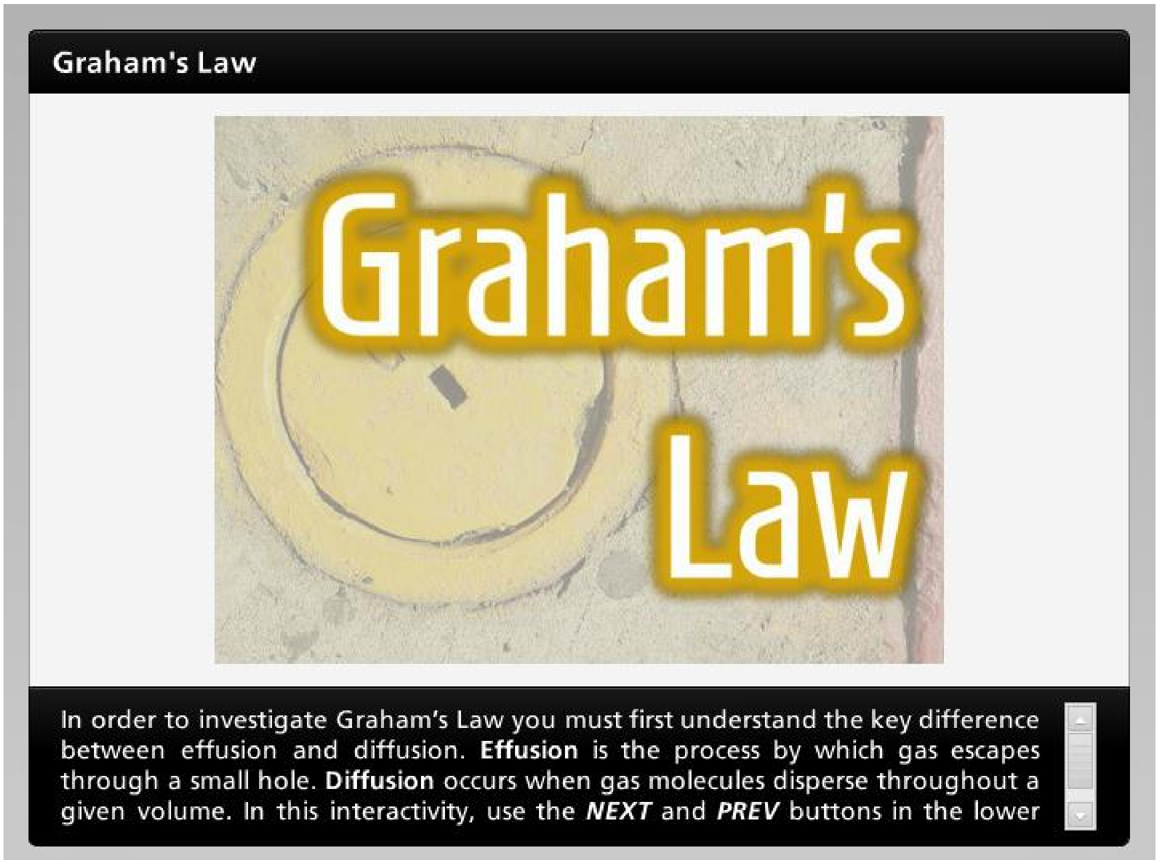
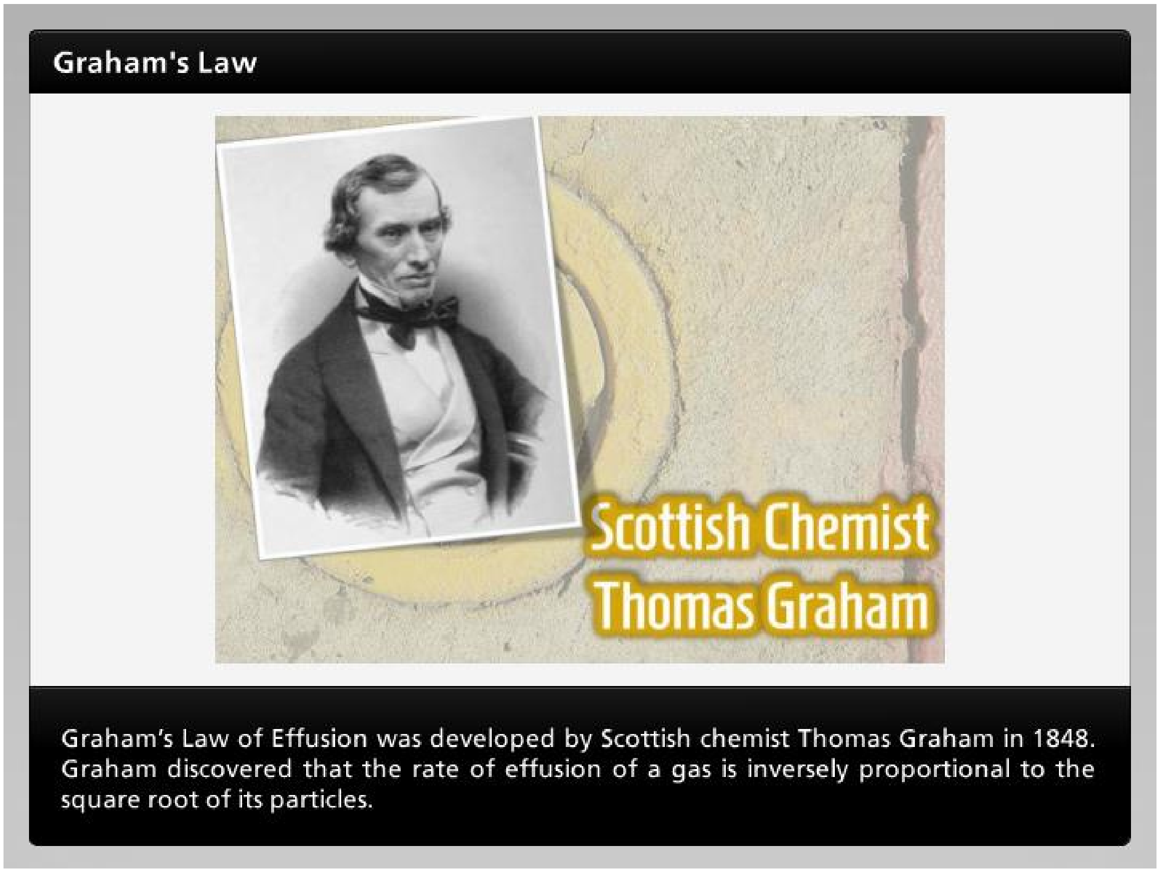
