Throughout the guide, teaching tips are in red.

Activity Description & Estimated Class Time

This activity focuses on the water cycle and requires parts of six 50-minute class periods. Some of the activities can be done in half a class period. Students investigate factors that affect evaporation and condensation by building and exploring variations on a model system in which water moves from place to place via evaporation and condensation. The variations reveal different factors that influence the water cycle. After predicting possible outcomes in each variation, students run the models to see examples of evaporation, condensation, and precipitation. Afterward, they are able to assign appropriate terms to events, relate the water cycle to weather phenomena, and explain from experience how the sun's energy drives the water cycle.

Objectives

Students will demonstrate knowledge and understanding of the following ideas and content:

- evaporation and condensation
- surface area related to evaporation
- the role of heat energy in driving evaporation

Students demonstrate knowledge and understanding by observing the outcome of an initial water cycle model and using this information with new models to explain and predict results.

Correlations to North Carolina Science Standards

5.E.1 *Understand weather patterns and phenomena, making connections to the weather in a particular place and time.*

5.P.2.1 *Explain how the sun's energy impacts the processes of the water cycle (including evaporation, transpiration, condensation, precipitation and runoff).*

Brief Science Background

When water evaporates, it becomes water vapor, an invisible gas form of water. Because water vapor is an invisible gas, it differs from steam, fog, or clouds, which are visible because they consist of tiny drops of water. Any moisture that you can see in the air is water and not water vapor, but the air can contain a lot of water in the invisible form of water vapor. The warmer the air, the more water vapor can remain mixed with that air. As air containing water vapor cools, some of the water vapor becomes liquid water. This process is called condensation. When water vapor condenses in the sky, it can form drops of water in the air that fall as rain. If some parts of the air cool below freezing, the condensed water can freeze and fall as snow, sleet, or hail. Often, tiny drops of condensed water float in the air and appear as clouds or fog. The sun is the most important source of energy causing the evaporation that puts water vapor into the air. The air in warm, sunny places, such as the tropics, can contain a lot of water vapor. Where there is less solar radiation coming in, such as near the poles, the air remains cooler, there is less evaporation, and the atmosphere as a whole in these places contains less water vapor.

Part 1 — Weather Tanks (50 minutes)

Materials for the whole class

- equipment to project all Black Line Masters of different Weather Tanks

Materials for groups of 4 students

- clear plastic tank
- thermometer
- large plastic bag
- twist tie
- 2 large rubber bands
- 9 oz squat cup
- 8 oz deli container
- warm water
- ice cubes
- dropper
- graduated medicine cup
- science notebook (supplied by teacher)

Preparation

1. Obtain enough ice for one cup of ice (3 or 4 ice cubes) for each set up.
2. Keep a thermometer out measuring the classroom temperature to compare to temperatures inside the tanks.
3. Set up teams of 4 students and make materials available to them.

Procedure

1. Project BLM 1 Weather Tank #1 and explain how to set up the tank. Do not explain the purpose of the set up or its components. That's for the students to figure out later. On BLM 1, point out how one gusset of the bag hangs down into the tank with its point directly over the deli container.
2. Give out BLM 2 Instructions for Weather Tank #1 to teams of 4 and ask them to set up their own Weather Tanks. Check teams' work as they assemble the tanks.
3. After all teams have made their tanks, set all of the tanks in the same area, preferably near a sunny window. Take care to arrange the tanks so that, as much as possible, they all receive the same amount of sunlight.
4. Allow students to observe the tank, discuss what they see, and record any observations.
5. Allow all of the tanks to sit in the same conditions overnight. Ask students to observe their tank the next day to look for changes.

Part 1 (cont.)

6. Ask students to collect and measure all water collected in the deli container using the dropper to count the number of drops in the container. This can be done with droppers and a graduated 1-oz cup. If 10 ml or more of water collects in the deli container, students can count the number of drops in 5ml, then pour water from the deli container into a graduated 1-oz cup to measure ml, then convert this to drops. This allows the class to use drops as the standard measure of volume so that they can compare results.

7. If no water accumulates in many of the deli containers after a day, allow all of the Weather Tanks to sit another day.

Wrap-Up

1. Ask students to report their observations.

2. Ask students to respond to this prompt in their notebooks:

Notebook Prompt: Write your explanation of how the water got into the container that was empty yesterday.

Part 2 — Four More Weather Tanks (50 minutes over two days)

Materials

Materials for the whole class

- equipment to project diagrams of weather tanks
- blue food coloring
- access to ice and water

Materials for groups of 4 students (each team gets a different combination)

- clear plastic tank
- copies of BLM 3 Instructions for Weather Tank #2, BLM 4 Instructions for Weather Tank #3, BLM 5 Instructions for Weather Tank #4, BLM 6 Instructions for Weather Tank #5
- thermometer
- large plastic bag
- 2 large rubber bands
- 9 oz squat cup
- 8 oz deli container
- warm water
- ice cubes
- dropper
- graduated medicine cup
- science notebook (supplied by teacher)
- clamp light
- blue ice cubes
- wooden blocks

Preparation

1. Make blue ice cubes using food coloring for Weather Tank #5 (if this is difficult you can simply put drops of food coloring on the regular ice) and plain water ice cubes for Weather Tank #2 and Weather Tank #4.
2. Keep one thermometer in the classroom to compare ambient air temperature to temperatures inside the tanks.
3. Make enough copies of black line masters 3-6 (instruction sheets for Weather Tanks 2-5) for the groups of 4 students
4. Be ready to project black line masters 7-10.
5. Assemble materials needed for the different set ups in a central location.

Procedure

1. Assign teams a specific weather tank setup. Depending on class size, multiple teams might work with one type of setup, so consider how to distribute setups among teams.
2. Distribute instructions for building Weather Tanks #3, #4, #5, or #6 among the teams. Ask teams to record in their notebooks how the new tank setup differs from Weather Tank #1.
3. Challenge students to predict and record in their notebooks how they think results from the new weather tank might be different from Weather Tank #1, and why they think this.
4. Ask students to use their instruction sheets to set up new Weather Tanks.
5. Once tanks are assembled, group like tanks together. Keep the tanks that should not get light away from windows and away from tanks with clamp lights.
6. One at a time, project Weather Tanks #2, #3, #4, and #5 (BLMs 7-10). As you show each diagram, ask students to write a sentence about how this tank is different from Weather Tank #1 and what they predict will happen in the new tank. **This is a good break point**.
7. The next day, ask students to record observations of their tank. Ask them to include the number of drops of water in the deli container and the temperature inside the tank.
8. Ask the teams that worked with the same kind of weather tank to meet and compare results. The goal of this meeting is produce an “average” result from their type of set up to present to the class.

Wrap-Up

Again, one at a time, project Weather Tanks #2, #3, #4, and #5 (BLMs 7-10). As you project each weather tank, ask a representative from the combined-team group that worked with that type of weather tank to report the average results. Challenge the class to explain why the observed results differ from the original set up.

Part 2 (cont.)

Answer Key

- Weather tank #2: without a cup of water in the tank, no water can evaporate to add water vapor to air in the tank. The underside of the bag would be wet only from humidity already in the air when the tank was put into the bag. No water or very little water would likely be in the deli container.
- Weather tank #3: blocks push down the plastic just like ice cubes, but are not cold. Water vapor does not condense without cooling the air. Little or no water would collect in the deli container.
- Weather tank #4: the light creates a larger temperature difference between warm and cool areas inside the tank. The greater difference causes more water to evaporate and condense. This setup will likely collect the most "rain" in the deli container.
- Weather tank #5: the blue ice tests the idea that water from the ice is getting through the plastic. The melted ice water is blue. If the water in the deli container is not blue it, is not from the melted ice.

Part 3 — Final Tanks (50 minutes over two days)

This activity uses three types of weather tanks, with each team working with one. Using teams of 4, depending on class size, two or three teams might need to work with the same type of weather tank, so set out materials grouped to accommodate the number of teams.

Materials

Materials for the whole class

- images to project: Weather Tanks #6, #7, and #8 (BLMs 14-16)
- blue food coloring
- access to ice and water

Materials for groups of 4 students (each team gets a different combination)

- clear plastic tank
- copies of of BLM 11 Instructions for Weather Tank #6, BLM 12 Instructions for Weather Tank #7, and BLM 13 Instructions for Weather Tank #8
- thermometer
- large plastic bag
- twist ties
- large rubber band
- 9 oz squat cup (2 additional cups for some groups)
- 8 oz deli container
- warm water
- ice cubes
- dropper
- graduated medicine cup
- scissors for some groups (supplied by teacher)
- science notebook (supplied by teacher)

Part 3 (cont.)

