



# Calibrating a Liquid Thermometer

## Topic

Temperature



Time

1 hour



Safety

Please click on the safety icon to view safety precautions.  
Be careful with the drill.

## Materials

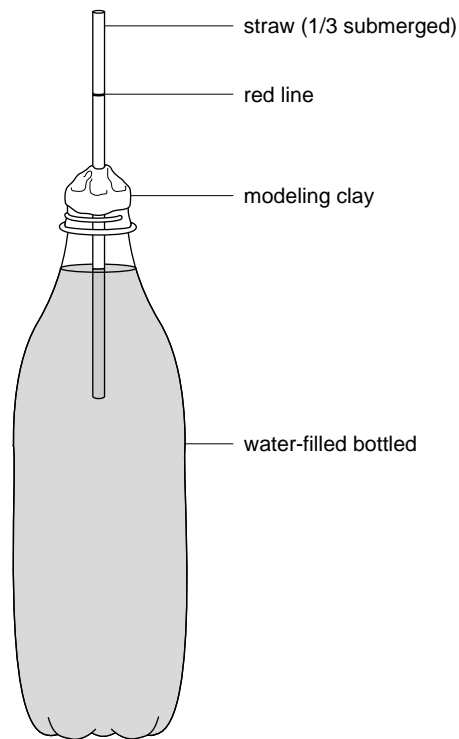
small soda plastic bottle	water
food coloring, red	ice water in a bowl
transparent plastic straw (use narrow party straws)	black permanent marker
clump of modeling clay (enough to seal the bottle)	

## Procedure

1. Pour water into the small soda plastic bottle until it is filled to the top.
2. Add 2 to 3 drops of red food coloring.
3. Put the straw into the bottle until approximately one-third is submerged in the bottle (see figure).
4. Mold the modeling clay around the straw to seal the bottle and secure the straw. Make sure the seal is watertight.
5. With the black permanent marker, draw a line on the straw where the red water has moved. This is your calibration for room temperature, 20°C.
6. Place the bottle in a bowl of ice water. Wait at least 15 min. With the black permanent marker, draw a line on the straw where the red water moved. This is your calibration for 0°C.

## What's Going On

When liquids are heated, the molecules move faster, farther apart from each other. When liquids are cooled, the molecules move slower and are closer together. Liquids expand when heated and contract when cooled. When you put a liquid into a container—a plastic soda straw in a plastic bottle that has been sealed—you have made a closed system. When you heat the water, the water's molecules begin moving faster and the water expands. Since there is nowhere but the straw for the water to expand into, the water expands up the straw. If you placed this bottle into a liquid of a known



temperature—for instance, ice water that is  $0^{\circ}\text{C}$ —after the system has readjusted to this temperature change, the water level in the straw could be calibrated to  $0^{\circ}\text{C}$ .

#### Connections

If you plan on growing vegetables or flowers, you need to use a guide to planting that farmers call “growing degree days.” For corn, the base temperature is  $50^{\circ}\text{F}$ . Every degree above the base temperature is considered to be a growing degree day. Therefore, if the outside mean temperature is  $80^{\circ}$ , the growing degree day is  $80 - 50 = 30$  growing degree days. Corn requires from 2,200 to 2,800 growing degree days to grow; therefore if the average growing degree days were 30, divide 2,200 by 30; thus, you need 73 days to harvest corn. On the seed packages, seed companies have calculated the growing degree days and made suggestions for times of planting.

#### Troubleshooting

If the liquid is not moving up and down in the straw as you change temperatures, your seal has been broken. Add more modeling clay and secure the seal. If you put the thermometer in the sun, the red liquid may spill over the edge from the heat.

#### Additional Activities

Obtain two empty glass soda bottles, one with a screw-on lid. Drill a hole in the center of the cap large enough for a plastic soda straw. Put the soda straw through the hole, and secure the straw to the cap with modeling clay or dripped candle wax. Secure the upside-down bottle to a stand so that the straw extends into the other bottle, which is filled with colored water. Place a ruler behind the straw. Warm the upper bottle with your hands to force air out into the other jar (you will observe bubbles in the water). Remove your hands, and watch the water rise into the straw. Place an ice cube on the top of the empty bottle. Observe the results.

# Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always 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, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

## PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

## PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

## USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and 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 low-current materials.
- Be careful when using stepstools, chairs, and ladders.

#### USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all 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 INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating 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 a fire extinguisher on hand.

#### WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

#### GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

#### 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 thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

**BE SAFETY-CONSCIOUS AT ALL TIMES**