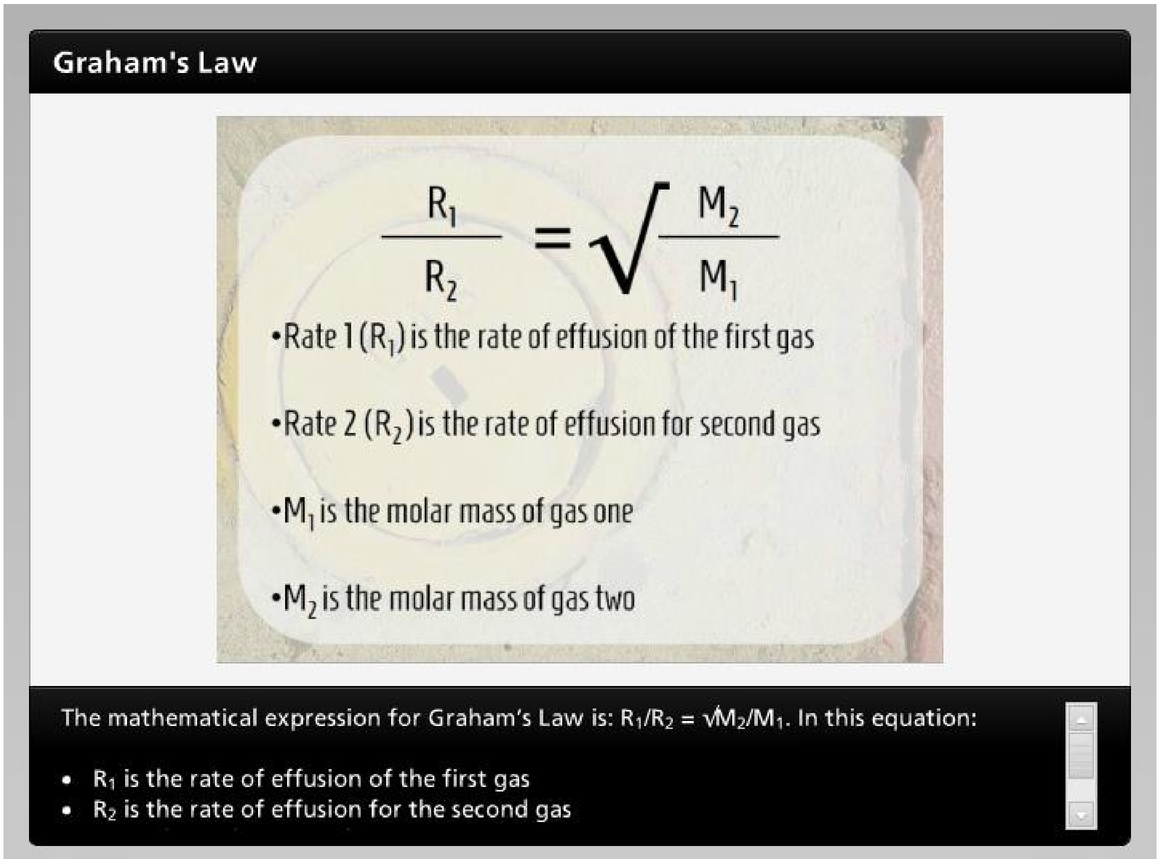
Module 9: States of Matter and Gas Laws
Topic 5 Content: Graham's Law Notes



