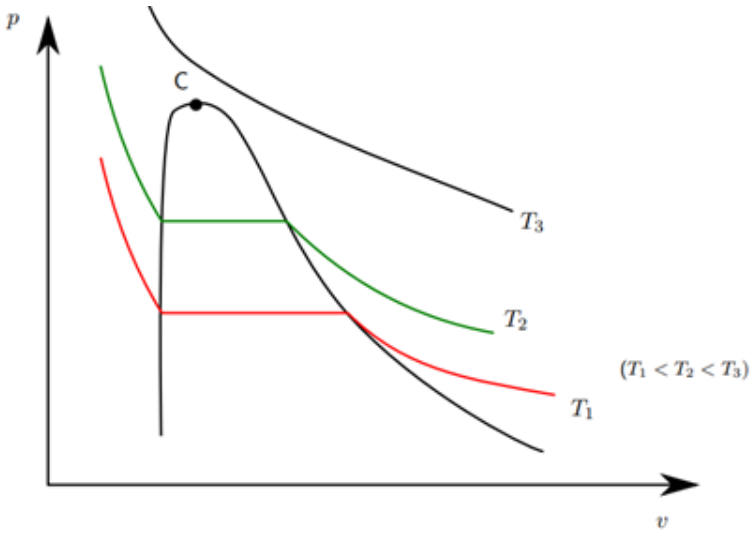
Exercise Set - TD 2: Thermodynamics

Exercise 1

1. Define the following thermodynamic processes:
   - Isobaric, isothermal, isochoric
   - Monobaric, monothermal
   - Adiabatic
   - Reversible



2. Calculate the work for the following processes:
   - Isochoric
   - Monobaric
   - Reversible isothermal

3. Add the following terms on the graph on the side: «liquid», «gas», «liquid + gas», «dewpoint curve», «bubble point curve».

Exercise 2

An air-fuel mixture, that we will consider an ideal gas, is compressed in 3 different ways from state 1 to state 2 with

- state 1: $P_1 = 1$ bar and $V_1 = 3$ L
- state 2: $P_2 = 3$ bars and $V_2 = 1$ L

In the first case, there is an isochoric and then an isobaric process; in the second case, an isobaric and then an isochoric process; in the last case, there is just an isothermal process ($PV = const.$).

1. Knowing that $\Delta U = C_V \Delta T$ for this gas, calculate ΔU for each pathway used.
2. Calculate the work in each case. Deduce the amounts of heat exchanged. Is the gas losing or gaining heat?

Exercise 3

The Lenoir cycle is an idealized model of the two-stroke engine cycle, introduced by Lenoir in 1860 to describe the operation of the gas engine he had developed the previous year. The air in the combustion chamber of the engine is considered an ideal gas. After a phase of introducing air into the combustion chamber and the ignition process, the air in the chamber is characterized by $T_1 = 100\ °C$, $V_1 = 10\ L$ and $P_1 = 2 \cdot 10^5\ Pa$. From this state 1, the air constitutes a closed system with quantity of matter n_0. The cycle it undergoes consists of the following stages:

- $1 \rightarrow 2$: isochoric heating up to pressure P_2;
- $2 \rightarrow 3$: isothermal expansion up to $V_3 = 2V_1$;
- $3 \rightarrow 1$: isobaric compression back to the initial volume V_1.

The burnt gases are then evacuated from the combustion chamber, and a new cycle begins.

1. We want to represent the cycle in the (P, V) diagram. To be able to define the state variables throughout the cycle, we assume that all processes are quasi-static.
    a. Determine the equation of a quasi-static isothermal of an ideal gas in the (P, V) diagram. What geometric shape does it correspond to?
    b. Deduce the representation of the cycle and draw it.
2. Determiner the temperature $T_2 = T_3$ at which the expansion takes place. Deduce the maximum pressure reached P_2.
3. Calculate the total work done by the engine during the cycle.
4. Justify without any calculation that $\Delta U = 0$ between the start and the end of the cycle. Deduce the amount of heat received by the system. What is the source of this transfer?