Brian Denton
CS 190C Introduction to Computational Thinking
Project 3
April 3, 2009

- In graph N_versus_Energy, how close is the actual system energy to the total energy? How does it change as N changes? How do the plots differ for the two different initial system states?

State = 1	The system energy is quite a bit less than the total energy for small-*N* systems, but gets closer to total energy as the number of molecules increase. This is because the demon initially has zero energy so all energy changes must be positive, which increases demon energy but lowers system energy. But where more molecules are present there are more demon-molecule interactions so the energy is transferred back to the system because the expected demon energy is zero since it is uniformly distributed around zero. Thus, we expect any energy the demon might have accumulated will eventually be returned to the system. This same outcome can be obtained even with small-N systems by increasing the number of steps, which has the same effect of increasing the number demon-molecule interactions.
State = 2	The system energy for small-N systems is very close to total energy. The demon initially starts with all the energy, but quickly transfers is to the system as it converges to its expected energy, which is near zero. The system energy actually decreases or larger-N systems because with a limited number of steps the demon cannot interact with a large share of the molecules. Therefore, many molecules will remain at zero energy. But if the number of steps increases, we see there is once again adequate time for demon-molecule interactions to transfer much of the energy from the demon to the system.

- Using histogram Final_Particle_Velocity, what kind of distribution do you judge the velocities to come from? How close is the molecule velocity to the initial velocity of `sqrt(2*totalEnergy/N)` used in initial state 1?

