

Name:

Partners' name(s):

## Laboratory 3: Kinetic Theory

1. Locker checkout
2. Kinetic Theory Lecture and Gases demonstrations: Vacuum pump

Some questions to consider:

What is Pressure?

What causes gas pressure?

What are some ways to change the pressure of a gas?

### Lecture Notes

#### Gas Laws

1. The pressure and temperature of a gas are indirectly proportional.  
If the gas pressure (P) is halved then the volume (V) is doubled, if the temperature (T) remains the same.

$$V_1P_1 = V_2P_2$$

2. The temperature and volume of a gas are directly proportional.  
If the temperature of a gas is doubled then the volume is doubled, if the pressure remains the same.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

#### Pressure

Standard pressure is 1 atmosphere (atm) or 760 mm Hg

#### Temperature

When doing gas calculations the Celsius ( $^{\circ}\text{C}$ ) temperature must be changed to Kelvin (K).

$$\text{Kelvin} = \text{Celsius} + 273$$

$$\text{Celsius} = \text{Kelvin} - 273$$

Standard Temperature is 0 degrees Celsius or 273 K

STP means standard temperature and pressure

Calculations:

- What is 300 degrees Kelvin in Celsius?
- What is 18°C in Kelvin?
- A gas has a pressure of 600 mm of mercury (mmHg) and a volume of 20 ml. If the pressure is changed to 660 mmHg, what happens to the volume?
- A gas has a volume of 225 ml at 73 °C. What is the volume if the temperature is changed to 102 °C

3. Kinetic Theory Lab

4. Discussion

**Purpose:** To develop a theory that explains why gases behave the way they do

**Procedure and Observations and Data:**

1. In this lab you will work in groups of three. Go to each station (not necessarily in order) and follow the directions on the instruction card.
2. Record observations and give a brief explanation for each station.
3. Draw a quick sketch of the apparatus for most stations on the back of the page.
4. Draw a diagram (model) for each station showing at the molecular level what the particles of gases are doing (Black box diagram).
5. Return the station to its original condition when your group is finished.

Station one: Cartesian diver  
Station two: Fill inverted vial  
Station three: Candle under beaker  
Station four: Boyle's law apparatus and computers  
Station five: Can crush  
Station six: Laser disc

## Stations

### **Station one: Cartesian diver**

**Materials:** Eye dropper and 2 liter bottle

**Challenge:** Can you make the eyedropper stay in the middle of the bottle? Keep the bottom of the bottle on the table. Make careful observations and describe what happens to the eyedropper.

**Observations:**

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How did you get the eyedropper to stay in the middle?

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### **Station two: Fill inverted vial**

**Materials:** Tray of water (1 inch); a vial and a syringe

**Challenge:** Can you fill the vial with water using the syringe? You must not raise the mouth of the vial above the water level.

**Observations:**

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How did you get the water into the vial?

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What did this station teach you about pressure?

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**Station three: Candle under beaker**

**Materials:** Tray of water (1inch); a candle held up by clay and a 150 ml beaker.

**Procedure:** Light the candle, then put the beaker over the candle.

**Observations:**

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What happened to the water inside the beaker?

