Department of Chemistry
University of Texas at Austin

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Gas Unit – Activity – Exploring Gas Behavior
Thinking about a gas in a syringe.

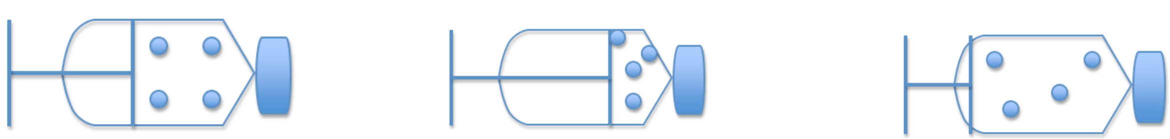
PART 1
Explore
You should have a 60 mL plastic syringe (with no needle). Pull the plunger out a ways and then put your finger over the end of the syringe. What does it feel like when you push the plunger in? What does it feel like if you start with the plunger in different places? Can you move it as far? What about pulling it out? When your finger is over the end does it matter where the plunger starts when you try to pull it out?

1. Pull the plunger out to about 30 mL. Set the syringe down. Draw a model (picture) of the gas inside the syringe under the word initial.

2. Pick up the syringe. Cover the end with your finger and push in the syringe. Think about the gas inside the syringe. Set the syringe down and draw a model of the gas when the syringe is depressed (and your finger is over the end) under the word depressed.

3. Reset the plunger to 30 mL, put your finger over the end and pull out the plunger a ways. Set it down and draw a model of the gas when the syringe is extended (and your finger is over the end) under the word extended.

Initial **Depressed** **Extended**



Part 2
Pressure and Volume
1. Pull the plunger NEARLY out of the back of the syringe, to the 60 mL mark. Assuming that the ambient air pressure in the room is 1 atm today, fill in the value of the initial pressure in the table in the appropriate cell.

2. Now, put your finger over the opening of the syringe, and push the plunger in as far as you can. Note this volume in the cell labeled Final V.

3. Assuming that a person of normal strength can resist a force of 2 atm, and assume that you are normal, fill in the value of the final pressure in the appropriate cell. If you think you have more strength than normal, compare your Final V answers with your neighbors (of lesser strength) and take an average Final V value (we are estimating here).

Initial V	Initial P	Final V	Final P
60 mL	1 atm	30 mL	2 atm
30 mL	1 atm	15 mL	2 atm
10 mL	1 atm	5 mL	2 atm

4. Repeat this process to fill out the table.

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5. Can you infer a mathematical relationship between volume and pressure of a gas in one state to another state from this exercise? If so, state it here.

Yes: $P_1V_1 = P_2V_2$ OR $PV = \text{Constant}$ OR $P = \text{Constant}/V$

Part 3

"Visualizing" the gas

1. Now take the plunger out of the syringe and stick a small marshmallow in the syringe. Set the plunger at 30 mL. Now put your finger over the end of the syringe, and push in on the plunger. Note your observations of the marshmallow. Explain why the marshmallow changed as it did.

Marshmallow shrinks. The air in the marshmallow compresses. The air pockets inside the marshmallow compress because the external pressure around the marshmallow increases while the air pockets inside the marshmallow maintain the same pressure.

You can think of the marshmallow like a balloon because the marshmallow is full of tiny pockets of air. By placing the marshmallow in the syringe you are able to change the external pressure on the air pockets of the marshmallow.

2. Reset the plunger at 30 mL, put your finger over the end, and pull the plunger toward the back of the syringe, but not all the way out. Note any observations here. Explain why the marshmallow changed as it did.

Marshmallow expands. The air in the marshmallow expands. The air pockets inside the marshmallow expand because the external pressure around the marshmallow decreases while the air pockets inside the marshmallow maintain the same pressure.

3. Summarize here the observed changes in the marshmallow when the plunger is forced in compared to pulled out. Include in your summary a drawing (model) of what is going with the air inside the syringe and within the marshmallow. In particular indicate the distances between the gas particles in each case.

