

3(a) State the first law of thermodynamics.

[1]

(b) A balloon contains a fixed mass of air that expands on heating, as illustrated in Fig. 3.1.

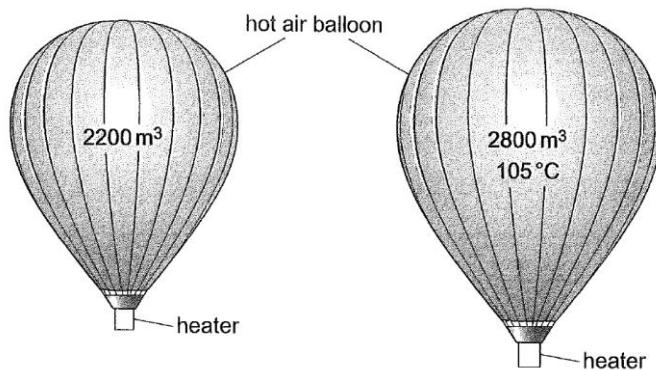


Fig. 3.1

The air is heated to a final temperature of 105°C and the balloon expands at atmospheric pressure from 2200 m³ to 2800 m³, when it is fully inflated. Atmospheric pressure is 1.01×10^5 Pa.

(i) Calculate the initial temperature, in °C, of the air.

[2]

(ii) Calculate the work done by the expanding balloon on the atmosphere.

[1]

- (iii) Assuming that the air inside the balloon is an ideal gas, explain why the internal energy of the air increases as it is heated. [2]
- (iv) The propane used in the heater produces 50 MJ of thermal energy for each kilogram of fuel that is burned. The air inside the balloon gains 116 MJ of internal energy during the expansion. Calculate the minimum mass of propane which must be burned to fully inflate the balloon. [2]