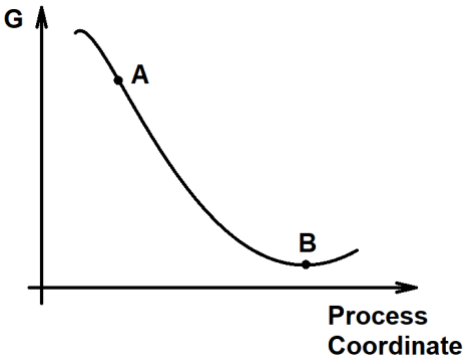
Homework 3

1. Let's try to find the boundary conditions for the below cases. Consider a system consisting of a gas container with a freely moving piston at one end. State the type of process occurring (e.g. isothermal) for cases a. to c. below. You can assume that no leaks occur.
   a. The gas is quasistatically heated from T1 to T2 using a heating plate
   b. The freely moving piston is replaced with a rigid lid, and the gas is heated from T1 to T2 using a heating plate
   c. The lid is replaced with a piston once more. A hole is drilled in the container, and a tube is attached. Additional gas is reversibly transferred into the container through the tube at constant temperature.
   d. For case c. above, is the container system open or closed?

2. An ideal gas system undergoes isothermal expansion from an initial volume V_i to a final volume V_f. What is the change in enthalpy of the system?

3. For an arbitrary process in a closed system, a plot of the Gibbs free energy looks like this:



   If the process is at the state **A**, is it possible for the system to spontaneously go to state **B**? Why or why not?

4. The heat capacity at constant volume C_V of many solids at low temperature has the proportionality: $C_V = \alpha T^3$. What function describes the internal energy of such a material? Find the expression for the internal energy.

5. In many thermodynamics' exercises a thermal bath is mentioned. Essentially, a thermal bath is an object or vessel, which can receive or give heat. We also consider it to be large enough so that it does not change its temperature. Usually water is used for such applications due to its large heat capacity. A copper piece (m = 10 g, C_{Cu} = 0.385 J/g·K) that has initial temperature T_{Cu} = 100 °C is dropped in a tank of water (C_{H2O} = 4.184 J/g·K) with temperature T_{H2O} = 25 °C. How much water is needed in the tank so the final equilibrium temperature of water and copper piece would be 25.1 °C? Note that in this exercise, we assume a constant heat capacity.