Preparation

1. One cup of ice (4 or 5 ice cubes) is required for each set up. Keep one thermometer in the classroom to compare ambient temperature to temperatures inside the tanks.
2. Assemble setup materials for teams at a central location accessible to teams. Set out materials for Weather Tank #6, #7, and #8 with directions for each setup (BLM 11-13) in its own tank.

Procedure

1. Assign each team a specific Weather Tank setup, either #6, #7, or #8. **Multiple teams are likely to work with one type of setup. Consider how to distribute setups among teams.**
2. Distribute instructions for building Weather Tanks #6, #7, or #8 to teams. Ask teams to record in their notebooks how the new tank setup differs from other tanks seen so far.
3. Challenge students to predict how their results from the new weather tanks might differ from the other set ups, and explain why they think this.
4. Ask students to get weather tank materials and set up their new weather tanks according to the instructions.
5. One at a time, project Weather Tanks #6, #7, and #8 (BLMs 14-16). As you show each one, ask students to write a prediction in their notebooks explaining what they think will happen in each tank, and why.
6. Group like tanks together and let all tanks run overnight in light and temperature conditions that are as similar as possible. **This is a good break point.**
7. The next class period, ask students record observations, temperature, and volume of water in the deli container measured in drops.
8. Ask the groups that worked on the same set up to meet and compare results with the goal of producing an average result from their type of set up to present to the class.
9. Again, project Weather Tanks #6, #7, and #8 (BLMs 14-16). As you project each weather tank, ask a representative from a combined group that made that tank to report the average results among teams.
10. Challenge the class to come up with explanations for the observed results. Look for (but do not provide) key insights as follows:

    Tank # 6: Dividing the half cup of water among three cups nearly triples the surface area of water. The increased surface area should result in more evaporation, more water vapor in the air inside the tank, and more water in the deli container.

    Tank #7: The food coloring in the water does not evaporate and condense with the water. If the water in the deli container had been blue, it would mean that the food coloring also made a vapor that condensed, or otherwise traveled with the water vapor. However, the water in the deli container is clear, meaning that the food coloring was left behind. Similarly, evaporation from the ocean makes fresh water rain not salt water rain.

Tank #8: The hole in the bag allows water vapor evaporating from the cup to escape into the room. As a result, most of water vapor escapes the bag and the cold spot condenses less water. In this setup, air in this tank mixes freely with room air. Because room air likely also contains some water vapor, the system condenses about the same amount of water that would condense from air in the room.

Wrap-Up

Project BLM 17 The Water Cycle, and BLM 9 Weather Tank #4. Ask students to draw their own diagram of Weather Tank # 4 and label it using the terms from the water cycle diagram. Encourage key insights as follows:

- The light is the sun.
- The cup of water is any body of water such as a lake or the ocean.
- The ice is the cold area in the upper atmosphere.
- The drops on the bag are rain.
- The deli container is water falling on land, lakes, the ocean, or any other surface.

Guided Practice

1. The water cycle …

a. …is driven by the energy of the sun.

b. …changes water to gas only.

c. …can not make snow.

d. …means that water only moves in a circle.

2. Use the ending you like best from the choices below to end the following sentence: “Water vapor in the air…” .

a. …always condenses to make rain.

b. …comes only from evaporation out of tree leaves.

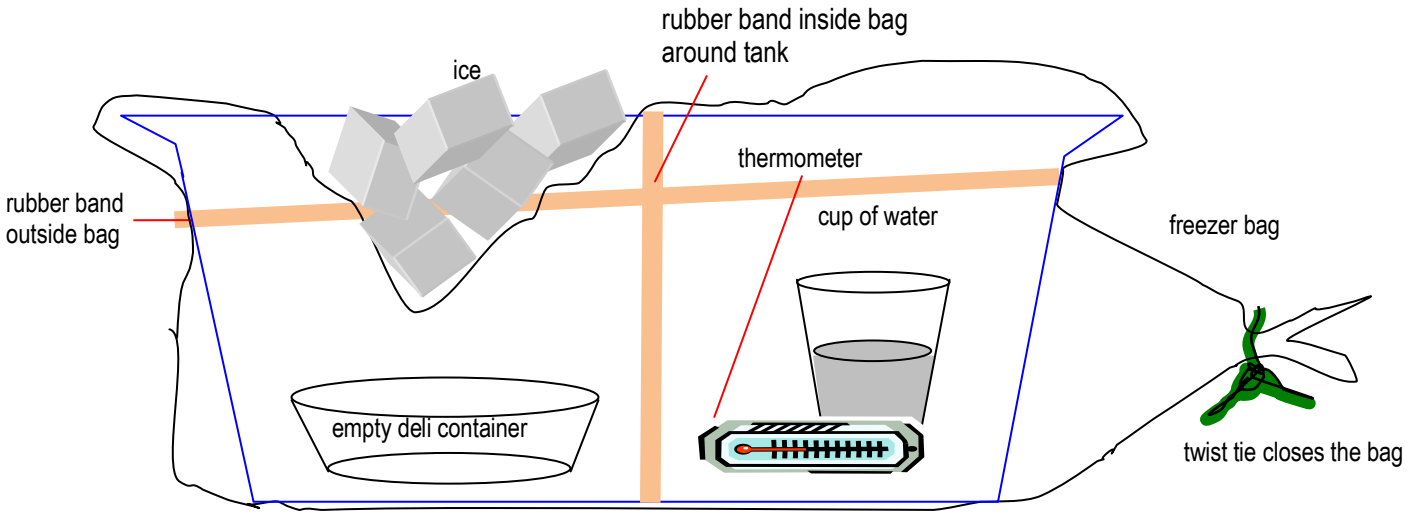
c. …can be cooled to turn into water on a cold can.

d. …is not important to the weather.

e. …can move from place to place.

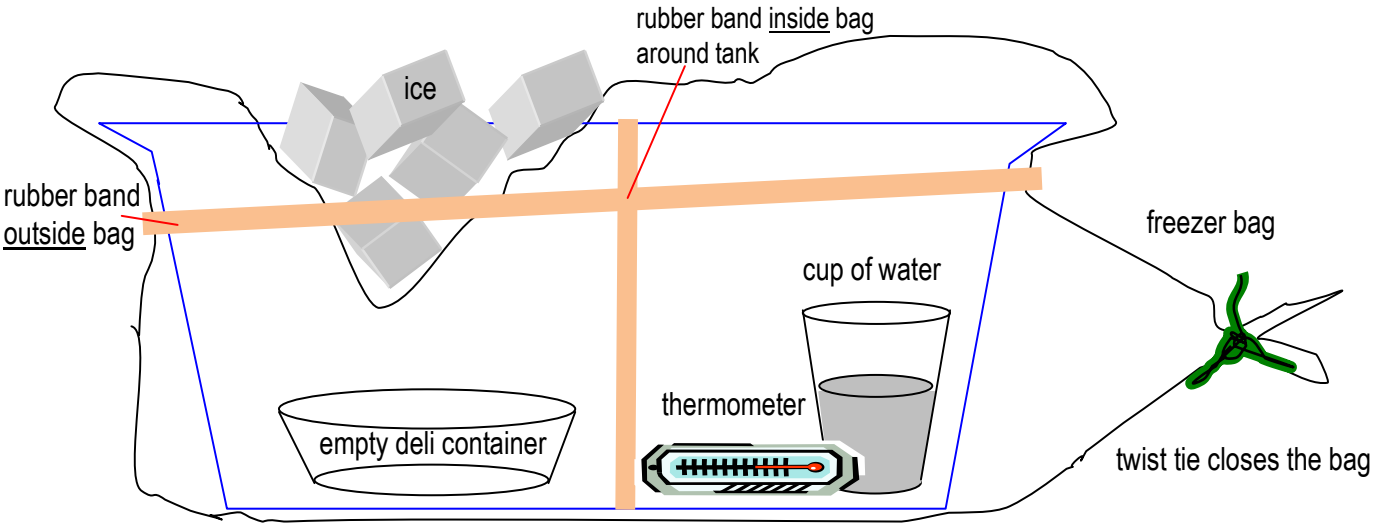
BLM 1 Weather Tank #1

Weather Tank #1

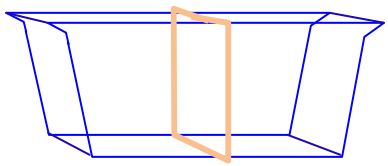


BLM 2 Instructions for Weather Tank #1

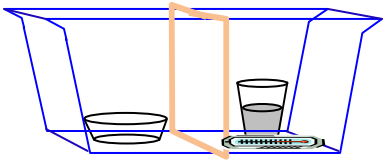
Instructions for Weather Tank #1



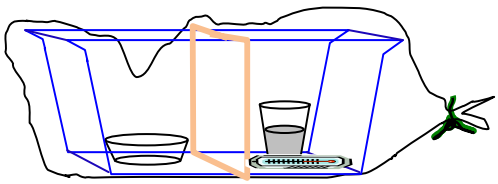
1. Stretch a rubber band around the middle of the tank:



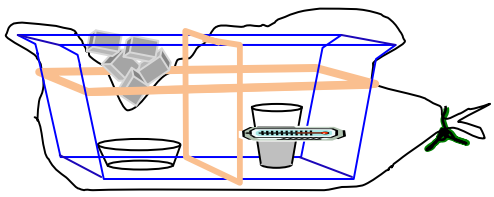
2. Place a 9 oz. cup half full of water, a thermometer, and an empty deli container at opposite ends of the tank.



