Homework 08

Problem 1 (5 points)

Using Maxwell-Boltzmann distribution and assuming the temperature of the sun to be 10^7 K, estimate the fraction of the hydrogen atoms capable to penetrate the Coulomb barrier at 1 fm.

Problem 2 (5 points)

Assuming density of sun to be 1300 kg/m^3 and heat capacity of it to be the same as for water (per kg). Estimate how much temperature of the Sun would raise as result of calculated above fraction of hydrogen to be converted to helium. Is it enough to overcome Coulomb barrier for a hydrogen atom with average thermal energy?

Problem 3 (5 points)

Derive the formula for the radiation pressure

$$P = \frac{1}{3} a T^4 \tag{1}$$

and show that $a = 4\sigma/c$

Problem 4 (5 points)

Using Maxwell-Boltzmann distribution derive the formula for the ideal gas pressure $P = nk_B T$.

Problem 5 (5 points)

What should happen with pressure when all hydrogen will be converted to helium? Assuming that the rest of the system does not change, how much higher should be the temperature to maintain the hydrostatic equilibrium? Disregard the ionization and assume that Sun consists only of helium at the final stage.

Problem 6 (5 points)

Assuming the mean molecular weight $\mu = 0.62$ and density $\rho = 1300$ kg/m^3, find at what temperature the radiation pressure equals to the ideal gas pressure.