VELOCITY OF JETS OF LIQUID ESCAPING FROM A RECEPTACLE

TOPIC:

Hydrodynamics

SCIENTIST:

Evangelista Torricelli 1608–1647

INTRODUCTION:

Evangelista Torricelli is generally thought of as the founder of hydrodynamics (the study of the mechanical properties of fluids). One of his interests in this field was determining the velocity of a jet of liquid escaping from a small hole at the bottom of a container. He worked out by experimentation that the velocity depends on the depth of the liquid in the container: the greater the depth, the greater the velocity of the escaping jet. He also determined that the escaping jet was parabolic, or curved, in shape.

TIME NEEDED:

45 minutes

MATERIALS:

Note: You will need a partner for this experiment.

- sink in a kitchen or laboratory
- 1 m length of plastic tubing (the diameter should be such that it will fit snugly onto a faucet)
- electric or cordless drill with 1/8-in. bit
- ruler
- marker
- clean, cylindrical plastic container (with a capacity of around 2 gallons)*

*Make sure it is alright for you to drill holes in this before doing so.

Note: You will need an electricity source (*e.g.*, an outlet) if using an electric drill.

Original Materials:

Torricelli would not have used a container made of plastic, but he would have used a container that was similar in shape.

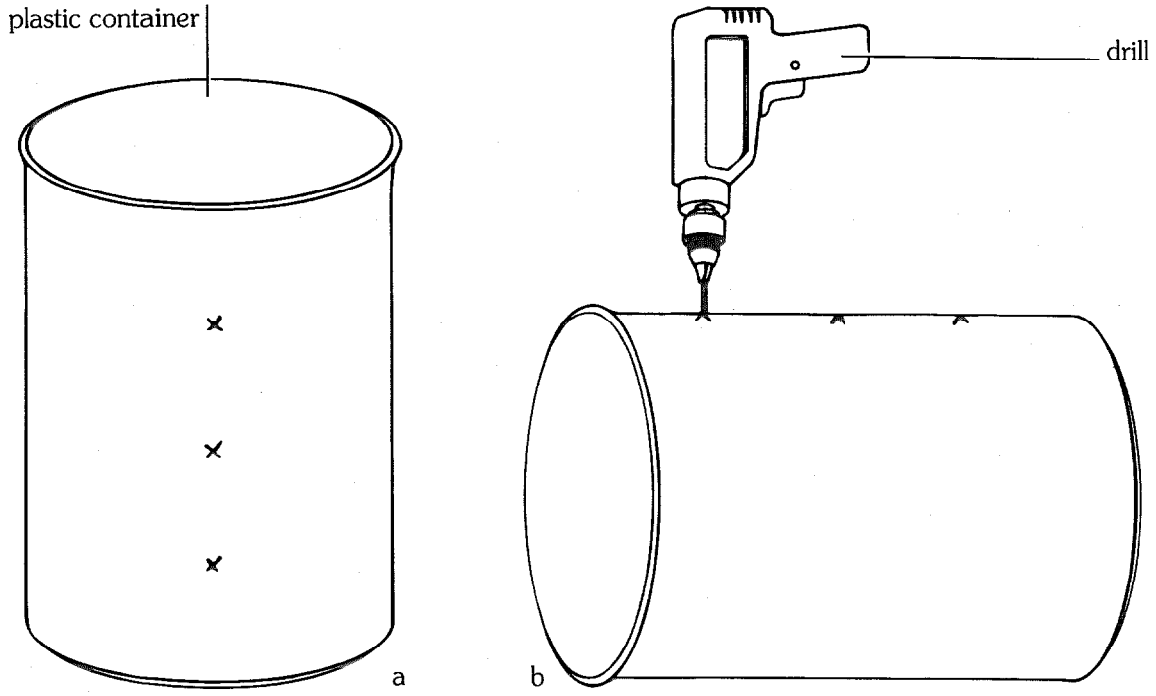
Safety Precautions

Adult supervision required. Please read and copy the safety precautions at the beginning of this book. Use the electric drill in a dry area; do not under any circumstances use electricity near water.

