2 **(a)** The pressure p and volume V of an ideal gas are related to the density ρ of the gas by the expression

$$p = \frac{1}{3}\rho\langle c^2 \rangle.$$

(i) State what is meant by the symbol $\langle c^2 \rangle$.

....

....[1]

(ii) Use the expression to show that the mean kinetic energy E_K of a gas molecule is given by

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

where k is the Boltzmann constant and T is the thermodynamic temperature.

[3]

(b) **(i)** An ideal gas containing 1.0 mol of molecules is heated at constant volume.
Use the expression in **(a)(ii)** to show that the thermal energy required to raise the temperature of the gas by 1.0 K has a value of $\frac{3}{2}R$, where R is the molar gas constant.

[3]

(ii) Nitrogen may be assumed to be an ideal gas. The molar mass of nitrogen gas is $28\,\mathrm{g\,mol^{-1}}$. Use the answer in **(b)(i)** to calculate a value for the specific heat capacity, in $\mathrm{J\,kg^{-1}\,K^{-1}}$, at constant volume for nitrogen.

specific heat capacity = ... $\mathrm{J\,kg^{-1}\,K^{-1}}$ [2]

[Total: 9]