Curs 5

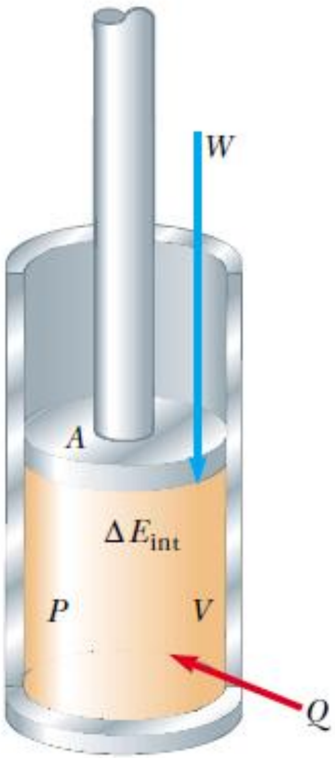
Legile gazului ideal

Ecuatia de stare a gazului ideal

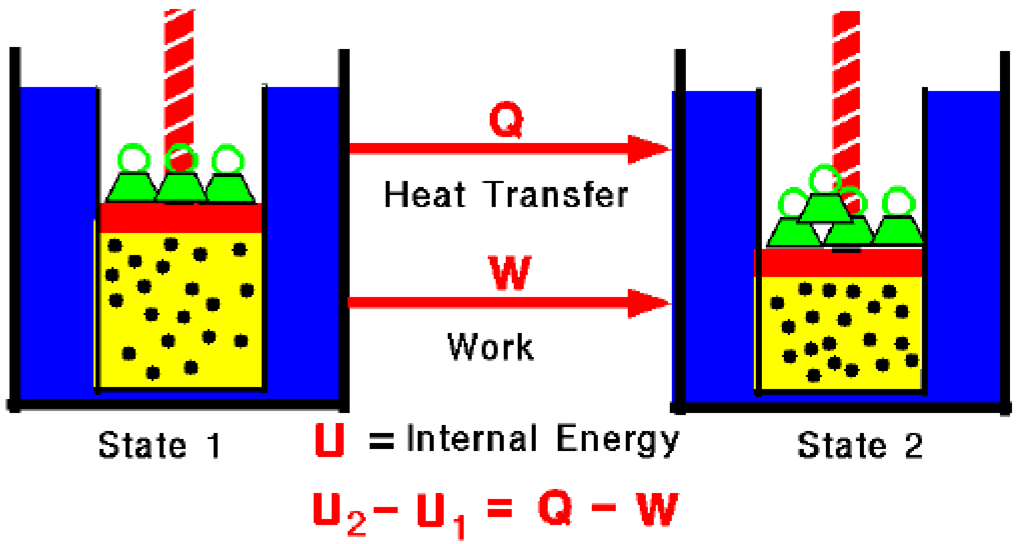
Teoria cinetico-moleculara

Gazul Van der Waals

Lucrul mecanic şi căldura nu depind doar de starea inițială şi finală ci depind de drumul parcurs de sistem…



Dar $\Delta U = Q - W$ nu depinde de proces

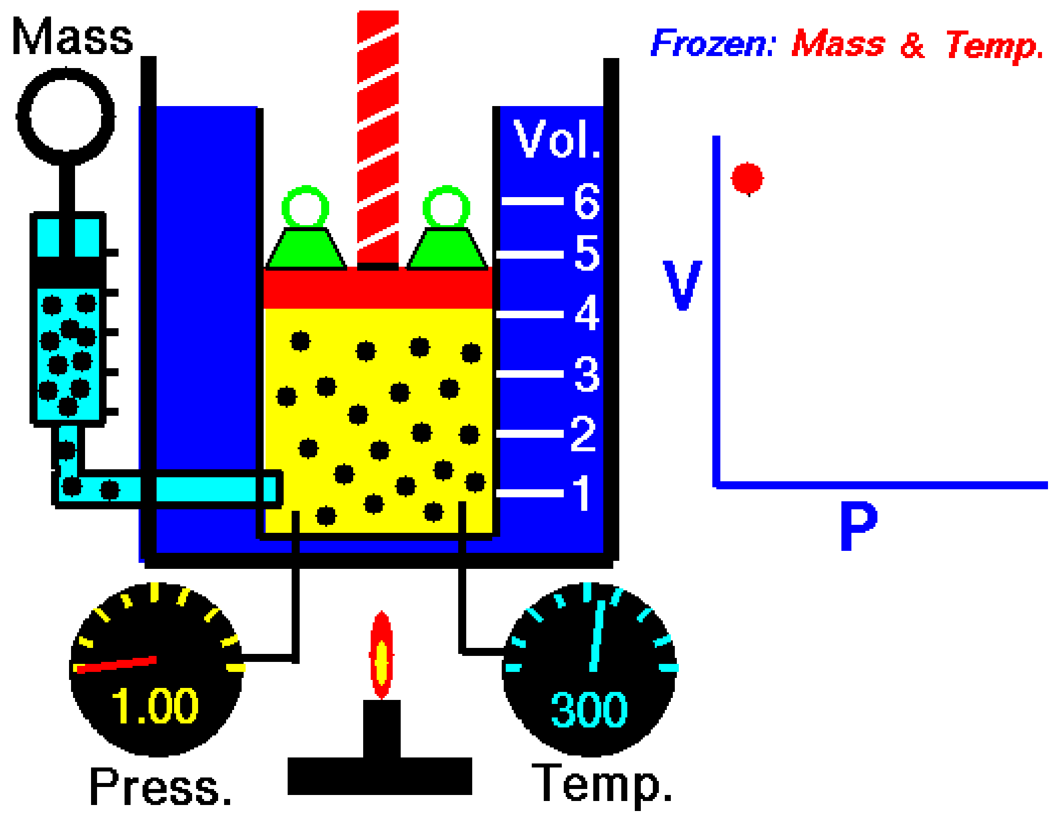


Variația energiei interne a unui sistem este egală cu diferența dintre căldura primită şi lucrul mecanic efectuat de sistem