PROCEDURE:

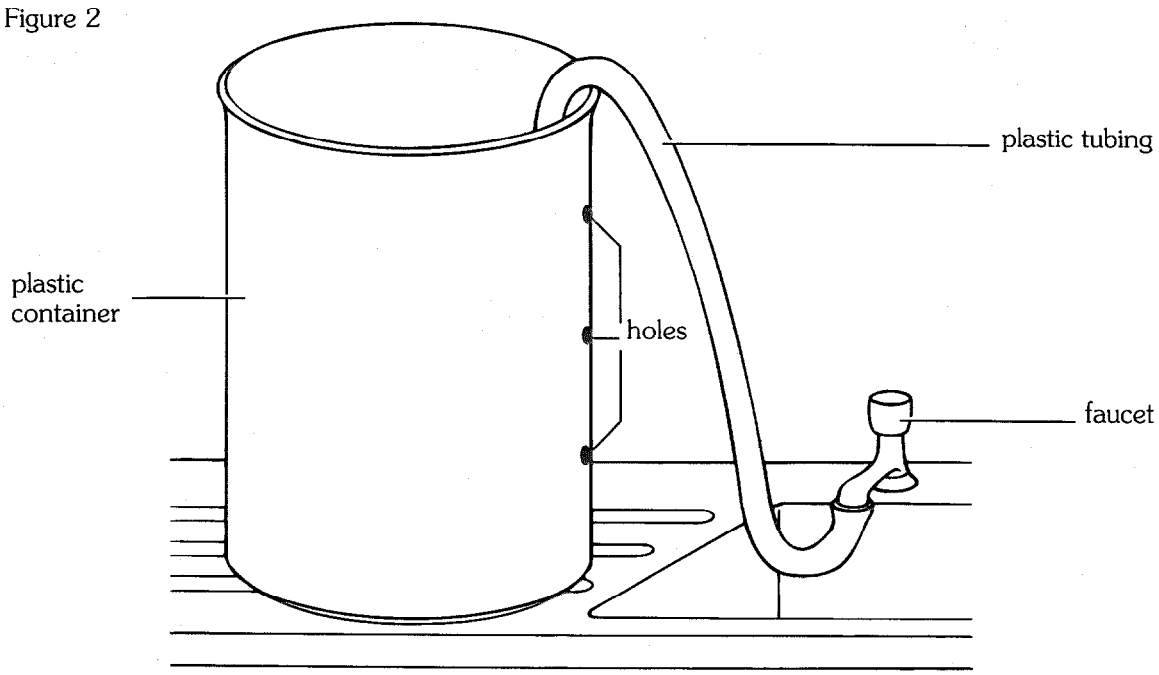
1. Put the plastic container on its side. Use the ruler and marker to mark three points equal distances from each other and from the top and bottom of the container (see figure 1a).
2. Put the container in a dry area well away from any water. Ask the adult to drill three holes in the side of the container through the points marked in step 1 (see figure 1b).
3. Place the container in an upright position next to the sink, with the drilled holes pointing toward the sink.
4. Put one end of the plastic tubing over the end of the cold-water faucet. Tell your partner to hold the other end of the tubing over the top of the container (see figure 2). Stand facing the sink in a position from which you will be able to see clearly what happens when water is poured into the container.

Figure 1



5. Tell your partner to turn on the faucet so that the container fills with water. Once the container is full, ask her or him to adjust the flow of water so that the container is kept filled without overflowing.
6. Look at the jets of water coming from the container. Record what you see.

Figure 2



ANALYSIS:

1. Did all the water jets spurt out the same distance or did some spurt out further than others?
2. Do some research. Explain your answer to question 1.

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO EXPERIMENTERS

Each experiment includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are performing the experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:
—Clear all surfaces before beginning experiments
—Read the instructions before you start
—Know the hazards of the experiments and anticipate dangers

PROTECTING YOURSELF:
—Follow the directions step-by-step; do only one experiment at a time
—Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
—Make sure there is adequate ventilation
—Do not horseplay
—Wear an apron and goggles
—Do not wear contact lenses, open shoes, loose clothing, or loose hair
—Keep floor and work space neat, clean, and dry
—Clean up spills immediately
—Never eat, drink, or smoke in laboratory or work space
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:
—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs
—Don't use your mouth to pipette; use a suction bulb
—Clean glassware before and after use
—Check glassware for scratches, cracks, and sharp edges
—Clean up broken glassware immediately
—Do not use reflected sunlight to illuminate your microscope
—Do not touch metal conductors
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders

USING CHEMICALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly

HEATING SUBSTANCES:
—Use goggles, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—Turn off hot plates, bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Have fire extinguisher on hand

FINISHING UP:
—Thoroughly clean your work area and glassware
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residue and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES