Bell Jar and Vacuum Pump Set

<u>Experiment 1</u>: Action of a Vacuum Pump and the Mass of Air

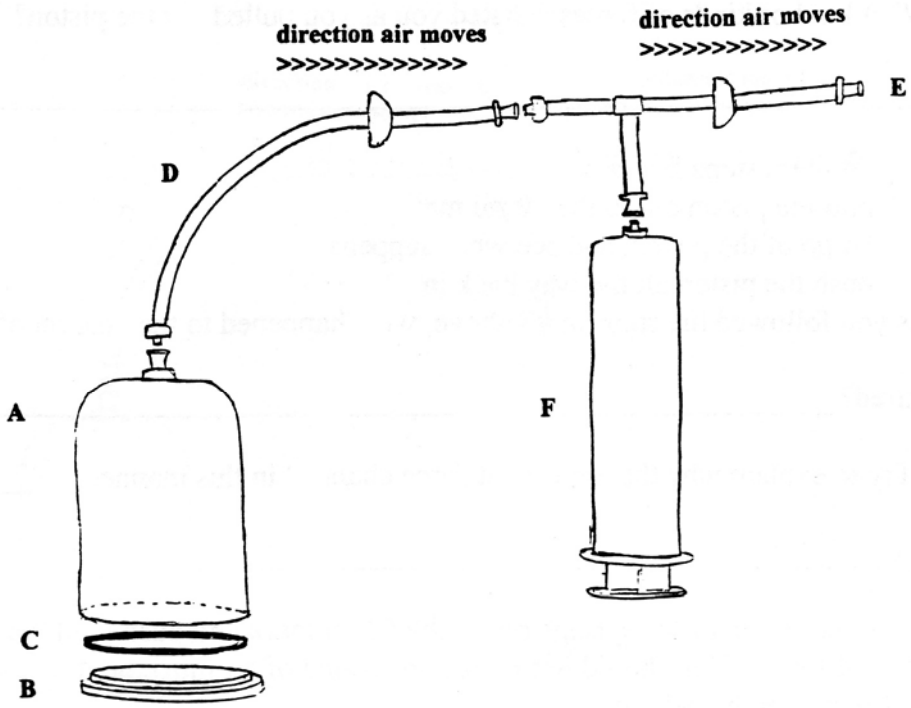

Figure 1

1. Assemble the apparatus as shown in Figure 1. Study Figure 1. The check valves will easily allow air to flow in the direction shown by the arrows, but not in the other direction. What is inside the bell jar now? (Hint: nothing is not the correct answer)

   _____

2. Have someone push down on the bell jar to make certain that the bell jar is pressing against the "O" ring. While doing this, pull the piston of the syringe out to the 60 ml mark.

3. Where does the air come from that fills the syringe?

   _____

4. Let go of the piston and watch what happens. Now, quickly push the piston all the way back into the syringe. Listen for the sound of the moving air.

5. Where did the air go that was in the syringe?

   _____

6. Describe, in words, the amount of force that was required to pull out the piston.

   _____

   _____

Experiment 1: Continued

7. What kind or kinds of forces resisted you as you pulled out the piston?

_____

_____

8. Repeat the below steps (a, b, c) five times:
   a. Pull the piston out to the 60 ml mark.
   b. Let go of the piston and see what happens.
   c. Push the piston all the way back in.

9. As you followed the steps in #8, what happened to the amount of force required?

_____

_____

10. Try to explain why the amount of force changed in this manner.

_____

_____

11. Pull the piston of the syringe out to the 60 ml mark and push it all the way back in. **Do this 24 times**. You should not notice any sound of air movement by the end of this step. What is the bell jar now?

_____

_____

12. Disconnect the two hoses, hose (D) from hose (E). Using an electronic balance to measure the mass of the air inside the bell jar, place the bell jar with it bottom plate and the connected hose (D) onto the balance pan. Be sure to "Tare –Zero" the balance before measuring. Make certain that hose (D) is not touching anything. Find the mass and record it.

_____

13. Loosen the connection between hose (D) and the bell jar, remove the hose, and then reconnect it. Did you hear the movement of air? **(YES) or (NO)**. What was the air doing?

