Chapter 17 Problem 24 †

Given
H_2 *at* 75 K
SO_2 *at* 350 K

Solution
Find the gas that has the faster moving molecules.

Use the relationship between kinetic energy and temperature.

$$\frac{1}{2}mv^2 = \frac{3}{2}kT$$

Solving for velocity gives

$$v = \sqrt{\frac{3kT}{m}}$$

The mass of the hydrogen gas is

$$m_{H_2} = 2\ u\left(\frac{1.67 \times 10^{-27}\ kg}{1\ u}\right) = 3.34 \times 10^{-27}\ kg$$

The velocity of the hydrogen gas is then

$$v = \sqrt{\frac{3(1.38 \times 10^{-23}\ J/K)(75\ K)}{(3.34 \times 10^{-27}\ kg)}} = 964\ m/s$$

The mass of the sulfur dioxide is

$$m_{SO_2} = 64\ u\left(\frac{1.67 \times 10^{-27}\ kg}{1\ u}\right) = 1.07 \times 10^{-25}\ kg$$

The velocity of the sulfur dioxide is

$$v = \sqrt{\frac{3(1.38 \times 10^{-23}\ J/K)(350\ K)}{(1.07 \times 10^{-25}\ kg)}} = 368\ m/s$$

Comparing the velocities we have

$$\frac{v_{H_2}}{v_{SO_2}} = \frac{964\ m/s}{368\ m/s} = 2.62$$

The hydrogen gas is travelling at 2.62 times the speed of the sulfur dioxide gas.

---

†Problem from Essential University Physics, Wolfson