3. Carefully put the bin, rubber band, thermometer deli container, and cup in a freezer bag and seal with a twist tie. Place a bottom corner (gusset) of the bag so that it dips down over the deli container.

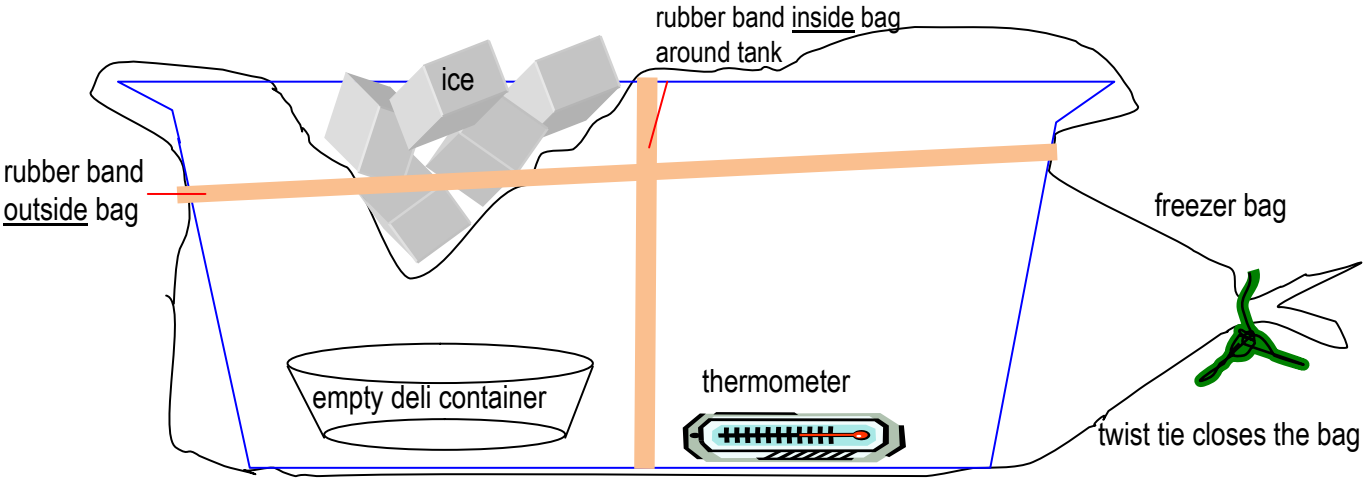


4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 ice cubes in the depression over the deli container.

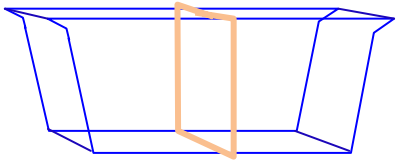


BLM 3 Instructions for Weather Tank #2

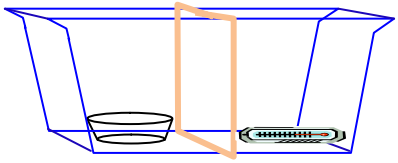
Instructions for Weather Tank #2



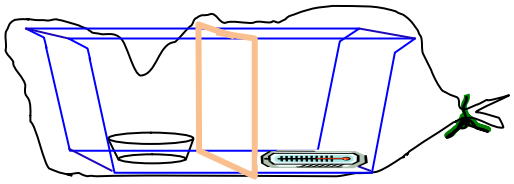
1. Stretch a rubber band around the middle of the tank:



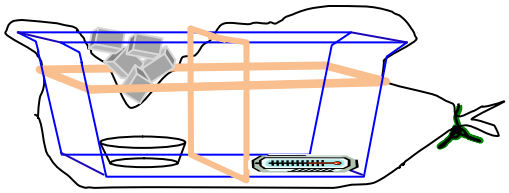
2. Place an empty deli container and a thermometer at opposite ends of tank.



3. Carefully put the tank, rubber band, thermometer, and deli container in a freezer bag and seal with a twist tie. Place a bottom corner (gusset) of the bag so that it dips down over the deli container.

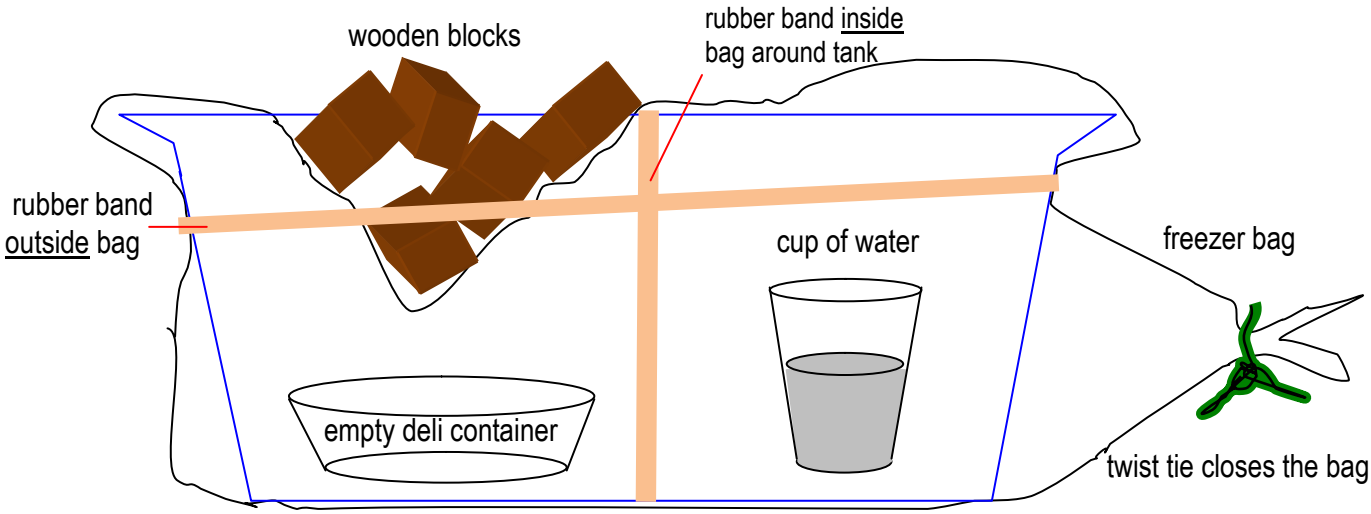


4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 ice cubes in the depression over the deli container.

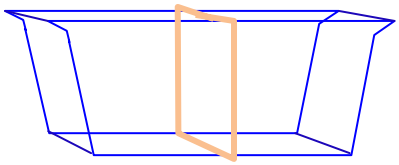


BLM 4 Instructions for Weather Tank #3

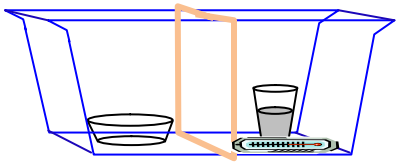
Instructions for Weather Tank #3



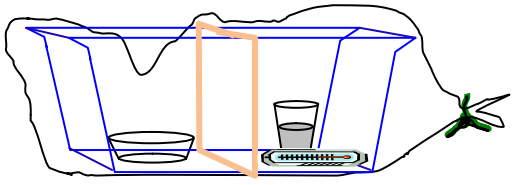
1. Stretch a rubber band around the middle of the tank:



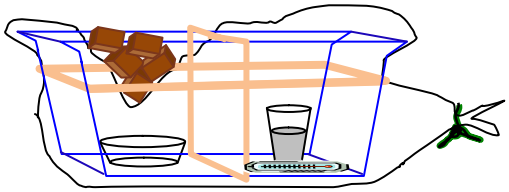
2. Place a 9 oz. cup half full of water, a thermometer, and an empty deli container at opposite ends of the tank.



