3 A cylinder enclosed by a gas-tight and frictionless piston of negligible mass, contains 0.600 m^3 of air with a density of 1.28 kg m^{-3} at 275 K.

The air inside the cylinder is then heated to 390 K. During the heating process, the air expands at constant pressure until the piston reaches a new equilibrium position as shown in Fig. 3.1.

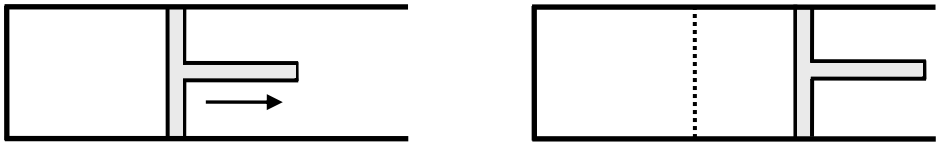

Fig. 3.1

The air is assumed to be an ideal gas. The specific heat capacity of the air under the conditions in which it is heated is 1000 J kg^{-1} K^{-1}.
Atmospheric pressure is 1.03×10^5 Pa.

(a) Explain what is meant by the internal energy of a system.

……...……

……...…….. [1]

(b) **(i)** Calculate the heat energy required to raise the temperature of air from 275 K to 390 K.

heat energy = ..……..…..…. kJ [2]

(ii) Show that the work done on the atmosphere during this process is 25.8 kJ.

[2]

(iii) Hence, determine the increase in the internal energy of the air in the piston during this process.

increase in the internal energy = ..……..…..…. kJ [2]

(c) The air in the cylinder is now compressed suddenly by applying an external force on the piston. Explain whether the temperature of the air in the cylinder increases, decreases or remains constant.

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……... [3]