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Class: Physics II AP

Period: 2

Group #: 6

Ideal Gas Law

Purpose: To determine the relationship between volume, pressure, and temperature within the Ideal Gas Law by isolating each variable respectively.

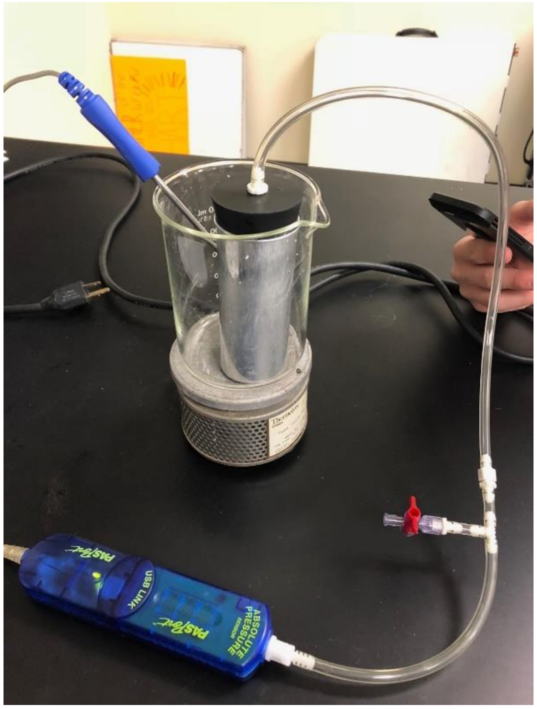
Equipment Used: Beaker, hot plate, PASCO Temperature Sensor, PASCO Pressure Sensor, Gas Law Apparatus, tubes, stopcock, Thermal Can, water

Procedures:

<u>Gay-Lussac's Law:</u> Temperature vs. Pressure

1. Fill beaker with 250 mL water.
2. Put Thermal Can and Temperature Sensor into beaker. Record initial temperature and pressure.

Apparatus should look like this



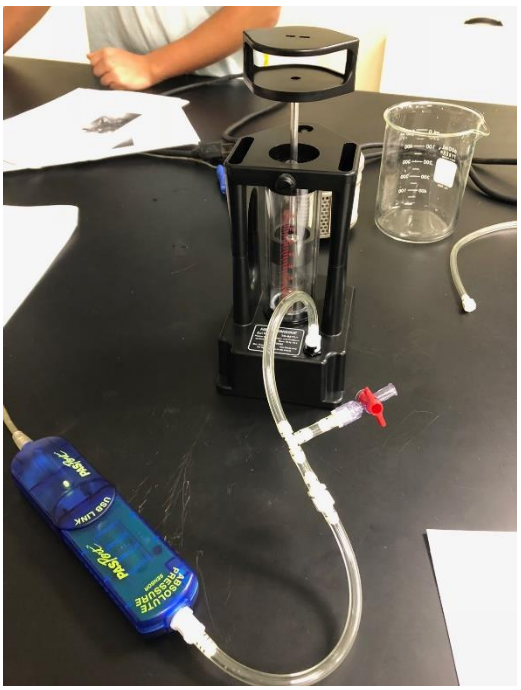
3. Place beaker on to hot plate.

4. Count for 20 seconds then stop data recording. Record given temperature and pressure (point on the end of the graph/line).
5. Repeat previous step 4 times
6. Turn off hot plate and leave the thermal can inside

<u>Boyle's Law:</u> Pressure vs. Volume

1. Remove pressure sensor from the Thermal Can and attach the pressure sensor to the Gas Law Apparatus.

Apparatus should look like this



2. Loosen piston screw on Gas Law Apparatus to allow for the piston to move up and down.
3. Twist the stopcock (red) until it is parallel with the tubing, this allows for air flow.
4. Move the piston to height of 50 mm, and close stopcock (twist until perpendicular with tubing). This should close off air flow.
5. Record pressure while piston is at 50 mm.
6. Slightly push down on the piston until it has reached height of 40 mm. and hold that position. Record height and pressure reading.
7. Let go of the piston. Then repeat previous step at 30,60, and 70 mm increments.

