Unit 9 Gas Laws **Name _____**
PhET Simulation - "Gases Intro" **Block ____**

Size vs Speed of Particles

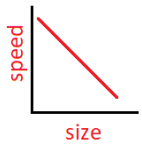
1. Click on the Intro icon. Click the green + sign to open the Particle box. Pump 100 heavy, blue gas molecules into the chamber. Explain their behavior. Do they move fast or slow? Do they curve or move in straight paths? What happens when they touch other gas molecules? Blue larger molecules move slowly in straight line paths. The spread out until they fill the entire container. They bounce off each other and do not stick together.

2. Now click the red dot under the pump that represents the smaller gas particles. Pump in 100 light, red gas molecules into the chamber. Explain how their behavior is similar or different to the heavy particles. Red smaller molecules move faster than the blue larger molecules. They also move in straight line paths and spread out to fill the entire container. They also bounce off other molecules and do not stick together.

3. What is the relationship between the size of the particles and the speed of the particles? The larger the particles the slower the speed.

4. What type of relationship is this: directly proportional or inversely proportional? Inversely proportional

5. Sketch a graph that represents this relationship:



Temperature (T) vs Pressure (P) of Particles

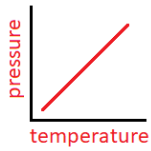
1. Click the heat control handle on the bucket below the gas chamber. Drag it upward to increase the heat to 500 K (227 °C). What is the current pressure? 39.0 atm (3955 kPa)

2. Now increase the heat to 1000 K (727 °C). What is the pressure at this temperature? 77.8 atm (7885 kPa)

3. What is the relationship between pressure and temperature? When the temperature increases, the pressure increases.

4. What type of relationship is this: directly proportional or inversely proportional? Directly proportional

5. Sketch a graph that represents this relationship:



Volume (V) vs Pressure (P) of Particles

1. Reset the system by clicking the orange circle with the curved arrow in the far right corner.

2. Click on the collision counter to open the Wall Collision window. Set Sample Period to 20 ps.

3. Click the green + sign to open the Particle box. Pump 100 heavy blue gas molecules into the chamber, and then pump in 100 light red molecules. Allow the molecules to spread out equally for 20 – 30 seconds.

4. Click the green GO arrow in the collision counter box to measure the number of collisions in 20 ps. Next click the green GO arrow a few more times. Notice how the number of collision changes each time.

5. Now select the Width ↔ check box at the top right. A dashed line with arrows will appear below the chamber indicating the current width is 10.0 nm. Record the maximum chamber width, speed of the particles, and current temperature and pressure below:

Chamber Width: 10.0 nm	Pressure: 23.3 atm (2359 kPa)
Temperature: 300 K (27°C)	Average Wall Collisions: 500 - 550

6. Click on the gas chamber's left side handle and drag the chamber wall to the **left** as far as it will go. Record the maximum chamber width, speed of the particles, and current temperature and pressure below:

Chamber Width: 15.0 nm	Pressure: 15.6 atm (1578 kPa)
Temperature: 300 K (27°C)	Average Wall Collisions: 400 - 450

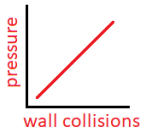
7. Click on the gas chamber's left side handle and drag the chamber wall to the **right** as far as it will go. Record the maximum chamber width, speed of the particles, and current temperature and pressure below:

Chamber Width: 5.0 nm	Pressure: 46.7 atm (4733 kPa)
Temperature: 300 K (27°C)	Average Wall Collisions: 900 - 950

8. What is the relationship between the number of wall collisions and the pressure? When the number of wall collisions increases, the pressure increases.

9. What type of relationship is this: directly proportional or inversely proportional? Directly proportional

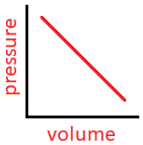
10. Sketch a graph that represents this relationship:



11. What is the relationship between the volume of the chamber and the pressure? When the volume decreases, the pressure increases.

12. What type of relationship is this: directly proportional or inversely proportional? Inversely proportional

13. Sketch a graph that represents this relationship:



Temperature (T) vs Volume (V)

1. Click the LAWS icon at the bottom menu to switch tabs.

2. Click the green + sign to open the Particle box. Pump 100 heavy, blue gas molecules into the chamber, and then pump in 100 light, red molecules. Allow the molecules to spread out equally for 20 – 30 seconds.

