UNIVERSITY OF OSLO

Exercise week 38: FYS2160, Thermodynamics and statistical physics, Fall 2019

1 Entropic forces

1. Problem 3.34 in Schroeder. Some initial considerations can be found in lecture notes from the lecture 12.09.
2. Show that the pressure of an ideal gas is entropic (and does not originate from the internal energy).

2 Bottle rocket thermodynamics

1. A bottle rocket contains compressed gas and water at pressure P_1 that are released when the plug bursts. The expansion of the gas ejects the water downwards and the reaction force propels the bottle upwards. How large is the work W that the compressed gas performs on it's environment?
2. How high can a bottle reach if all work were converted into kinetic energy and the drag coefficient
$$C_D = \frac{2F_D}{\pi r^2 \rho v^2} \simeq 1, \tag{1}$$
where F_D is the drag force, v is the velocity of the bottle rocket, ρ is the density of air, the radius of the bottle is $r = 5$ cm, the initial volume of gas is $V_1 = 0.5$ l, the mass of the bottle is $m = 100$ g, the initial pressure of the gas is $P_1 = 0.4$ MPa (4 bar) and the temperature is $T = 20°$C.
3. In the lecture 10.09. we calculated the entropy change ΔS from the volume change only and showed that ΔS is path independent. Use the minimum work path and the isothermal path to calculate the ΔS of the expansion of the gas that was initially compressed in the bottle.
4. Can you from the ΔS you just calculated calculate the work W of the expanding gas that drives the bottle rocket?

Some initial considerations can be found in lecture notes from the lecture 12.09.

3 Some more problems from Schroeder

2.42, 3.7, 3.19, 3.22