3. Carefully put the tank, rubber band, deli container, and cup in a freezer bag and seal with a twist tie. Place a bottom corner (gusset) of the bag so that it dips down over the deli container.

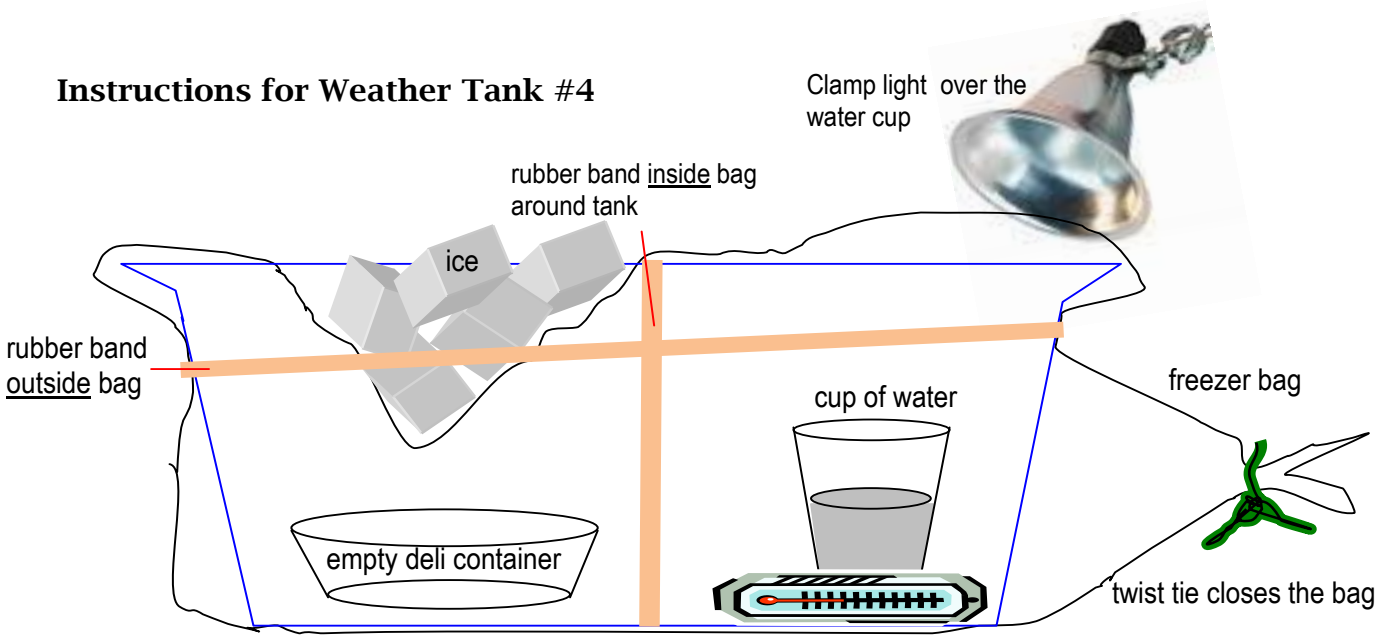


4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 wooden blocks in the depression over the deli container.

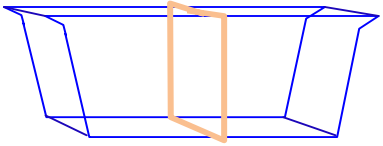


BLM 5 Instructions for Weather Tank #4

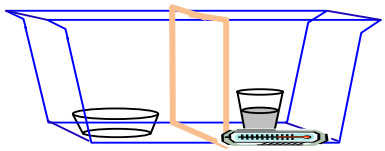
Instructions for Weather Tank #4



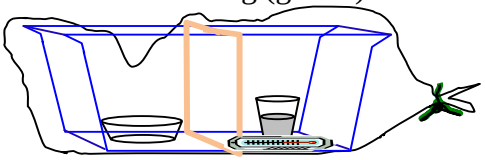
1. Stretch a rubber band around the middle of the tank:



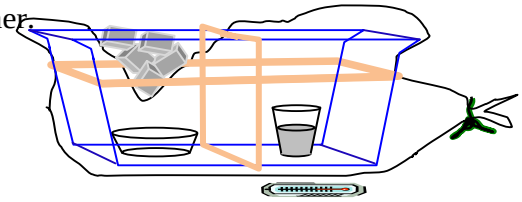
2. Place a 9 oz. cup half full of water, a thermometer, and an empty deli container at opposite ends of the tank.



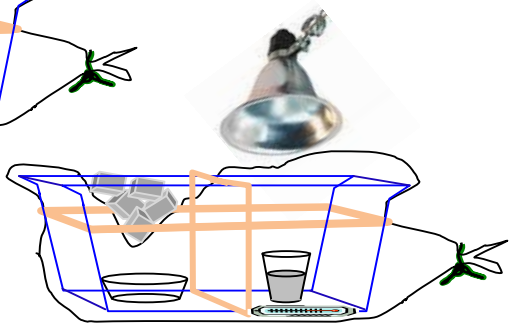
3. Carefully put the tank, rubber band, deli container, and cup in a freezer bag and seal with a twist tie. Place a bottom corner of the bag (gusset) so that it dips down over the deli container.



4. Stretch a rubber band outside the bag around the top of the tank. Push a corner of the bag down over the deli container. Put 5 ice cubes in the depression over the deli container.

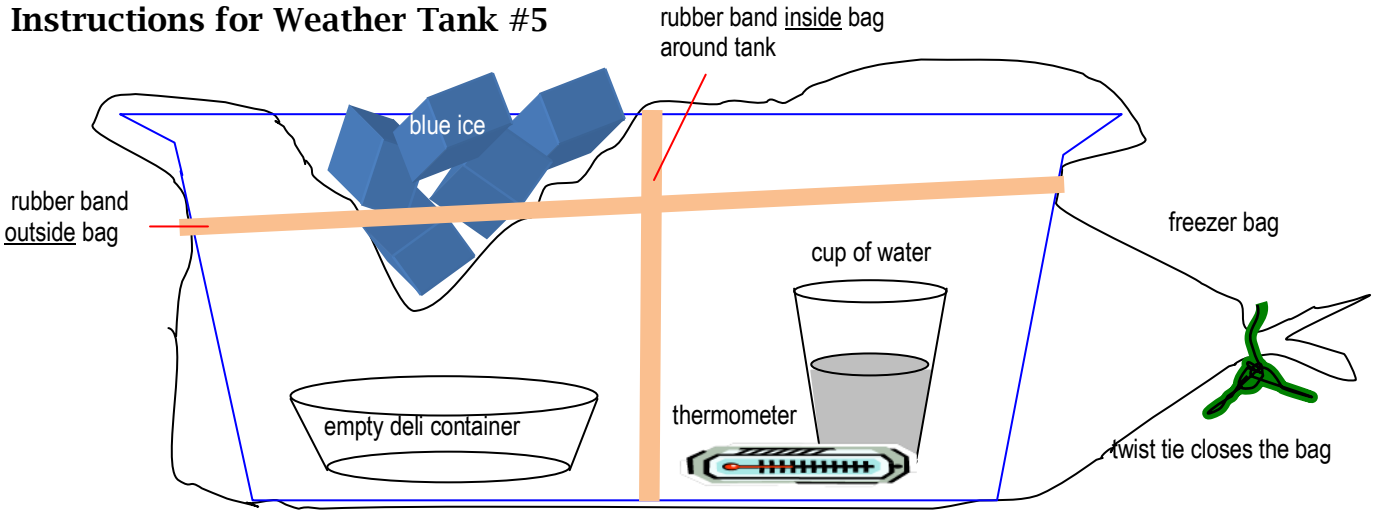


5. Place a clamp light about 12 inches away so it shines over the water cup.

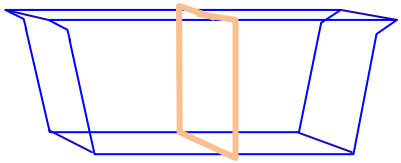


BLM 6 Instructions for Weather Tank #5

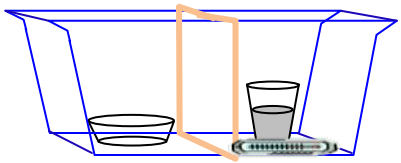
Instructions for Weather Tank #5



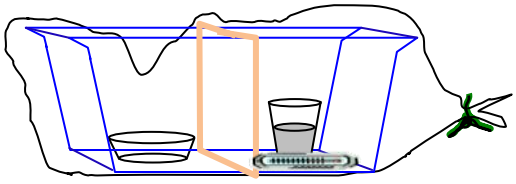
1. Stretch a rubber band around the middle of the tank:



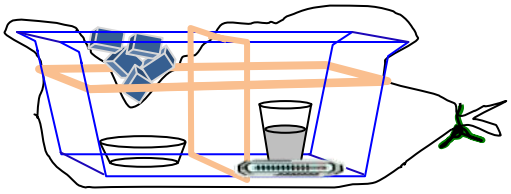
2. Place a 9 oz. cup half full of water, a thermometer, and an empty deli container at opposite ends of the tank.