Plunger is forced in → V decreases → P increases because there are more collisions with the walls
Compression (the distance between the particles decreases)

Plunger is pulled out → V increases → P decreases because there are fewer collisions with the walls
Expansion (Distance between particles increases)

Volume and Pressure are ***inversely*** proportional.

Below are pictures of the gas inside the syringe and marshmallow. First, before anything has been done to the syringe, then compression and finally expansion.

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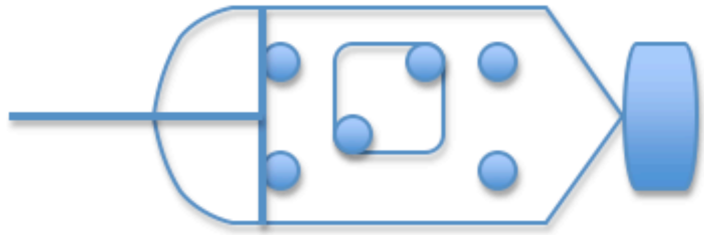

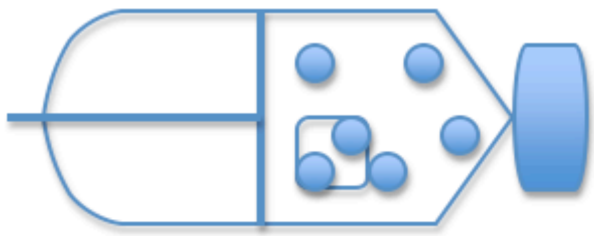

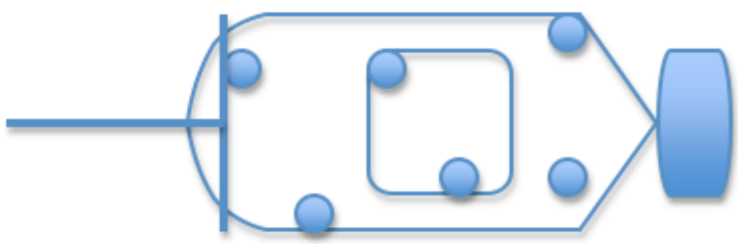

4. Observe a demonstration of a balloon in the room versus in a vacuum jar. Model the gas in the balloon versus in the vacuum jar before and after the pump is turned on.

Vacuum turned on → Decreases pressure of gas around the balloon → Volume of balloon increases against the low external pressure

Below are pictures of the gas inside the vacuum jar and inside the balloon before and then after the vacuum has been turned on.

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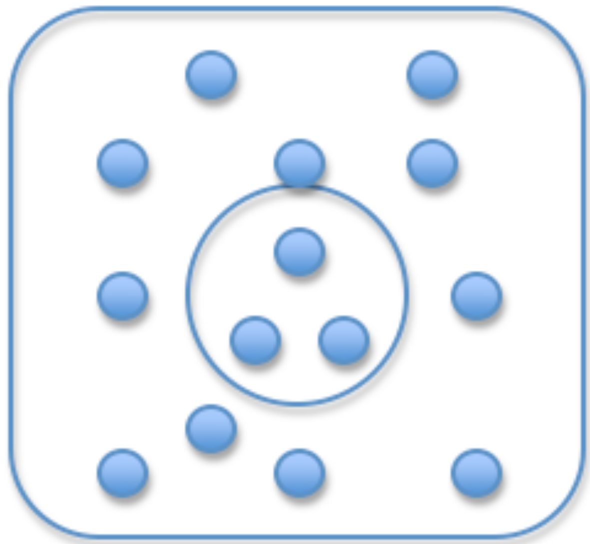

