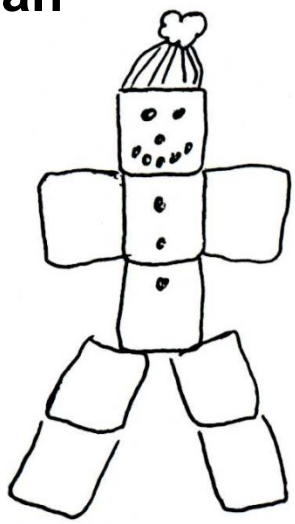
Boyles Law Demonstrations:
Marshmallow Snowman



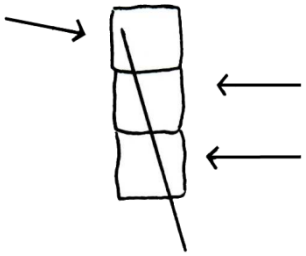
Chemicals and Equipment Needed

- Marshmallows – **L3**
  - If theyre stale, get fresh ones
  - Kraft Jet Puffed are the best
- 4 wood sticks – **U1**
- Bell Jar setup – **M5**
  - includes styrofoam cup, hat, and scarf
- Vacuum pump – **M5**
- Baggie if storing MM overnight – **U4**

Preparation

- Construct the marshmallow man:

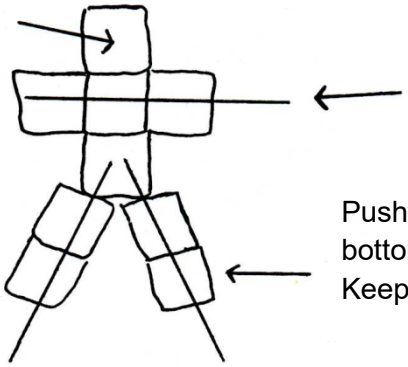
1) Face will be on this side



This is the back

Push the first stick through at a slight angle. This is a side view. Don't break off the stick.

2) Face will be here



Push the second stick through the arm and chest marshmallows, then break off the excess stick

Push sticks through two marshmallows and into the bottom marshmallow at a slight angle from the front. Keep some stick free at the bottom of each leg.

3) Attach the hat and use a Sharpie to decorate the face and add buttons, as shown above.

4) Use a wood stick to punch three holes in the bottom of a styrofoam cup (may be already made).

Then stand the marshmallow man on the inverted cup by pushing the leg and back sticks through the holes in the cup. (or place in Ziploc bag to save for later)

5) Set the marshmallow man and cup in the bell jar and put his hat on. On delivery, attach the vacuum hose to the bell jar.

Presentation

- Turn on the vacuum pump and the marshmallow man expands. Make sure to pull the hose before turning the pump off.

Discussion

- Prompt the audience to list the ingredients of marshmallows
    - If further prompting is needed, ask why marshmallows are “squishy” or draw an analogy to whipped cream in a can
    - Eventually someone will say “air” and you can explain that marshmallows are made by whipping air into a gooey sugary mess
- Explain what a vacuum pump does (sometimes I ask if there is air in space)
    - Ask: What will happen when we remove the air from around the marshmallow man?
    - Ask: How do P and V relate to each other?
    - Boyle’s Law is $PV = k$
    - Ask: Will the marshmallow man shrink, expand, or do nothing when we turn the pump on?
- When you evacuate the bell jar, the marshmallow man will expand. The gas is air trapped in tiny “cells” of sugar in the marshmallow. As the pressure decreases, the volume of the gas (and therefore the marshmallows) increases.
    - I like to run the pump as long as possible so that the marshmallow man gets huge. If you run it too long, you can break the sugar cells and air will leak out. If you notice the marshmallow man starting to shrink, it’s time to pull the hose.
    - Disconnect the hose from the bell jar before turning off the vacuum pump.
    - The marshmallow man will shrivel and it is hilarious

NOTES

- Fresh marshmallows work best. The marshmallow man is only good for one demonstration, but reuse the cup, hat, and scarf. When making a new cup, cut the top off so everything will comfortably fit in the bell jar.
- He probably needs more accessories
- Drawings by Mary Bailey