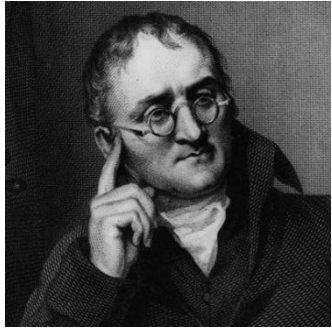


Termodinamica

1. Structura materiei. Stari de agregare
2. Echilibru termic. Temperatura
3. Energie. Lucru mecanic. Caldura
4. Principiul I al termodinamicii
5. Gazul ideal

Materia este alcatuita din atomi - Democrit

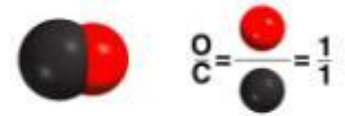
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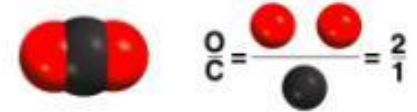
John Dalton (1803) – legea
proportiilor multiple

100g carbon se combina fie
cu 133 g fie cu 266 g oxigen

Carbon monoxide

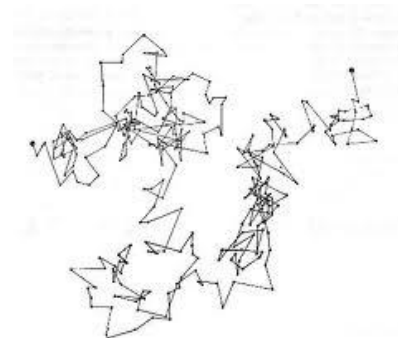
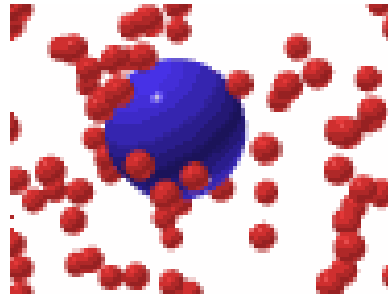


Carbon dioxide



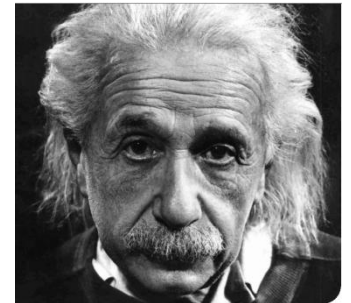
Ratio of oxygen in
carbon monoxide to
oxygen in carbon dioxide: 1:2

-prima dovada consistenta in sprijinul teoriei atomice – miscarea Browniana



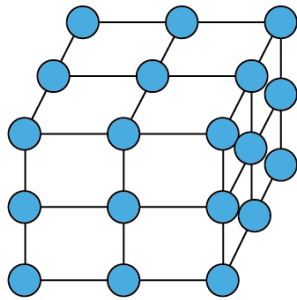
Robert Brown (1872)

Albert Einstein (1905) explicarea teoretica a miscarii
termice – a calculat dimensiunea atomilor (10^{-10}m)

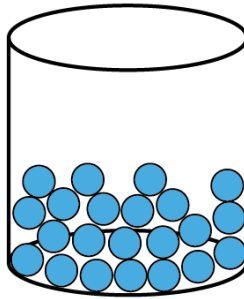


States of Matter

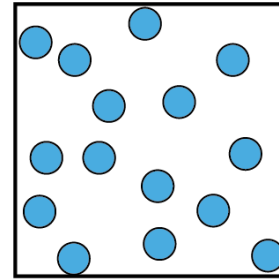
● = atom
⊕ = nucleus
⊖ = electron



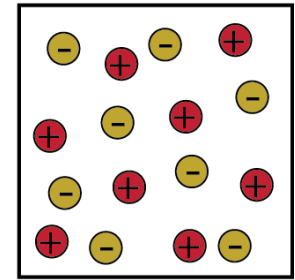
Solid



Liquid

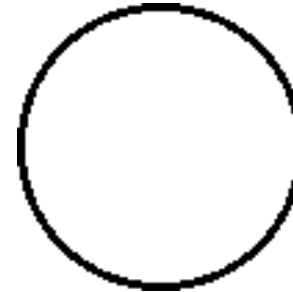
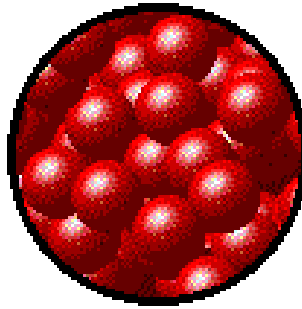
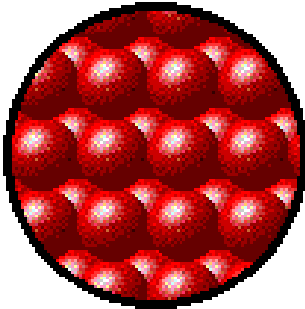


Gas



Plasma

—————→
Add **Heat**



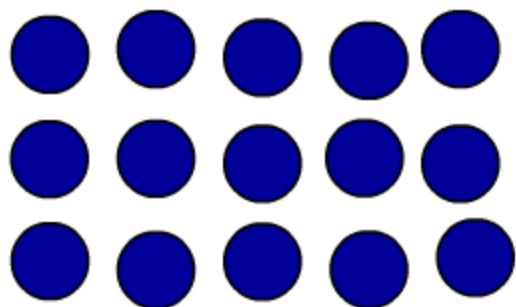
Solid – volum si forma fixe; incompresibil;

Lichid – volum fix; ia forma vasului; incompresibil;

