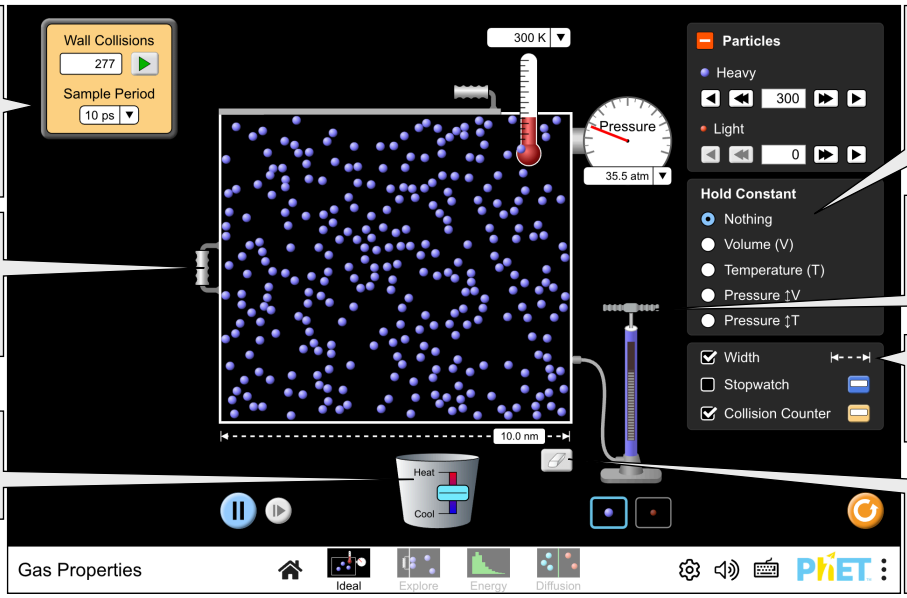
PhET Tips for Teachers

Gas Properties

Ideal Screen

Pump gas molecules into a container and discover what happens as you change the volume, add or remove heat, and more.



COUNT the number of particle-wall collisions

RESIZE the container without doing work

ADD or **REMOVE** heat

HOLD a parameter constant

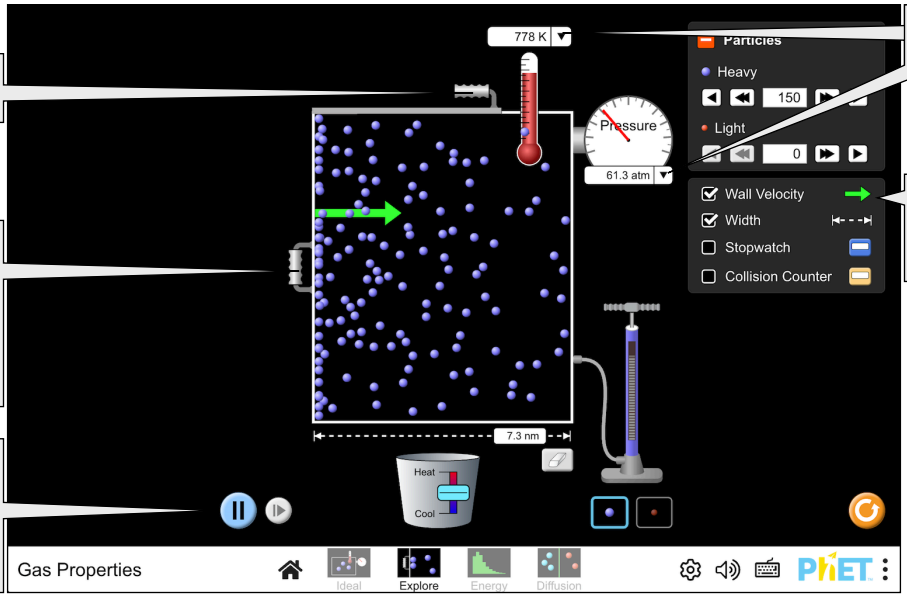
PUMP particles into the container

VIEW container width

EMPTY the container

Explore Screen

Discover what happens when a gas is compressed or expanded, and identify when P-V work is done on or by a gas.



OPEN the lid

COMPRESS or **EXPAND** the volume to explore P-V work.

PAUSE and **STEP** forward frame-by-frame

TOGGLE units

VIEW wall velocity

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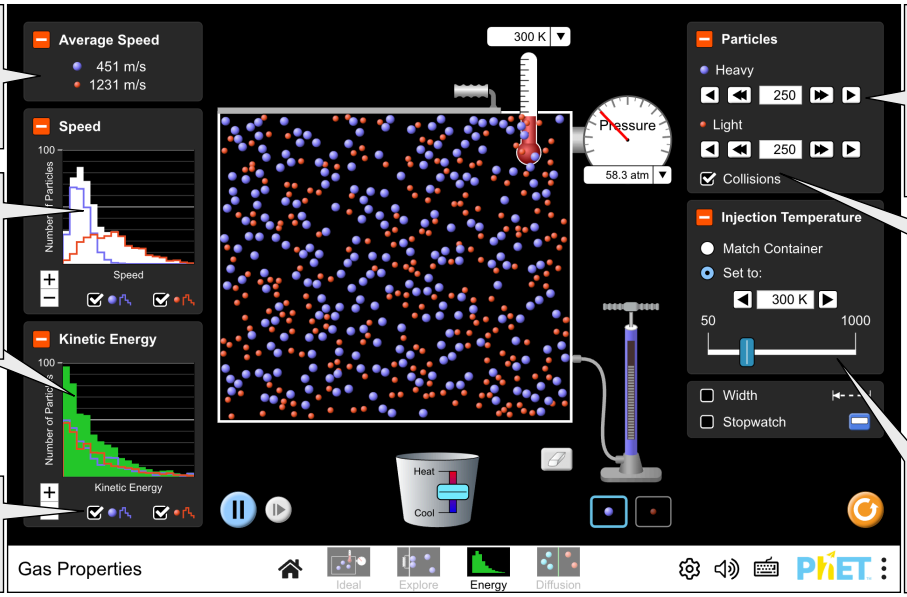
Energy Screen

Examine speed and kinetic energy distributions, and compare heavy and light gases.

OBSERVE the average speed of each species

EXAMINE speed and energy distributions in real time

SEE distributions of each species



ADD or **REMOVE** particles 50 at a time or 1-by-1

EXPLORE systems with or without particle-particle collisions

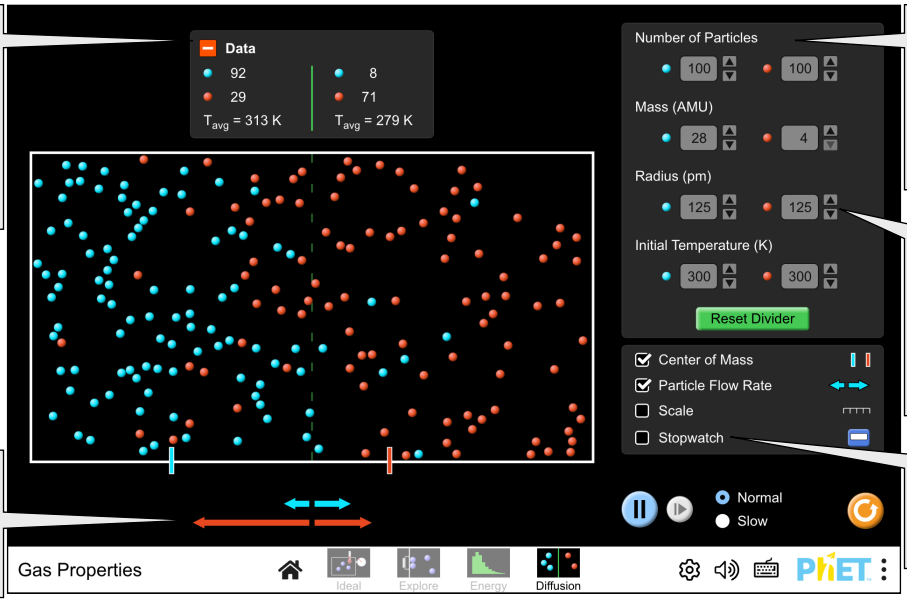
PUMP particles in at varying temperatures

Diffusion Screen

Explore how two gases mix, and experiment with the factors that affect the rate of diffusion.

