Answer on question #61872, Physics / Other

Question A Nitrogen molecule on the surface of the earth happens to have the root mean square speed at exactly 0 degree. Assuming this molecule went up without colliding with other molecules, how high would it go? The molecular mass of nitrogen is 4.651026kg
a. 4.6 km b. 12.4 km c. 20.3 km d. 7.2 km

Solution Root means square speed is related to temparature as:

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M_m}}$$

where $T = 273$ K in our case and M_m is molar mass of Nitrogen in kg/mol, for our case $M_m = 0.028$ kg/mol. Knowing speed we can find height

$$h = \frac{v\text{rms}^2}{2g} = \frac{3RT}{2M_m g} = \frac{3 \cdot 8.31 \cdot 273}{2 \cdot 0.028 \cdot 9.8} \approx 12401\, m \approx 12.4\, km$$

Answer is b. 12.4 km