

Mean Square Speed of Gases Comparison

<https://gemini.google.com/app/fe33b17289d83989>

Response: Here is the step-by-step solution to the problem:

Formula

The mean square speed ($\overline{c^2}$) of a gas molecule is given by the kinetic theory of gases as:

$$\overline{c^2} = \frac{3RT}{M}$$

Where:

- R = Universal gas constant
- T = Absolute temperature (in Kelvin)
- M = Molar mass of the gas

Molar Masses

- For Hydrogen gas (H_2):

$$M_{\text{H}_2} = 2 \times 1 = 2 \text{ g/mol}$$

- For Nitrogen gas (N_2):

$$M_{\text{N}_2} = 2 \times 14 = 28 \text{ g/mol}$$

Calculation

Given that the mean square speed of H_2 at temperature T is equal to the mean square speed of N_2 at temperature T' :

$$\overline{c^2}_{\text{H}_2} = \overline{c^2}_{\text{N}_2}$$

$$\frac{3RT}{M_{\text{H}_2}} = \frac{3RT'}{M_{\text{N}_2}}$$

Cancel $3R$ from both sides:

$$\frac{T}{2} = \frac{T'}{28}$$

Solving for T :

$$T = \frac{2}{28}T'$$

$$T = \frac{T'}{14}$$

Correct Answer

(5) $T = \frac{T'}{14}$
