Tutorial-5, Statistical Mechanics & Others (Paper-203), January 20,2016

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Maximum Marks: 50

Q-1. Obtain E_{elec}, A_{elec} and S_{elec} of a monoatomic gas. Discuss nuclear partition function of monoatomic gas. Calculate the fraction of He atoms in the lowest $^1S_0$ state at 300^0K and 3000^0K.

Q-2. Find E_{tot} and A_{tot}. Obtain $Sackur\text{-}Tetrode$ equation of S_{tot} of monoatomic gas.

Q-3. Find equation of ideal monoatomic, diatomic and polyatomic gases ($\bar{p}V = Nk_BT$). Why $'\bar{p}V = Nk_BT'$ does not differ for monoatomic and diatomic gases?

Q-4. Discuss briefly how nuclear spin (I) of a homonulcear diatomic molecule modulates rotational partition function?

Q-5. How many spin microstates H_2 has? Write a short note on C_v of H_2 gas at $\sim 0^0K$ and 300^0K? Why cannot nuclear spin of H_2be inclusive as reciprocal of rotational symmetry factor σ at moderate temperature?

Q-6. Show that $\hat{S}^2$ is an eigen-operator of o-H_2 and (p-H_2). Obtain their eigen-values.

Q-7. Find $'\sigma'$ of NO_2, H_2O, SO_2, N_2O, CO_2, COS (diagrams).

Q-8. Find E_{rot} and C_v of polyatomic gas at moderately high temparatue.

Q-9. Find S_{rot} of polyatomic gas at moderately high temparatue.

Q-10. Find E_{tot}, C_v and S_{tot} of a polyatomic gas at moderately high temparatue.

Q-11. Prove that $\bar{p}V = k_BT\ln(Z(v,T,\mu)$ of a grand-canonical ensemble. What are thermodynamic characteristic functions of different ensembles?

Books: McQuarrie (Statistical Mechanics), Callen (Thermodynamics and Thermostatistics), Nash (Elements of Statistical Thermodynamics), Atkins (Physical Chemistry), Landau & Lifshitz (Statistical Physics),MC Gupta (Statistical Mechanics).