_____

14. Again place the bell jar with bottom plate, with hose (D) back onto the balance pan. Make certain that hose (D) in not touching anything. Find the mass and record it.

_____

15. Calculate the difference between the balance reading in steps 12 and 14. What is the difference in mass, and what is this answer of mass of?

_____

16. Do you think that the bell jar was really empty when you weighed it in step 12? The next experiment will allow you to find out.

_____

End of Experiment 1

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<u>Experiment 2</u>: The Density of Air

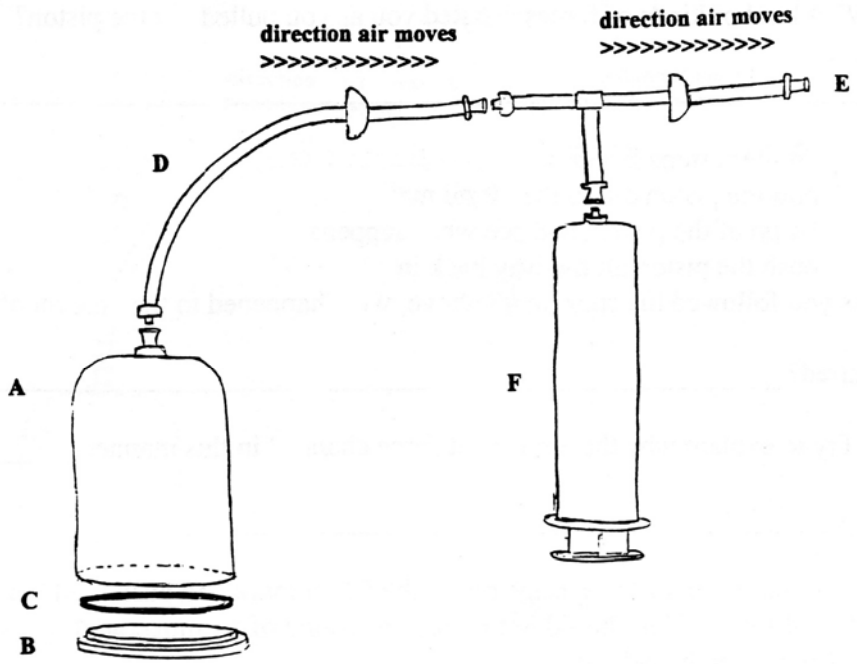

Figure 1

1. Assemble the apparatus as shown in Figure 1. Pull the piston of the syringe out to the 60 ml mark and push it all the way back in. **Do this 30 times**.

2. Disconnect hose (D) from hose (E). Hold the bottom plate on the bell jar, and hold the bell jar entirely under water in a large beaker or pail. To ensure that the bell jar stays entirely under water, allow water from the water faucet to continue to flow into the beaker or pail while performing this step. Now loosen and remove the hose from the bell jar. Describe what happens, and explain why it happens as it does.

   _____

   _____

   _____

3. Put you finger over the hose fitting on the bell jar, and lift it out of the water. Keep you finger over the hose fitting. There will be some air in the bell jar, showing that the pump had not removed all of the air. What fraction (or percentage) of the air was left? Estimate: _____. What fraction (or percentage) of the air was removed? _____

4. Use a graduated cylinder to measure the volume of water in the bell jar. This is equal to the volume of the air that was removed. Record this volume. _____

5. Now you know the mass of the air (from experiment 1) and volume of the air (experiment 2) that you removed. Calculate the density of air. Show your calculations below. Remember to include units of measurements in your answer.
   (**Density = Mass / Volume)**

Dry out the apparatus with a towel!!!

<u>End of Experiment 2</u>

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<u>Experiment 3</u>: Removing Atmospheric Pressure from Objects

1. A rubber balloon has been included with this kit. It was designed to be blown up to a nine inch diameter round shape, but in this experiment it will barely be inflated. Blow into the balloon (if not already inflated) until the rubber is tight, but not stretched. Then tie it. Why is the balloon now the size it is and not bigger?