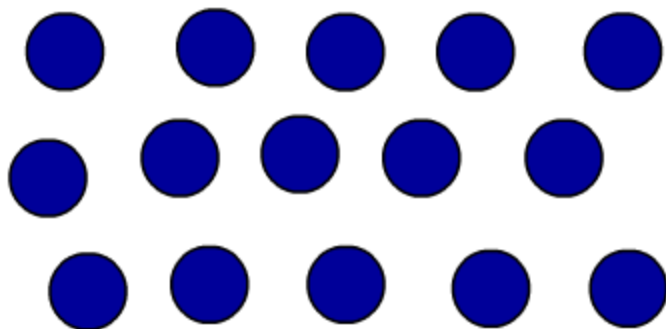
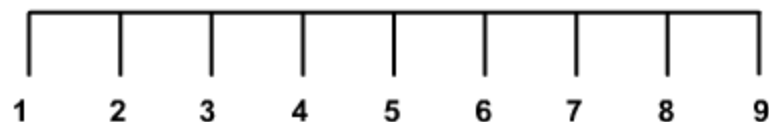
Gaz – forma si volumul vasului; compresibil

Transfer de caldura – convecție, conducție și radiație





Low temperature - particles move less & take up less space.



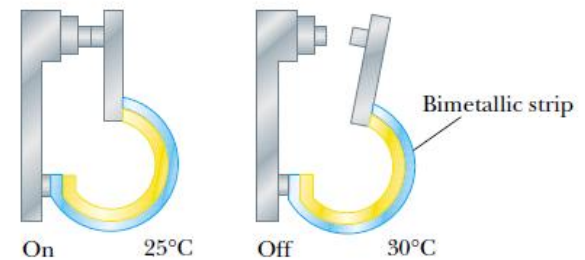
High temperature - particles move more & take up more space.

Dilatatia termica a solidelor

$$\Delta L = \alpha L \Delta T$$

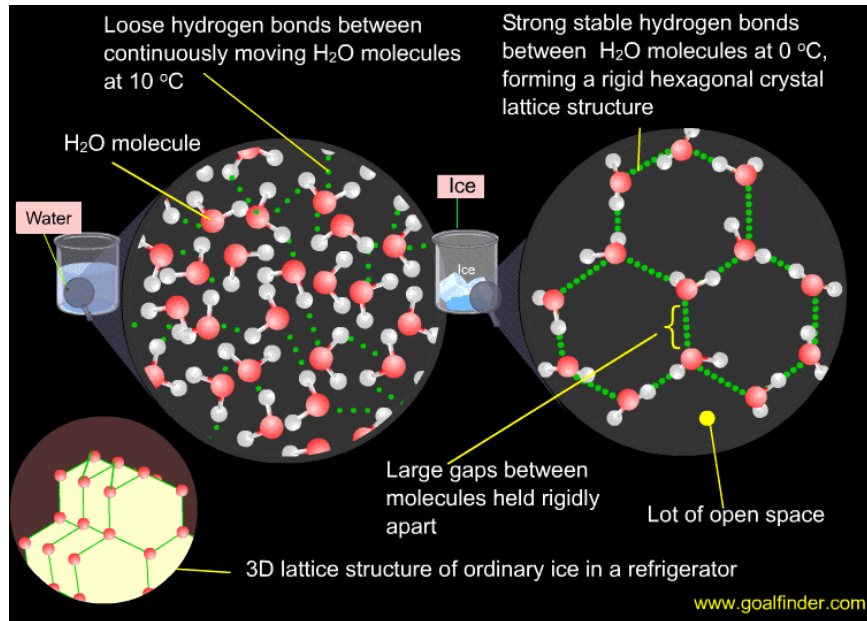


(a)

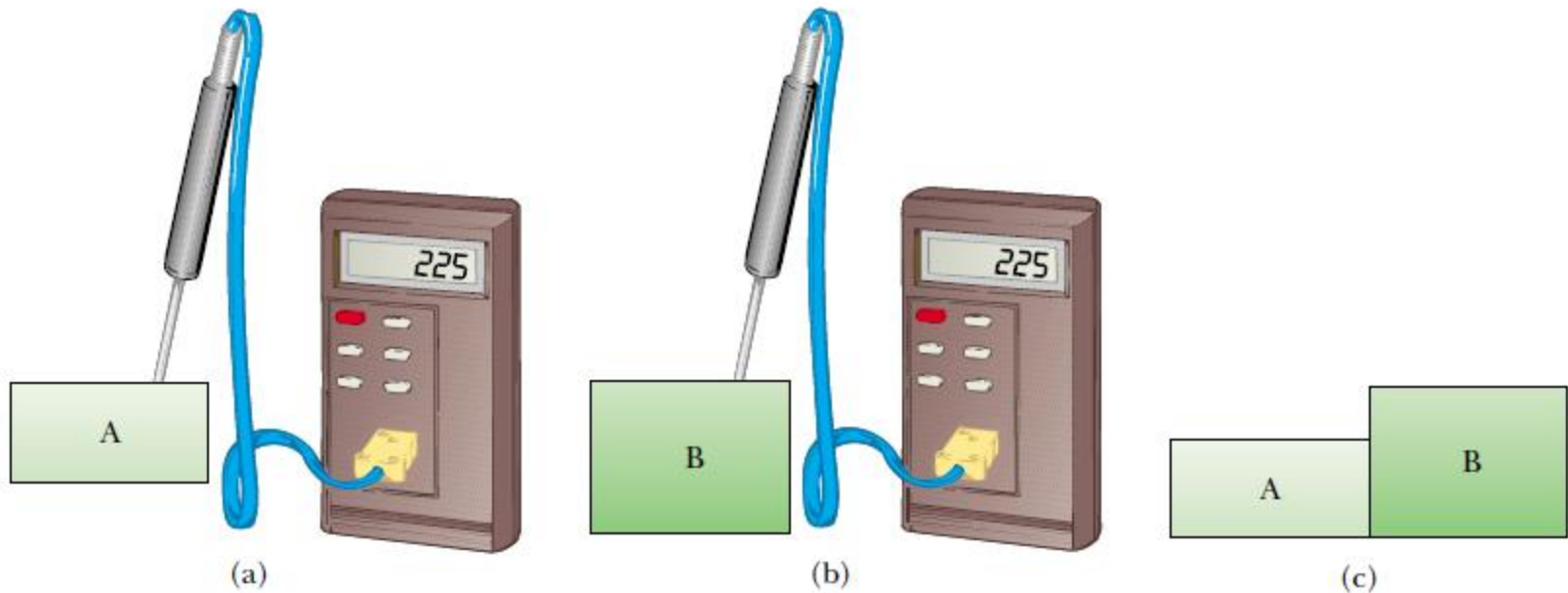


(b)

