3 a. Explain how it is possible for water at 100 °C to vaporise to become steam without any change in temperature, even though heat is supplied to it during the process.

……..

……..

……..

…….. [2]

b. An ideal monatomic gas in a sealed container with an attached frictionless piston undergoes the following sequence of processes that bring it from state A to states B, C, D and back to A.

The temperature of the gas remains constant during processes AB and CD.
The volume of the gas remains constant during the processes BC and DA.

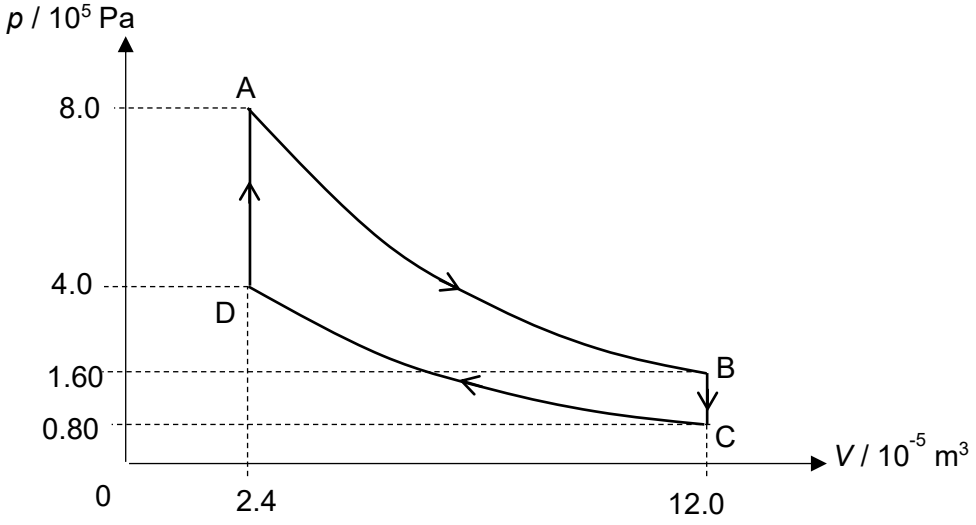

Fig. 3.1

The temperature of the gas at A is 526 K.
It is known that the work W done by a monatomic ideal gas during an isothermal expansion from volume V_1 to V_2 at temperature T is given by

$$W = \mu RT \ln\left(\frac{V_2}{V_1}\right)$$

where μ is the number of moles of gas atoms.

(i) Show that the amount of gas present in the container is 4.4×10^{-3} mol.

[1]

(ii) Show that the temperature of the gas at C is 263 K.

[1]

(iii) Determine the amount of heat energy absorbed by the gas during process AB.

Heat absorbed during AB = …….. J [2]

(iv) Determine the amount of heat energy lost by the gas during process BC.

Heat lost during BC = …….. J [2]

(v) The total amount of heat absorbed in one cycle is 45.4 J.
Calculate the efficiency of this heat engine, given by

$$\text{efficiency} = \frac{\text{net work done per cycle}}{\text{heat absorbed per cycle}}$$

Efficiency = …… [2]

[Total: 10]