2 **(a)** State the basic assumptions of the kinetic theory of gases.

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.....[4]

(b) Use equations for the pressure of an ideal gas to deduce that the average translational kinetic energy $<E_K>$ of a molecule of an ideal gas is given by the expression

$$<E_K> = \frac{3}{2}\frac{R}{N_A}T$$

where R is the molar gas constant, N_A is the Avogadro constant and T is the thermodynamic temperature of the gas.

[3]

(c) A deuterium nucleus ${}^{2}_{1}H$ and a proton collide. A nuclear reaction occurs, represented by the equation

$${}^{2}_{1}H + {}^{1}_{1}p \longrightarrow {}^{3}_{2}He + \gamma.$$

(i) State and explain whether the reaction represents nuclear fission or nuclear fusion.

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..... [2]

(ii) For the reaction to occur, the minimum total kinetic energy of the deuterium nucleus and the proton is 2.4×10^{-14} J.
Assuming that a sample of a mixture of deuterium nuclei and protons behaves as an ideal gas, calculate the temperature of the sample for this reaction to occur.

For Examiner's Use

temperature = ... K [3]

(iii) Suggest why the assumption made in **(ii)** may not be valid.

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.....[1]