Exercise 1: Gas expansion (3 Points)

A thermally-insulated cylinder holds an ideal gas at a pressure P_2 and a temperature T_2. The surroundings are at pressure P_1. The gas is contained by a thermally-insulated massless piston with a stack of many small weights on top of it. Suppose two different processes:

a) All of the weights are removed from the piston instantaneously and the gas expands until the pressure matches that of the surroundings. (Hint: Note that the work is given by the pressure of the surroundings, which is not the pressure of the system in this case)

b) Suppose that the weigths are removed very slowly, in such a way that the pressure variates in a quasi-static way, until the system reaches a pressure P_1.

For both cases calculate how much work was done by the system and what is its final temperature.

Exercise 2: The idealized spark-ignition internal-combustion engine (3.5 Points)

This machine can be modelled by the following ideal cycle:

1) Isobaric ($P = P_0$) expansion from V_2 to $V_1 > V_2$.
2) Adiabatic compression back to V_2.
3) Increase of pressure at constant volume.
4) Adiabatic expansion until reaching a volume V_1.
5) Decrease of pressure at constant volume, until P_0 is reached.
6) Isobaric compression back to V_2.

Draw the cycle in a $P - V$ diagram. Calculate the efficiency of the idealzed cycle as a function of the ratio $r = V_2/V_1$.

Exercise 3: The idealized gas turbine. (3.5 Points)

The idealized cycle consists of the following steps:

1) Adiabatic compression from a pressure P_A to a pressure P_C.
2) Isobaric expansion.
3) Adiabatic expansion back to the pressure P_A.
4) Isobaric compression to the initial volumen.

Draw the cycle in the $P - V$ diagram. Calculate the efficiency and express it in terms of the ratio $\sigma = P_C/P_A$.