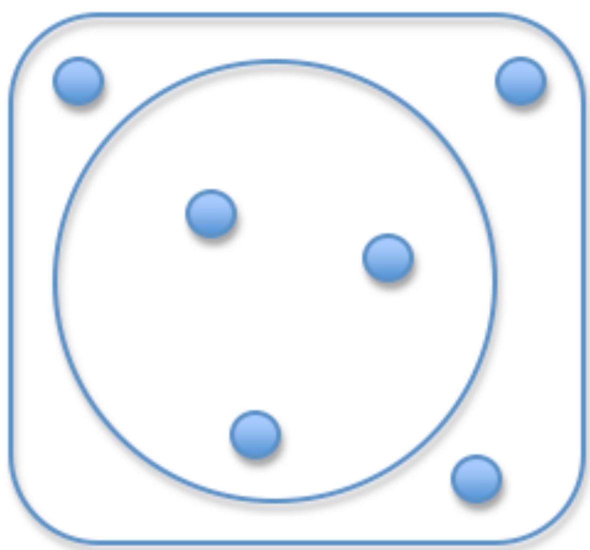

5. Observe a demonstration of a "collapsing can". Model the gas in the can initially and then at the point of the collapse.

The steam inside the can condensed back into liquid, but because the can is upside down in the water,

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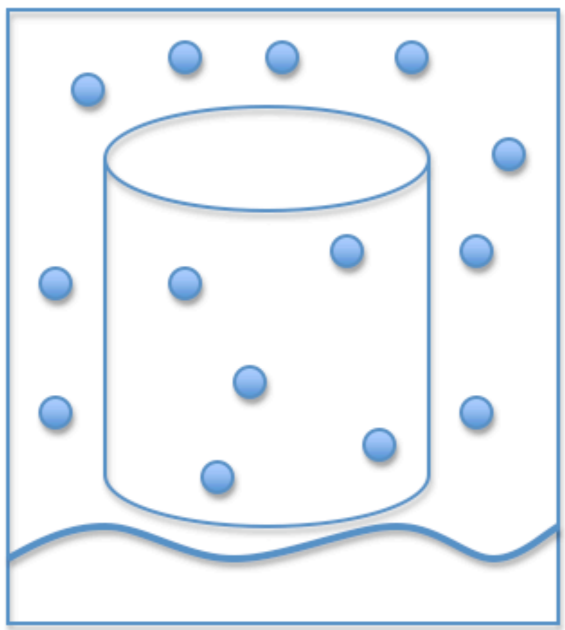
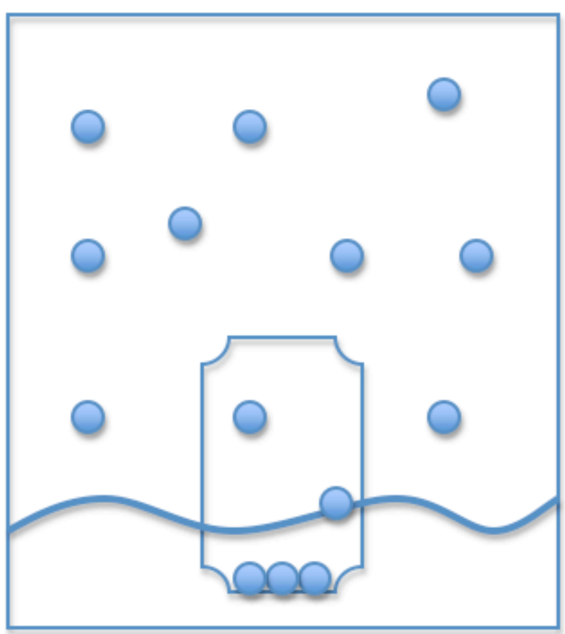
no gas can flow into the can. Therefore, the pressure inside the can drops and the can is crushed by the atmospheric pressure.

Pressure inside decreases as the steam condenses into liquid → Volume of the can decreases in response to the higher external pressure

The pictures below show the can before it is crushed and after it is crushed. In the second picture, observe that some of the steam particles inside the can have condensed together to form a liquid at the bottom of the can, thus lowering the internal pressure of the can.





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