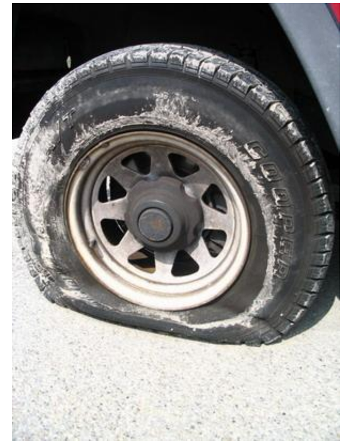
Procese termodinamice simple

Procesul izoterm – legea lui Boyle; T = cst. ⇒ pV = cst.

Robert Boyle (1627-1691)

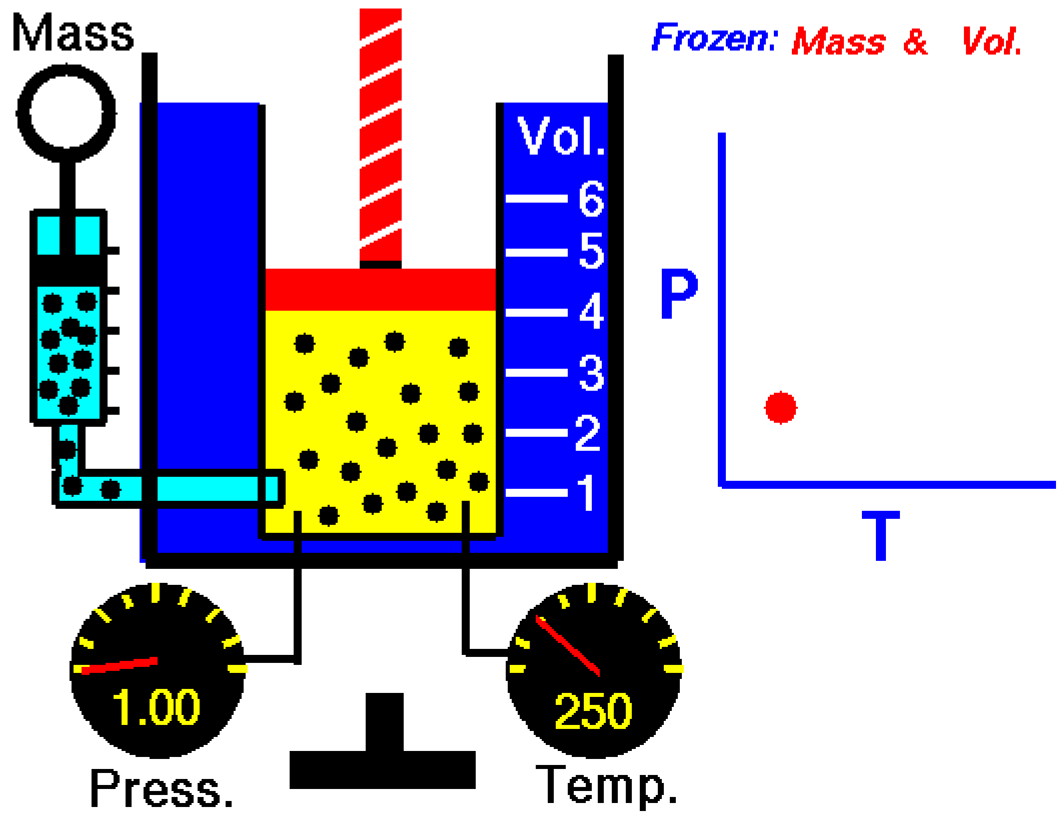


Procese termodinamice simple

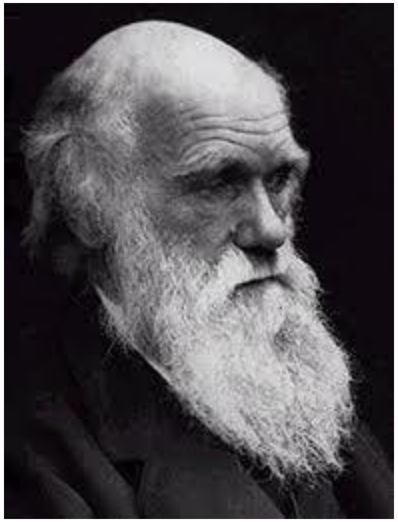


Procesul izocor – legea Gay-Lussac; V = cst. ⟹ p/T = cst.

Joseph Louis Gay-Lussac
(1788-1850)



Charles Darwin



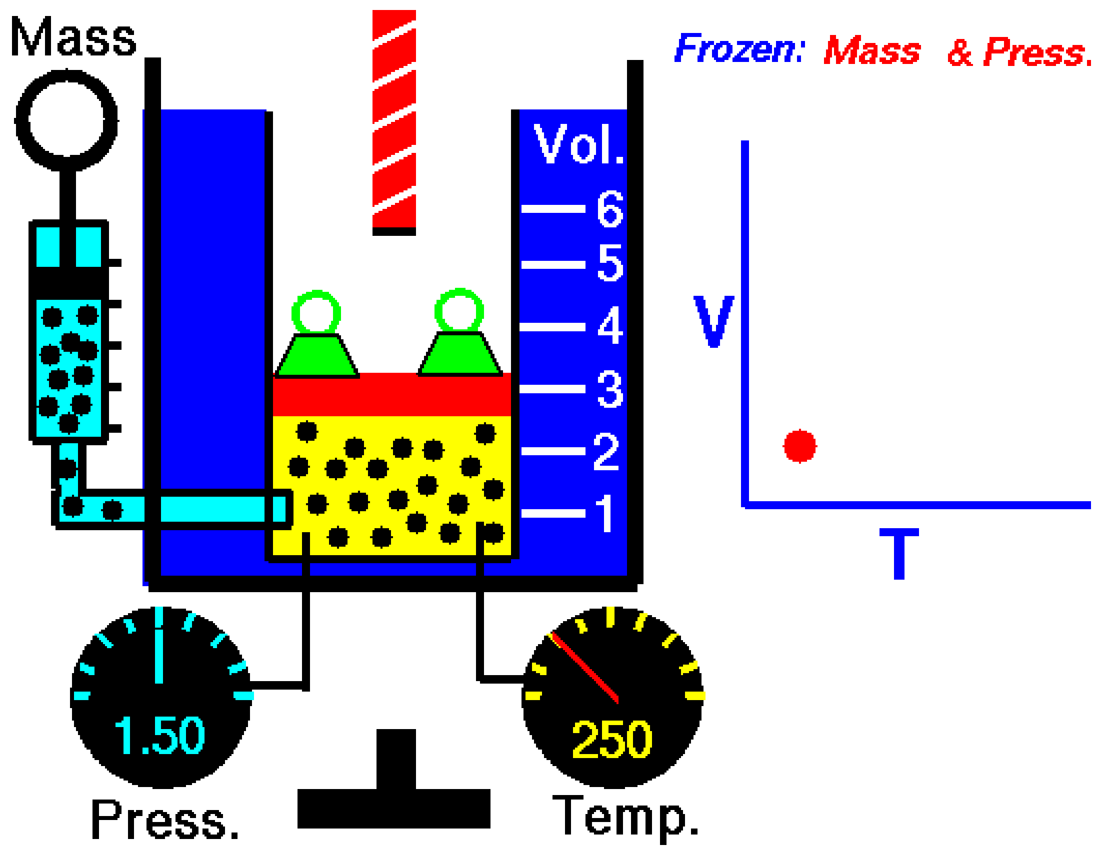
$$pV = \nu RT$$

"…the potatoes, after remaining for some hours in the boiling water, were nearly as hard as ever" (Charles Darwin – Voyage of the Beagle)

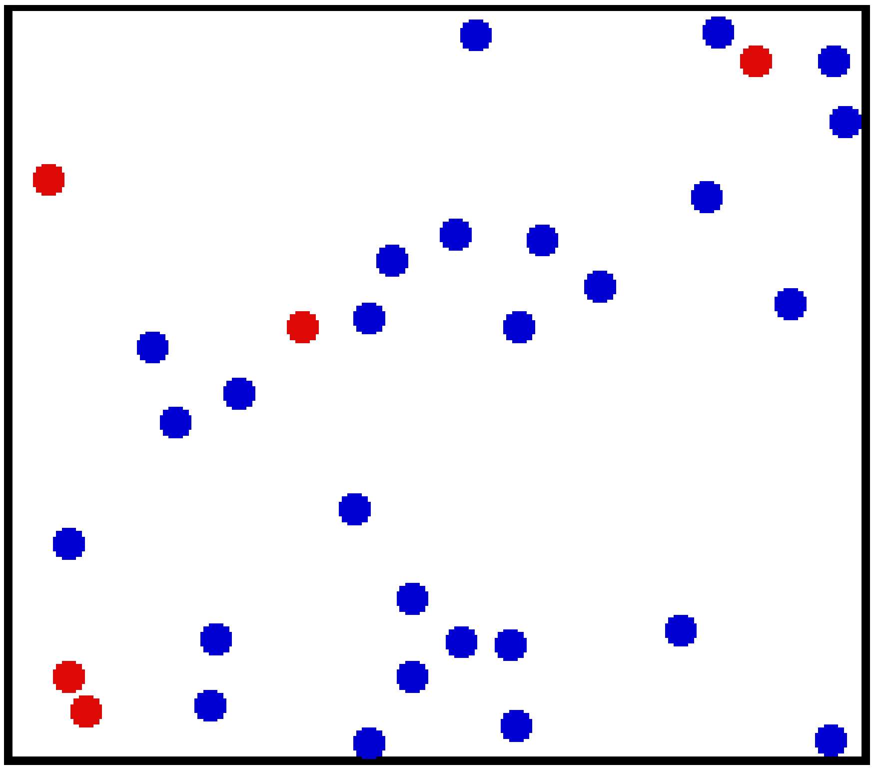
Procese termodinamice simple

Procesul izobar – legea Charles; p = cst. ⟹ V/T = cst.

Jacques Charles (1746-1823)



Teoria cinetico-moleculară

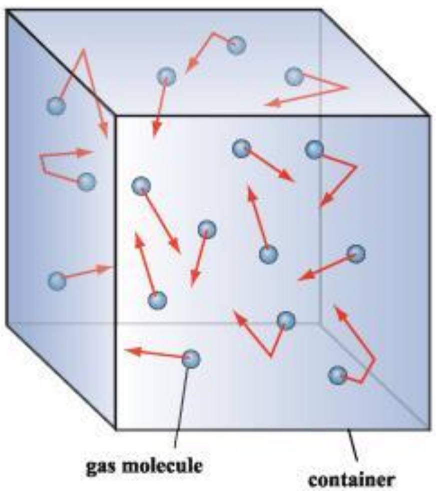


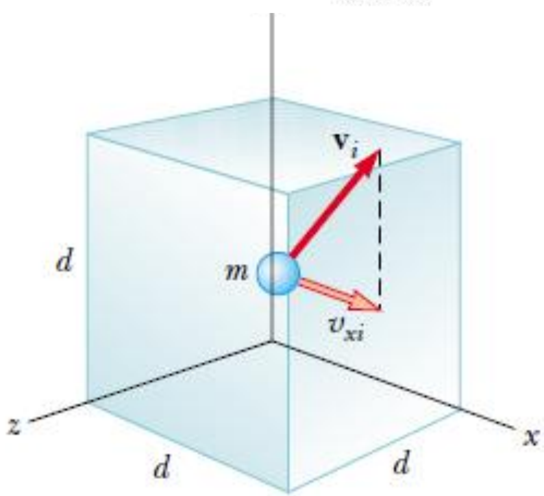
1. Gazul este alcatuit dintr-un numar foarte mare de molecule identice; acestea se afla in miscare continua de agitatie termica, cu viteze diferite orientate in directii diferite

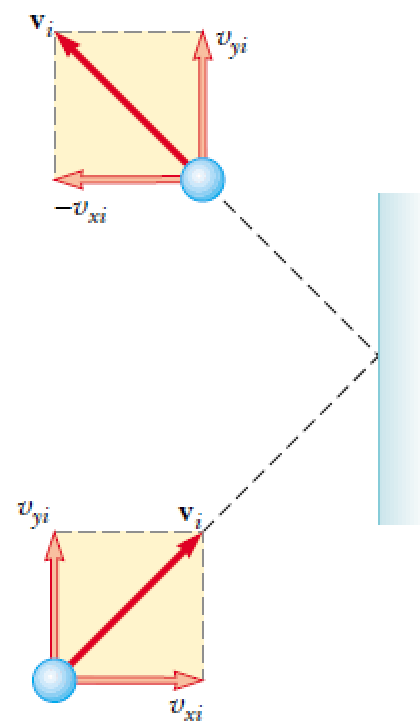
2. Moleculele gazului se afla la distante foarte mari intre ele in raport cu dimensiunile moleculare; moleculele pot fi considerate puncte materiale; ele nu interactioneaza intre ele si cu peretele decat prin ciocniri elastice

