Question Number	Answer		Mark
12(a)	Use $V_{\text{grav}} = -\frac{GM}{r}$ to obtain ΔE Equate ΔE to $\frac{1}{2}mv^2$ **and** re-arrangement to obtain $v = \sqrt{\frac{2GM}{r}}$ <u>Example of derivation</u> $\Delta E = m \times V_{\text{grav}} = \frac{GMm}{r}$ $\frac{1}{2}mv^2 = \frac{GMm}{r}$ $\therefore v^2 = \frac{2GM}{r}$ $\therefore v = \sqrt{\frac{2GM}{r}}$	**(1)** **(1)**	**2**
12(b)(i)	Use of $v = \sqrt{\frac{2GM}{r}}$ $v = 1.12 \times 10^4$ (m s^{-1}) <u>Example of calculation</u> $v = \sqrt{\frac{2 \times 6.67 \times 10^{-1}\ \text{N m}^2\ \text{kg}^{-2} \times 5.98 \times 10^{24}\ \text{kg}}{6.36 \times 10^6\ \text{m}}}$ $\therefore v = 1.12 \times 10^4\ \text{m s}^{-1}$	**(1)** **(1)**	**2**
12(b)(ii)	There is a range of molecular speeds **Or** Some molecules will be travelling (much) faster than 1900 m s^{-1} So there will be some molecules with a speed greater than the escape velocity **Or** There will be some molecules with enough kinetic energy to escape [A correct comparison of the escape velocity (1.1×10^4 m s^{-1}) with $\sqrt{\langle c^2 \rangle}$ (1900 m s^{-1}) scores a maximum of 1 mark.]	**(1)** **(1)**	**2**
	Total for question 12		**6**