

## Exercises in Statistical Mechanics

Based on course by Doron Cohen, has to be proofed  
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This exercises pool is intended for a graduate course in “statistical mechanics”. Some of the problems are original, while other were assembled from various undocumented sources. In particular some problems originate from exams that were written by B. Horovitz (BGU), S. Fishman (Technion), and D. Cohen (BGU).

### ===== [Exercise 1026]

#### Fluctuations in the grand canonical ensemble

A fluid in a volume  $V$  is held (by a huge reservoir) at a temperature  $T$  and chemical potential  $\mu$ . Do not assume an ideal gas. Find the relation between  $\langle(E - \langle E \rangle)^3\rangle$  and the heat capacity  $C_V(T, z)$  at constant fugacity  $z$ . Find the relation between  $\langle(N - \langle N \rangle)^3\rangle$  and the isothermal compressibility  $\chi T(V, \mu) = -(\partial v / \partial \mu)|_{V, T}$  where  $v = V / \langle N \rangle$ . [Hint: Evaluate 3rd derivatives of the grand canonical partition function.] Find explicitly results in case of a classical ideal gas.