# Pre-Lab Information

Purpose Explore the relationship between pressure and the volume of a gas, as described by Boyle’s law.

Time Approximately 45 minutes

Question What is the effect of pressure on the volume of a gas?

Hypothesis If the pressure on a gas is increased, then its volume will decrease because the gas molecules will be pushed closer together. Furthermore, the relationship between pressure, *P*, and volume, *V*, should be an inverse proportion, in which *PV* is constant and P = kV–1 for some constant, *k*.

Variables *Independent Variable*:pressure; *Dependent Variable*:volume  
*Constants*: temperature and number of moles

Summary By placing various amounts of weight on a syringe, you will increase pressure on the gas inside. You will collect the pressure and volume data for each trial and analyze their mathematical relationship.

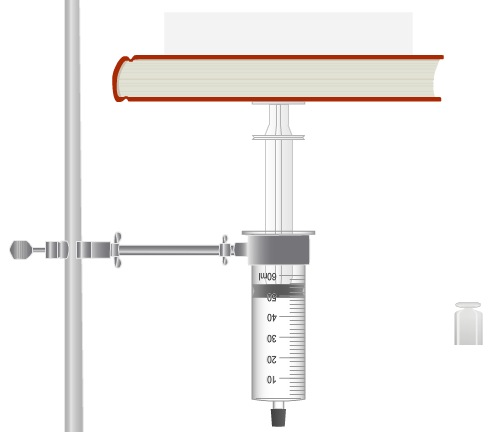
# Safety

* Always wear a lab apron, safety glasses, and gloves while performing an experiment.
* Do not use any equipment unless you have been trained and its use has been approved by your teacher.
* Be careful setting up the syringe with weights. The setup is not very stable and can fall over easily   
  if care is not taken.
* Report all accidents—no matter how big or small—to your teacher.
* Keep your work area clear of all materials except those needed for the experiment.

# Procedure

1. **Gather Materials**

|  |  |
| --- | --- |
| * 60 mL syringe with cap * Ring stand * Burette clamp * Balance | * Silicone lubricant * Ruler * Book * Four 1 kg weights (2 kg weights can be substituted) |

1. **Measure the Area of the Top of the Syringe**
   1. The top of the syringe’s plunger is a circle. You need to compute its area for use in later computations of pressure values. Start by using a ruler to measure the diameter. Estimate the final significant digit.
   2. Divide by two to find the radius. Maintain significant figures.
   3. Substitute the radius into the formula A = *πr*2 to find the area of the top of the syringe. Maintain significant figures.
2. **Prepare the Syringe System**
   1. Remove the cap from the syringe. Slide the plunger out as well.
   2. To prevent friction that could affect volume changes, add several drops of silicone lubricant to the gasket.
   3. Reinsert the plunger and position it precisely at the 50 mL mark.
   4. Put the cap back on at the other end of the syringe.
   5. Suspend the syringe from a ring stand, using a burette clamp to secure it. Make sure that the mL markings are facing you so you can read the volumes later.
   6. If you set up the syringe correctly, the initial volume should be 50.0 mL, which is recorded for you in the data table, as is the baseline pressure of 1 atmosphere, which is equivalent to 1.03 kg/cm2.
3. **Measure the Mass of the Book**

The book will serve as a flat surface on which you will later place additional weights. However, it has its own mass, which you need to measure.

* 1. Zero the balance. Place the book on the balance.
  2. Measure the mass to the nearest gram (1 g).
  3. In this experiment, you will measure all masses in kilograms. Convert the book’s mass to kilograms. Record this value on the data sheet.

**Sub-steps for Steps 5–9:**

1. Place the correct amount of weight on the syringe to apply additional pressure on the gas. Watch as the plunger slides down.
2. Total the mass on the syringe. Record this value in the correct row of the data table.
3. Calculate the pressure using the formula *P* = 1.03 + Mass on Syringe⁄Area of Top of Syringe.  
   (This formula adds the pressure from the weight to the atmospheric pressure, 1.03 kg/cm2.)
4. Measure the volume of the gas in the syringe. Estimate to the nearest 0.5 mL.
5. Compute the product of P • V. Make sure to record all values in the data table.
6. **Measure Pressure and Volume with the Weight of the Book**
7. **Measure Pressure and Volume with the Book and 1 kg of Weight**
8. **Measure Pressure and Volume with the Book and 2 kg of Weight**
9. **Measure Pressure and Volume with the Book and 3 kg of Weight**
10. **Measure Pressure and Volume with the Book and 4 kg of Weight**
11. **(Non-Virtual Lab Only) Repeat All Measurements** If you are doing this experiment in a real laboratory (i.e., not virtually), perform at least one additional set of trials, adding lubrication to ensure that the plunger slides freely. You may wish to use 0.5 kg weights to measure at intermediate values.

# Data

Record your data either in the space below or in your lab notebook.

**Circular Top of the Syringe**

|  |  |  |
| --- | --- | --- |
| **Diameter (cm)** | **Radius, *r* (cm)** (Divide the diameter by 2) | **Area, π*r2*** **(cm2)** (π ≈ 3.14159) |
|  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mass on Syringe  (kg)** | **Pressure, *P* (kg/cm2)** | **Volume, V (mL)** | ***P • V*** |
| **No Book or Weight** | 0 | 1.03 | 50.0 | 51.5 |
| **Book Only** |  |  |  |  |
| **Book + 1 kg of Weight** |  |  |  |  |
| **Book + 2 kg of Weight** |  |  |  |  |
| **Book + 3 kg of Weight** |  |  |  |  |
| **Book + 4 kg of Weight** |  |  |  |  |

\* Calculate the pressure using the formula *P* = 1.03 + Mass on Syringe⁄ Area of Top of Syringe. This formula adds the pressure from the weight to the atmospheric pressure, 1.03 kg/cm2.

**Graph:** Enter all six (*P*, *V*) pairs into a regression calculator so that you can compute the power

regression equation *V = aPn*. (The *x*-variable is pressure, *P*, and the *y*-variable is volume, *V*.) How close

is the power, *n*, to the value –1, predicted by Boyle’s law?