In order to investigate Graham's Law you must first understand the key difference between effusion and diffusion. **Effusion** is the process by which gas escapes through a small hole. **Diffusion** occurs when gas molecules disperse throughout a given volume. In this interactivity, use the ***NEXT*** and ***PREV*** buttons in the lower right corner to learn about Graham's Law.

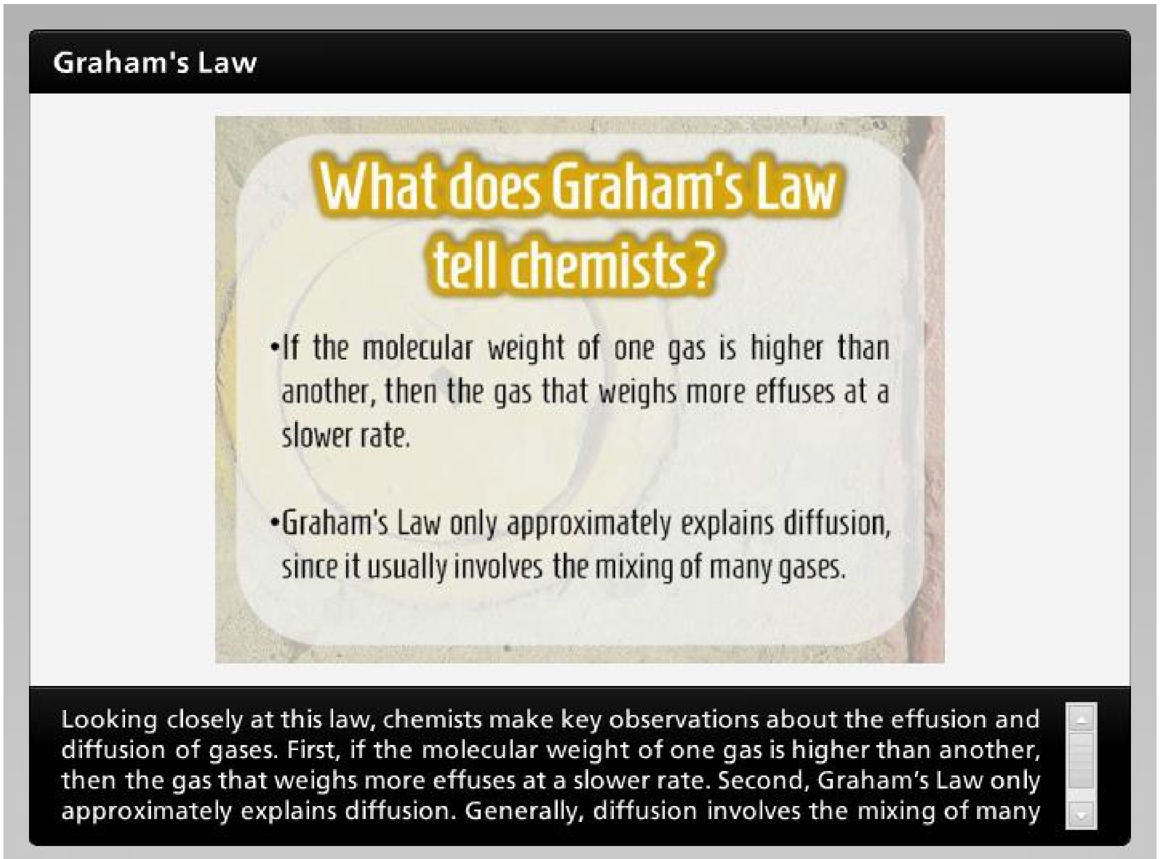


Graham's Law of Effusion was developed by Scottish chemist Thomas Graham in 1848. Graham discovered that the rate of effusion of a gas is inversely proportional to the square root of its particles.

