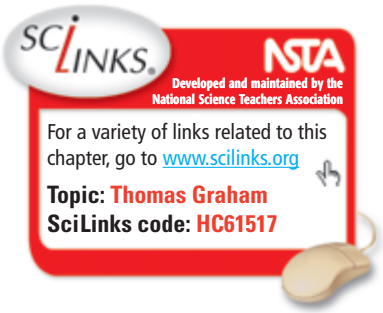
From the equation relating the kinetic energy of two different gases at the same conditions, one can derive an equation relating the rates of effusion of two gases with their molecular mass. This equation is shown below.

$$\frac{\text{rate of effusion of } A}{\text{rate of effusion of } B} = \frac{\sqrt{M_B}}{\sqrt{M_A}}$$

In the mid-1800s, the Scottish chemist Thomas Graham studied the effusion and diffusion of gases. The above equation is a mathematical statement of some of Graham's discoveries. It describes the rates of effusion. It can also be used to find the molar mass of an unknown gas. **Graham's law of effusion** *states that the rates of effusion of gases at the same temperature and pressure are inversely proportional to the square roots of their molar masses.*



QuickLAB

Wear safety goggles and an apron.

Diffusion

Materials

- household ammonia
- perfume or cologne
- two 250 mL beakers
- two watch glasses
- 10 mL graduated cylinder
- clock or watch with second hand

Question

Do different gases diffuse at different rates?

Procedure

Record all of your results in a data table.

1. Outdoors or in a room separate from the one in which you will carry out the rest of the investigation, pour approximately 10 mL of the household ammonia into one of the 250 mL beakers, and cover it with a watch glass. Pour roughly the same amount of perfume or cologne into the second beaker. Cover it with a watch glass also.
2. Take the two samples you just prepared into a large, draft-free room. Place the samples about 12 to 15 ft apart and at the same height. Position someone as the observer midway between the two beakers. Remove both watch glass covers at the same time.
3. Note whether the observer smells the ammonia or the perfume first. Record how long this takes. Also, record how long it takes the vapor of the other substance to reach the observer. Air the room after you have finished.

Discussion

1. What do the times that the two vapors took to reach the observer show about the two gases?
2. What factors other than molecular mass (which determines diffusion rate) could affect how quickly the observer smells each vapor?