Densitatea apei scade la solidificare – anomalia apei



Principiul “0” al termodinamicii

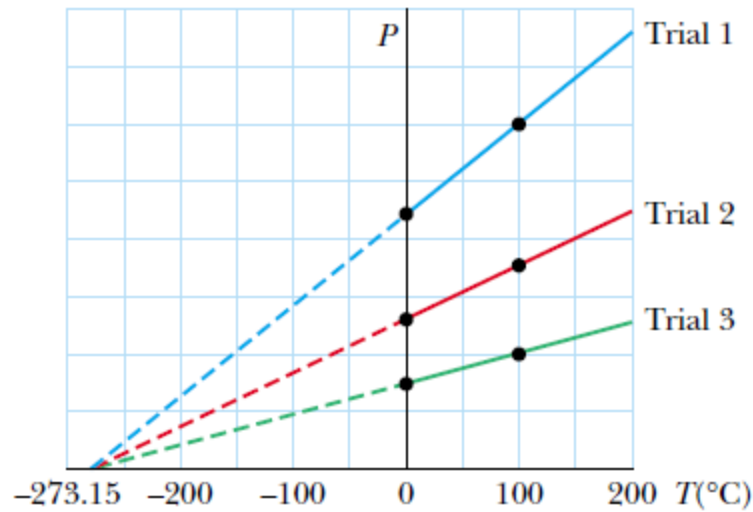
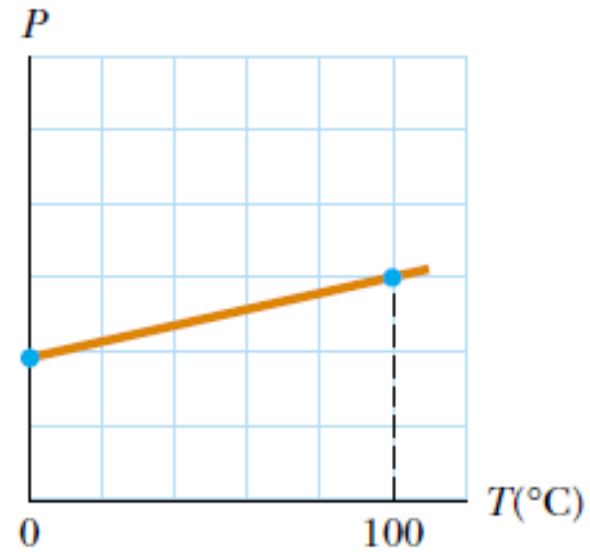
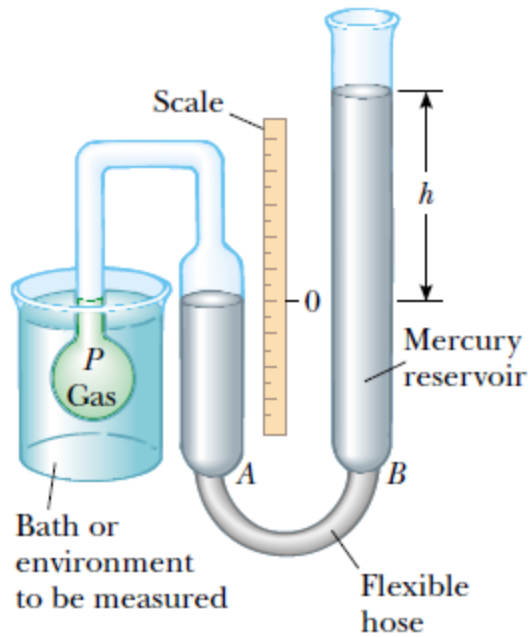


-doua corpuri sunt in echilibru termic daca nu schimba energie sub forma de caldura atunci cand sunt puse in contact

Temperatura – proprietate a unui sistem care determina daca sistemul se afla in echilibru termic cu alte sisteme

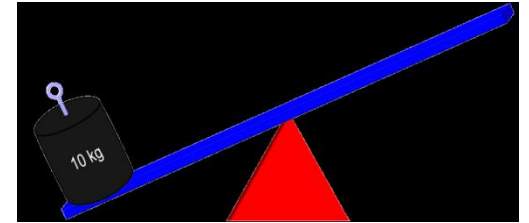
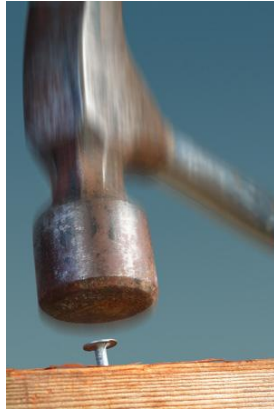
-doua obiecte aflate in echilibru termic au aceeasi temperatura

Masurarea temperaturii – scarile Celsius si Kelvin



$$t_{\text{C}} = T - 273,15$$

Energia



Energia descrie abilitatea unui sistem de a schimba starea altor sisteme cu care interacționează