3. In the HOLD CONSTANT menu, select Pressure ↕ V. Now select the Width ↔ check box at the top right. A dashed line with arrows will appear below the chamber indicating the current width is 10.6 nm. Record the current chamber width, temperature and pressure below:

   Chamber Width: 10.0 nm Pressure: 23.4 atm (2366 kPa)

   Temperature: 300 K (27°C)

4. Click the HEAT control handle on the bucket below the gas chamber. Adjust the temperature to 400 K (127 °C). Record the current chamber width, temperature and pressure below:

   Chamber Width: 14.1 nm Pressure: 23.4 atm (2366 kPa)

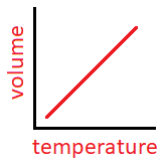
   Temperature: 400 K (127°C)

5. What happens when you try to increase the temperature to 500 K (227°C)? Pressure cannot be held constant because volume would be too large.

6. What is the relationship between the temperature and volume, when pressure is held constant? When the temperature increases, the volume increases.

7. What type of relationship is this: directly proportional or inversely proportional? Directly proportional

8. Sketch a graph that represents this relationship:



Number of Particles (n) vs Temperature (T)

1. Reset the system by clicking the orange circle with the curved arrow in the far right corner.

2. Click the green + sign to open the Particle box. Pump 100 heavy, blue gas molecules into the chamber, and then pump in 100 light, red molecules. Allow the molecules to spread out equally for 20 – 30 seconds.

3. In the HOLD CONSTANT menu, select Pressure ↕ T. Now select the Width ↔ check box at the top right. A dashed line with arrows will appear below the chamber indicating the current width is 10.0 nm. Record the current total number of particles, chamber width, temperature, and pressure below:

   Total Number of Particles: 200 Temperature: 300 K (27°C)

   Chamber Width: 10.0 nm Pressure: 23.4 atm (2366 kPa)

4. Now increase the number of particles to 1000 so that there are 500 heavy, blue particles and 500 light, red particles. Record the current total number of particles, chamber width, temperature, and pressure below:

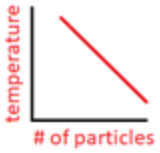
   Total Number of Particles: 1000 Temperature: 60 K (– 213°C)

   Chamber Width: 10.0 nm Pressure: 23.4 atm (2366 kPa)

5. What is the relationship between the number of particles and temperature, when the pressure and volume are held constant? When the number of particles increases, the temperature decreases.

6. What type of relationship is this: directly proportional or inversely proportional? Inversely proportional

7. Sketch a graph that represents this relationship:



Number of Particles (n) vs Volume (V)

1. Reset the system by clicking the orange circle with the curved arrow in the far right corner.

2. Click the green + sign to open the Particle box. Pump 100 heavy, blue gas molecules into the chamber, and then pump in 100 light, red molecules. Allow the molecules to spread out equally for 20 – 30 seconds.

3. In the HOLD CONSTANT menu, select Pressure ↕ T. Now select the Width ↔ check box at the top right. A dashed line with arrows will appear below the chamber indicating the current width is 10.0 nm. Record the current total number of particles, chamber width, temperature, and pressure below:

   Total Number of Particles: 200 Temperature: 300 K (27°C)

   Chamber Width: 10.0 nm Pressure: 23.4 atm (2366 kPa)

4. Now add 50 more blue particles and 50 more red particles so that the total particle count is 300. Click on the gas chamber's left side handle and drag the chamber wall to the **left** until the temperature matches the initial temperature reading from Question #3 above. Record the current total number of particles, chamber width, temperature, and pressure below:

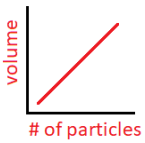
   Total Number of Particles: 300 Temperature: 300 K (27°C)

   Chamber Width: 15.0 nm Pressure: 23.4 atm (2366 kPa)

8. What is the relationship between the number of particles and volume of the chamber, when the temperature and pressure are held constant? When the number of particles increases, the volume increases.

9. What type of relationship is this: directly proportional or inversely proportional? Directly proportional

10. Sketch a graph that represents this relationship:



Ideal Gas Law

The ideal gas law combines the variables for Pressure (P), Volume (V), number of particles (n), and Temperature (T) into one equation. Based on the data recorded in this activity, try to write an equation for the ideal gas law. The gas law constant has already been added for your convenience**.** *(Hint: Variables on the same side of the equation are inversely proportional, and variables on opposite sides of the equation are directly proportional.)*

P V = n R T.