Kinetic Molecular Theory of Gases

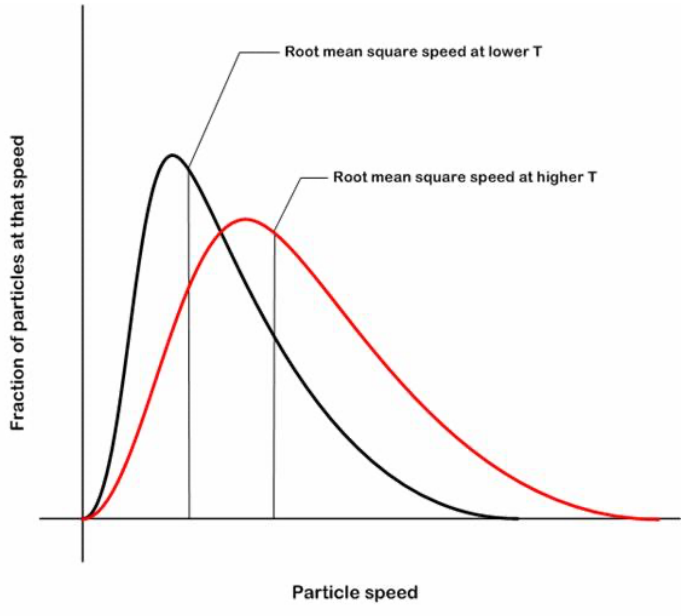
The **kinetic molecular theory** is a simple model that explains the properties of an ideal gas. The postulates of the kinetic molecular theory as they relate to the particles of an ideal gas are:

1. The particles are so small compared to the distance between them that the volume of the individual particles can be assumed to be negligible (zero).
   - Gases consist of small particles that are separated from each other by empty space.
   - The volume of the particles is small compared with the volume of the empty space.

2. The particles are in constant motion. The collisions of the particles with the walls of the container are the cause of the pressure exerted by the gas.
   - Gas particles move in straight lines until they collide with other particles or with the walls of their container.
   - The collisions between gas particles are **elastic** (no kinetic energy is lost, only transferred from one particle to the other).

3. The particles are assumed to exert no forces on each other; they are assumed neither to attract nor repel each other.
   - Because gas particles are far apart, there are no significant attractive or repulsive forces between them.

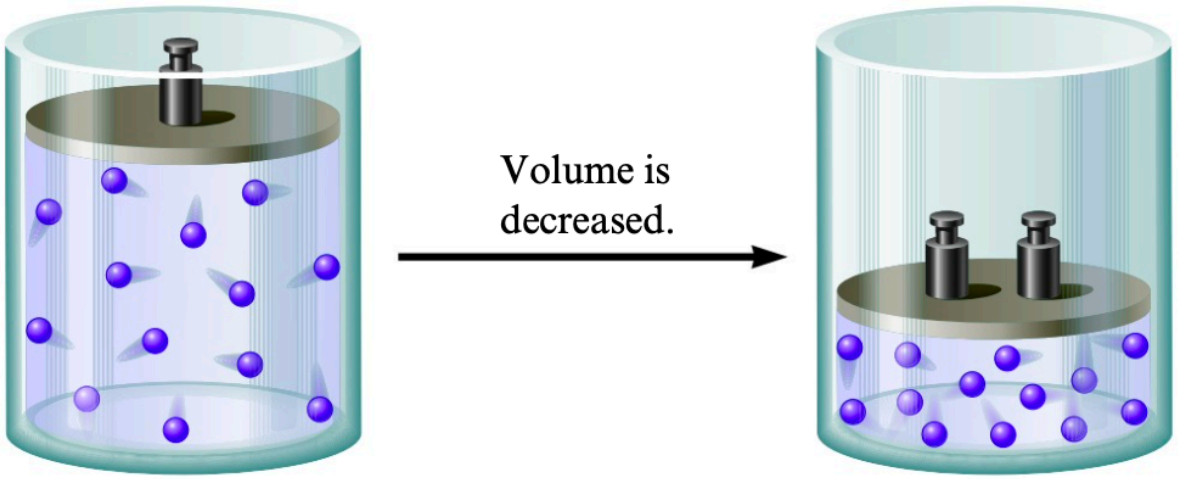
4. The average kinetic energy of a collection of gas particles is assumed to be directly proportional to the Kelvin temperature of the gas.
   - Two factors determine the kinetic energy of a particle: mass and velocity
   - In a sample of a single gas, all particles have the same mass, but not the same velocity (thus, they have different kinetic energies).
   - **Temperature** is a measure of the average kinetic energy of the particles in a sample of matter.