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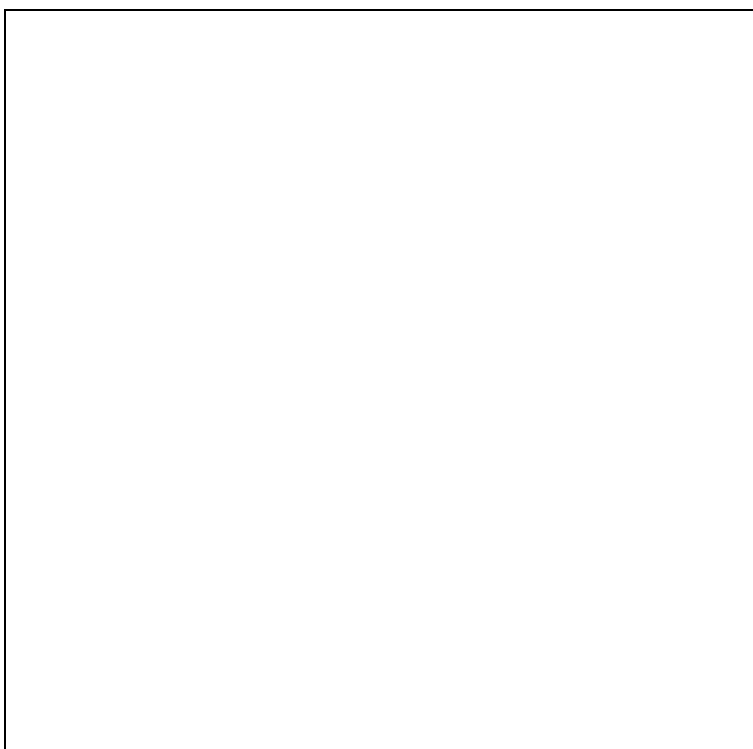
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Explain your answer to the above question? Why did the water do what it did?  
Then, draw a diagram of what happens in the above experiment at the molecular level.

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**Station four: Boyle's law apparatus**

**Materials:** Boyle's Law apparatus, 15 books of uniform size

**Procedure:** Place a book on the apparatus and record the volume of gas in your table. Continue by adding one book at a time, recording data, until all of the books are on the syringe

**Observations:**

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**Data Table:** Make a table and record your data (pressure in books and volume in ml) into your notebook.

**Table 1: Changes in pressure and volume**

Pressure (Books)	Volume (ml)

What happens to the air molecules in the syringe?

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What happens to the pressure inside the syringe?

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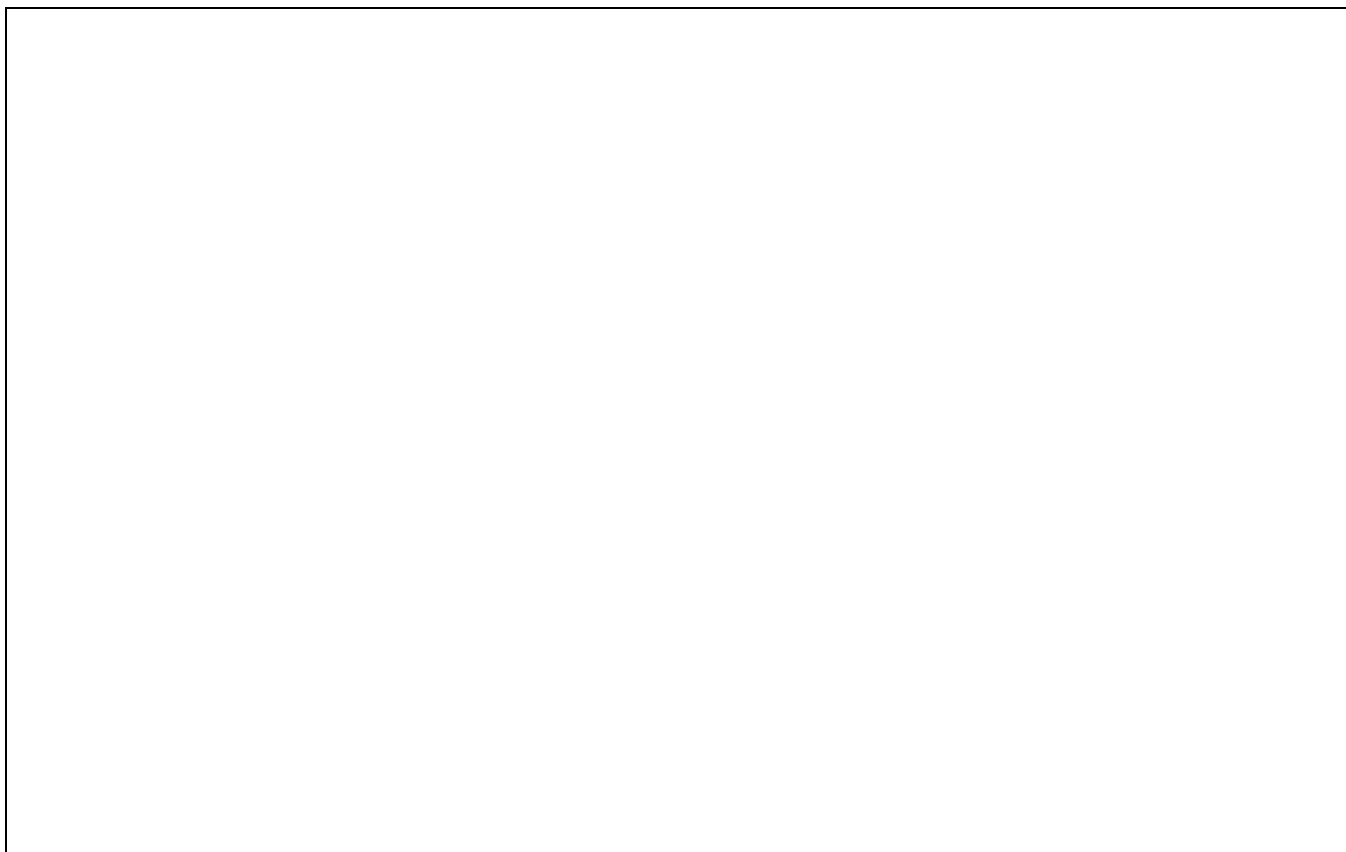
Do you think the speed of the moving particles changes?

