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 3.34×10^{-27} 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]

[Total: 12]