Tips for Teachers — Gases Intro

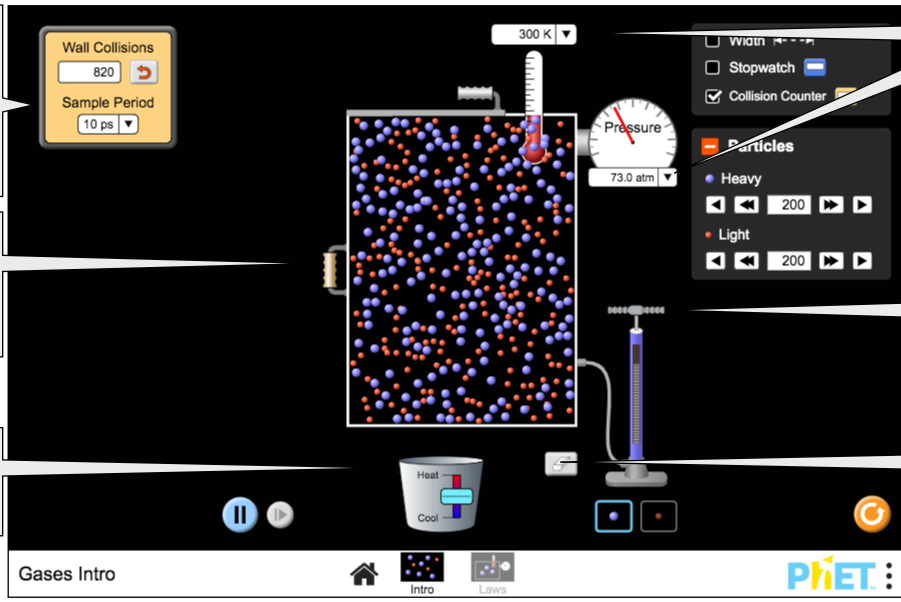
Intro Screen

Pump gas molecules into a box 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 (no work done)

ADD or **REMOVE** heat



TOGGLE units

PUMP particles into the container

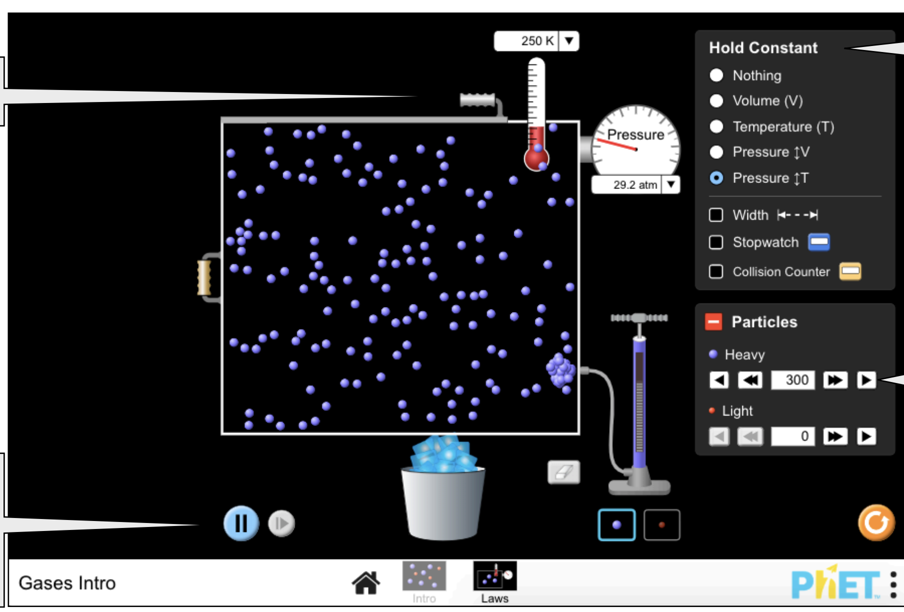
EMPTY the container

Ideal Screen

Explore how properties of the gas vary in relation to each other, and experiment by holding one parameter constant.

OPEN the lid

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



HOLD a parameter constant

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

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Complex Controls

- For better contrast when projecting the simulation, use Projector Mode found under the Options menu.
- By default the pressure gauge displays the exact pressure in the model, derived from the ideal gas law. Artificial noise case be added to the pressure gauge under Options > Pressure Noise. Alternatively, append `?pressureNoise=true` to the end of the URL.

Model Simplifications

- The particle-particle collisions are modeled as hard sphere collisions. 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, $P = \frac{NkT}{V}$. 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 option 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 ≤ 50K it will linearly decrease until it becomes 0 kPa when T ≤ 5K.
- Moving the container wall 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.
- 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.
- 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.

Suggestions for Use

Sample Challenge Prompts

- Describe the relationship between particle-wall collisions and pressure.
- Predict how changing temperature will affect the speed of the gas molecules.
- Design an experiment to determine the relationship between two gas properties, such as pressure and temperature.
- Identify the relationship between pressure, volume, temperature, and number of gas molecules.

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

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