

Marshmallow in a Vacuum

Boyle's Law



Introduction

Help students explore and understand Boyle's Law with this simple demonstration. See how a change in pressure affects the volume of a marshmallow. Students will easily remember the relationship between pressure and volume after participating in this activity.

Concepts

- Pressure
- Volume
- Boyle's law
- Gas laws

Materials

Syringe, without needle, plastic, 30-mL

Felt-tip pen (optional)

Miniature marshmallow, fresh

Syringe tip cap (optional)

Safety Precautions

Although the materials used in this activity are considered nonhazardous, please observe all normal laboratory safety guidelines. Food-grade items that have been brought into the laboratory are considered laboratory chemicals and are for lab use only. Do not taste or ingest any materials in the chemistry laboratory. Wash hands thoroughly with soap and water before leaving the laboratory.

Procedure

1. If desired, use a felt-tip pen to draw a happy face on the end of a miniature marshmallow.
2. Remove the end cap from the tip of a 30-mL plastic syringe.
3. Remove plunger from the syringe and insert the marshmallow into the syringe.
4. Place plunger back in syringe so the volume reading is approximately at the 15-mL mark.
5. Place a syringe tip cap over the tip of the syringe. Pull the plunger out—decreasing the pressure inside the syringe. The marshmallow should expand as its volume increases.
6. Now push the syringe in—increasing the pressure inside the syringe. The marshmallow should shrink as its volume decreases.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The marshmallow should be removed from syringe and put into the trash according to Flinn Suggested Disposal Method #26a. Clean work area and wash hands thoroughly with soap and water before leaving the laboratory.

Tips

- A finger may be used to "seal" the syringe instead of a syringe tip cap, if needed.
- Compare the marshmallow from the syringe to a fresh marshmallow.

Discussion

When the syringe plunger is pulled out, the volume of the chamber increases but the amount of gas remains constant because it is in a closed system. This causes the pressure inside the syringe chamber to decrease. The lower pressure on the marshmallow causes its volume to increase according to Boyle's Law. The expansion is due to the many trapped air bubbles (like small "internal balloons") within the marshmallow that are initially at atmospheric pressure. As the pressure outside these air bubbles (within the chamber) is reduced, the bubbles will expand to many times their original volume in order to equilibrate the pressure on either side of the bubble wall. Thus, as the pressure decreases ($P \downarrow$), volume increases ($V \uparrow$) in an inverse relationship according to the following equations.

$$PV = nRT \quad \text{Equation 1 – Ideal Gas Law}$$

$$P_1 \times V_1 = P_2 \times V_2 \quad \text{Equation 2 – Boyle's Law}$$

This increase in volume makes for a memorable visual event and a great stimulus for the discussion of the elements of Boyle's Law. Students can visualize the loss in pressure and easily see the increase in volume.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation

Constancy, change, and measurement

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure and properties of matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Marshmallow in a Vacuum* activity, presented by Jesse Bernstein, is available in *Boyle's Law*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Marshmallow in a Vacuum* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP1732	Syringe, 30-mL
AP1297	Felt-tip Pen, Black
AP8958	Syringe Tip Cap

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.