Problem 1. The compression ratio of a four-stroke internal combustion engine is $\varepsilon = 9.5$. The engine draws in air and gaseous fuel at a temperature 27 °C at a pressure 1 atm = 100 kPa. Compression follows an adiabatic process from point 1 to point 2, see Fig. 1. The pressure in the cylinder is doubled during the mixture ignition (2–3). The hot exhaust gas expands adiabatically to the volume V_2 pushing the piston downwards (3–4). Then the exhaust valve opens and the pressure gets back to the initial value of 1 atm. All processes in the cylinder are supposed to be ideal. The Poisson constant (i.e. the ratio of specific heats C_p/C_V) for the mixture and exhaust gas is $\kappa = 1.40$. (The compression ratio is the ratio of the volume of the cylinder when the piston is at the bottom to the volume when the piston is at the top.)

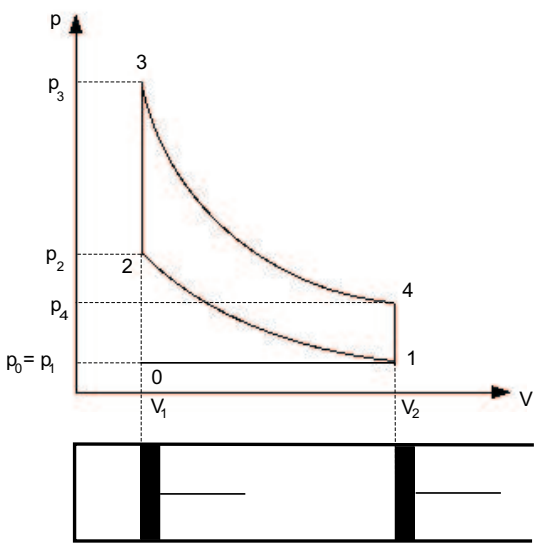

Figure 1:

a) Which processes run between the points 0–1, 2–3, 4–1, 1–0?

b) Determine the pressure and the temperature in the states 1, 2, 3 and 4.

c) Find the thermal efficiency of the cycle.

d) Discuss obtained results. Are they realistic?