Section A

For Examiner's Use

Answer **all** the questions in the spaces provided.

1 The planet Mars may be considered to be an isolated sphere of diameter 6.79×10^6 m with its mass of 6.42×10^{23} kg concentrated at its centre.
A rock of mass 1.40 kg rests on the surface of Mars.

For this rock,

(a) (i) determine its weight,

weight = ... N [3]

(ii) show that its gravitational potential energy is -1.77×10^7 J.

[2]

(b) Use the information in **(a)(ii)** to determine the speed at which the rock must leave the surface of Mars so that it will escape the gravitational attraction of the planet.

speed = ... $m\,s^{-1}$ [3]

(c) The mean translational kinetic energy $<E_K>$ of a molecule of an ideal gas is given by the expression

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

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

(i) Determine the temperature at which the root-mean-square (r.m.s.) speed of hydrogen molecules is equal to the speed calculated in **(b)**.
Hydrogen may be assumed to be an ideal gas.
A molecule of hydrogen has a mass of 2 u.

temperature = ... K [2]

(ii) State and explain one reason why hydrogen molecules may escape from Mars at temperatures below that calculated in **(i)**.

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..... [2]