

## 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 3745]

#### Fermions in a gravitational field

Consider fermions of mass  $m$  and spin  $1/2$  in a gravitational field with constant acceleration  $g$  and at uniform temperature  $T$ . The density of the Fermions at zero height is  $n(0) = n_0$ . In item (3) assume that at zero height the fermions form a degenerate gas with Fermi energy  $\epsilon_F^0$  that is much larger compared with  $T$ .

1. Assume that the fermions behave as classical particles and find their density  $n(h)$  as function of the height.
2. Assume  $T = 0$ . Find the local Fermi momentum  $p_F(h)$  and the density  $n(h)$  as function of the height.
3. Assume low temperatures. Estimate the height  $h_c$  such that for  $h \gg h_c$  the fermions are non-degenerate.
4. In the latter case find  $n(h)$  for  $h \gg h_c$ , given as before  $n_0$  at zero height.