Problem set 3, 29.01.2021:

(Problem A) The equation of state of a gas can be written in the form

$$p = nkT(1 + B_2 n)$$

where p is the mean pressure of the gas, T its absolute temperature, $n \equiv {}^{N}/_{V}$ the number of molecules per unit volume, and $B_2 = B_2(T)$ is the second virial coefficient. B_2 is an increasing function of the temperature.
Find how the mean internal energy E of this gas depends on its volume V, i.e., find an expression for $\left(\frac{\partial E}{\partial V}\right)_T$. Is it positive or negative?
(*Transferred from problem set 2*)

(Problem B) Consider one mole of van der Waals gas with equation of state

$$\left(p + \frac{a}{V^2}\right)(V - b) = RT$$

where a and b are constants.

a) Calculate the amount of heat produced in a reversible isothermal expansion from V_1 to V_2.
b) Show that in an adiabatic process

$$T(V - b)^{{}^{R}/_{C_V}} = \text{const.}$$

where C_V is heat capacity for one mole of gas at constant volume.
c) Calculate the entropy of this gas.

(Problem C) Read the paper by Berut et al., that has been uploaded on your course material. Based on what you learn, explain the Landauer principle. Show that erasure of a single bit costs on the average energy which is equal to or larger than $k_B T \ \ln 2$.

Deadline for Problem set 3: 5th February at 10:00 a.m.
Send the solutions to bayan.karimi@aalto.fi