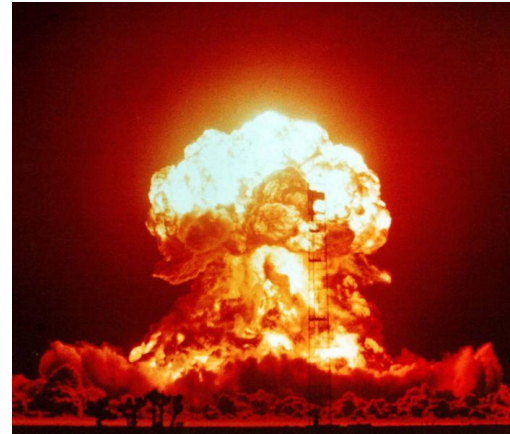
cinetica



electrica



potentia
gravitatională



nucleară

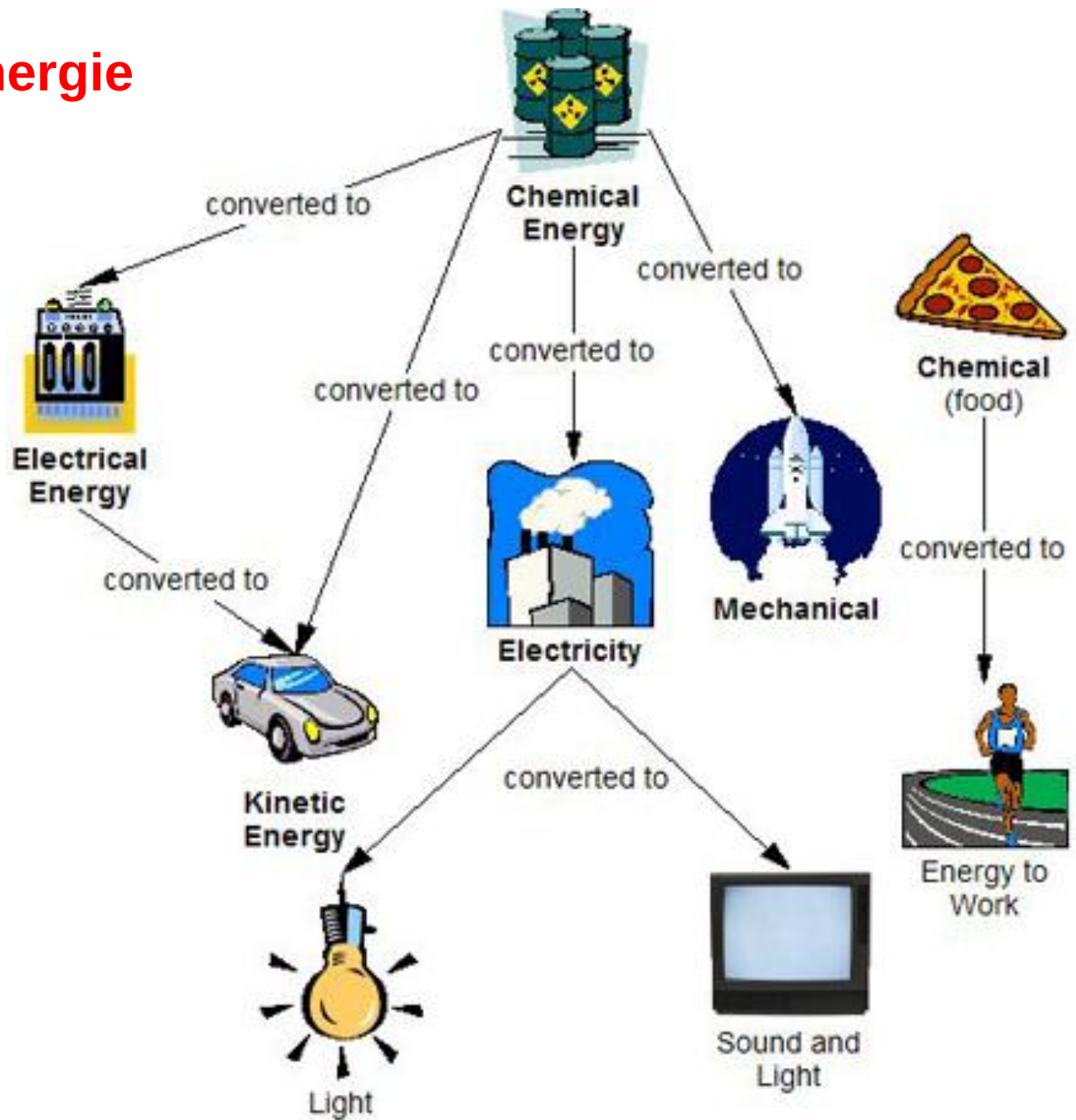


termică



chimică

Transferul de energie



Transfer de energie



Lucrul mecanic – forma de transfer de energie asociată cu deplasarea centrului de masă al sistemului (deplasarea sistemului ca întreg)

$$dW = p dV$$

Căldura – forma de transfer de energie asociată cu variația temperaturii sistemului

$$dQ = \nu C dT$$

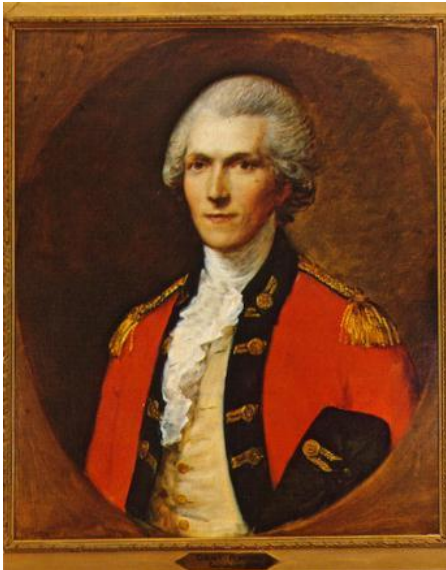
Lucrul mecanic și căldura nu sunt forme de energie, ci forme de transfer (schimb) de energie – nu sunt mărimi de stare ci **mărimi de proces**

Ce este căldura?

