

- 3 (a) The product  $pV$  for an ideal gas is given by

$$pV = \frac{1}{3} Nm \langle c^2 \rangle$$

where  $p$  is the pressure of the gas and  $V$  is the volume of the gas.

- (i) State the meaning of the symbols  $N$ ,  $m$  and  $\langle c^2 \rangle$  in this equation.

$N$ : .....

$m$ : .....

$\langle c^2 \rangle$ : .....

[3]

- (ii) Use the equation of state for an ideal gas to show that the average translational kinetic energy  $E_K$  of a molecule of the gas at thermodynamic temperature  $T$  is given by

$$E_K = \frac{3}{2} kT.$$

[2]

- (b) The surface of a star consists mainly of a gas that may be assumed to be ideal. The molecules of the gas have a root-mean-square (r.m.s.) speed of  $9300 \text{ m s}^{-1}$ .

The mass of a molecule of the gas is  $3.34 \times 10^{-27} \text{ kg}$ .

Determine, to three significant figures, the temperature of the surface of the star.

temperature = ..... K [2]

- (c) The radiant flux intensity of the radiation from the star in (b) is  $2.52 \times 10^{-8} \text{ W m}^{-2}$  when observed at a distance of  $4.16 \times 10^{16} \text{ m}$  from the star.

(i) Calculate the luminosity of the star. Give a unit with your answer.

luminosity = ..... unit ..... [2]

(ii) Determine the radius of the star.

radius = ..... m [2]

- (d) The gas at the surface of a star has a very high pressure.

Use the basic assumptions of the kinetic theory to suggest why, in practice, a gas at the surface of a star is unlikely to behave as an ideal gas.

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 .....  
 .....  
 ..... [2]