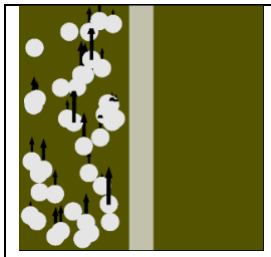
Investigating a simulation of free expansion of a gas: Prediction

Below is a series of simulations of a hard-sphere gas under different conditions. Try to describe and explain the development of the system for each of the simulations. A picture of the initial state of the system is given in the upper left cell of each table; the black arrows represent the velocities of the particles.

1. Gas without collisions, directed velocity

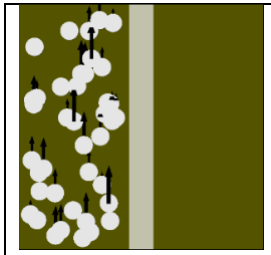
Initial positions – The particles are randomly scattered in the left half of the container. Initial velocities – all the particles have equal velocities: fixed magnitude and upward direction. Collisions – no collisions, the particles pass through each other.

 Initial state	*Micro (particle) description*	*Macro (system) description*	
	Animation (Dynamics and equilibrium)	**Graph of the average number of particles in the monitor vs. time: *N*(t)** (Dynamics and equilibrium)	**Histogram of the average spreading of particle positions *N*(x)** (in the equilibrium state)
Describe the development of the system and **schematically** sketch the graphs that you think will be found.			

Explain why the system behaves as you described.			

2. Gas with collisions, directed velocities

Initial positions – The particles are randomly scattered in the left half of the container. Initial velocities – all the particles have equal velocities: fixed magnitude and upward direction. Collisions – The particles collide with each other with a fixed force.

 Initial state	*Micro (particle) description*	*Macro (system) description*	
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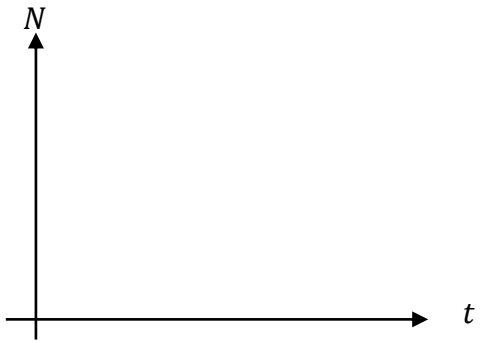
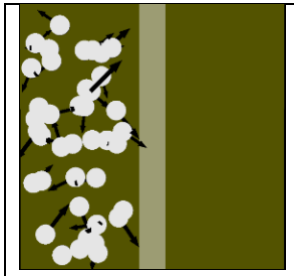
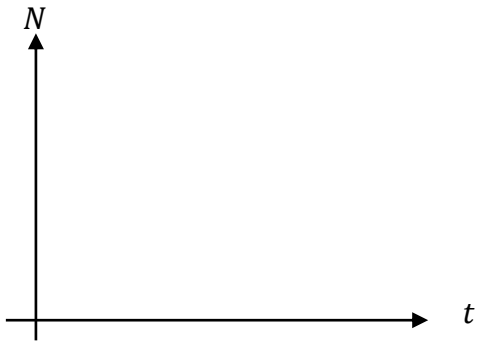
Describe the development of the system and **schematically** sketch the graphs that you think will be found.			
Explain why the system behaves as you described.			

3. Gas with no collisions, random velocities.

Initial positions – The particles are randomly scattered in the left half of the container. Initial velocities – the particles' velocities are random (magnitude and direction). Collisions – no collisions, the particles pass through each other.

 Initial state	*Micro (particle) description*	*Macro (system) description*	
	Animation (Dynamics and equilibrium)	**Graph of the average number of particles in the monitor vs. time: *N*(t)** (Dynamics and equilibrium)	**Histogram of the average spreading of particle positions *N*(x)** (in the equilibrium state)
Describe the development of the system and **schematically** sketch the graphs that you think will be found.			
Explain why the system behaves as you described.			