

Vacuum Sealer Gas Law Demos

Theory:

The normal boiling point of a liquid is the temperature at which the vapor pressure of the liquid equals atmospheric pressure. For water, this is 100°C. When the air is removed, the atmospheric pressure is reduced, so a lower temperature will provide enough vapor pressure to boil the water.



Additionally, the air pressure inside a balloon or a marshmallow is typically the same as the pressure outside. When the atmospheric pressure is reduced, the balloon or marshmallow pushes "out" causing it to get larger.

Typically, these demonstrations have been done using a bell jar and vacuum pump, or in closed syringes. Here a kitchen vacuum packer with canisters is used instead. This provides an affordable alternative to the bell jar version and a more macroscopic alternative to the syringe version.

Materials:

- Kitchen Vacuum Packer (Foodsaver®, or Black and Decker® both work well)
- Food Storage Containers that come with Vacuum Packer
- Water @ approximately 75° C
- Aquarium thermometer or small digital thermometer
- Small inflated balloon

Safety Precautions: Caution should be taken when handling the heated water. The canister may bubble over when the boiling begins. Do not fill more than half way.

Preparation:

To Demonstrate the Boiling Point of Water:

- 1. Heat water to approximately 75° C
- 2. Place the thermometer into the food storage container
- 3. Place the water into the food storage container

To Demonstrate the balloon or marshmallow:

Place the balloon or marshmallow into the food storage container

Demonstration Procedure:

Boiling Point:

- 1. Explain to students the relationship between vapor pressure and boiling point of water.
- Show that the temperature on the thermometer reads approximately 75°C. Connect the canister to the vacuum packer and remove the air inside the canister. The water that was not warm enough to boil at atmospheric pressure will now boil when the pressure is reduced.

3. Once the sealer has stopped, remove the canister from the machine. The container remains void of air and at reduced pressure until you press the button on the top and let the air back in. The water continues to boil for several minutes. The appearance of bubbles slows as the water cools down.

Volume of a Marshmallow or Balloon:

- 1. With the balloon in the sealed flask, remove the air.
- 2. Explain to the students that since there is no pressure outside of the balloon, the air inside the balloon pushes out, causing the balloon to get larger.
- 3. Do the same with the marshmallow or "Peep". Explain that marshmallow have a great deal of air inside them, just like the balloon.
- 4. Make a dramatic show of pressing the button, allowing air back into the canister. The size of the balloon or marshmallow reduces drastically and rapidly.

Disposal: Water can be dumped down the drain, marshmallows disposed of in the garbage.

References:

Duncan, Patti, "**Morning of Chemistry** –*Innovative Demonstrations from the New Wave of Chemistry Teachers*". Flinn Scientific, Inc. 2004 NSTA Convention .Atlanta, GA. 2 April 2004.