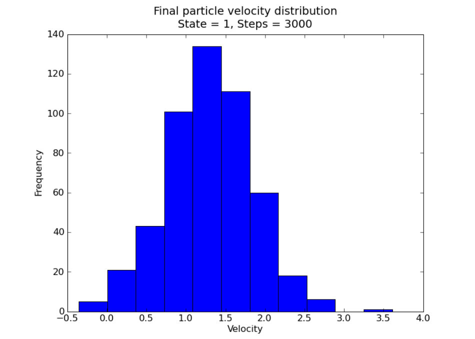
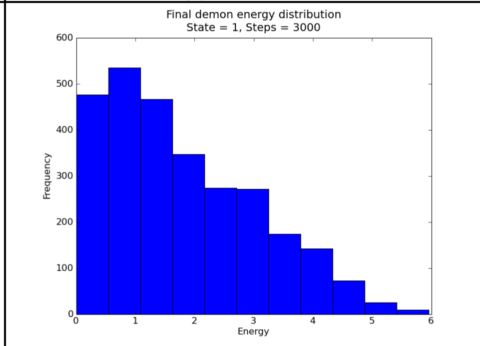
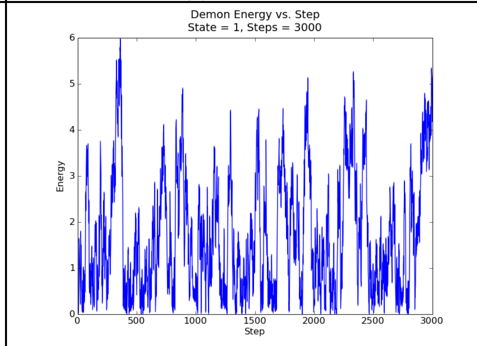
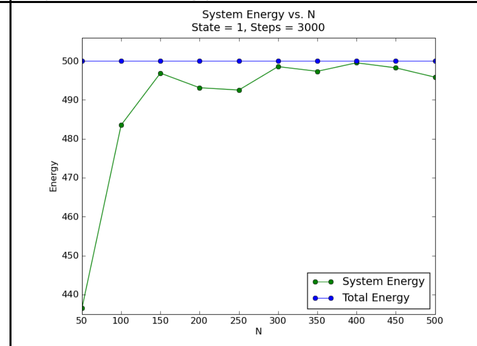
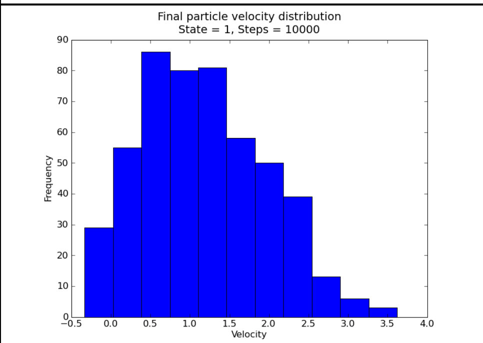
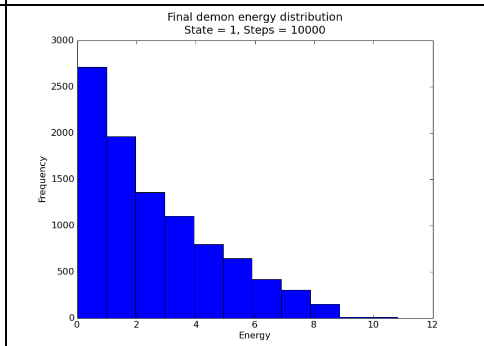
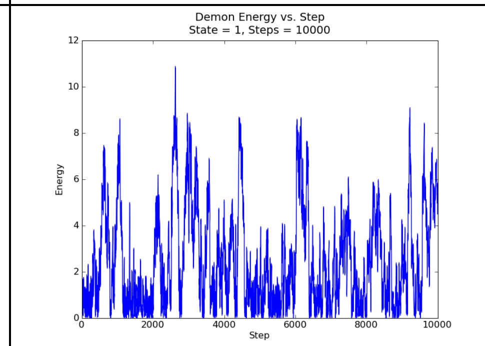
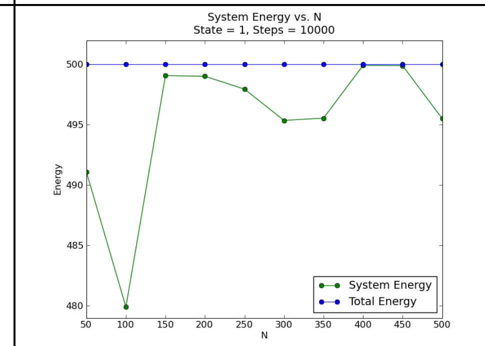
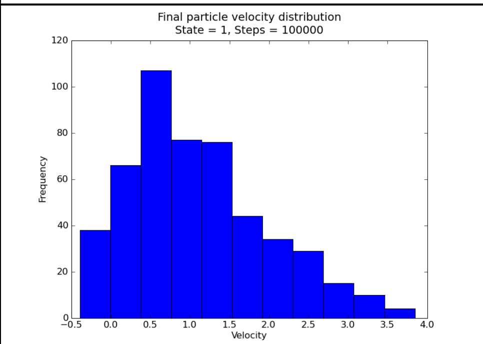
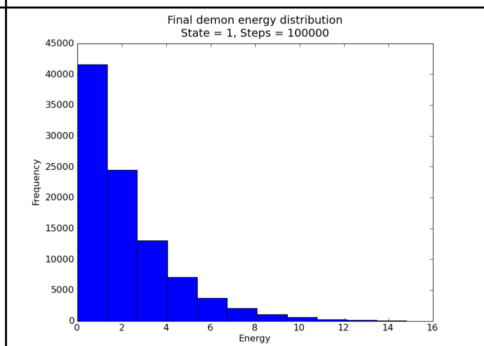
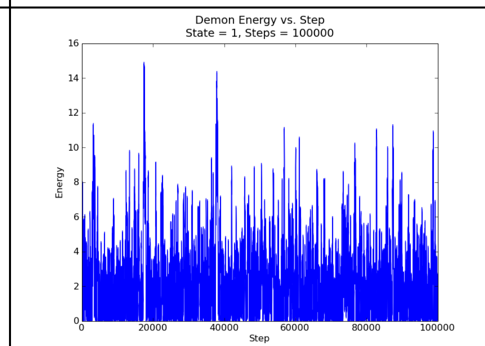
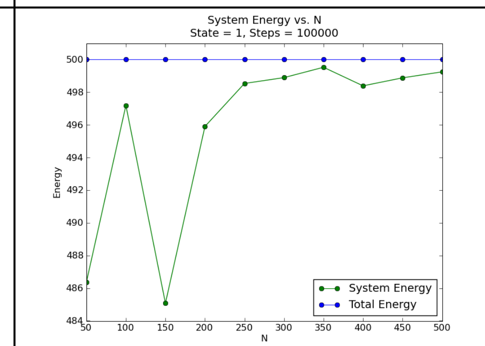
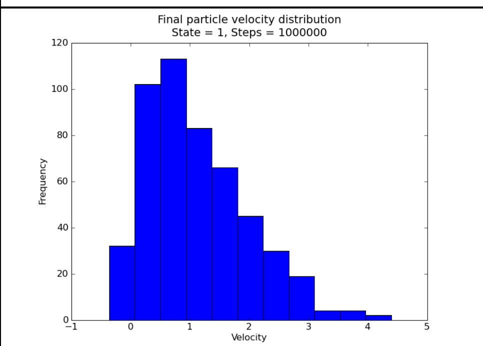
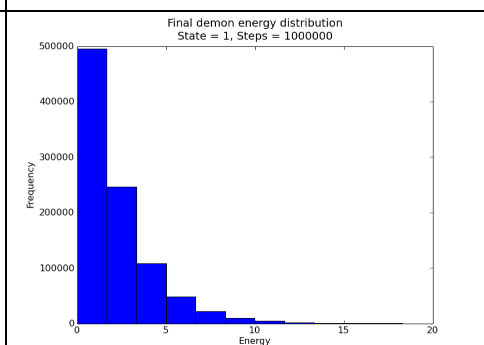