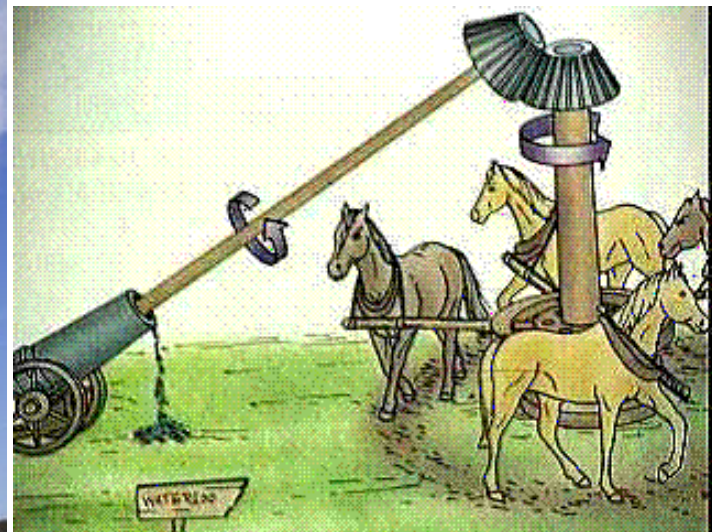


Antoine Lavoisier – teoria caloricului – fluid care este transferat între corpuri cu temperaturi diferite;

Caloric – fluid invizibil care trece de la corpurile calde la cele mai reci



-infirmată de către **Benjamin Thompson** (conte Rumford), pe baza observației experimentale că lucrul mecanic poate genera căldura



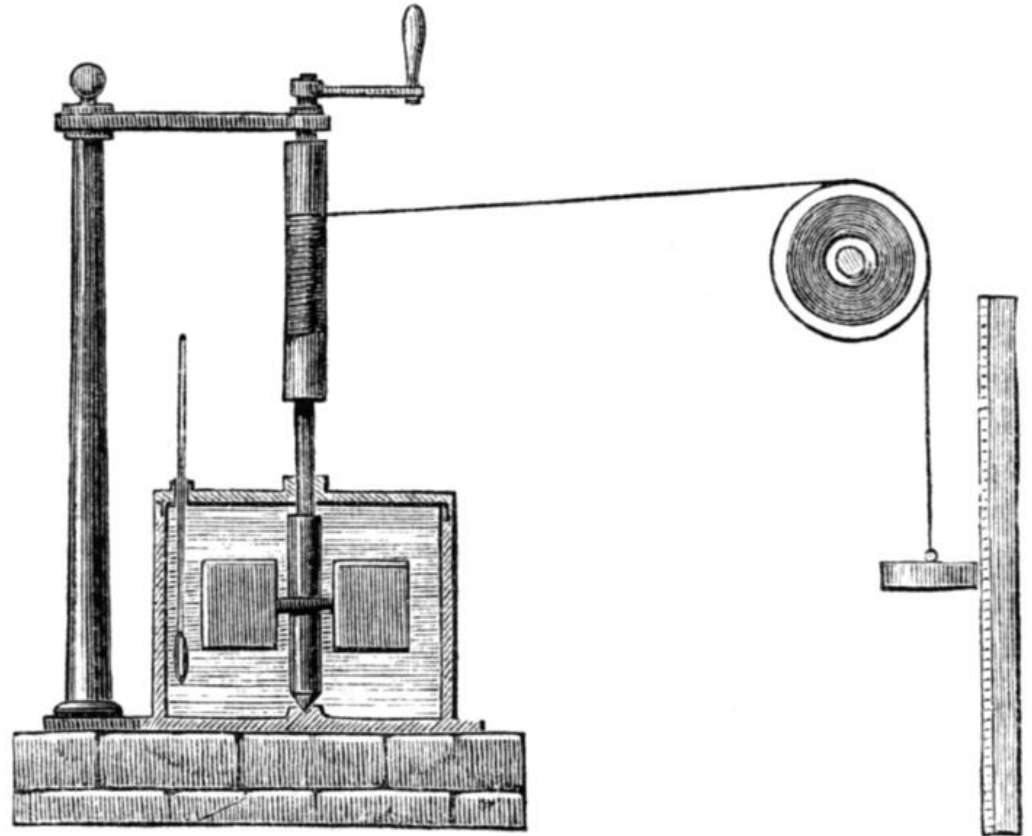
Căldura ca formă de transfer de energie – James Prescott Joule

