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Day 05 | Fire and Ice

2016

5.0.C.1 Hands-on Gas Law Experiments

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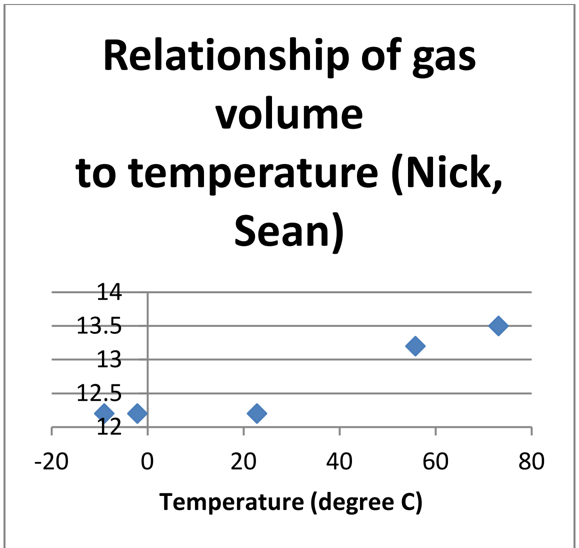

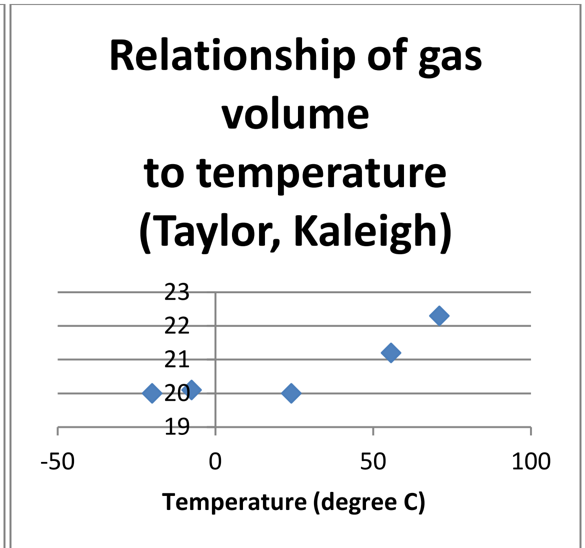

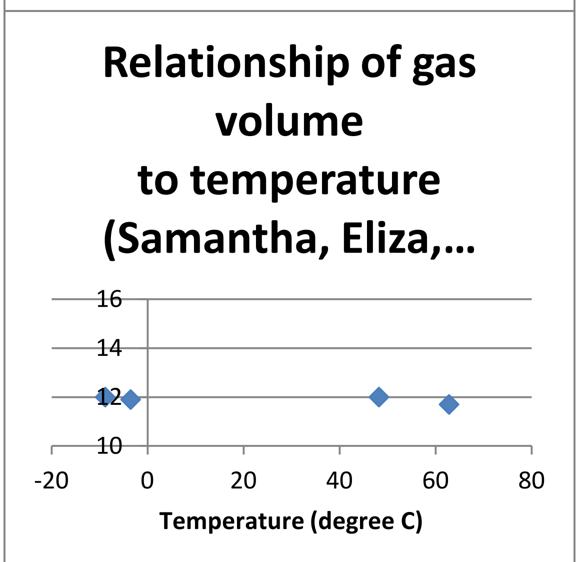