3. Carefully put the plastic tank, rubber band, deli container, and cup in a freezer bag and seal with a twist tie. Place a bottom corner of the bag (gusset) so that it dips down over the deli container.

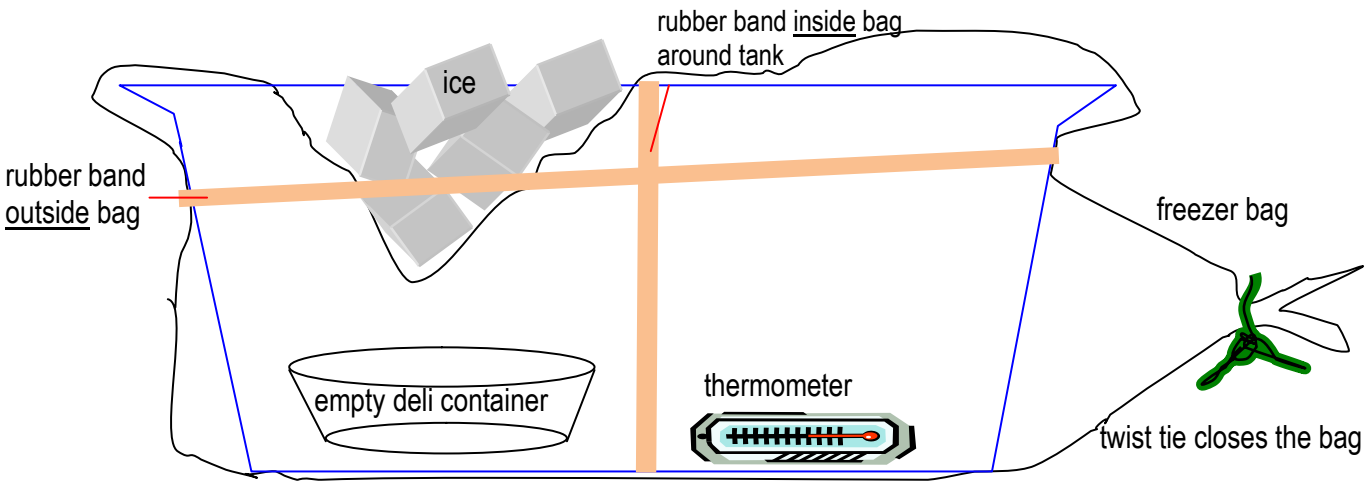


4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 blue ice cubes in the depression over the deli container.