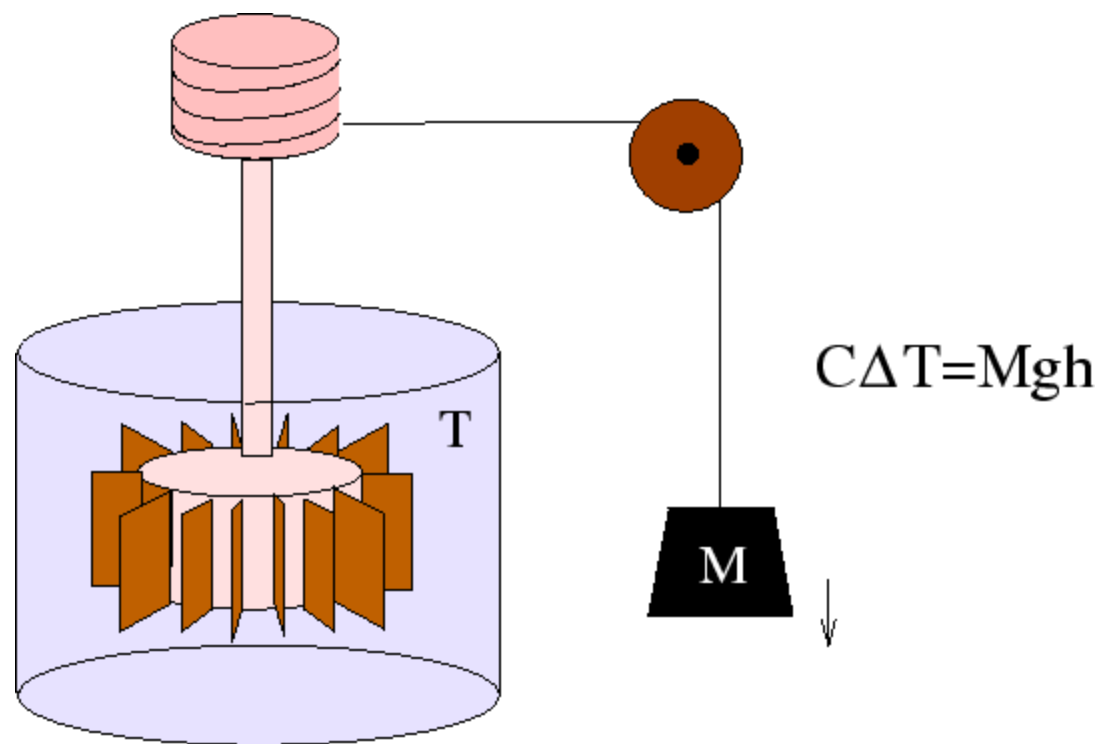


James Joule
(1818-1889)



Experimentul lui Joule – convertirea lucrului mecanic în căldura

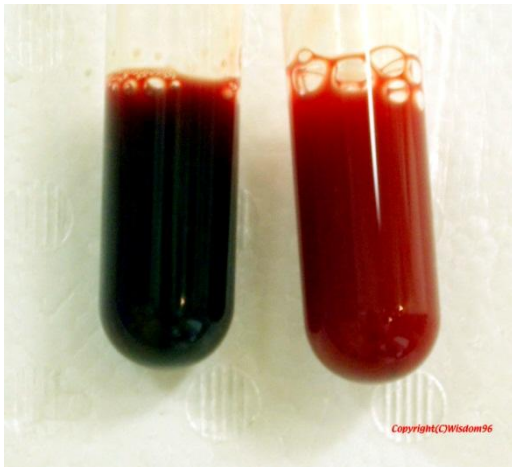




Primul principiu al termodinamicii – existența energiei interne

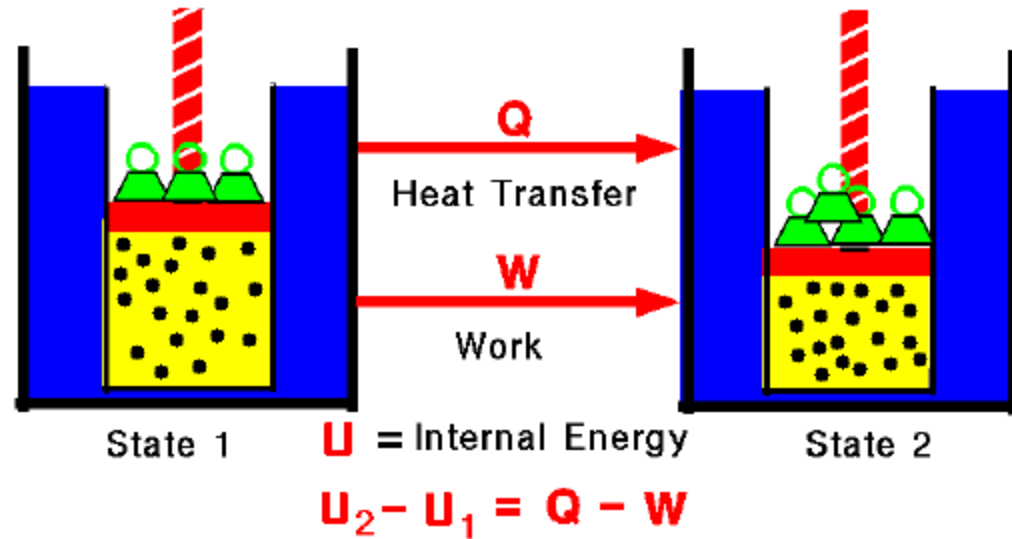
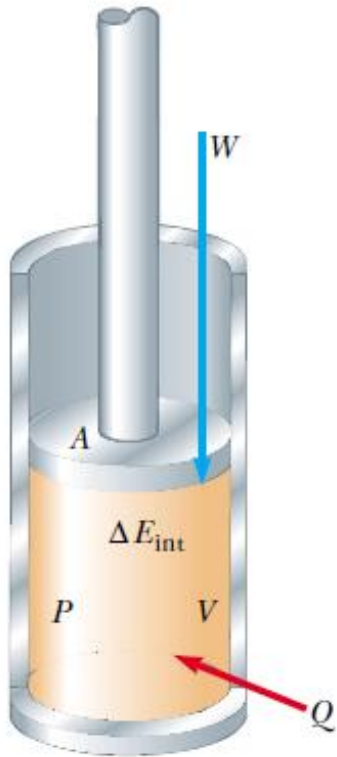


Julius Robert Mayer (1814-1878)



Lucrul mecanic și căldura nu depind doar de starea inițială și finală ci depind de drumul parcurs de sistem...