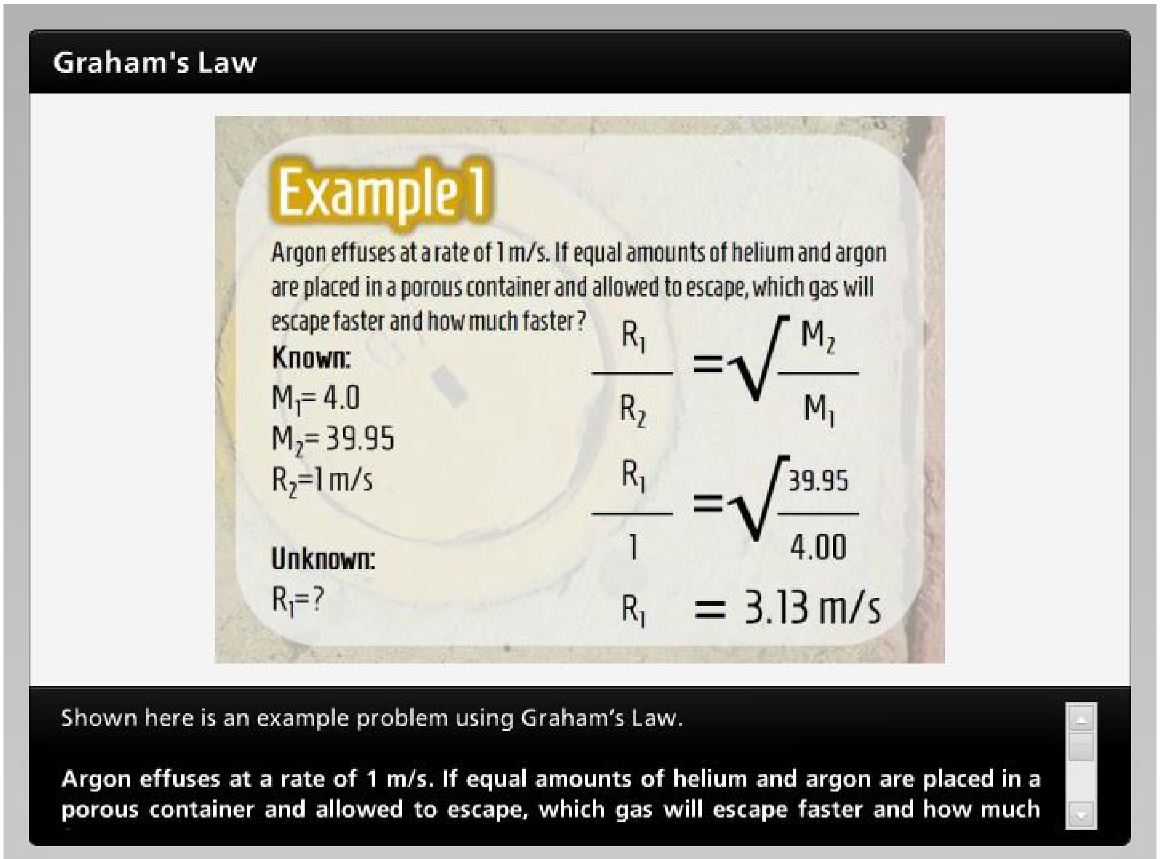


The mathematical expression for Graham's Law is: $R_1/R_2 = \sqrt{M_2/M_1}$. In this equation**:**

- R_1 is the rate of effusion of the first gas
- R_2 is the rate of effusion for the second gas
- M_1 is the molar mass of gas one
- M_2 is the molar mass of gas two



