***LAB [15 pts]***
***Boyle's Law: P vs. V***

***NAME*** _____
***Lab Partner*** _____
***Period*** _____

**Purpose:** The purpose of this experiment is to experimentally determine the relationship between pressure and volume of a gas at constant temperature and number moles.

**Background**

**Boyle's Law** states that as the pressure of a gas increases, the volume of the gas decreases, as long as temperature and the number of moles of gas remain constant. This can be expressed mathematically by PV = constant or P = constant × (1/V), where P is pressure and V is volume. The second equation above tells us that a plot of P vs. 1/V should give us a straight line.

**Prelab Observations:** *Qualitative observation on compressibility* [2 pts]

1) Unscrew the cap on the syringe and pull the plunger all the way out to 60 mL. Now screw the cap back on. Place the plunger back into the syringe and push the plunger in as hard as you can.
   a) It gets **(easier, harder)** to push the plunger in as you decrease the gas volume.
   b) Can you push the plunger all the way in (make the volume = 0)? **(Yes No)**
2) Remove the cap and push the plunger all the way in. Now screw on the cap. Attempt to remove the plunger from the syringe. Is it difficult to remove the plunger? **(Yes, No)**

**Procedure:**

1) Take your syringe, unscrew the cap, move the plunger until it is set at 60 mL. Put the cap back on.
2) Securely clamp the syringe to the ring stand. The syringe tip must be firmly resting on the platform of ring stand. The volume markings should be clearly visible.
3) Carefully center a textbook on top of the plunger. *(Any textbook will do, but you will need a total of 6 textbooks of the same text to complete the lab.)* Read the volume of the trapped gas in the syringe when a load of one book is on the plunger. Read volume to the nearest ml.
4) Now add another textbook and record the volume. Continue adding books until a pressure of six books is obtained. Repeat 3 & 4 for a second trial, then average volumes and record in table.
5) *Calculate* 1/Vol from your average volumes and record in table. Do NOT enter a fraction!

**Data: [2 pts]**

| **Pressure (in # of books)** | **Trial 1 Volume (ml)** | **Trial 2 Volume (ml)** | **Average Volume (mL)** | $\frac{1}{\text{Vol}}$ **(in 1/mL)** (Write values decimals and keep 2 sig figs.) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |

**Analysis:** [5 pts] ***Make two graphs.***

1) **P vs V Graph:** Make a graph of **P vs V** using the **top one third** of the graph paper. Plot the pressure (in books) on the y-axis and the volume (in ml) on the x-axis. *(Axes do NOT have to go through the origin).* Put in your points and draw a **"best fit"** smooth **curve** through the points.
2) **P vs 1/vol Graph:** Make a graph of **P vs 1/vol** (P on y-axis) on the next ⅓ of the graph paper. *(Leave the bottom ⅓ of the paper empty).* **The axes MUST go through the origin**. (Thus, each scale must start at zero and be evenly spaced out all the way.) Put in your points, and draw a "best fit" **straight line**. Now, extend this straight line down below the x-axis until it intersects the y-axis. On the y-axis, extend the pressure scale (in books) downward as far as is necessary to read the value of the y-intercept (this will extend into the bottom ⅓ of the paper).

**Before moving on, make sure each graph includes**
**a descriptive title and axes are labeled with correct quantities and units.**

**Post Lab Questions:** [8 pts] **Write all answers in full sentences on a separate sheet of paper**

1) [1 pt] How do gas molecules create pressure upon their container? (What are the molecules doing?)

2) [1 pt] In prelab question #1, when you compressed the plunger, it got more and more difficult to push the plunger in. Explain why. (What happens to the *molecules* and *collisions* with the plunger?)

3) [1 pt] In prelab question #2, you found that it was difficult to pull the plunger out. Why was it so difficult? What force is responsible? (You might want to draw a diagram. Hint: vacuum is not a force.)

4) [1 pt] Look at your first graph. Is this a direct or inverse relationship? How do you know?

5) [1 pt] Look at your second graph. Is this a direct or inverse relationship? How do you know?

6) [1 pt] In this experiment, you were never able to see anything in the syringe. How do you know that there must be ***something*** in the syringe? (*HINT: Think about what happened when you put the books on top of the syringe.)*

7) [1 pt] When a book is place on the plunger, the plunger slowly moves downward, but eventually it stops moving. Is the pressure on top of the plunger less than, equal to, or greater than the pressure of the gas inside when the plunger stops moving?

8) [1 pt] Why can gases be compressed? *Explain why by discussing the arrangement of molecules.*