Properties of Gases and the KMT

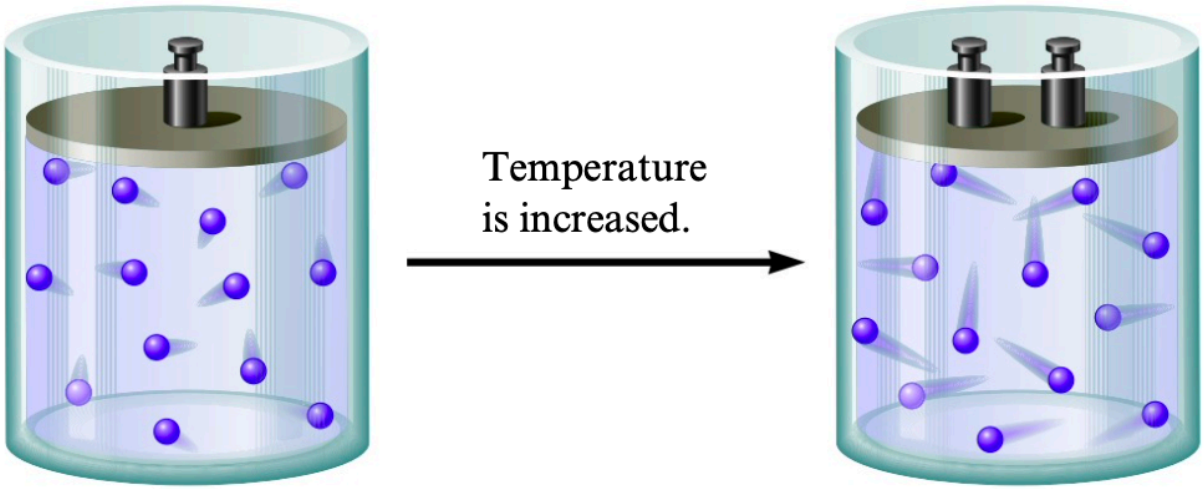
Pressure and Volume (Boyle's Law)

If the volume of a gas is decreased (*n* and *T* are constant) the gas particles will hit the walls of the container more often. More frequent collisions will result in an increase in pressure.