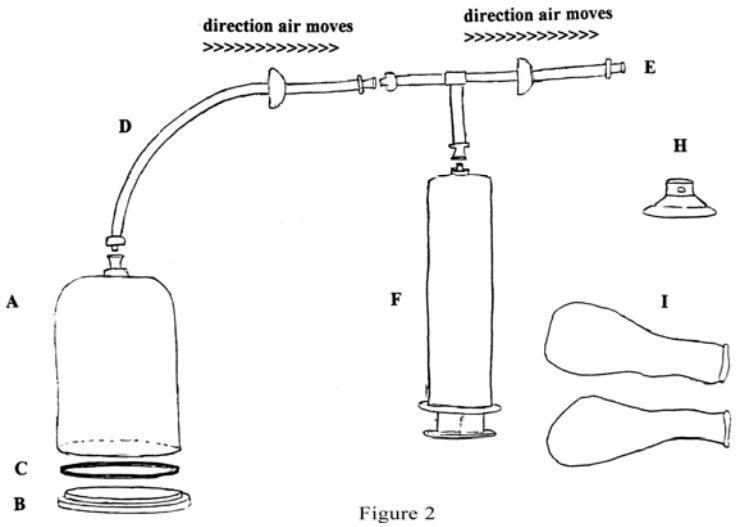

Figure 2

2. Place the balloon inside the bell jar and assemble the apparatus as shown in Figure 2. Start pumping the piston. What happens to the balloon?

3. Why did the balloon change in the way that it did? Why didn't it do this before you started the pumping?

4. Loosen the connection between hose (D) and the bell jar until you hear the movement of air. What happens to the balloon? Why does this change occur?

5. Open the apparatus and take out the balloon. Place the balloon back into the box for the next students. By pressing down on the suction cup, **stick** the suction cup to the center of the bottom plate, and put the bell jar over it so that the suction cup is inside. Why does the suction cup stick tightly to the bottom of the plate instead of falling off?

Have someone hold the apparatus with the hose down and the plate up. Pump the piston several times until something happens to the suction cup. What happens? What is the explanation?

<u>End of Experiment 3</u>

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Experiment 4: Liquids in a Vacuum

1. Imagine some water from the hot water tap that has just been poured into a cup. Why is the water not boiling now?

_____

2. Think about the boiling process. The water becomes a gas (steam) bubbles that take up much more room that the water that made them. Do you think that the presence of atmospheric pressure helps the boiling process, or makes it more difficult?

_____

_____

3. Can you predict what would happen if we put a container of hot tap water into the bell jar and pumped out the air?

_____

4. A small, clear vial has been included with this kit. Fill it about halfway with hot tap water. Do this quickly so that the water does not get cool. If the water temperature is safe and you don't have a thermometer, you might want to judge its temperature by dipping your finger into the water. Note any observations about the temperature:

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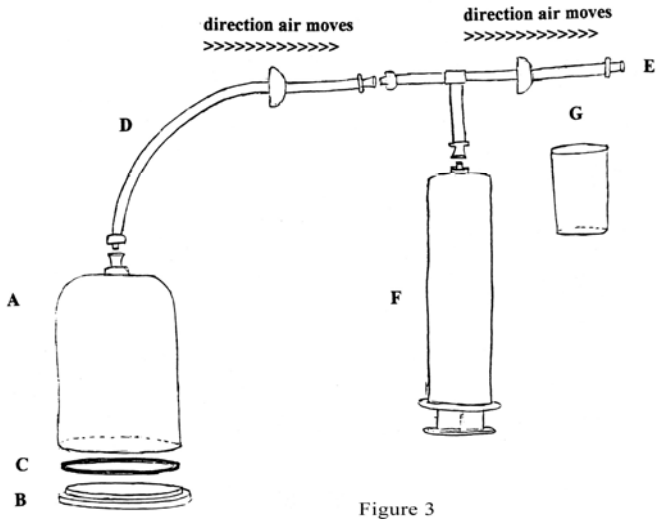

Figure 3

5. Place the vial on the bottom plate, inside the bell jar. Assemble the apparatus as shown in Figure 3. Have someone hold the bell jar in position so it does not tip over. Start pumping the piston and watch the vial of water. Something should happen after several strokes of the piston. What happens?

_____

6. What do you think has happened to the temperature of the water?

_____

7. Keep pumping until there is no further effect. Then slowly loosen the connection between hose (D) and the bell jar. Now open the bell jar and check the temperature of the water. What has happened? Can you explain the change?

_____

_____

End of Experiment 4