

Grade Level: 9th-10th Grade

Subject / Content Area: Chemistry

Unit of Study: Matter and Energy

Lesson Title: Introduction to Gas Laws

**Central Focus for the learning segment:**

What is the relationship between the pressure, volume, and temperature in gases?

How do clouds form from atmospheric water vapors?

**Content Standard(s):**

Performance Expectations:

**HS-PS1-9. Analyze data to support the claim that the combined gas law describes the relationships among volume, pressure, and temperature for a sample of an ideal gas.** [Clarification Statement: Real gases may be included at conditions near STP. The relationships of the variables in the combined gas law may be described both qualitatively and quantitatively.] [Assessment Boundary: Assessment is limited to the relationships among the variables of the combined gas law, not the gas law names, i.e. Boyle's Law.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<b>Analyzing and Interpreting Data</b> Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-PS1-9)	<b>PS1.A: Structure and Properties of Matter</b> <ul style="list-style-type: none"><li>(NYSED) The concept of an ideal gas is a model to explain behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature. (HS-PS1-9)</li></ul>	<b>Patterns</b> <ul style="list-style-type: none"><li>Mathematical representations can be used to identify certain patterns. (HS-PS1-9)</li></ul> <b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> <ul style="list-style-type: none"><li>Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)</li></ul>

**Learning Objectives**

*Students will quantitatively determine the relationship between variables for each gas law.*

**Language Function students will develop. Additional language demands and language supports:**

Vocabulary:

- Pressure, Temperature, Collisions, Boyle's Law, Charles' Law, Gay-Lusacc's Law.

Language Function:

Describe, in terms of collisions between the gas particles and its container, how changes in pressure, volume, or temperature impact one another.

Construct an explanation as to why changes in pressure can cause phase changes.

**Materials:**

- Isopropyl Alcohol
- Water Bottles
- Laptops

**Objective:**

- Students will be able to...
  - Determine the relationships described in each gas law by analyzing quantitative data.
  - Construct an explanation, in terms of particle movement, of each gas law.

**Central Task/ Focus:** Students will simulate changes in a closed gaseous system to determine the different gas laws.

Aim- What are the different gas laws related to pressure, temperature, and volume?

Content (Slides): [Link](#)

- I. (**Engage**) **Phenomenon:** How are clouds formed?
  - a. Students will model the formation of clouds using a water bottle and isopropyl alcohol.
    - i. Add isopropyl alcohol to the bottle, cap it, and twist the bottle.
    - ii. Release the bottle and watch the condensation of the vapors into a cloud.
    - iii. CER- Students will complete a “**Claim**” about the cloud demo and “**Evidence**”
      1. Students are given the start of the claim.
      2. Evidence will be guided via teacher instruction (i.e. what do you notice about the bottle before and after releasing pressure? // does condensation imply a temperature increase or decrease?)
  - b. Use this as an introduction to the different variables of the gas laws.
- II. (**Explore**) **Students will explore the different gas laws using the following PhET lab:**  
<https://phet.colorado.edu/en/simulations/gas-properties>
  - i. Teacher will model the different functions of the simulation. As students work on the simulation, the teacher will walk around and check their graphs.
  - ii. ([Worksheet Link](#)) Students will plot the data between two variables (pressure, volume, and/or temperature).
    1. For each gas law, they will identify the mathematical relationships (inverse/ directly proportional).

- a. **Differentiation-** Mathematical concepts for each law will have a fill-in-the-blank.
  2. (Explain) Students will apply what they know about gas particles and pressure/ collisions to explain these relationships.
  - iii. (Elaborate) Students will complete the “**Reasoning**” of their CER.
- III. (Evaluate) [Formative Assessment]- Students will complete practice problems on the different gas laws.
- i. Ex. What is the new volume of a gas if 50 mL at 81.0 kPa has its pressure increased to 101.3 kPa?
- IV. Teacher will teach the combined gas law and its relationship to the individual gas laws.