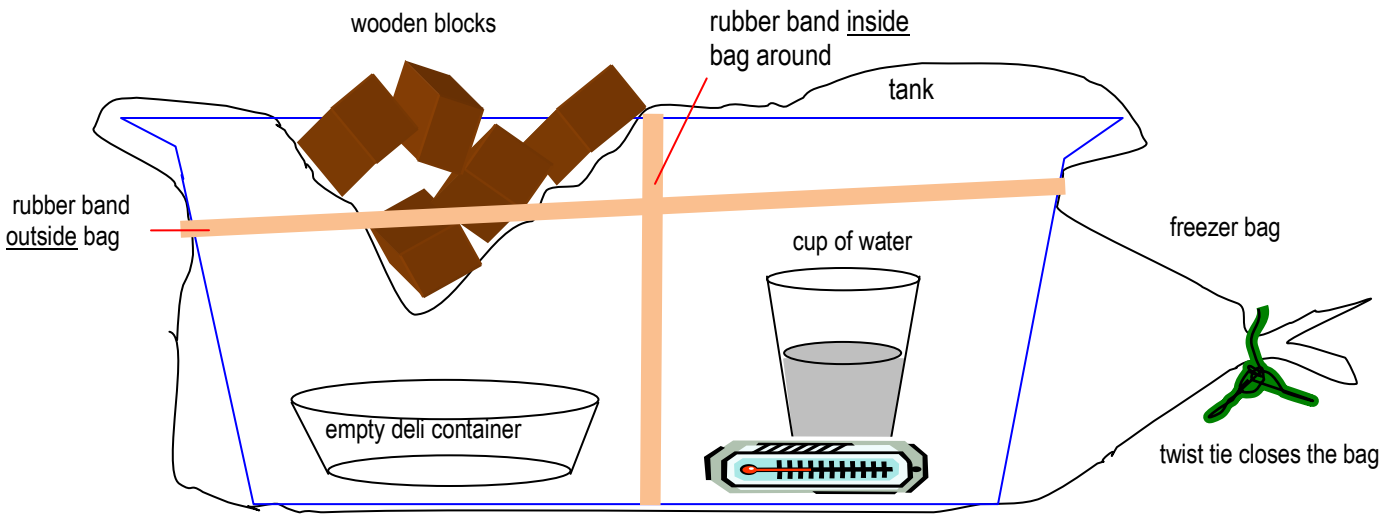
BLM 7 Weather Tank #2

Weather Tank #2



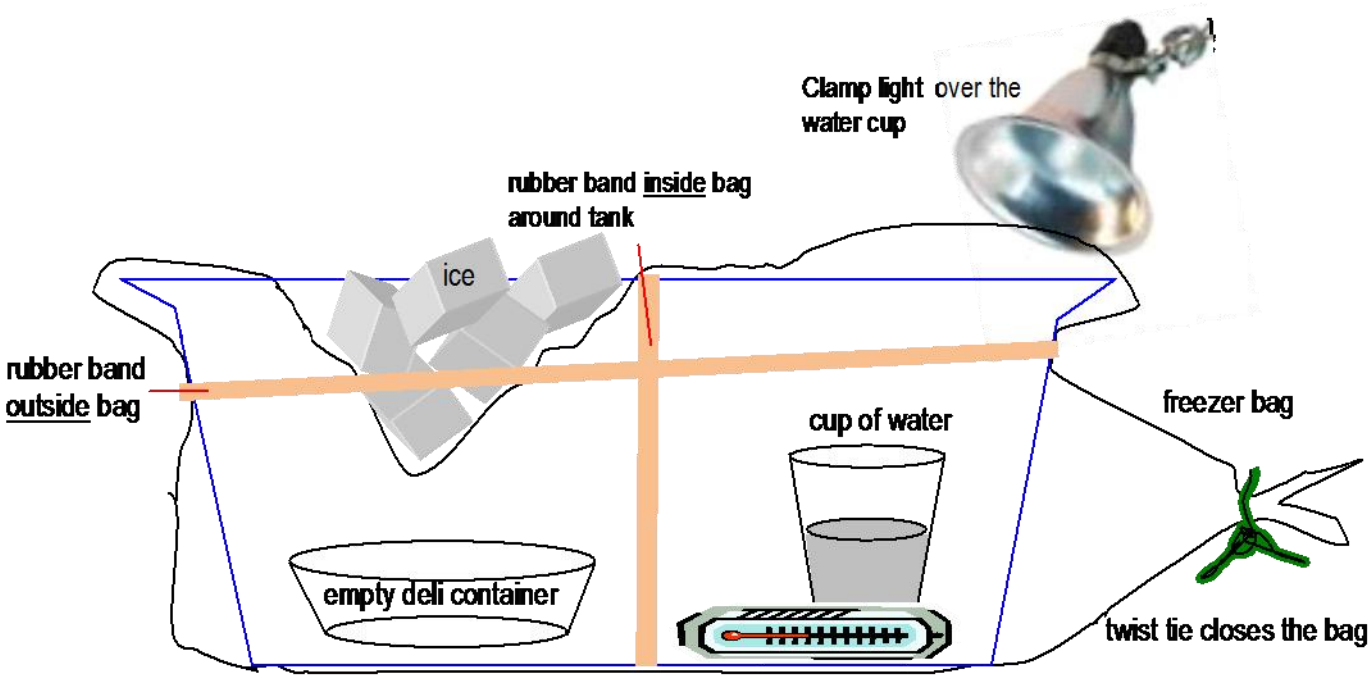
BLM 8 Weather Tank #3

Weather Tank #3



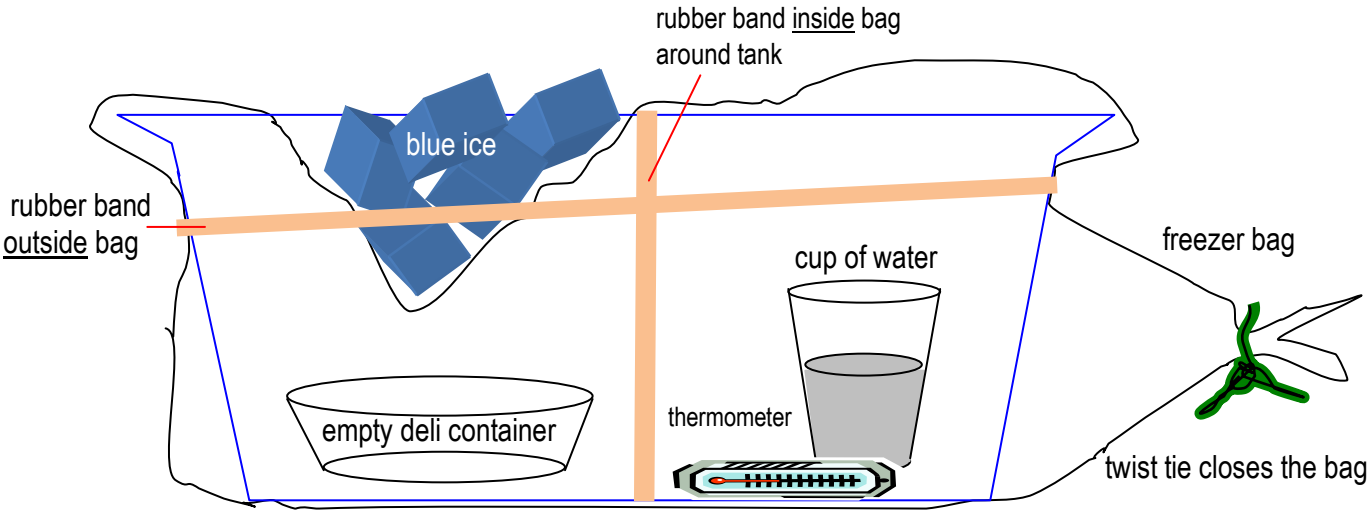
BLM 9 Weather Tank #4

Weather Tank #4



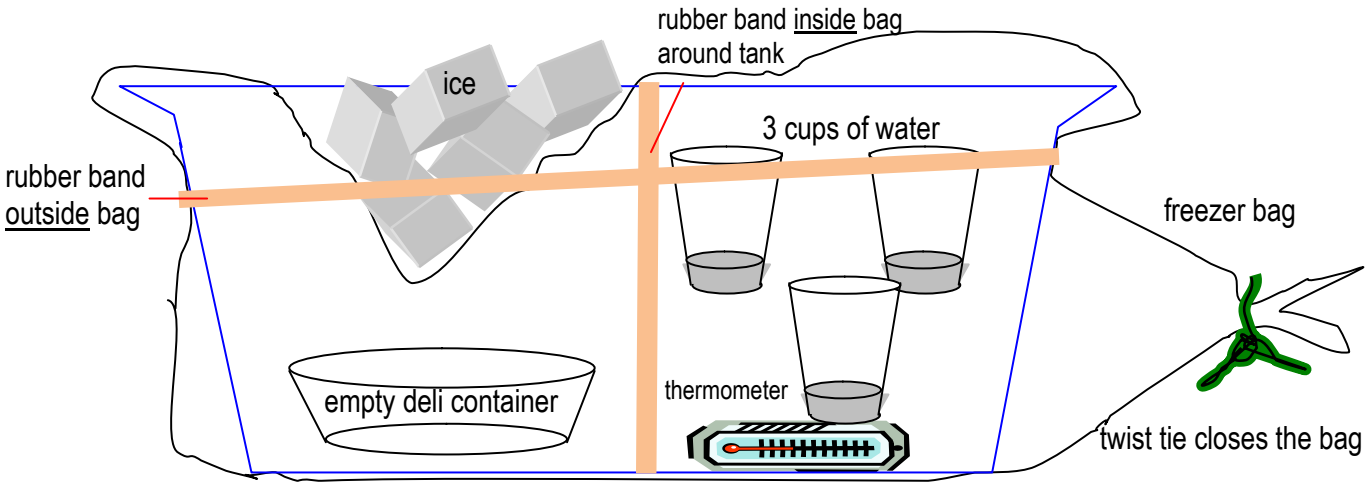
BLM 10 Weather Tank #5

Weather Tank #5

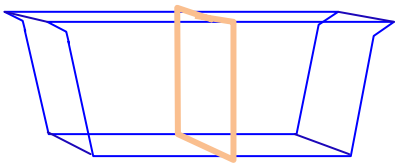


BLM 11 Instructions for Weather Tank #6

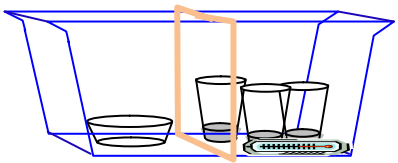
Instructions for Weather Tank #6



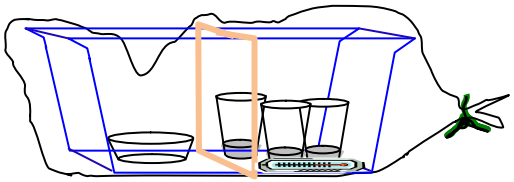
1. Stretch a rubber band around the middle of the tank:



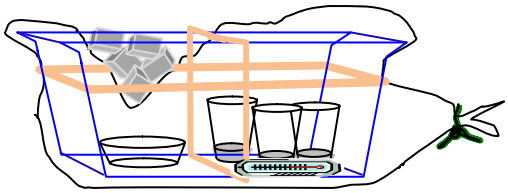
2. Divide a half cup of water among three 9 oz. cups and place the three cups and a thermometer at one end of the tank with an empty deli container at the opposite end of the tank.



3. Carefully put the tank, rubber band, deli container, and cups in a freezer bag and seal with a twist tie. Place a bottom corner (gusset) of the bag so that it dips down over the deli container.

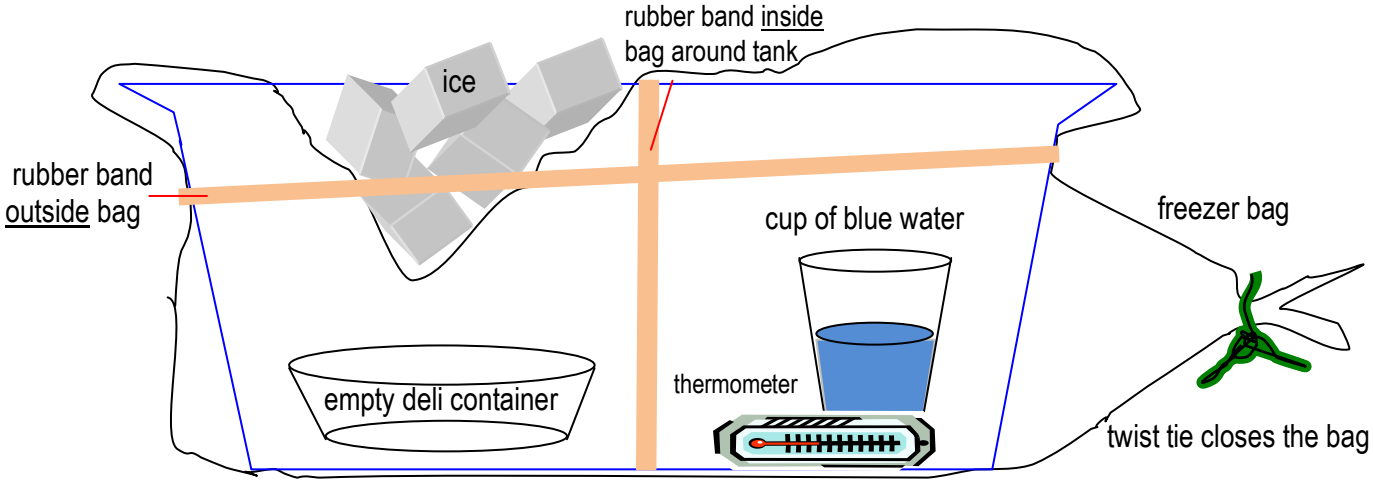


4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 ice cubes in the depression over the deli container.