3. Moleculele respecta legile mecanicii newtoniene

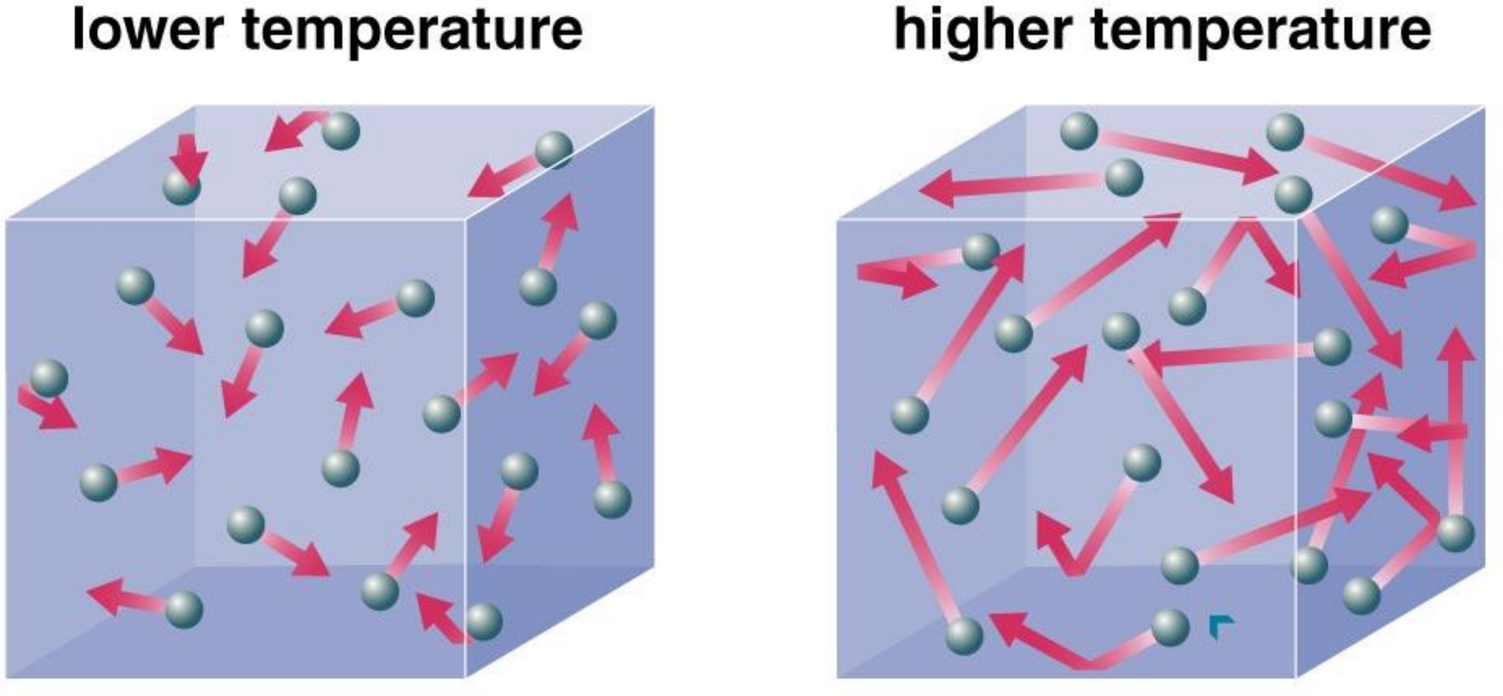
Teoria cinetico-moleculară







Temperatura – măsură a mişcării moleculare



Viteze patratice medii ale gazelor

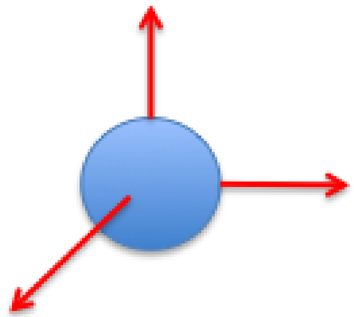
Some rms Speeds

Gas	Molar mass (g/mol)	v_{rms} at 20°C(m/s)
H_2	2.02	1 902
He	4.00	1 352
H_2O	18.0	637
Ne	20.2	602
N_2 or CO	28.0	511
NO	30.0	494
O_2	32.0	478
CO_2	44.0	408
SO_2	64.1	338

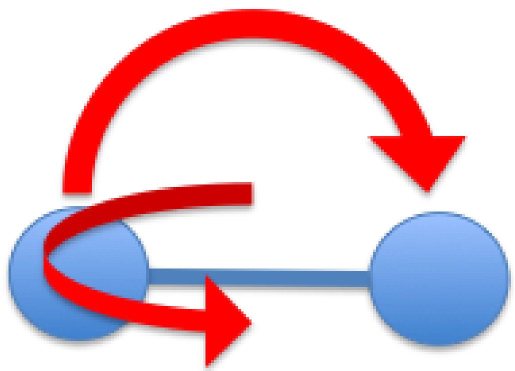
Calduri specifice molare ale gazelor

Molar Specific Heats of Various Gases

	Molar Specific Heat (J/mol · K)[a]			
Gas	C_P	C_V	$C_P - C_V$	$\gamma = C_P/C_V$
Monatomic Gases				
He	20.8	12.5	8.33	1.67
Ar	20.8	12.5	8.33	1.67
Ne	20.8	12.7	8.12	1.64
Kr	20.8	12.3	8.49	1.69
Diatomic Gases				
H_2	28.8	20.4	8.33	1.41
N_2	29.1	20.8	8.33	1.40
O_2	29.4	21.1	8.33	1.40
CO	29.3	21.0	8.33	1.40
Cl_2	34.7	25.7	8.96	1.35
Polyatomic Gases				
CO_2	37.0	28.5	8.50	1.30
SO_2	40.4	31.4	9.00	1.29
H_2O	35.4	27.0	8.37	1.30
CH_4	35.5	27.1	8.41	1.31

