JCE WebWare: Web-Based Learning Aids

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A Pedagogical Simulation of Maxwell's Demon

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Keywords: Computer-Based Learning; Internet / Web-Based Learning; Thermodynamics; Statistical Mechanics

Requires: Windows-compatible PC running Windows XP, 2000, or 98.

Maxwell's demon was conceived by James Clerk Maxwell in 1871 to illustrate the statistical basis of thermodynamics *(1),* and the concept has since formed an arena for investigation and clarification of many concepts in thermodynamics *(2)*. Chemistry students often have difficulty developing an intuitive knowledge of some concepts in thermodynamics. *A Pedagogical Simulation of Maxwell's Demon* aims to help make these concepts more understandable for students.

Teaching thermodynamics from the microscopic point of view can help students develop an intuitive understanding of its concepts. This program simulates, at the microscopic level, two gas chambers with an opening between them. The program allows students or their instructors to set up simulations that illustrate the thermodynamics and statistical behavior of the system. The user determines the basis for whether the demon permits or denies passage of particles through the opening using information from the microscopic level, such as specific particle velocity. Students can track and analyze how this affects particle distribution, thermal equilibrium, relaxation time, diffusion, and distribution of particle velocities.

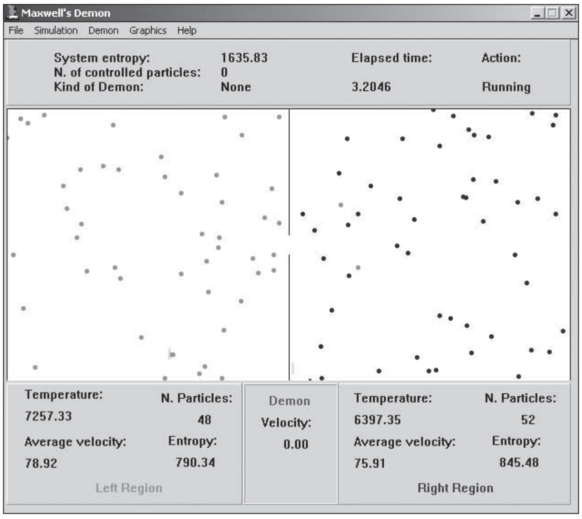
Students need only an understanding of elementary classical mechanics and the basic notions of probability to take advantage of this simulation.

Using *A Pedagogical Simulation of Maxwell's Demon*, students can

1. Examine the relationship between entropy and information.
2. Measure thermodynamic relaxation time as a function of the size of the opening between chambers.
3. Study the change in the entropy of the system as it moves from an initial configuration with different temperatures in the chambers to final thermodynamic equilibrium.
4. Study the degree of reversibility of different processes as a function of the number of particles of the system.
5. Study the relationship of diffusion and thermal equilibrium.
6. Observe fluctuations of temperature, entropy, and the number of particles in the chambers.
7. Study the distribution of velocities at different temperatures of the system.

Literature Cited

1. Maxwell, J. C. *Theory of Heat;* Longmans, Green and Co.: London, 1871.
2. Leff, H.; Rex, A. F., Eds. *Maxwell's Demon: Entropy, Information, Computing (Princeton Series in Physics);* Princeton University Press: Princeton, NJ, 1991.



The main window of A Pedagogical Simulation of Maxwell's Demon.