Answer on Question 67199, Physics, Other

Question:

The ratio of the speed of sound in nitrogen gas to that in helium gas at $300\ K$ is?

Solution:

We can find the speed of sound in gas at certain temperature from the formula:

$$c = \sqrt{\gamma \frac{RT}{M}},$$

here, γ is the adiabatic index of gas ($\gamma_{N_2} = \frac{7}{5}$, $\gamma_{He} = \frac{5}{3}$), $R = 8.3145\ \frac{J}{mol \cdot K}$ is the molar gas constant, T is the temperature in Kelvin, M is the molar mass of gas ($M_{N_2} = 0.02801\ \frac{kg}{mol}$, $M_{He} = 0.004\ \frac{kg}{mol}$).

Then, we can find the speed of sound in nitrogen gas at $300\ K$:

$$c_{N_2} = \sqrt{\gamma_{N_2} \cdot \frac{RT}{M_{N_2}}} = \sqrt{\frac{7}{5} \cdot \frac{8.3145\ \frac{J}{mol \cdot K} \cdot 300\ K}{0.02801\ \frac{kg}{mol}}} = 353\ \frac{m}{s}.$$

Similarly, we can find the speed of sound in helium gas at $300\ K$:

$$c_{He} = \sqrt{\gamma_{He} \cdot \frac{RT}{M_{He}}} = \sqrt{\frac{5}{3} \cdot \frac{8.3145\ \frac{J}{mol \cdot K} \cdot 300\ K}{0.004\ \frac{kg}{mol}}} = 1019\ \frac{m}{s}.$$

Finally, we can find the ratio:

$$\frac{c_{N_2}}{c_{He}} = \frac{353\ \frac{m}{s}}{1019\ \frac{m}{s}} = 0.346.$$

Answer:

$\frac{c_{N_2}}{c_{He}} = 0.346.$