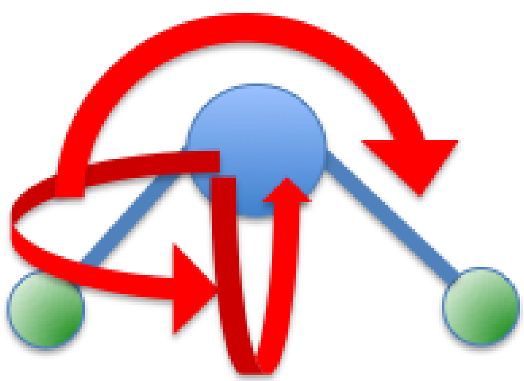


3 degrees of translational freedom



3 degrees of translational freedom

2 rotational degrees of freedom

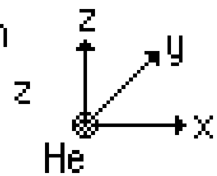


3 degrees of translational freedom

3 rotational degrees of freedom

Degrees of freedom

3

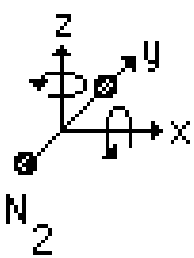


Monoatomic

$$C_v = \frac{3}{2}R = 12.5 \frac{J}{mol\ K}$$

Helium	12.5
Argon	12.6

5

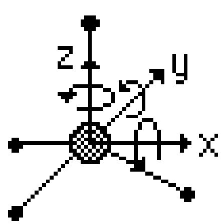


Diatomic

$$C_v = \frac{5}{2}R = 20.8 \frac{J}{mol\ K}$$

Nitrogen (N_2)	20.7
Oxygen (O_2)	20.8

6

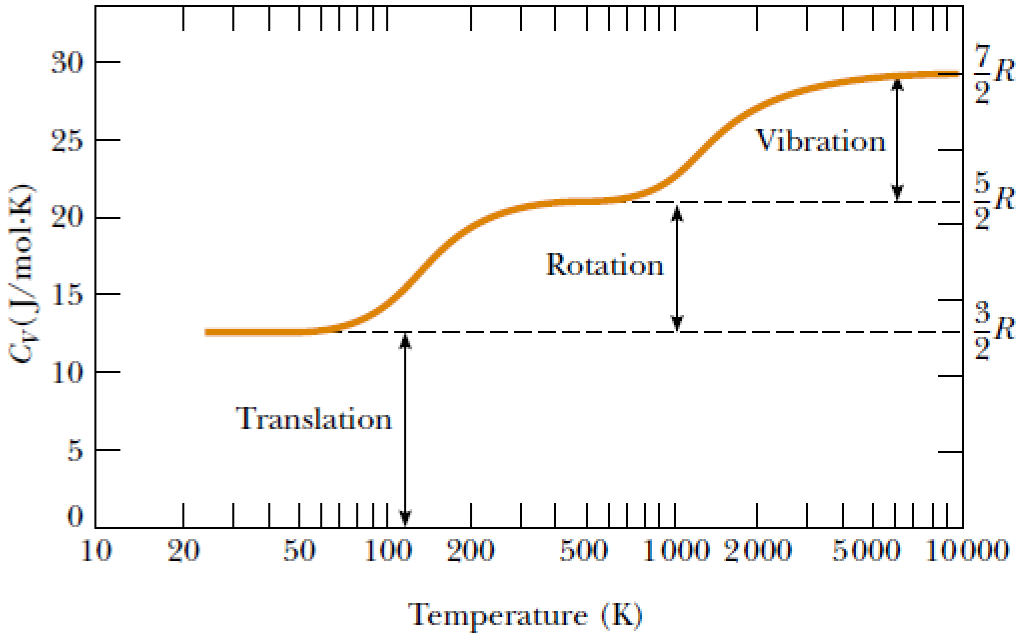


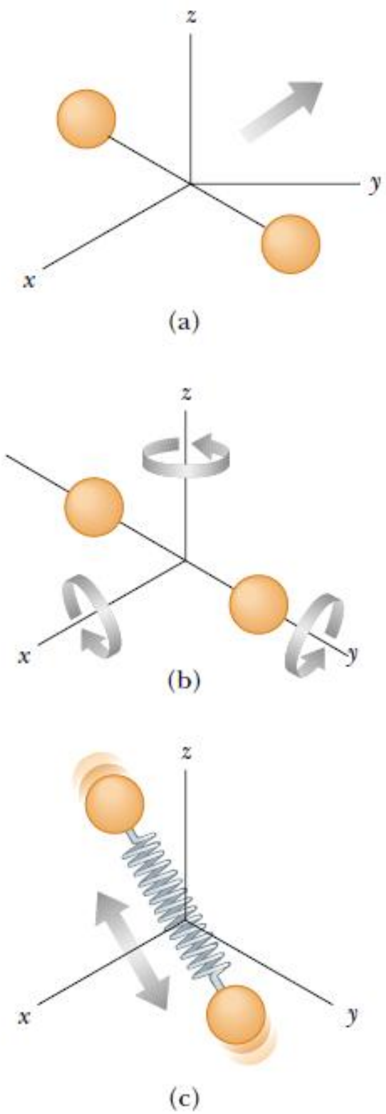
Polyatomic

$$C_v = \frac{6}{2}R = 24.9 \frac{J}{mol\ K}$$

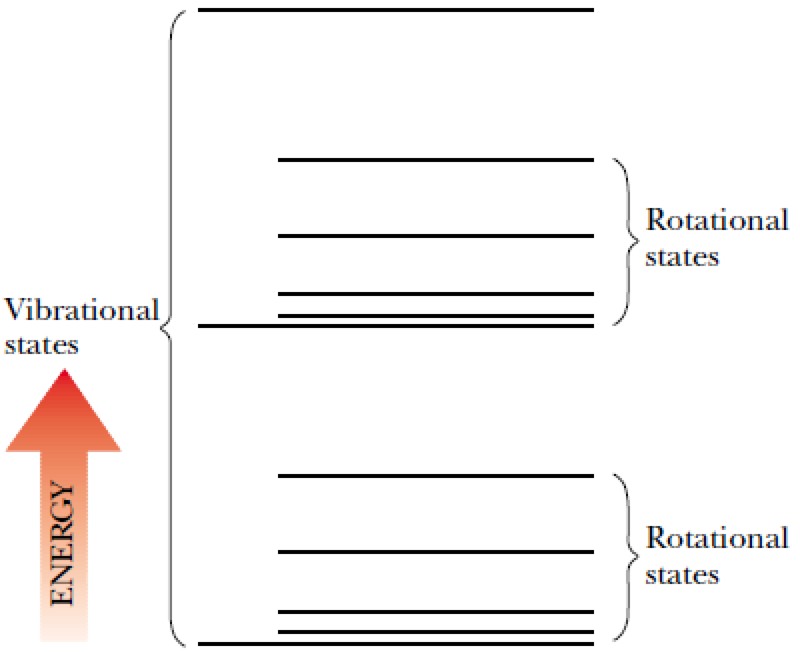
Ammonia (NH_4)	29.0
Carbon dioxide (CO_2)	29.7