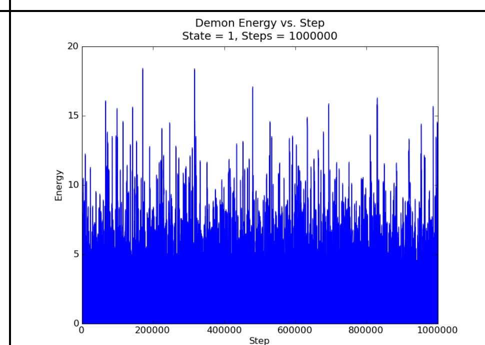
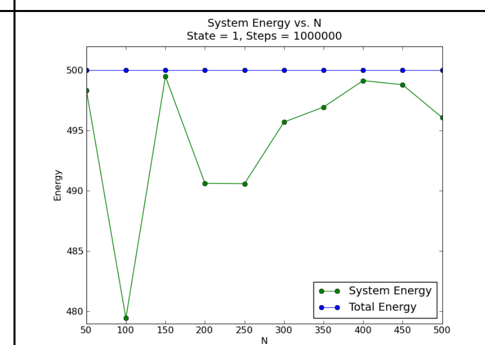
State = 1	The final particle velocities appear to be normally distributed. The initial velocity is $\sqrt{\frac{2 \cdot 500}{500}} \approx 1.414$. The mean of the final velocities does not appear to have moved from this value too much.
State = 2	The final particle velocities are roughly normal in this state as well – though the distribution has a long right-tail. The initial velocity was zero, and the final velocities appear to be centered around 0.5.