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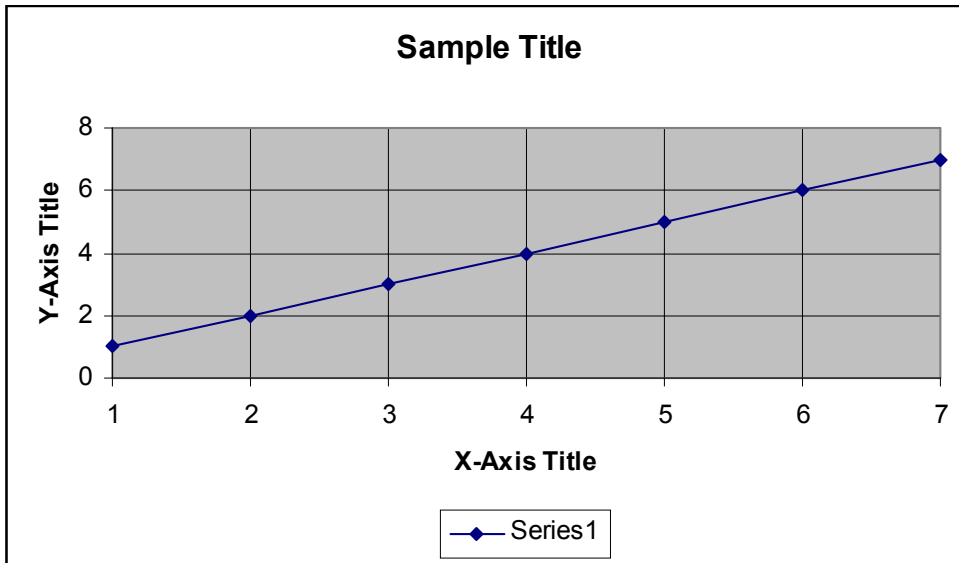
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Make a sketch of your “Black Box” diagrams for the Boyle’s law apparatus. Draw the apparatus before any books and after 12 books. Show a diagram of what it would look like at the molecular level:



Improved Theory:

**Graph:** Scientists often use graphs to visualize the relationship between two series of data. You will use a graph to find the relationship between the volume and pressure of gases. Using the computer and Microsoft Excel, make a graph of the volume (in ml) versus the corresponding pressure (in books) and make a second graph of volume versus  $[1/\text{pressure}]$ . Be sure that each graph includes: 1) title 2) x-axis and y-axis labels 3) curve fit



**Station five: can crush**

**Materials:** Small hot plate, empty soda can, 1000 ml beaker, beaker tongs, cold water

**Procedure:** Be sure to wear goggles! Put about 15-20 ml of water into the can and place it on the hot plate. When the water is boiling (you can hear it and you can see steam) grab the can with the beaker tongs and very quickly stick the top of the can into the beaker of water so that the opening of the can is underwater.

