A combined air filled, spring loaded cylinder has a frictionless piston of area 0.012 m2 that rests against the spring. The spring loaded end of the cylinder is open to atmosphere. The spring force in terms of piston movement is given by:

∆Spring Force = k ∆X

Show that i) the change in pressure is proportional to change in volume and spring position X such that:

∆P/∆V = k/A2 where A is the piston cross section area

The air temperature is increased by means of an electric heater so that the piston moves by 0.04 m with the pressure in the cylinder rising to 5 bars. The piston. The cylinder is then allowed to cool down to a temperature of 300K at which the pressure in the cylinder has dropped to 1 bar. ii) Calculate the volumetric change in the cylinder due to heating. If the air in the cylinder had an initial volume of 0.0005 m3, iii) calculate the mass of air.

The cylinder is heated again so the volume becomes 1.3 times the original volume. Calculate iv) the final pressure, v) final temperature, vi) the work done if it is assumed that when the pressure-volume graph is extended, it would pass through origin, vii) the change in internal energy and the heat transfer.

Note: Cp = 1005J/kgK , Cv = 718J/kgK for air