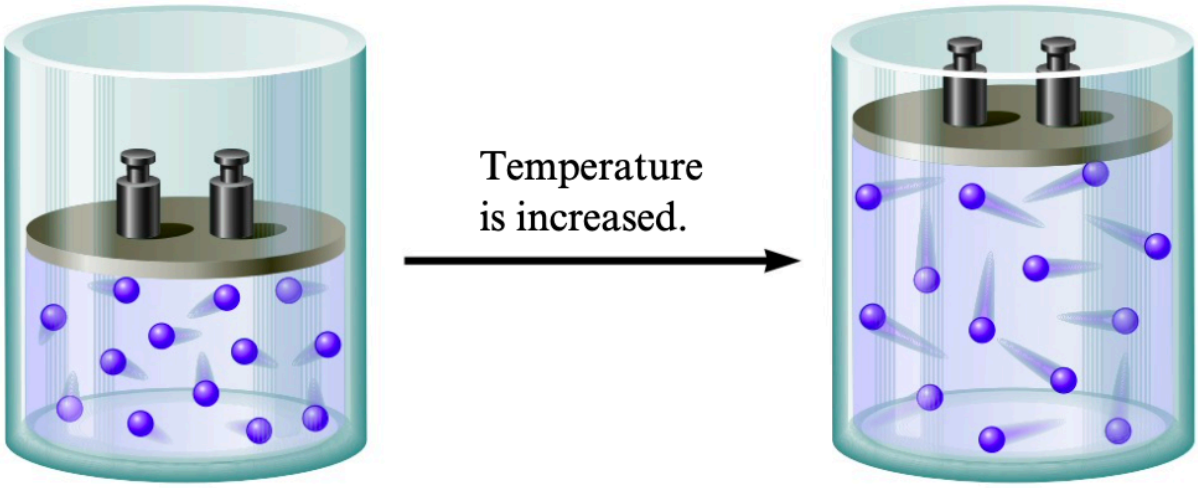
Pressure and Temperature

When the temperature of a gas increases (*n* and *V* are constant) the speeds of its particles increase. As a result, the particles hit the wall with greater force and greater frequency. Since the volume remains the same, this would result in increased pressure.



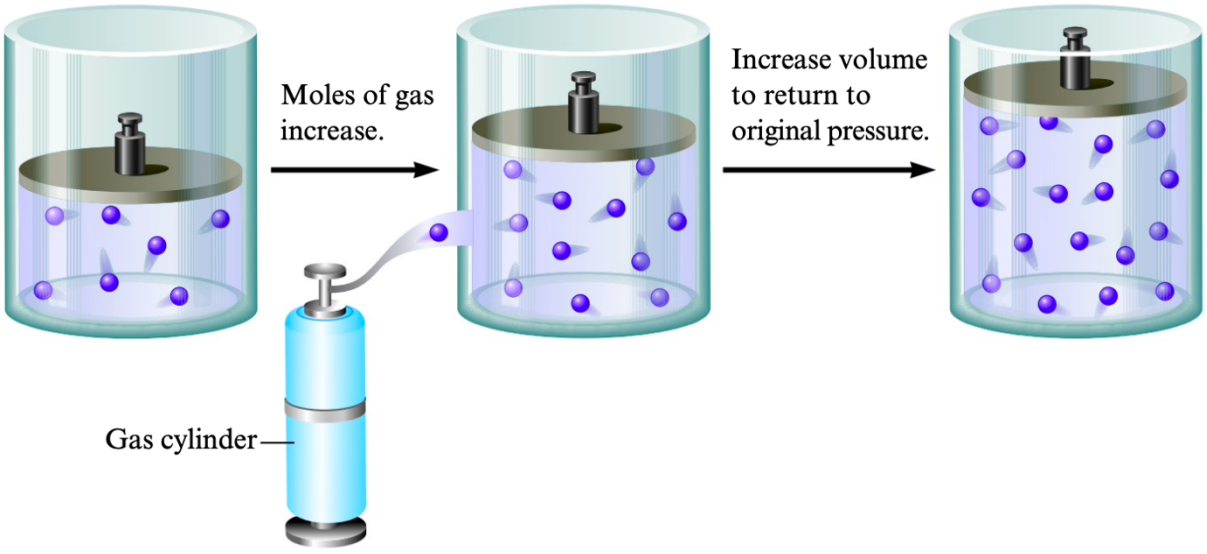
Volume and Temperature (Charles's Law)

When a gas is heated to a higher temperature (n and P are constant) the speeds of its molecules increase. As a result, the particles hit the wall with greater force and greater frequency. The only way to keep the pressure constant in this situation is to increase the volume of the container. This compensates for the increased particle speeds.



Volume and Number of Moles (Avogadro's Law)

Increasing the number of gas particles (P and T are constant) would cause the pressure to increase if the volume were held constant. The only way to return the pressure to its original value is to increase the volume.



Worksheet

1. Identify each statement as True or False.

   a) Gas particles are far apart.

   b) Gas particles have significant volume with respect to the volume of the space they occupy.

   c) Gas particles are in constant random motion.

   d) Gas particles lose kinetic energy in collisions.

2. Using the KMT, explain why a gas can be easily compressed.

3. Using the KMT, explain why a tire or balloon expands when air is added.

4. Using the KMT, explain what causes the pressure exerted by a gas inside a container.

5. Explain how the temperature of a gas relates to its kinetic energy.

6. Describe the effect of adding more gas to a container that cannot expand.

7. Describe the effect that decreasing the size of a container would have on the gas it contains.

8. A gas is stored in a container whose volume can increase or decrease as needed. Describe what would happen if the gas was cooled.