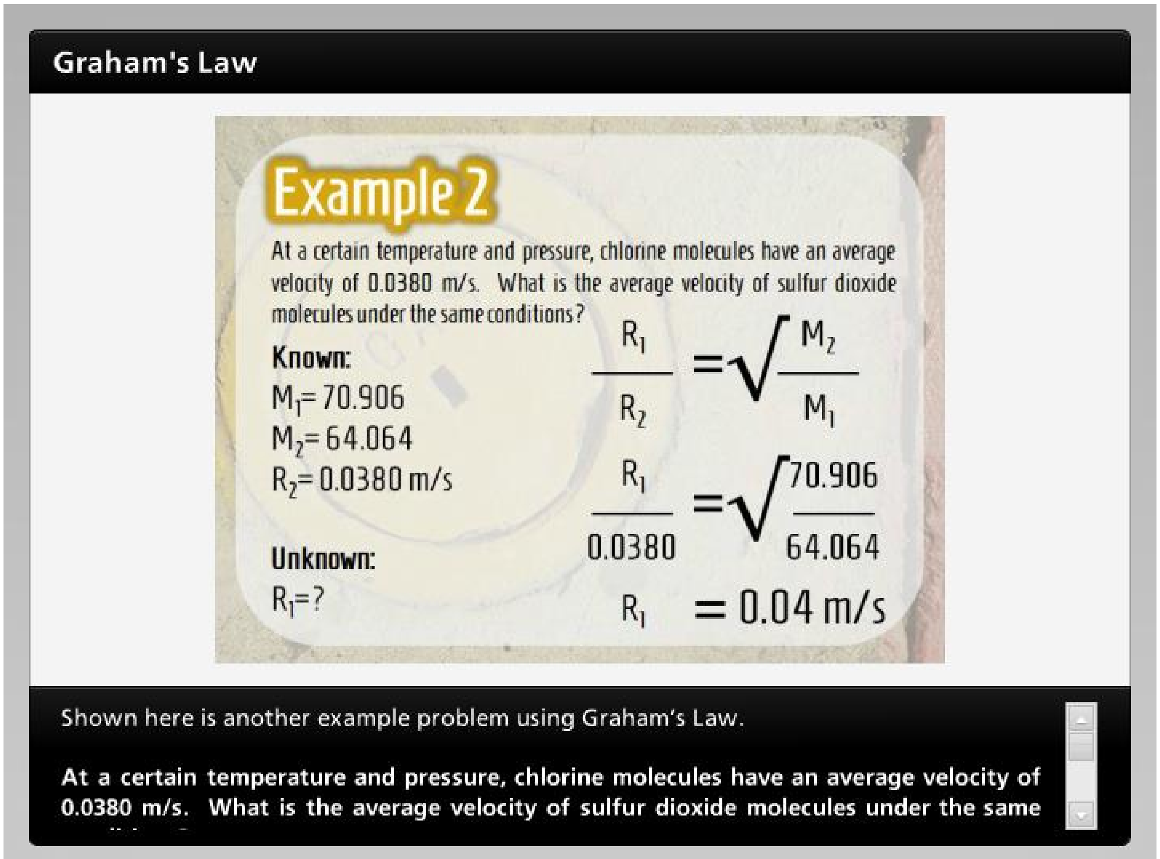
Looking closely at this law, chemists make key observations about the effusion and diffusion of gases. First, if the molecular weight of one gas is higher than another, then the gas that weighs more effuses at a slower rate. Second, Graham’s Law only approximately explains diffusion. Generally, diffusion involves the mixing of many gases which are not accurately explained by Graham’s Law of Effusion.



Shown here is an example problem using Graham's Law.

Argon effuses at a rate of 1 m/s. If equal amounts of helium and argon are placed in a porous container and allowed to escape, which gas will escape faster and how much faster?

The best way to solve this problem is by listing the known and unknown variables, then solve the problem using mathematics. The known variables in the problem are M_1 , M_2, and R_2. The unknown variable is R_1, so you need to rearrange the equation to solve for R_1. The new equation reads: R_1 divided by R_2 equals the square root of M_1 divided by M_2. Once you have the problem set up, solve for R_1 by plugging the known variables into the equation. You can see that R_1 is equal to the square root of 39.95 divided by four. R_1 equals 3.13 m/s. Helium escapes at a faster rate than argon.



Shown here is another example problem using Graham's Law.

At a certain temperature and pressure, chlorine molecules have an average velocity of 0.0380 m/s. What is the average velocity of sulfur dioxide molecules under the same conditions?

The best way to solve this problem is by listing the known and unknown variables, then solve the problem using mathematics. The known variables in the problem are M_1, M_2, and R_2. The unknown variable is R_1, so you will need to rearrange the equation to solve for R_1. The new equation reads: R_1 divided by R_2 equals M_1 divided by M_2. Once you have the problem set up, solve the problem by plugging the known variables into the equation. You can see that R_1 divided by 0.0380 is equal to the square root of 70.906 divided by 64.064. R_1 equals 0.04 m/s.