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Oct-Nov 2015

Statistical Thermodynamics

I. Introduction : Temperature of an Noble Gas

Further reading : Quanta, Matter and Change , Peter Atkins

1. State of a system

- Thermodynamic system : part of Universe under consideration
→ real / imaginary boundary separates from rest , i.e. environment

* isolated : ϕ heat / matter / work exchange
* closed : ϕ matter exchange, $q + w$
  - adiabatic : ϕ q exchange $\neq$ - rigid : ϕ w exchange .
* open : free exchange with environment

- State : System in eq. under certain conditions = state
→ System properties have specific value , e.g composition, p, V, T *
* function of state & independent of path

Ideal gas equation : $\boxed{pV = nRT}$ → Avogadro's law

For an ideal gas : $T \propto \sum K_E$, i.e. $\boxed{\frac{1}{2}Mc^2 = \frac{3}{2}RT}$

Proof : • $v_x^2 = \frac{1}{3}c^2$ • mean free path : l • time $\tau = \frac{l}{v_x}$
→ n° collisions $= \frac{1}{2} lA\rho$ (in time τ)

$p = \frac{F}{A}$ $F = \frac{\Delta mv}{\Delta t}$ $\Rightarrow$ $p = \frac{Al\rho}{2} \cdot \frac{2mv_x}{\tau} \cdot \frac{1}{A} \Leftrightarrow p = \frac{Al\rho 2 v_x^2 m}{2 l A}$

$\Leftrightarrow p = \frac{1}{3}\rho mc^2 \Leftrightarrow pV = \frac{1}{3}Nmc^2$
$\Leftrightarrow pV = \frac{1}{3}nMc^2$
$\Leftrightarrow RT = \frac{1}{3}Mc^2$
$\Leftrightarrow \frac{1}{2}Mc^2 = \frac{3}{2}RT$

Boyle's law : $P \propto \frac{1}{V}$ Charles' law : $V \propto T$ Avogadro's law : $n \propto T$