**Observations:**

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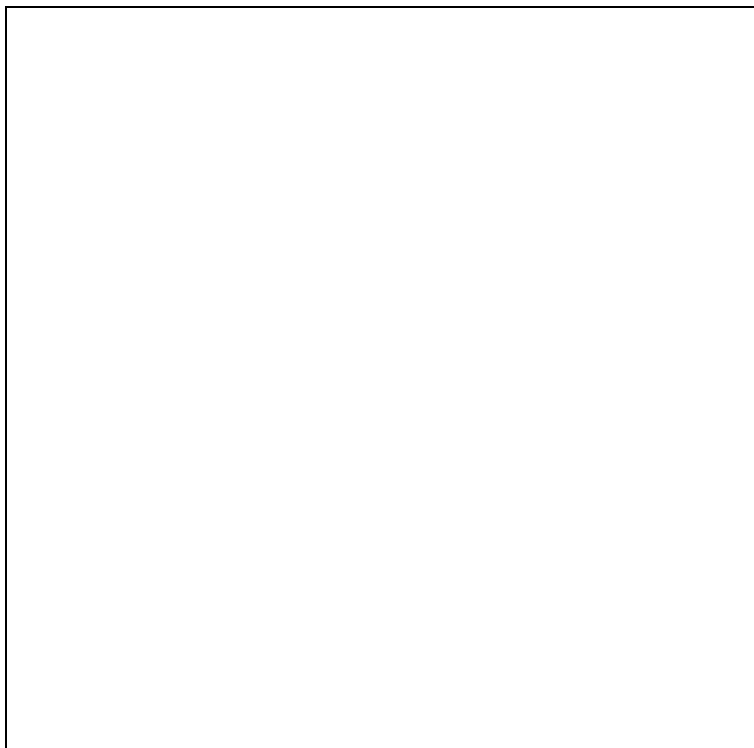
Explain what happened to the can.

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Draw a diagram of what happens in the above experiment at the molecular level.



**Station six: laser disc**

**Materials:** Monitor and Laser disc player

**Procedure:** Watch the movies on the laser disc

**Observations:**

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Can you explain what happened in each of the movies?

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Once you have completed all of the stations, get a piece of butcher paper and some pens. Draw a “Black box diagram” of what happens to the molecules inside the Boyle’s Law apparatus. Draw the apparatus with 2 books on it and draw it with 10 books on it.

**Calculations**

Using the computer and Microsoft Excel, make a graph of the volume (in ml) verses the corresponding pressure (in books) and make a second graph of volume verses 1/pressure. Staple an original printout of the graph into your notebook/journal. Make sure that your name is in the title

**Demonstrations:**

Watch the demonstrations and record your observations and draw a diagram in the spaces provided

Demonstration: The Vacuum Pump

Observations and notes:

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Demonstration: Balloon and a flask

Draw a picture of what will happen to the balloon:

Draw a picture of what actually happened to the balloon:

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Notes:

Explain:

Assessment:

Demonstration: Egg and a flask

Draw a picture of what will happen to the egg:

Draw a picture of what actually happened to the egg:

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Explain what happened to the balloon and the egg:

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**Questions and Answers:**

1. What causes pressure?

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2. What are some ways to change pressure?

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3. What happens to the pressure of a gas as you change the temperature?

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**Conclusions and Reflections**

What does the kinetic theory mean to you now?

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What is something from today's lab that you could use in your classroom someday?

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What are some different ways for people to learn about gases? Which do you think is the best way?

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At what point during the day did you reach a good understanding of gases?  
What happens to the volume of a gas when the pressure on it is increased? Explain

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How do you obtain equipment from the stockroom?

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