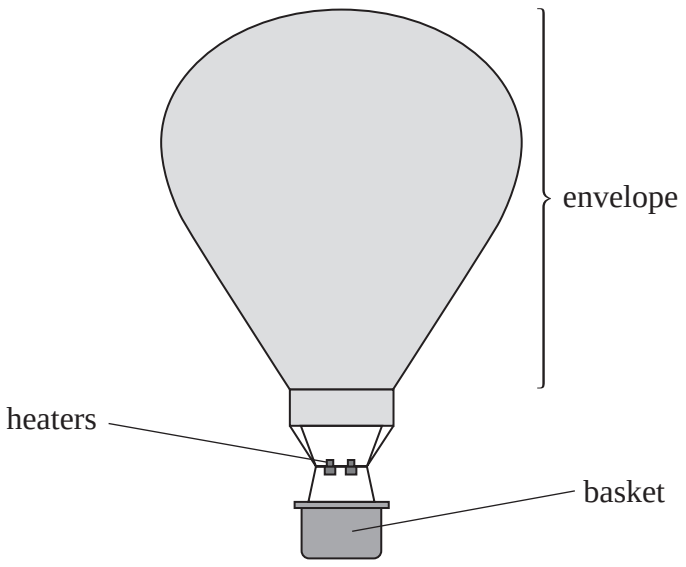
17 (a) A hot air balloon consists of a fabric envelope, heaters and a basket, as shown.



When the balloon is set up, the envelope is partly filled with air at 20°C. The air is then heated to 120°C and expands to fill the envelope and becomes less dense.

The air pressure inside the envelope is always equal to the air pressure outside the envelope because the envelope is open at the bottom.

The balloon takes off when the upthrust is more than the total weight of the balloon, the air in the envelope and the passengers.

Deduce whether the balloon can take off.

volume of air at 120°C in inflated envelope = 2800 m^3
density of air at 20°C = 1.2 $kg\,m^{-3}$
mass of balloon = 380 kg
mass of passengers = 340 kg
upthrust when the envelope is full = 33 000 N

(6)

(b) (i) State one assumption of the kinetic theory of gases.

(1)

(ii) Derive an equation to show that, for a gas at temperature T,

the mean kinetic energy of the molecules = $\frac{3}{2}kT$

(2)

(iii) Calculate the root-mean-square speed of nitrogen molecules at a temperature of 120°C.

mass of nitrogen molecule = 28 u

(3)

Root-mean-square speed = ...

(Total for Question 17 = 12 marks)