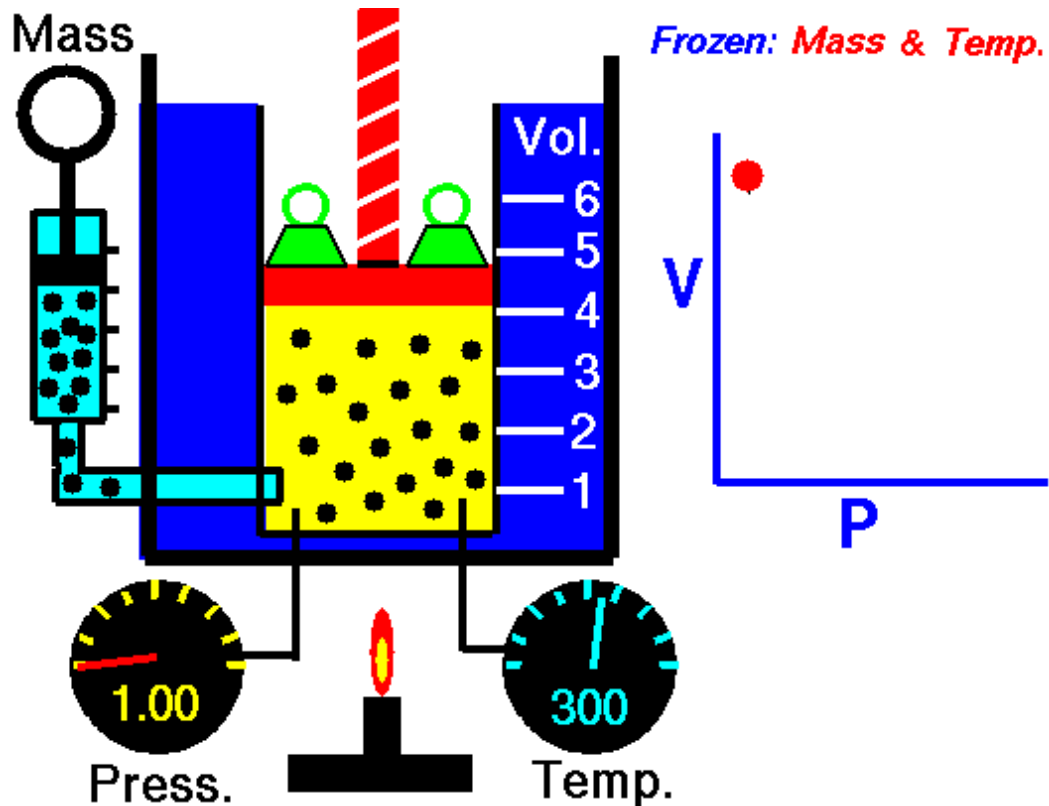
Dar $\Delta U = Q - W$ nu depinde de proces



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

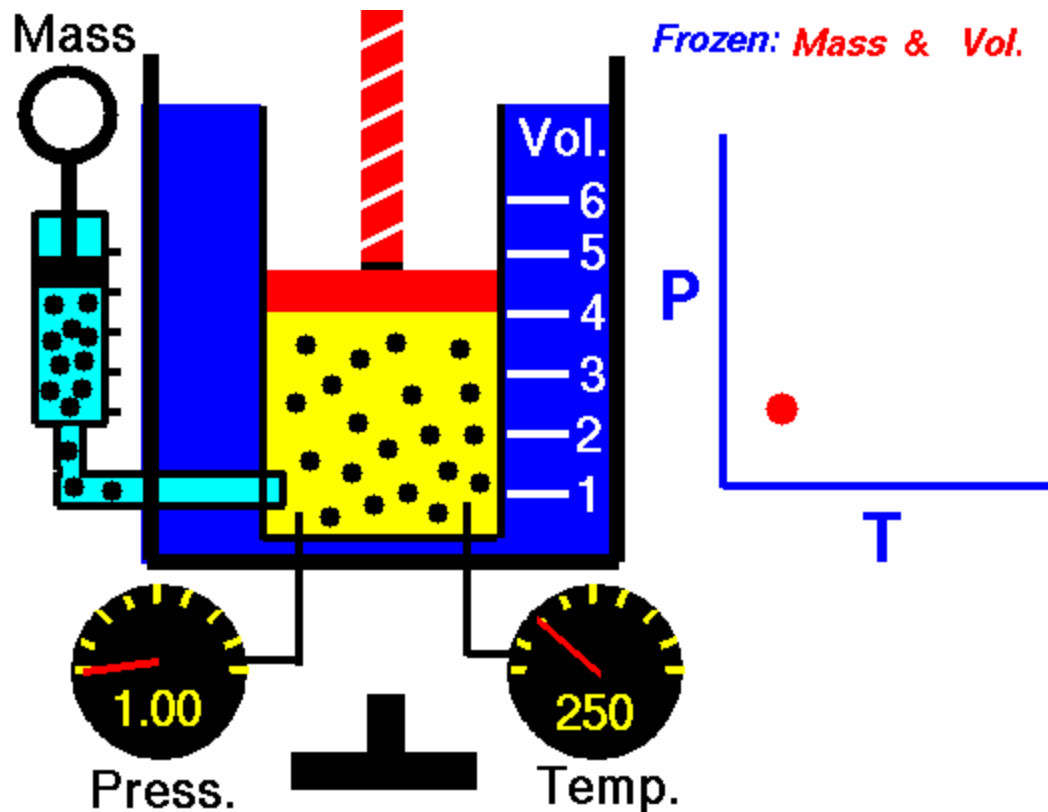
Procese termodinamice simple

Procesul izoterm – legea lui Boyle; $T = \text{cst.} \longrightarrow pV = \text{cst.}$