Caldura specifică molară la volum constant a unui gaz real biatomic



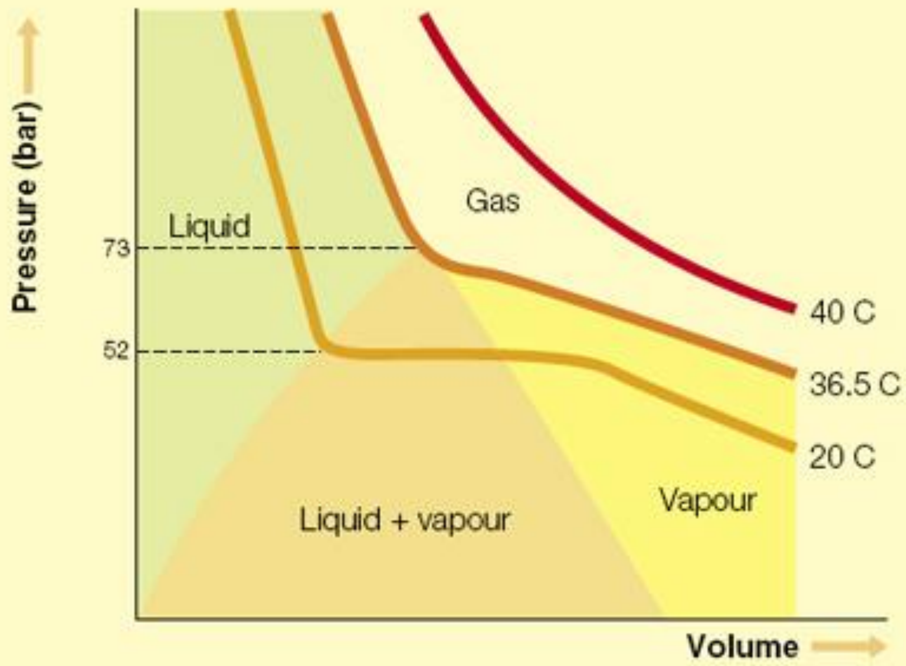


Explicatia cuantica a dependentei Cv de temperatura



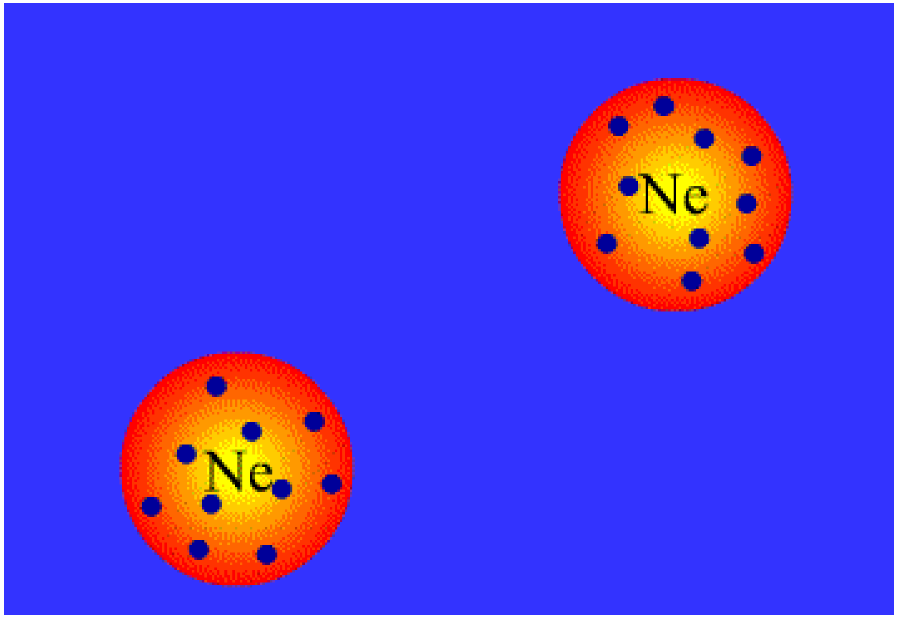
Izoterma gazelor reale

Isotherms of nitrous oxide

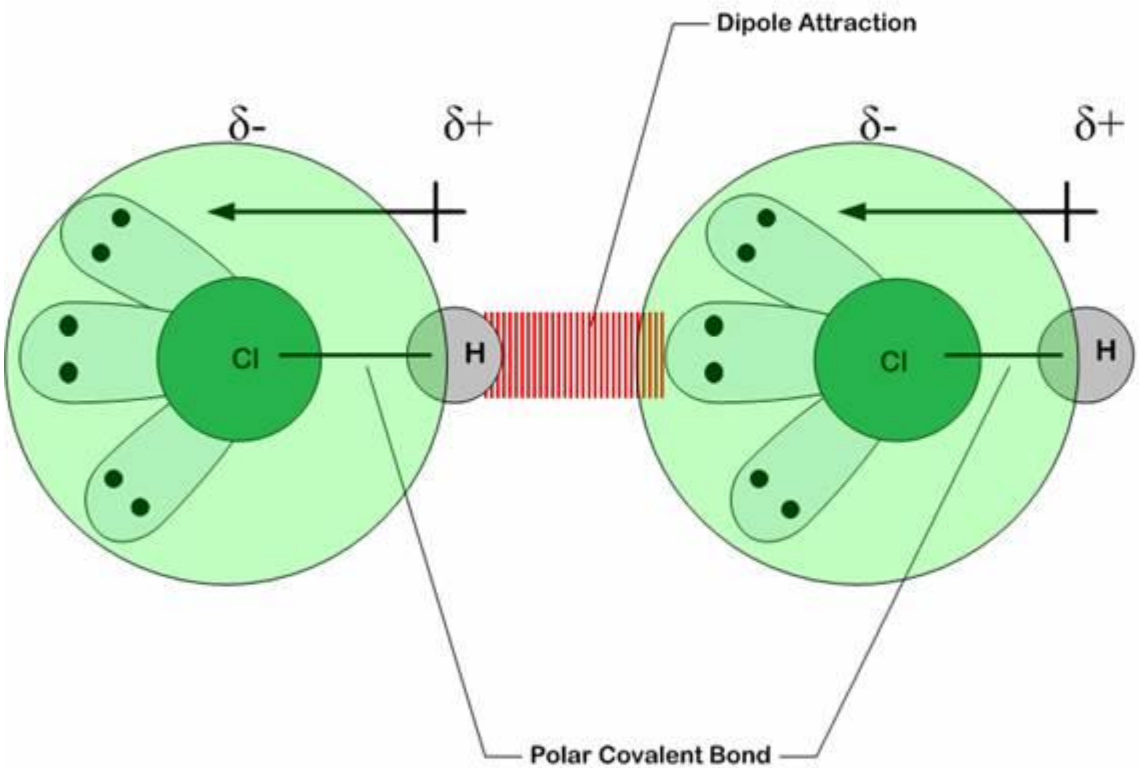


The isotherm at 40 C is above the critical temperature of nitrous oxide (36.5 C) and threfore obeys Boyle's law. As the volume decreases the pressure rises. At the critical temperature 36.5 C there is a critical pressure at which nitrous oxide becomes a liquid. Liquids are relatively