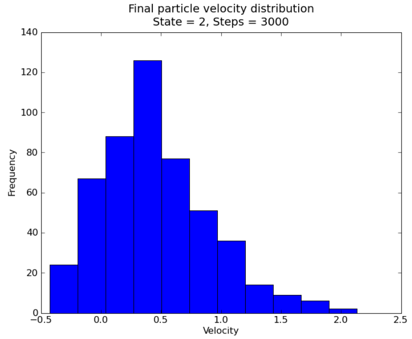
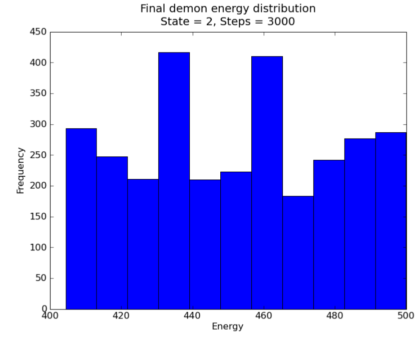
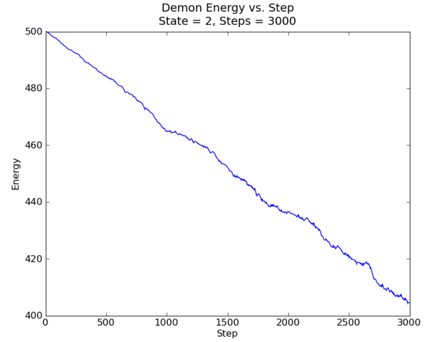
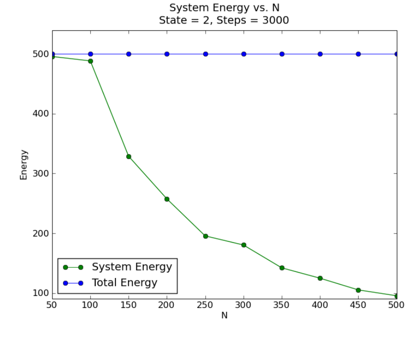
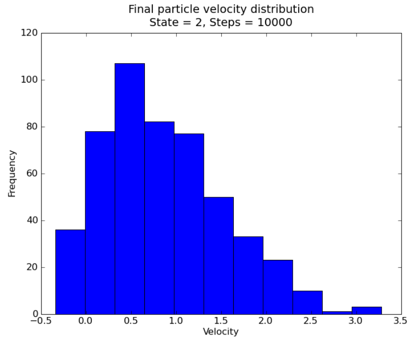
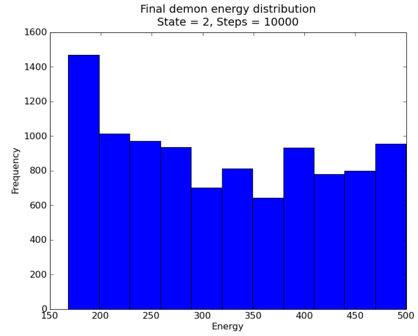
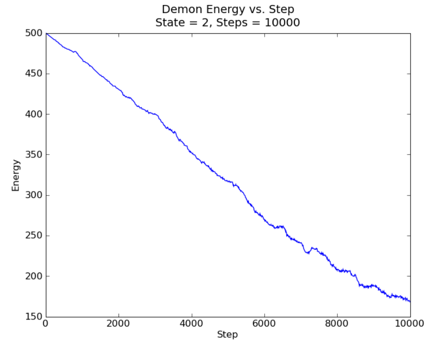
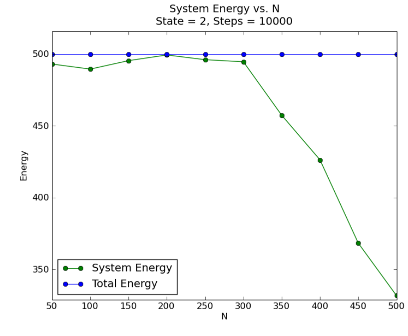
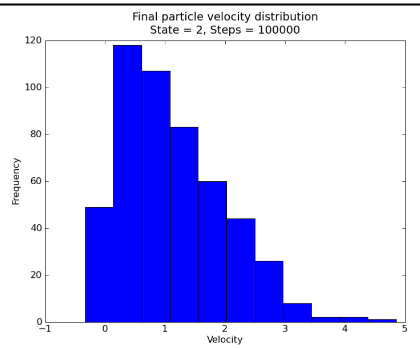
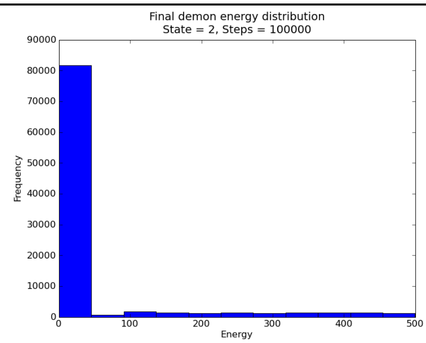
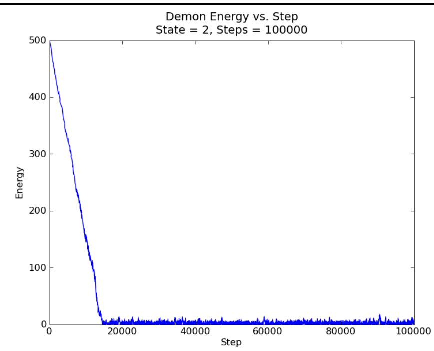
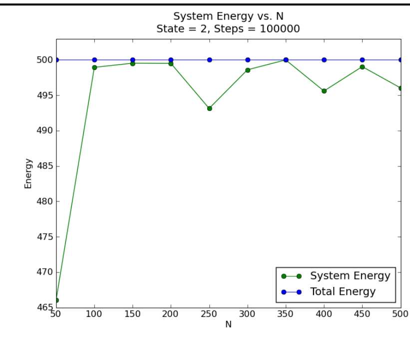
- Using histogram Demon_Energy, what kind of distribution do you judge the demon energies to come from?

State = 1	The demon energy appears to follow an exponential distribution.
State = 2	At a lower number of steps the demon energy looks like it could be uniformly distributed. But at a higher number of steps we see this is not the case. It looks like demon energy follows an exponential distribution in this state as well. It just takes longer to converge to that distribution.

- Comment of the differences and similarities of graph Demon_Energy_Time for different values of N and the two initial state.

State = 1	The demon energy seems to have some periodicity in the first state. There are periods where the demon energy follows a general upward trend, and other periods when it follows a downward trend.
State = 2	The demon energy follows a clear downward (and almost monotonic) trend for the first 15,000 steps until it has transferred nearly all its energy to the system and then fluctuates randomly near zero energy.

	State = 1			
	Final Molecule Velocity	Demon Energy	Demon Energy Time	System Energy vs. N
Steps = 3,000				
Steps = 10,000				
Steps = 100,000				
Steps = 1,000,000				

	State = 2			
	Final Molecule Velocity	Demon Energy	Demon Energy Time	System Energy vs. N
Steps = 3,000				
Steps = 10,000				
Steps = 100,000				
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