

# Homework problems #2

1. Determine the density of states of free relativistic particle with mass  $m$  in 3D.
2. For a system of  $N$  quantum harmonic oscillators (each of them has energy levels  $E_n = (n + \frac{1}{2})\hbar\omega$ ,  $n \in N$ ) determine heat capacity at constant pressure and prove that  $\lim_{T \rightarrow 0^+} C_V = 0$ .
3. *Computer problem:* Plot the internal partition function corresponding of excitation of Si IV ion for temperatures  $T \in [10^3, 10^8]$  K (use logarithmic scaling for temperature axis). Explain behaviour of a function. Take into account first 15 levels of the ion according to data from NIST  
[https://www.nist.gov/pml/atomic-spectra-database:](https://www.nist.gov/pml/atomic-spectra-database)

Configuration	Term	$J$	$g$	Energy [eV]
2p6.3s	2S	1/2	2	0.000000
2p6.3p	2P	1/2	2	8.838528
		3/2	4	8.895698
2p6.3d	2D	5/2	6	19.883893
		3/2	4	19.884040
2p6.4s	2S	1/2	2	24.050317
2p6.4p	2P	1/2	2	27.061641
		3/2	4	27.081703
2p6.4d	2D	5/2	6	30.997044
		3/2	4	30.997059
2p6.4f	2F	5/2	6	31.507742
		7/2	8	31.507984
2p6.5s	2S	1/2	2	32.907632
2p6.5p	2P	1/2	2	34.282086
		3/2	4	34.291429

The solution should be submitted not later than on April 24th.