Termodünaamika: molekulaarkinemaatika

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$k = R/N_A$

Eelmisest korrast:

$$pV = \nu RT \tag{1}$$

Üheaatomilistel gaasidel (He) on i=3, kaheaatomilistel (H_2) i=5 ning mitmeaatomilistel (CH_4) i=6 vabadusastet.
Tähised:
p - gaasi rõhk, V - gaasi ruumala, T - temperatuur
ν - moolide arv, M - molaarmass
i - vabadusaste
U - siseenergia
K_k - kineetiline energia
R = 8,3145 J/mol*K ideaalgaasi konstant
k = 1,3806 J/K Boltzmanni konstant
N_A = 6.022 *10^{23} molekul/mol Avogadro arv
v_{rms} - osakese ruutkeskmine (root mean square) kiirus
Ruutkeskmise leidmine: $x_{rms} = \frac{1}{n}\sum_{i=1}^{n} x_i^2$

1 Rõhk

Tõesta, et gaasi rõhu arvutamiseks kehtib valem

$$p = \frac{\nu M v_{rms}^2}{iV} \tag{2}$$

2 Gaasiosakese kineetiline energia

Tõesta, et molekuli kineetilise energia arvutamiseks kehtib valem

$$K_k = \frac{i}{2}kT \tag{3}$$

3 Siseenergia

Tõesta, et gaasi siseenergia arvutamiseks kehtib valem

$$U = \frac{i}{2}\nu RT \tag{4}$$

4 Disk in Gas (EuPhO 2018 Pr2)

Consider a thin flat disk of mass M and face area S at temperature T_1 resting initially in weightlessness in a gas of mass density ρ at temperature T_0 ($T_1 = 1000T_0$).
One of the faces of the disk is covered with a thermally insulating layer, the other face has a very good thermal contact with the surrounding gas: gas molecules of mass m obtain the temperature of the disk during a single collision with the surface.
Estimate the initial acceleration a_0 and maximal speed v_{max} of the disk during its subsequent motion.
Assume the heat capacity of the disk to be on the of order Nk_B, where N is the number of atoms in it, and k is the Boltzmann constant, and molar masses of the gas and the disk's material to be of the same order. The mean free path length of molecules is much larger than the size of the disk.
Neglect any edge effects occuring at the edge of the disk.

5 Physics Cup 2012 Pr3

Determine or estimate the net heat flux density P between two parallel plates at distance L from each other, which are at temperatures T_1 and T_2, respectively. The space between the plates is filled with a monoatomic gas of molar density n and of molar mass M. You may use the following approximations:

1. The gas density is so low that the mean free path $\lambda \gg L$
2. $T_1 \gg T_2$
3. When gas molecules bounce from the plates, they obtain the temperature of the respective plates instantaneously