Charles' Law: Volume vs. Temperature

1. Unplug the tubing with the stopcock form pressure sensor
2. Replace the pressure sensor with the thermal can

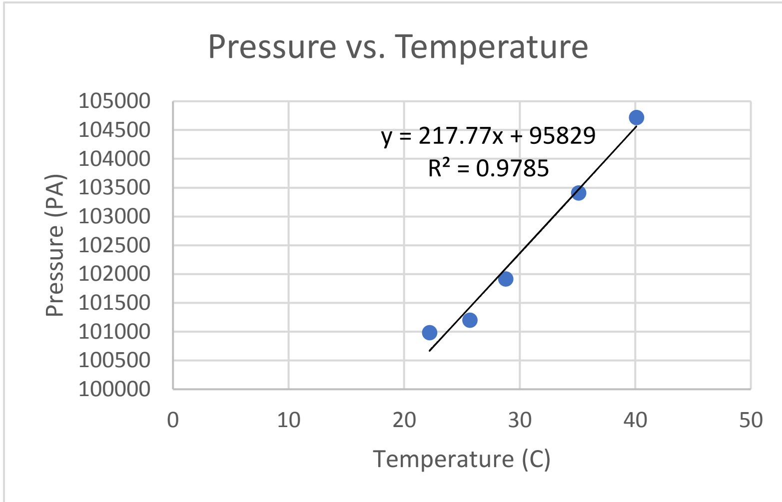
Apparatus should look like this

3. Unlock stopcock (parallel with tubing) and push piston down until it reaches 0 mm.
4. Close stopcock.
5. Remove the screw of the Gas Law Apparatus (The very big one) completely
6. Lay the Gas law Apparatus down horizontally on the table
7. Fill beaker with 250 mL water.
8. Put Thermal Can and Temperature Sensor into beaker, then place beaker on to hot plate. Record initial temperature and volume.
9. Turn on hot plate. Start data recording.
10. Count for 20 seconds and stop data recording. Record given temperature (point on the end of the graph/line) and height (from the Gas Law Apparatus). Keep in mind that the volume of the Thermal Can matters as well, so be sure to add it when calculating volume of apparatus.
11. Repeat previous steps 9-10 four more times using 20 second increments.

Data: For each gas law create a data table and a graph

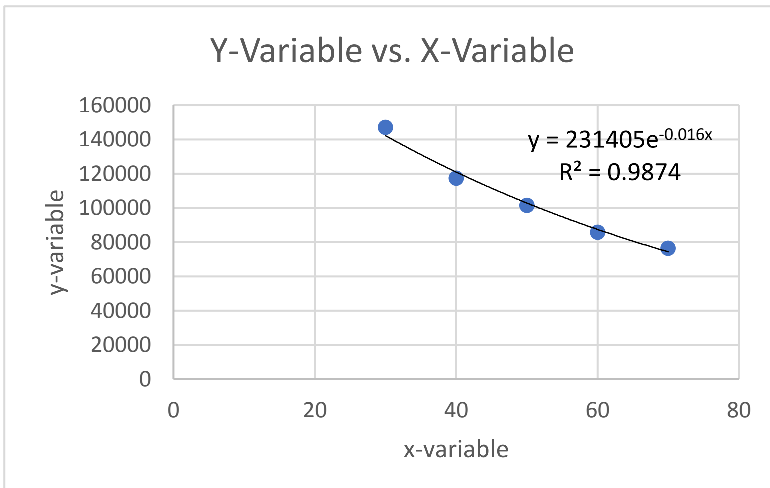
Gay-Lussac's Law

Temperature (C°)	Pressure (Pa)
22.2	100982
25.7	101198
28.8	101916
35.1	103411
40.1	104720



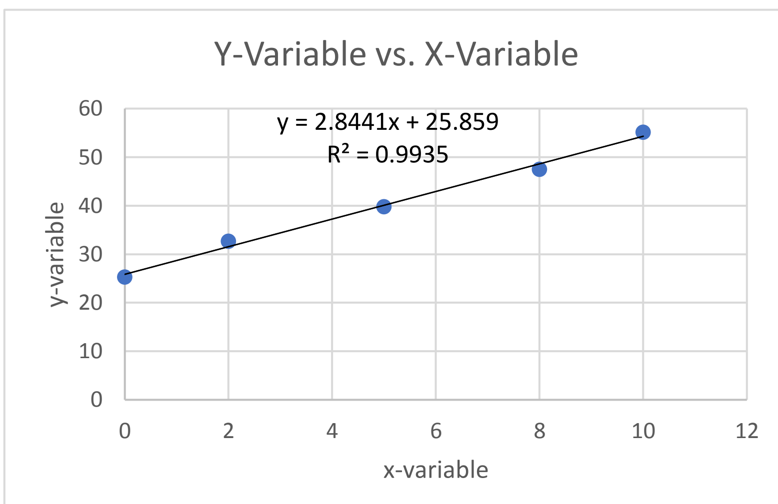
Boyle's Law

Volume (mL)	Pressure (Pa)
50	101542
40	117400
30	147147
60	85842
70	76497



Charles' Law

Volume (mL)	Temperature (C°)
0	25.3
2	32.7
5	39.8
8	47.5
10	55.1



<u>Analysis Questions</u> - Answers should be written in red in their respective boxes.

1. **a) What type of relationship exists between temperature and pressure?**

   b) What type of relationship exists between pressure and volume?

   c) What type of relationship exists between temperature and volume?

a) Direct **b) Inverse** **c) Direct**

2. **In the Gas Law Apparatus, why can the height of the piston be used as a replacement for volume?**

Because when the radius of a cylinder is constant, the height is directly proportional to volume

3. **Why does the Gas Law Apparatus in the Charles law procedure have to be laid down horizontally? If the Apparatus wasn't laid down horizontally how would it affect your data? Explain.**

If the apparatus was upright, then there would be a gravitational force downward on the plunger. This would decrease the volume and corrupt the data.

4. **Helium gas is placed in two containers, container B has half the volume and three times the pressure of container A. What is the relationship between the temperatures in container A and B? Formulate an expression to help you solve your problem.**

$$\frac{P_a V_a}{T_a} = \frac{P_b V_b}{T_b}$$

$$\frac{P_a V_a}{T_a} = \frac{3P_b * \frac{1}{2} V_b}{T_b}$$

$$\frac{P_a V_a}{T_a} = \frac{\frac{3}{2} * P_b V_b}{T_b}$$

$$T_a = \frac{3}{2} T_b$$