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Problem 23.39 (RHK)

Air at 0.00^0C *and* 1.00 atm *pressure has a density of* 1.291×10^{-3} g cm^{-3}, *and the speed of sound is* 331 m s^{-1} *at that temperature. We have to compute* (a) *the value of* γ *for air and* (b) *the effective molar mass of air.*

Solution:

Data of the problem are

$P = 1.01\times10^5$ Pa,

$\rho = 1.291\times10^{-3}$ g cm^{-3} $= 1.291$ kg m^3,

$T = 273.16$ K,

and $v = 331$ m s^{-1}.

(a)

Speed of sound, v, is related to pressure, density and γ for the medium as

$$v = \sqrt{\frac{\gamma P}{\rho}} ,$$

or

$$\gamma = \frac{v^2 \rho}{P}.$$

Substituting the data, we find

$$\gamma = \frac{331^2 \times 1.291}{1.01 \times 10^5} = 1.4 \ .$$

(b)

For determining the effective molar mass of air, we use the ideal gas equation of state

$$P = \frac{\rho RT}{M},$$

or

$$M = \frac{\rho RT}{P} = \frac{1.291 \times 8.3145 \times 273.16}{1.01 \times 10^5} \text{ kg}$$

$$= 29.0 \text{ g.}$$