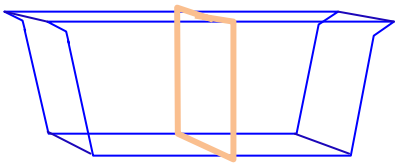


BLM 12 Instructions for Weather Tank #7

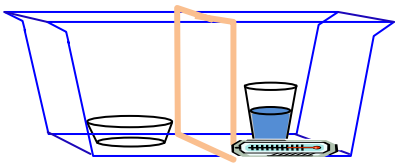
Instructions for Weather Tank #7



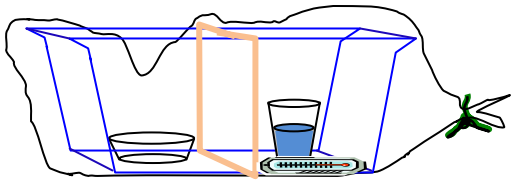
1. Stretch a rubber band around the middle of the tank:



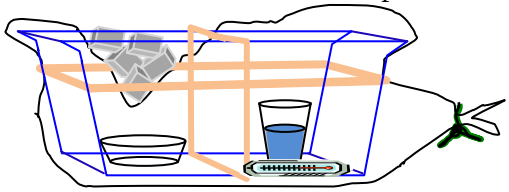
2. Place a 9 oz. cup half full of blue water, a thermometer, and an empty deli container at opposite ends of the tank.



3. Carefully put the tank, rubber band, deli container, and cup in a freezer bag and seal with a twist tie. Place a bottom corner of the bag (gusset) so it dips down over the deli container.

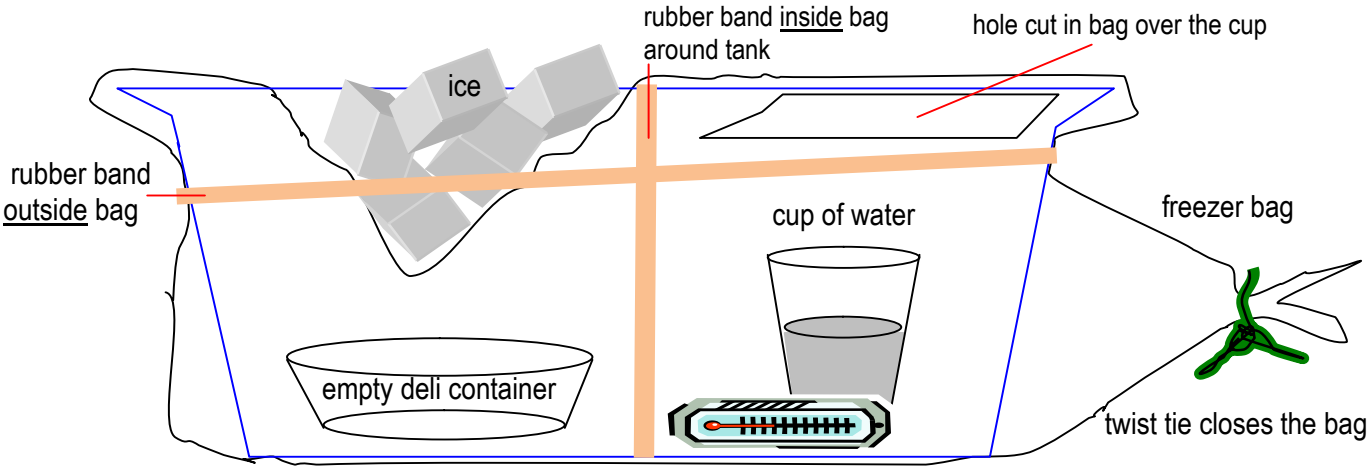


4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 ice cubes in the depression over the deli container.

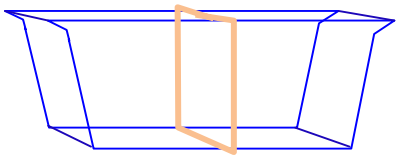


BLM 13 Instructions for Weather Tank #8

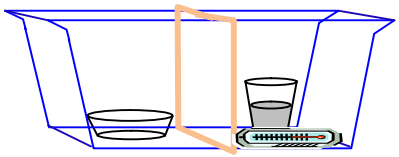
Instructions for Weather Tank #8



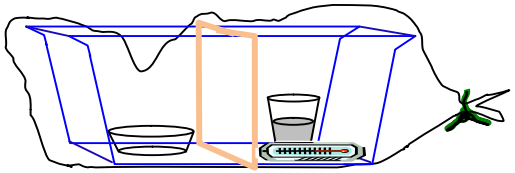
1. Stretch a rubber band around the middle of the tank:



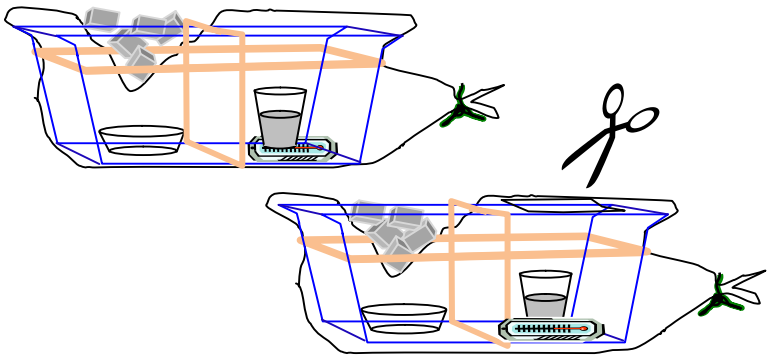
2. Place a 9 oz. cup half full of water, a thermometer, and an empty deli container at opposite ends of the tank.



3. Carefully put the tank, rubber band, deli container, and cup in a freezer bag and seal with a twist tie. Place a bottom corner of the bag (gusset) so it dips down over the deli container.



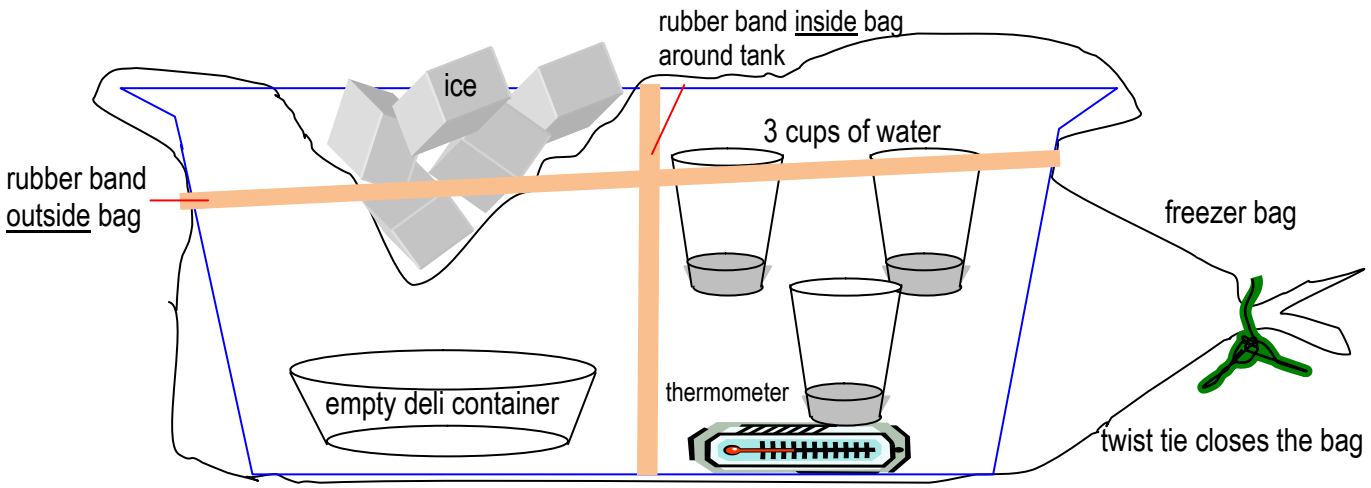
4. Stretch a rubber band outside the bag around the top of the tank. Push the corner of the bag down over the deli container. Put 5 ice cubes in the depression over the deli container.