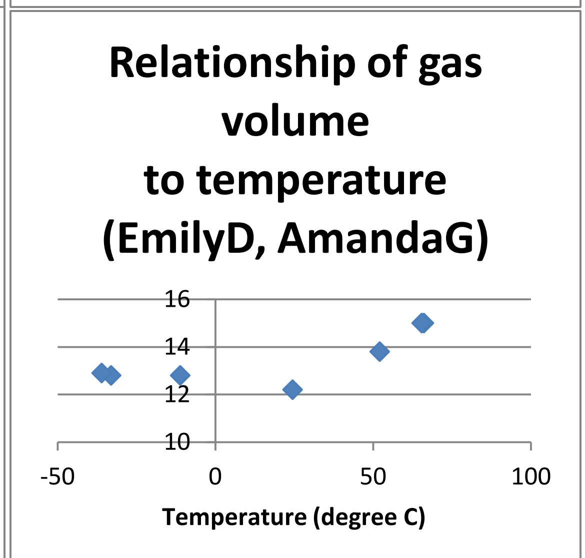

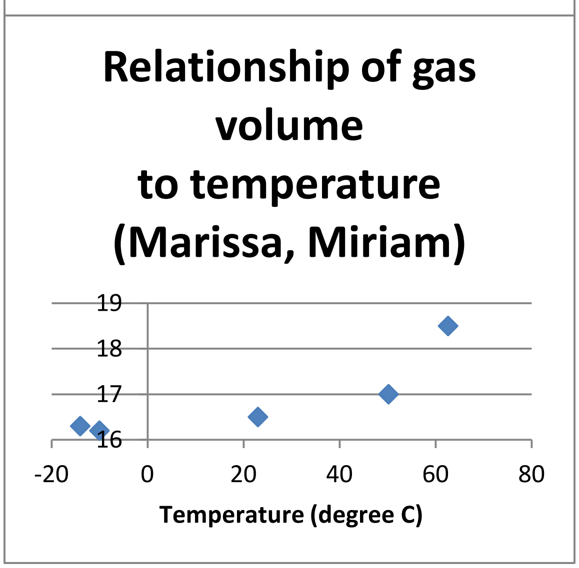

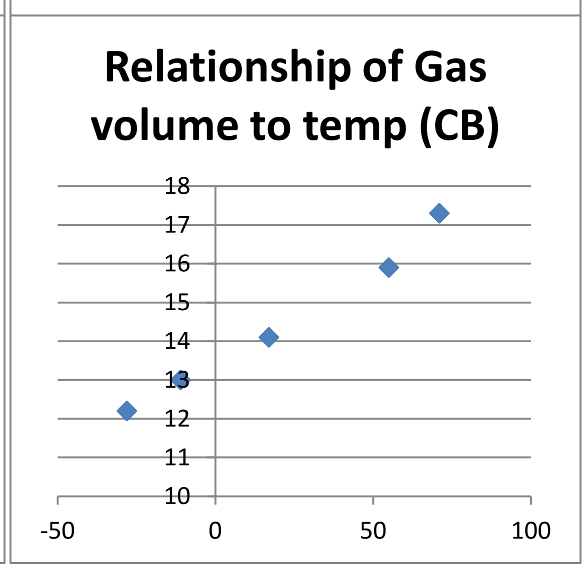

Christopher F. Bauer, Principal Investigator.
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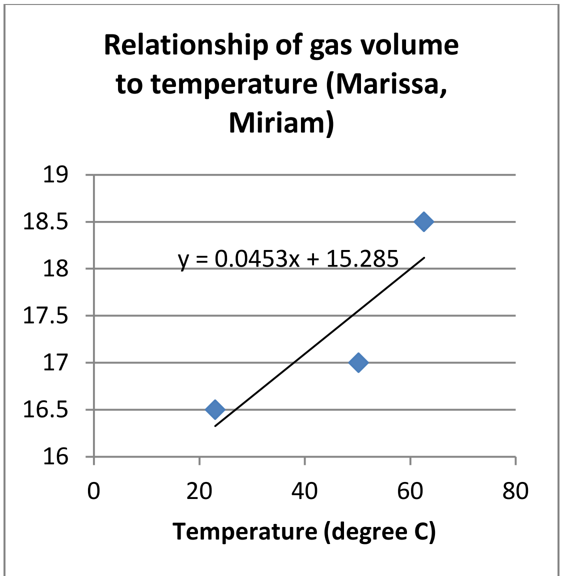