incompressible and therefore a decrease in volume leads to a dramatic rise in pressure. At 20 C as the nitrous oxide is compressed some of it liquefies at a pressure of 52 bar (saturated vapour pressure of nitrous oxide). Further reduction in volume causes more vapour to condense with no change in pressure. When all the vapour is condensed to liquid a rapid rise in pressure is seen with further decrease in volume.

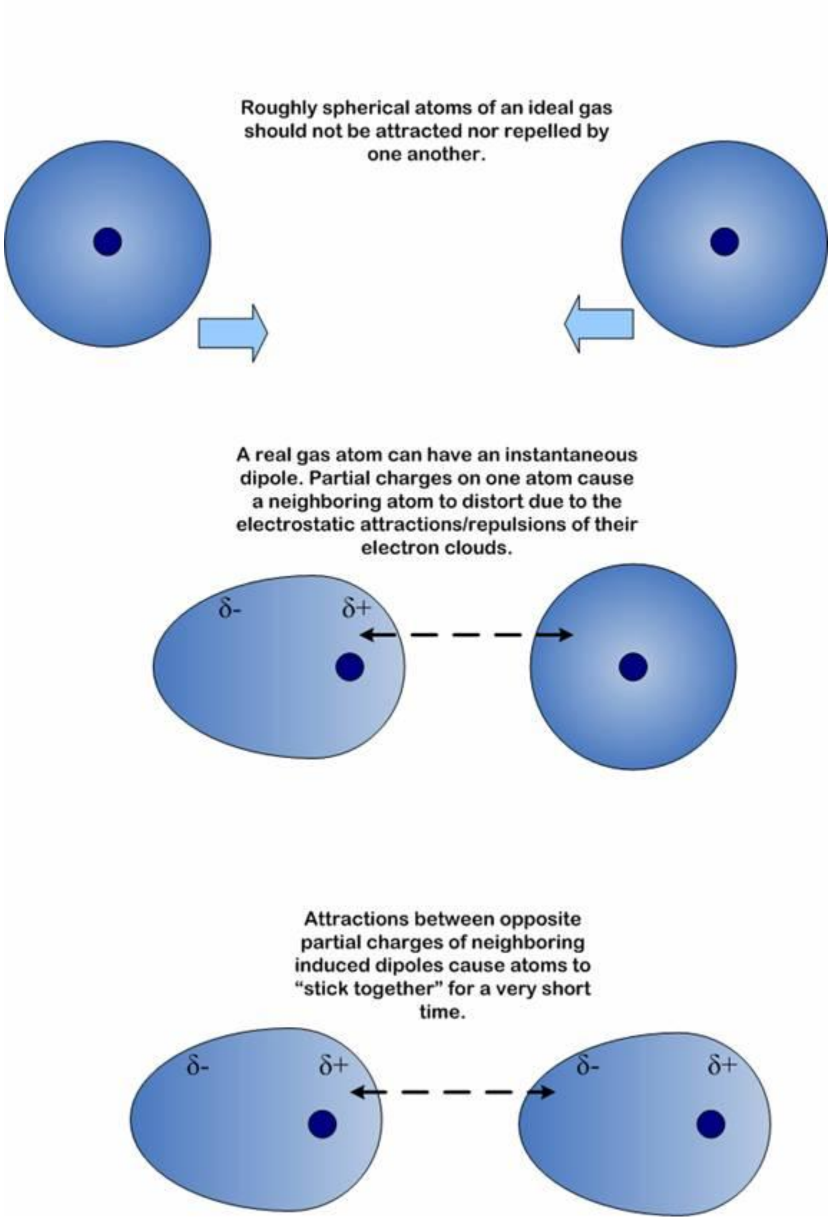
Interacții între particule - Forțe van der Waals



Interactiunea dipol - dipol



Interactiunea dipol indus – dipol indus



Gazul van der Waals