5. Cut a hole in the bag over the cup.

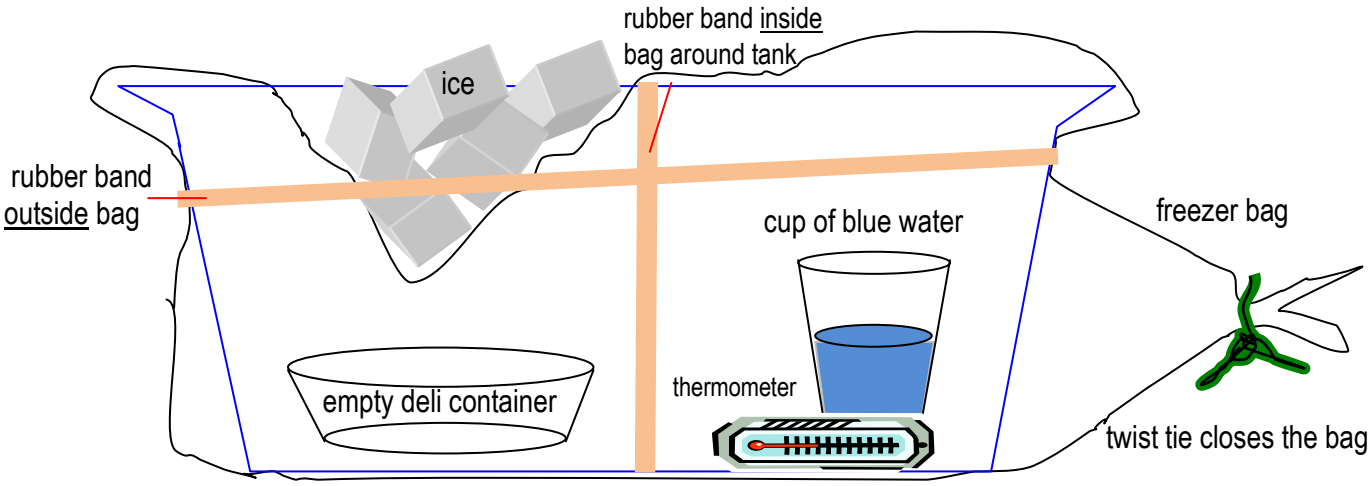
BLM 14 Weather Tank #6

Weather Tank #6



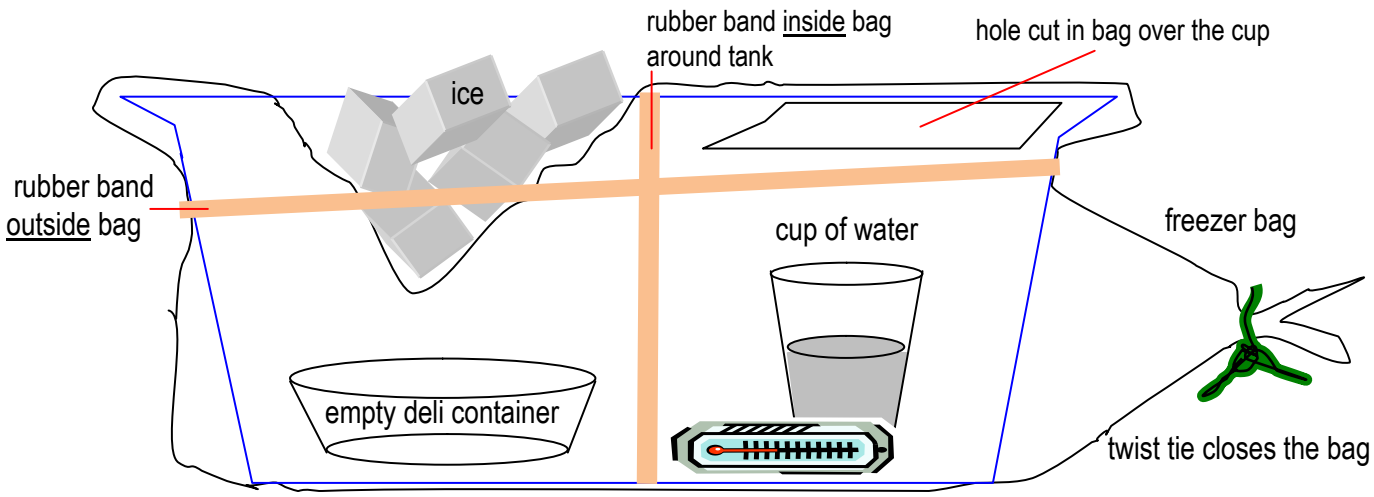
BLM 15 Weather Tank #7

Weather Tank #7

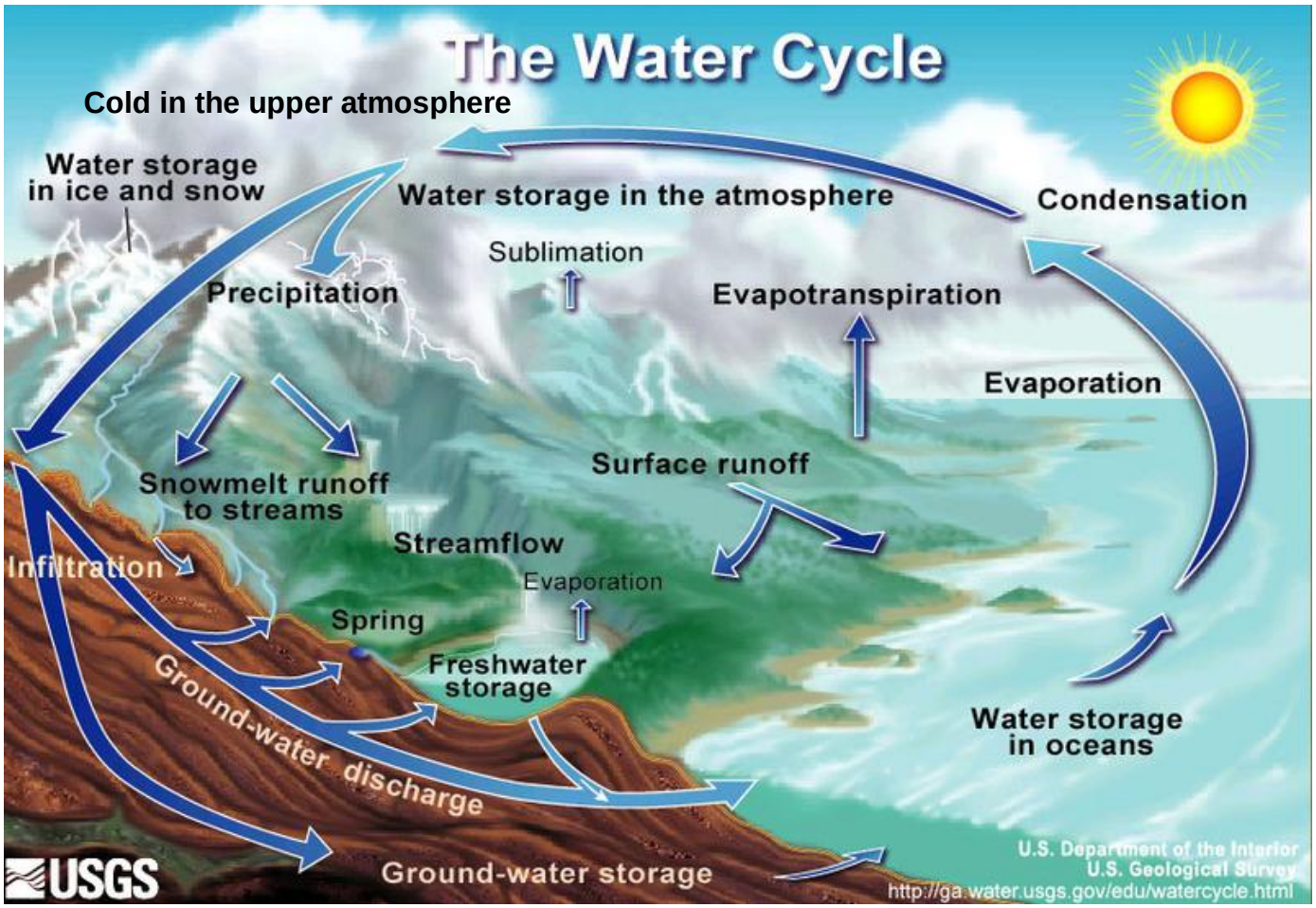


BLM 16 Weather Tank #8

Weather Tank #8



BLM 17 The Water Cycle



Appendix

Common Student Preconceptions About This Topic

When children observe water changing to water vapor, they see something visible disappear. As a result, they believe it loses its weight or mass, and its very substance. Because the idea of conservation of mass is still very abstract to them, they must simply take the teacher's word that all of the water that was visible as liquid continues to exist as an invisible gas. Understanding evaporation seems to depend on a grasp of conservation, the particle theory of matter, and the concept that gases such as air are material. Typically, these concepts may be only partially developed by grade 5. Similarly, children often see condensation as a kind of leakage from water elsewhere or as "coldness changing into water." When pressed for explanations of this, some students say that the coldness does something to the air that makes it create water, and some say that coldness is a substance that can become water. Surprisingly, when children are asked to explain how their hands become wet when held in steam above boiling water, a few students think their hands sweat, but many correctly think that the steam changes into water on their hands, or that their hands become wet from the steam.