Lesson   planning

In this experiment Boyle's Law is verified.

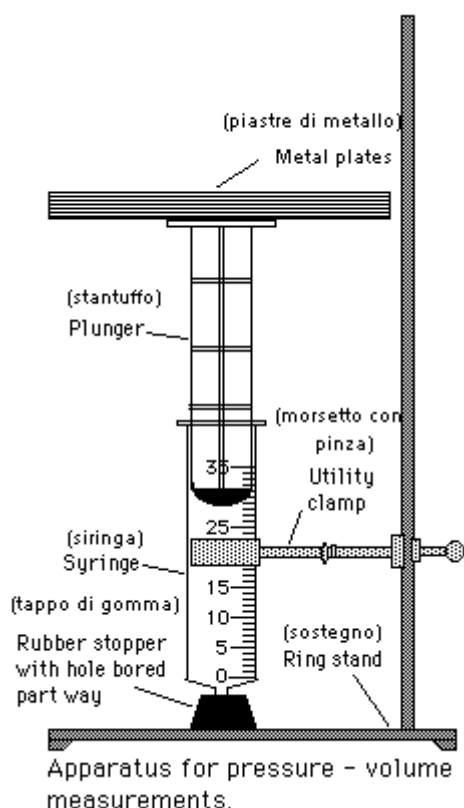The experiment was already carried out by the pupils using Italian language.

Pupils worked in small groups and each group wrote a report.

Now the experiment will be repeated using the English language.

1. the instructions in English are read by the teacher

2. the instructions are read again by pupils

3. the apparatus is described

4. the experiment is carried out

5. pupils are divided into small groups

6. a bilingual glossary is written by each group

7. visuals are made by each group (a sketch of the apparatus with words, a scheme of the operations, a concept map)

QUANTITATIVE RELATIONSHIP BETWEEN GAS PRESSURE AND GAS VOLUME

(piastre di metallo)
Metal plates

(stantuffo)
Plunger

(morsetto con pinza)
Utility clamp

(siringa)
Syringe

(tappo di gomma)
Rubber stopper with hole bored part way

(sostegno)
Ring stand

Apparatus for pressure – volume measurements.

INTRODUCTION:

What is the relationship between the pressure applied to a gas and the volume it occupies? In this experiment, a given quantity of gas will be trapped in a syringe. The pressure on the gas will then be increased by weights (metal plate*) on top of the plunger of the syringe. The total pressure acting on the gas consists of the weight of the metal plate plus the weight of the atmosphere.

*metal plates=piastre di metallo (basi)

TOTAL PRESSURE = PRESSURE DUE TO METAL PLATE + PRESSURE DUE TO ATMOSPHERE

The volume of the gas will be recorded for each of the pressures used. The data (values of pressure and volume) will be plotted on the graph in several ways in order to find a simple mathematical relationship between pressure and volume.

MATERIALS NEEDED:

Ring stand	50 mL plastic syringe
Utility clamp	*Large rubber stopper
5- metal plates (identical)	

PROCEDURE:

1. Set the plunger at the **50.0 mL mark** of a dry syringe. Place the tip of the syringe into the rubber stopper. Clamp the syringe-stopper arrangement in an upright position, as shown in the drawing. Be sure not to tighten the clamp to tightly or the syringe will bind and your data will be affected.

2. Carefully center a metal plate on top of the plunger. One person will steady the metal plate while the other reads the volumes. Read as precisely as possible the volume of gas trapped in the syringe when a load of one metal plate is on the plunger. Record the volume of gas in milliliters, for one metal plate, in your **DATA TABLE**.

3. Now add another metal plate and carefully determine the volume. Continue in this manner until a pressure of 5 metal plates is obtained. Record your data in **DATA TABLE** for **group**. It is important to keep the metal plate centered over the plunger so the apparatus does not tip.

DO NOT WORRY IF THE SYRINGE DOES NOT RETURN TO THE ORIGINAL VOLUME WHEN THE METAL PLATES ARE REMOVED. THIS IS NOT DUE TO AIR LOSS, BUT TO FRICTION BETWEEN THE PLUNGER AND THE SYRINGE. DO NOT ATTEMPT TO CORRECT FOR IT.

CALCULATIONS AND RESULTS:

Graphical relationships between pressure and volume.

Review the procedure for drawing the **best line of fit**.

5. From the data in table, calculate the **AVERAGE** gas volume associated with each pressure in metal plates. Record these average values in the appropriate column in **DATA TABLE**.

6. **On graph number one**, plot the pressure (in metal plates) on the vertical (**Y**) axis and the average volume (in mL) on the horizontal (**X**) axis. Fit the best **smooth curve** line to your points.

7. Find the **reciprocal** of volume (**1/V**) for each of the values of average volume. Record your answers in **DATA TABLE**.

8. **On graph number two**, plot the pressure (in metal plates) on the vertical (**Y**) axis. Put **y=0** up the graph high enough so that you will have enough room below it for at least **y= -4**. Plot the reciprocal (1/V) on the horizontal (**X**) axis. Be sure to start with **x=0** at the origin. Fit the best Straight line to your points. Be sure to use a straight edge, and extend your line to the "**Y**" axis.

Mathematical relationship between pressure and volume.

The plot of graph 2 shows a straight-line relationship between pressure (in metal plates) and 1/V. However, this line does not pass through the origin of the graph. How can this be? Surely a gas under zero pressure should occupy an infinite volume. The value of 1/V should be zero when no pressure is being exerted on the gas. The answer, of course, is that in addition to " metal plate pressure", atmospheric pressure is also pushing on the gas.

9. Determine the value for atmospheric pressure in the following manner: Extend the pressure scale (in metal plates) downward as far as is necessary to read the value of the **Y-intercept**. The difference between the y-intercept and y=0 is the value for the atmospheric pressure (in metal plates) pushing on the gas in addition to the " metal plate pressure" that you measured. **Record the value of the atmospheric pressure in DATA TABLE**. This will be the same for each metal plate line so simply repeat it 5 times in the table. DO NOT WORRY THAT THE VALUE FOR ATMOSPHERIC PRESSURE APPEARS TO HAVE A NEGATIVE SIGN. THIS SIMPLY SHOWS A RELATIONSHIP AND THE NEGATIVE SIGN NEEDS TO BE IGNORED.

10. Find the mathematical relationship between pressure and volume in the following manner:

Calculate the value for the **TOTAL** pressure for each pressure in metal plates that you have recorded. This is done by adding atmospheric pressure to each "metal plate pressure".

Find the product of pressure and volume by multiplying the **TOTAL** pressure by the **AVERAGE** volume the gas occupied under that pressure. Use the correct number of significant figures.

N	P Plates	group V (mL)								V_m mL	$1/V$ mL^{-1}	P_{tot} Plates	$P_{tot} \cdot V_m$ plates·mL
		1	2	3	4	5	6	7	8				
1	0	50	50	50	50	50	50	50	50	50			
2	1												
3	2												
4	3												
5	4												
6	5												

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