



CALIFORNIA STATE SCIENCE FAIR 2010 PROJECT SUMMARY

Name(s) Michael J. Feldman	Project Number S1911
Project Title Factors Affecting Gas Diffusion	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals My objective was to determine how atomic radii, atomic masses, and container shapes affect the time for two separate gases to become a homogeneous mixture and to explore the effectiveness of computer simulation methods.</p> <p>Methods/Materials Processing, a Java-based programming language, was used to simulate a two-dimensional model of gas diffusion under different conditions. Three separate experiments were conducted, with variation of (1) atomic radii, (2) the atomic mass ratio, and (3) the container shape. For each test, 120 repetitions were completed using different random number seeds, and 95% confidence intervals were constructed for the mean time for the gas mixture to become homogeneous.</p> <p>Results The time for the mixture to become homogeneous increased significantly when atoms had a higher mass. Homogeneity time decreased when the atomic radii were reduced. When the gases were mixed in containers with the same area but different shapes, the time for the mixture to become homogeneous increased in the following order: the skinny rectangle, the circular container, the square container, the thick rectangle, and finally the dumbbell shaped container. These results are statistically significant at a 95% confidence level.</p> <p>Conclusions/Discussion The computer simulation is an effective and powerful method in investigating how atomic interactions produce the macroscopic effect of diffusion. It allows one to study the effect of a single parameter (e.g., atomic mass) while holding all other parameters perfectly fixed, which is impossible in a lab situation. When the atomic radii decreased, atoms collide less frequently and the time to achieve homogeneity is reduced. If the mass of atoms in a type of gas increases, the average velocity must decrease if temperature is held constant. The heavier atoms therefore have smaller velocities and the diffusion process is slower. Corners tend to trap atoms and slow diffusion. Changing container shape from a square to a circle eliminates corners, making it easier for an atom to move from the edge of the container to the interior. I am currently expanding my project to simulate diffusion of radon gas through a porous material such as sandstone or shale; this is a concern for some homes in Santa Barbara.</p>	
Summary Statement Investigation of how atomic masses, atomic radii, and shape of the container affect the time it takes for two separate gases to become a homogeneous mixture.	
Help Received Discussed project with Professor Richman twice for 1.5 hours and received references from him; Consulted parents and sister regarding showboard	