

13) Escape speed from Earth $v_{esc} = 11.2 \text{ km/s} = 11.2 \times 10^3 \text{ m/s}$

At what temperature will 11.2% of O_2 molecules have speeds $> v_{esc}$?

From table on formula sheet:

$$11.2\% \rightarrow 2\langle K \rangle = E_{\text{escape}}$$

$$\begin{aligned} \therefore \langle K \rangle &= \frac{1}{2} E_{\text{escape}} \\ &= \frac{1}{2} \left(\frac{1}{2} m v_{\text{esc}}^2 \right) \end{aligned}$$

For O_2 molecules,

$$m \approx 32 \times 1.66 \times 10^{-27} \text{ kg} = 53.12 \times 10^{-27} \text{ kg}$$

$$\begin{aligned} \langle K \rangle &= \frac{1}{4} \times 53.12 \times 10^{-27} \text{ kg} \times (11.2 \times 10^3 \text{ m/s})^2 \\ &= 1.67 \times 10^{-18} \text{ J} \end{aligned}$$

$$\frac{3}{2} kT = 1.67 \times 10^{-18} \text{ J}$$

$$T = \frac{2 \times 1.67 \times 10^{-18} \text{ J}}{3 \times 1.38 \times 10^{-23} \text{ J/K}} = 0.8 \times 10^5 \text{ K}$$

(B)