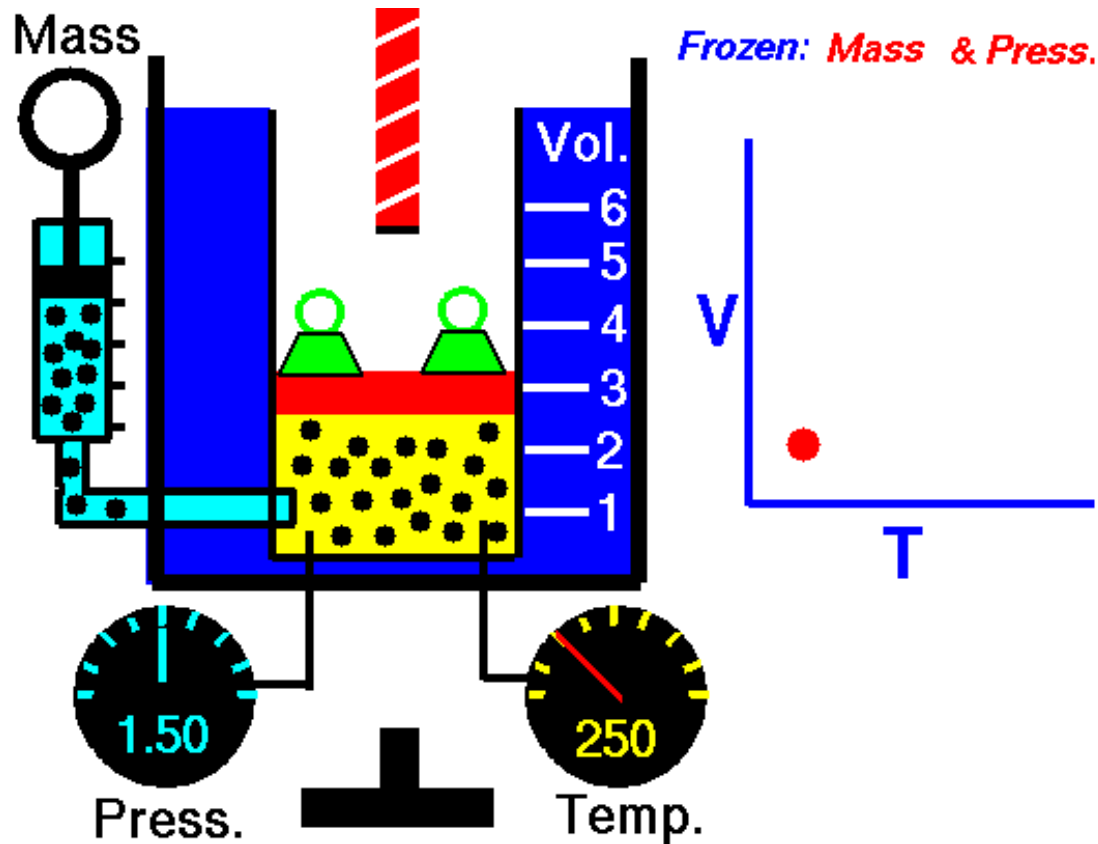
Procese termodinamice simple

Procesul izocor – legea Gay-Lussac; $V = \text{cst.} \longrightarrow p/T = \text{cst.}$

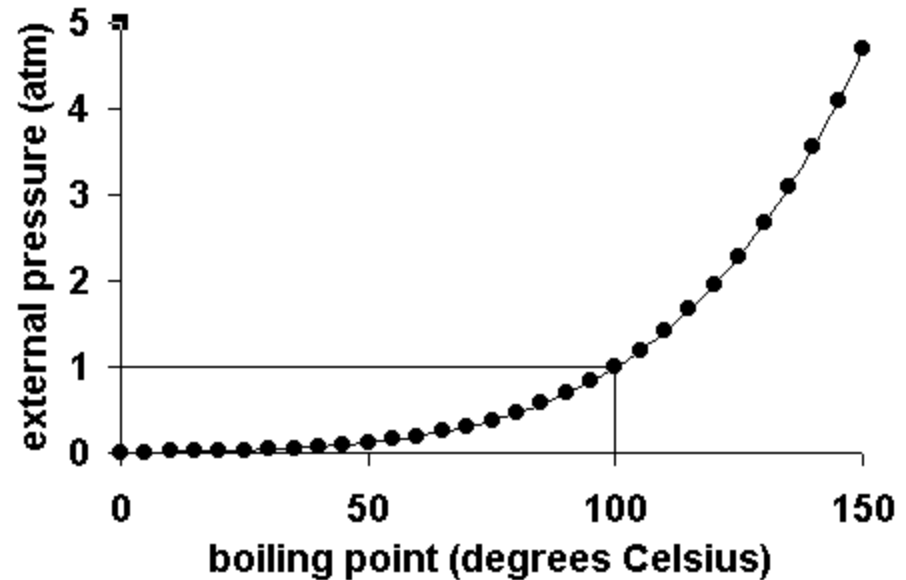
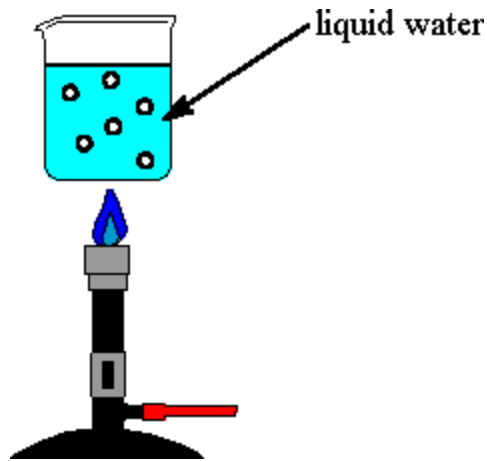


Procese termodinamice simple

Procesul izobar – legea Charles; $p = \text{cst.} \longrightarrow V/T = \text{cst.}$



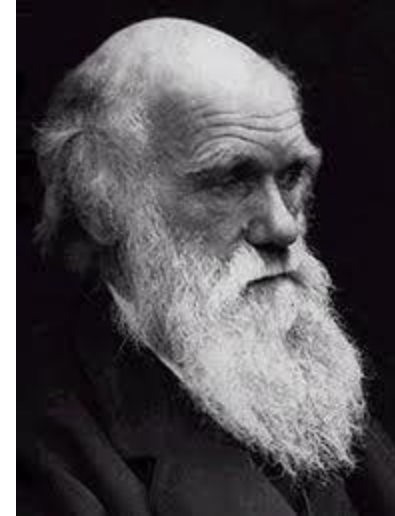
Fierberea



- cu cresterea temperaturii creste presiunea vaporilor ($PV = \nu RT$)
- cand $P_v = P_{atm}$ (la $t = 100\text{ }^{\circ}\text{C}$), bulele de gaz din lichid devin stabile si urca la suprafata lichidului
- daca presiunea atmosferica scade sub 760 torr, apa va fierbe la mai putin de $100\text{ }^{\circ}\text{C}$
- pe Everest (8850 m), $P = 235\text{ torr}$ (0,3 atm) – apa fierbe la $70\text{ }^{\circ}\text{C}$



Charles Darwin



$$pV = nRT$$



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