TRACK the number of particles and temperature on each side

VISUALIZE the flow of particles between sides



EXPERIMENT with number, mass, radius, and initial temperature

EXPLORE the effects of mean free path by changing radius

MEASURE diffusion rate

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '`?`' to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Gas Properties, if you only want to include the 1st and 2nd screens (`screens=1,2`), with the 2nd screen open by default (`initialScreen=2`) use:
https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html?screens=1,2&initialScreen=2

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To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html?locale=es&screens=1,2&initialScreen=2

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	
⚙ `pressureNoise` - removes the noise displayed in the pressure gauge, also found in the PhET menu under Options > Pressure Noise.	`pressureNoise=false`

`screens` - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the Help Center.	`screens=1`
	
	`screens=2,1`

`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=1` `initialScreen=3`
`locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
`colorProfile` - changes simulation colors for easier projection. Also found in the PhET menu under Options > Projector Mode.	`colorProfile=projector`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`

Model Simplifications

- The particle-particle collisions are modeled as hard sphere collisions. All inter-molecular forces are ignored. A detailed description of the model can be found here.
- The container depth (4 nm) and height (8.75 nm) are constant, so volume varies linearly with width.
- The light particles have a mass of 4 AMU and the heavy particles have a mass of 28 AMU. While these masses respectively correspond to He and N_2, the radii differ to optimize the visual size difference.
- The pressure in the model is derived from the ideal gas law. The pressure will be non-zero as soon as $N > 0$, and remains constant until N, T, or V is changed. The pressure displayed on the pressure gauge may vary from the model value under certain circumstances.
  - The pressure gauge will display zero pressure until the first particle-wall collision.
  - If the Pressure Noise preference is on, the pressure reading will fluctuate every 0.75 ps by a maximum of 50 kPa. The amount of pressure noise is inversely proportional to the pressure, and for $T \leq 50K$ it will linearly decrease until it becomes 0 kPa when $T \leq 5K$.
- Moving the container wall on the Ideal screen will not do any work on/by the system. When the container wall is grabbed, the simulation will pause. Upon release, the particles will instantaneously redistribute in the container, and their speeds will remain unchanged.

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- On the Explore screen, moving the container wall will affect the velocity of the particles colliding with it. When 'Wall Velocity' is turned on, a vector representing the wall's velocity will be displayed while moving the wall. The wall has speed limit of 800 pm/ps when reducing the volume to avoid always blowing the lid.
- The container lid will blow off if the pressure gauge reaches its maximum reading, unless the lid is already open beyond a crack.
- Adding particles to the container will not change the temperature of the system, as the newly-added particles are given the appropriate velocity to match the temperature of the gas in the container. On the Energy Screen, use the Injection Temperature controls to instead set the temperature of the particles before adding them to the container.
- When the system temperature is below 0.5 K, the display will show 0 K. Particle motion will eventually stop if the container is cooled further, though this may take some time.
- The Speed and Kinetic Energy histograms are designed to be qualitative. The zoom buttons will rescale the y-axes of both histograms simultaneously. The x-axes are static, and in rare cases some data may fall off-scale. The data refreshes every 1 ps.
- The Particle Flow Rate arrows are proportional to the number of particles that have crossed the midline and is time-averaged over 300 ps.

Suggestions for Use

Sample Challenge Prompts

- Describe the relationship between particle-wall collisions and pressure.
- Design an experiment to determine the relationship between two gas properties, such as P and T.
- Identify the relationship between pressure, volume, temperature, and number of gas molecules.
- Compare and contrast the effect of moving the container wall on the temperature of the system on the Ideal and Explore screens. What effect does the speed of the wall have on the temperature change?
- Describe the shape of the speed distribution. Which species is faster, on average? What happens when particle-particle collisions are turned off?
- Explain how two gases mix.
- Describe what the Particle Flow Rate arrows represent.
- Design an experiment to determine the factors which affect the rate of diffusion.

See all published activities for Gas Properties here.
For more tips on using PhET sims with your students, see Tips for Using PhET.

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