



$$p \propto T$$

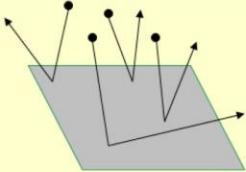
$$V \propto n$$

Ideale Gaswet
 $pV \propto nRT$

R: gasconstante, $8.314 \text{ J K}^{-1} \text{ mol}$

Gassen

kinetische gastheorie



- ✓ druk ~ botsingen op wand
- ✓ kracht = uitgewisseld impuls per seconde

$$p = \frac{1}{3} N \frac{1}{V} m u^2$$

Experimentele toets

$$N_A \frac{dE_{kin,mol}}{dT} = \frac{3}{2} R = 12.5 \text{ J K}^{-1} \text{ mol}^{-1}$$

II

warmtecapaciteit edelgassen

Fysische betekenis

ideaal gas

geen moleculaire interacties

\Rightarrow

$E_{kin,mol} = \frac{3}{2} k_B T$

$k = 1.38 \cdot 10^{-23} \text{ J K}^{-1}$ (constante van Boltzmann = R/N_A)

Gassen

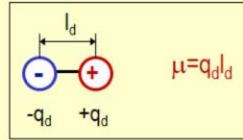
reële gassen

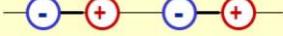
Compressibiliteit $Z = \frac{pV}{RT}$

condensatie

Gassen

dipool-dipool interacties


 $\mu = q_d l_d$



$V_{\text{ext}} \propto \mu_1 \mu_2 r^{-3}$
 $V_{\text{tot}} \propto \mu_1^2 \mu_2^2 r^{-6}$

2 kJ mol⁻¹
 0.3 kJ mol⁻¹

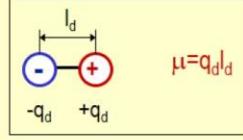
HCl, CO, CH₃Cl

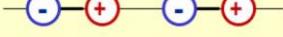
	Dipoolmoment Waterstofhalogeniden (Debye)
HF	1.91
HCl	1.03
HBr	0.80
HI	0.44

1D(debye)=3.336 10⁻³⁰ Cm ($\approx 0.1\text{e}$ gescheiden over 0.2 nm)

Gassen

dipool-dipool interacties

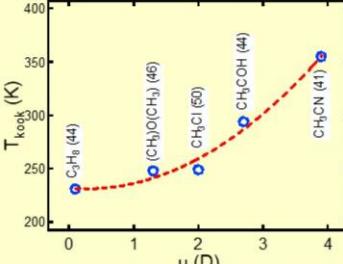

 $\mu = q_d l_d$



$V_{\text{ext}} \propto \mu_1 \mu_2 r^{-3}$
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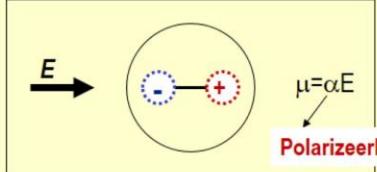
2 kJ mol⁻¹
 0.3 kJ mol⁻¹

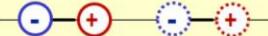
HCl, CO, CH₃Cl


1D(debye)=3.336 10⁻³⁰ Cm ($\approx 0.1\text{e}$ gescheiden over 0.2 nm)

Gassen

geïnduceerde dipoolinteracties

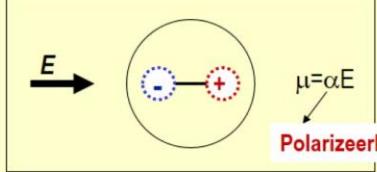


dipool-geïnduceerde dipool	London	
		
$V \propto \mu_1^2 \alpha_2 r^{-6}$	$V \propto \alpha_1 \alpha_2 r^{-6}$	
<1 kJ mol ⁻¹	2-20 kJ mol ⁻¹	
He, CH ₄ , O ₂		

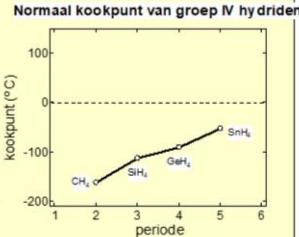
Polarizeerbaarheidsvolume (Å ³)	
He	0.21
Ne	0.39
Ar	1.63
Kr	2.48
Xe	4.01
HF	0.51
HCl	2.63
HBr	3.61
HI	5.42

Gassen

geïnduceerde dipoolinteracties



dipool-geïnduceerde dipool	London	
		
$V \propto \mu_1^2 \alpha_2 r^{-6}$	$V \propto \alpha_1 \alpha_2 r^{-6}$	
<1 kJ mol ⁻¹	2-20 kJ mol ⁻¹	
He, CH ₄ , O ₂		



Normaal kookpunt van groep IV hydiden

kookpunt (°C)

periode

Gassen

de waterstofbinding

Normaal kookpunt van groep IV tot VII hydiden

waterstofbrug

- ✓ gebaseerd op orbitaaloverlap
- ✓ A en B = N, O of F
- ✓ contactinteractie (kort bereik)
- ✓ 20 kJ mol^{-1}

Voorbeeld: H_2O

20 kJ mol^{-1}
 460 kJ mol^{-1}

Gassen

moleculaire interacties

afstoting $\propto r^{-12}$

aantrekking $\propto r^{-6}$

- elektrostatisch
- Pauli-principe

- elektrostatisch

Lennard-Jones potentiaal $V(r) = 4\epsilon \left[\left(\frac{r_0}{r} \right)^{12} - \left(\frac{r_0}{r} \right)^6 \right]$