Problem 22. Mixture of two gases, $A$ and $B$, is in a homogeneous gravitational field $g$ at constant temperature $T$. Pressure measured at zero altitude $h = 0$ is $P_0$. Fraction of the gas $A$ at zero altitude is $x_0$ (correspondingly, the fraction of the gas $B$ is $1 - x_0$).

a) Find a fraction of the gas $A$ at an altitude $h \neq 0$. [4 points].

b) Find (total) pressure $P$ at this altitude $h$ [3 points].

c) Assuming that gases $A$ and $B$ are molecular oxygen and nitrogen, and that their fractions at zero altitude are 21% and 79%, respectively, calculate the oxygen fraction at the altitude $h = 10km$. Assume that temperature is independent of the altitude and equal 300K (not a very realistic assumption, rigorously) [3 points].

*Hint:* Use the fact that in equilibrium the sum of the chemical potential and the potential energy (per mole) in the gravitational field for each gas is independent of the altitude. Also make use of the expression for the chemical potential in a mixture of two gases, see Eq. (8-3).