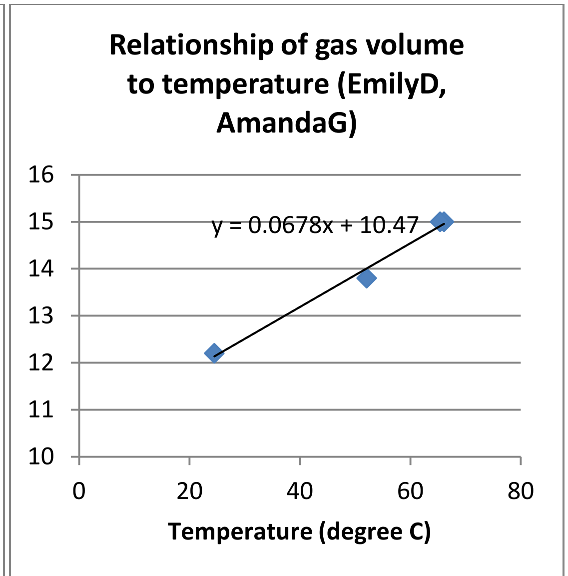

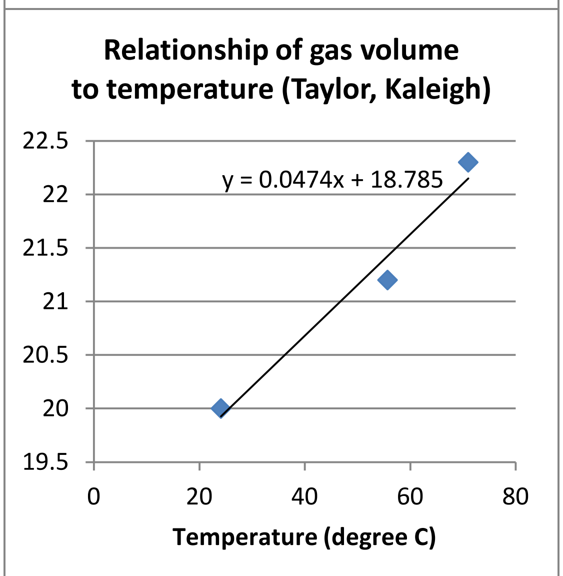

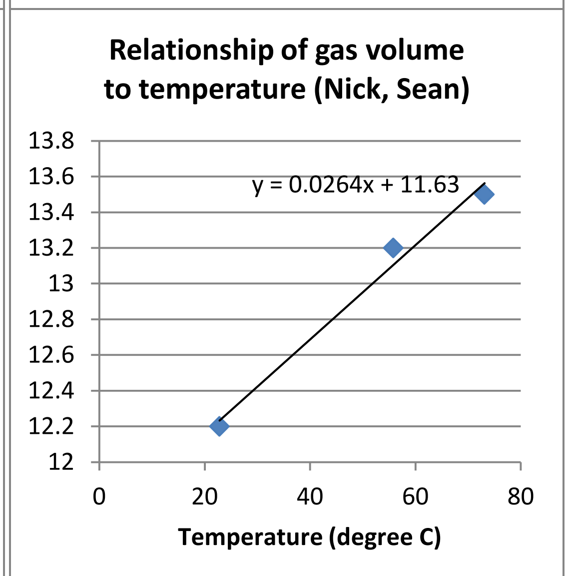

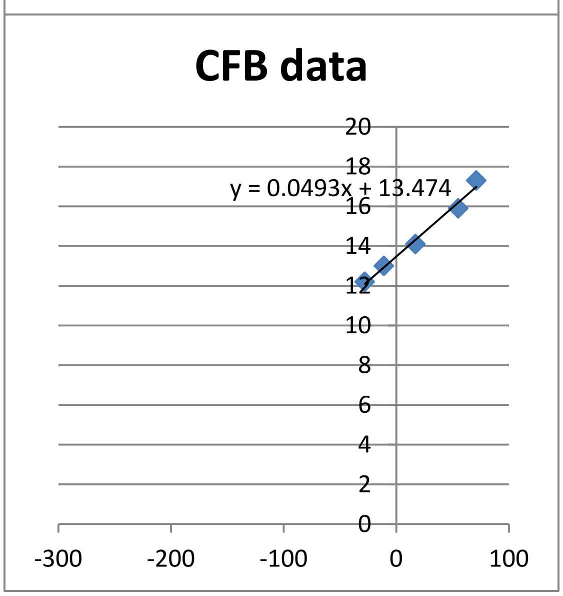

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Expt B Sublimation of Dry Ice in syringe

	mass (mg)	volume (mL)	ratio (mL/mg)	
KR CC	24	5.5	0.23	
	22	3.9	0.18	
EmmaJake	22	7	0.32	
	12	5	0.42	
TimJon	16	3	0.19	
	25	7	0.28	
HP AJ	15	4	0.27	
	19	4.5	0.24	
BP EK	20	7	0.35	
	8	1	0.13	
			0.26	average
			0.09	stddev
			0.55	theory

Results of Expt C

Substance	Compressibility?
sand	not (unless there was small air gap)
salt (NaCl)	not (unless there was small air gap)
water	compressed, but only if there was an air bubble
air	compressed, then rebounded (unless some escaped)
TFE (tetrafluoroethane)	compressed, then rebounded (unless some escaped)

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Chem 444A, Fire & Ice, Exploration of some aspects of gases

At your table of four, split into two working pairs. Each pair needs a recorder and safety monitor.

Info for Safety Monitor:
HOT WATER: You will be working around water temperatures that will could cause significant burns.
DRY ICE: This material is extremely cold and if held for more than a few seconds, could cause frostbite.
GASES IN CLOSED CONTAINERS: If gases overheat in a sealed container, then can rupture the container. This is not likely to be a hazard with the equipment we are using.

One pair is in charge of experiment A, and the other of experiment B.

Carry out the procedures. Each pair should "eavesdrop" on what the other pair is doing to get a sense of what the experiment looks like and what the manipulations are. When there are dead times while you are waiting, you can do experiment C in pairs or all together. It is very quick.

Procedures:

A) This is an experimental test of simulation test #4 from Tuesday's class. You are going to look at how the volume of a gas responds to temperature.

Obtain a large syringe with a twist valve on the end (30 mL capacity if you have that one). Test the valve so you know when it is open and when it is closed.

Set the plunger to around the 20 mL mark (30 mL syringe) and 13 mL mark (20 mL syringe). You will want to check with me about how to read the scale appropriately. Close the valve. Before taking any reading, depress the plunger slightly and let it expand to its final position. (There is a reason for this.) But don't grab it and hold it in your hand when you do this (why not).

Now, put the syringe into different temperature environments, allow it to adjust (at least 2 min), and then read the position of the plunger. Wait 1/2 minute then read again. (Why?) Start at room temp, then go cold to hot, or hot to cold. Note how to get a reliable measurement:

- Room temperature. Use standard thermometer sitting over by sink.
- Coffee mug on its side, containing powdered dry ice. Lay syringe on the bed of dry ice. Use digital thermometer to check the temperature at the top surface of the syringe (don't embed the thermometer in the dry ice)
- Freezer. Lay the syringe on the floor of the freezer so you can read it without handling it. There is a standard thermometer standing in a coffee mug in the freezer. You can move the thermometer.
- Hot water in a large beaker. I will prepare this in microwave oven. Hold the syringe in the water, valve side down but don't go above the end of the barrel. You should be able to read the volume marking through the side of the beaker. Use digital thermometer to measure temperature.
- Really hot water. Same.
- Report your data to me. I may plot and display on big screen. *Does your data reflect what you found in simulation #4? Discuss the implications when the group is all back together.*

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B) This experiment addresses the question of how much space is there in a gas. Indirectly, it helps us judge how realistic the simulation we have been using is.

This work will be conducted in an adjacent room. You will need instruction from me about use of the balance and the procedure. Read over the procedure first and then grab me to get started.

Obtain two large syringes with a twist valve on the end. Test the valves so you know when it is open and when it is closed. Remove the plunger from the syringe (it will pop out). Open the valve.

Using a balance, measure a small piece of dry ice about 5 to 25 mg of dry ice in a plastic weighing dish. This will be about the size of this letter O. Quickly, transfer that dry ice into the syringe (hold it mostly horizontally). Cautiously but quickly insert the plunger, depressing it all the way in. Then close the valve and watch.

A few minutes later, record the volume of gas in the syringe. Do this at least twice (you have 2 syringes).

There will be a spot on the board in S150 to record your data, accumulating it from the rest of the class.

Given your measurements, when the entire group is back together, consider your data and observations. Discuss your ideas about what gases consist of, and how true the simulation was or was not to that.

C) Obtain a coffee mug containing a set of syringes (no needles on these).

Each syringe is filled with a different substance. There is a label on the barrel. Inspect to see what the materials are.

FIRST, make your own prediction about what you expect to see happen when the plunger is compressed. Poll the group and note your predictions. Then do it. Each person in the group should test each syringe so you have firsthand experience.

When the group is back together, discuss your observations in comparisons to your predictions. Suggest a tentative explanation for the behaviors you saw.

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