Water Pressure

Subject: Science (Earth Science, Environmental Science, Aquatic Science, Physics)

Grade level: 6-8

Rationale or Purpose: Artesian wells and springs flow up from the ground with varying amounts of force. This force is from the pressure of water elsewhere in the aquifer at higher elevations. This demonstration illustrates how the force of water is related to the amount of overlying water.

Materials:

- clear plastic soda bottles with label removed
- thumbtack
- water
- large tubs/trays to catch water

Lesson Duration: 50 minutes

Objectives:

- Science 112.22 (1A), demonstrate safe practices during lab investigations
- Science 112.22 (2A), plan and implement investigative procedures
- Science 112.22 (2B), collect data by observing
- Science 112.22 (2C), analyze and interpret information
- Science 112.22 (2E), construct graphs
- Science 112.22 (3A), analyze scientific explanations
- Science 112.22 (3C), represent the natural world using models
- Science 112.22 (3E), connect science concepts with history of science
- Science 112.22 (4A), collect information using tools
- Science 112.22 (6A), identify changes in position, motion and speed by force
- Science 112.22 (14B), identify relationships between groundwater and surface water

- Science 112.23 (1A), demonstrate safe practices during lab investigations
- Science 112.23 (2A), plan and implement investigative procedures
- Science 112.23 (2B), collect data by observing
- Science 112.23 (2C), organize evidence and make inferences
- Science 112.23 (2E), construct graphs
- Science 112.23 (3A), analyze scientific explanations
- Science 112.23 (3C), represent the natural world using models
- Science 112.23 (3E), connect science concepts with history of science
- Science 112.23 (4A), collect information using tools
- Science 112.23 (4B), recognize patterns such as rates of change
- Science 112.23 (5A), describe how systems may reach an equilibrium
- Science 112.23 (14C), make inferences about effects of human activities on Earth

- Science 112.24 (1A), demonstrate safe practices during lab investigations

- Science 112.24 (2A), plan and implement investigative procedures
- Science 112.24 (2B), collect data by observing
- Science 112.24 (2C), organize evidence and make inferences
- Science 112.24 (2E), construct graphs
- Science 112.24 (3A), analyze scientific explanations
- Science 112.24 (3C), represent the natural world using models
- Science 112.24 (3E), connect science concepts with history of science
- Science 112.24 (4A), collect information using tools
- Science 112.24 (4B), extrapolate from collected information
- Science 112.24 (7A), demonstrate how unbalanced forces cause changes in speed
- Science 112.24 (12C), predict the results of modifying the Earth's water cycle

Activity:

Step 1: Show students a water-filled soda bottle with the lid off. Ask the students to write down their hypothesis of what will happen if you poked a hole in the side of the bottle.

Step 2: Ask the students to write down a hypothesis of what will happen if you poked two holes in the side of the bottle: one near the top and one near the bottom. Ask the students to write down a hypothesis of what will happen if you put the lid on the bottle with two holes.

Step 3: Give a soda bottle and thumbtack to each team so that they can test their hypotheses. Instruct them to clean up any spilled water immediately.

Step 4: Tell the students to poke one hole in the bottle about a ¼ of the way from the bottom. The second hole should be ¼ from the top. Do this above a tub or sink to catch the water.

Step 5: Have students record their observations, including the distance the water shoots out of each hole and which hole shoots the water out with the most pressure.

Step 6: Put the lid on the bottle tightly. Record the observations again.

Step 7: Have the students hypothesize what will happen if the lid is removed and the bottle is allowed to drain for several minutes.

Step 8: Remove the lid and at one-minute intervals record the changes: relative force of water from each hole, distance the water shoots from the bottle from each hole, height of the water in the bottle

Step 9: Have students graph the distance water shoots from the lower hole, against the height of the water in the bottle.

Modification: none

Student Product: Students will have created a very inexpensive, but fully functional mariotte bottle. They will also have created written hypothesis, recorded data, and graphed data.

Closure: Discuss observations: the lower hole will release water with more force because of the pressure from the overlying water. The upper hole has less water above it, and therefore less pressure. Be sure the students understand the

pressure is from the force of gravity on the water. When the lid is put on the bottle, water only flows out the lower hole because pressure is less at the upper hole, allowing air to enter there.

Artesian wells and springs work in the same manner. Within the same aquifer, there will be more pressure on water at lower elevations; therefore wells and springs in different areas can discharge water with different levels of force. In nature, aquifers receive recharge from the surface; the soda bottles could be recharged by pouring water into the top. As the soda bottle continued to lose water, the force with which water was pushed out decreased with time. The top hole eventually stopped losing water because the water level was below that opening. If you wait long enough, the same will happen with the lower hole; water will still be in the bottle, but the bottle is no longer losing water. When aquifers lose water faster than they are recharged, the same happens with them; flow decreases and can stop all together, even though some water remains.

Assessment or evaluation: Students should turn in their written hypotheses, observations, and graph.

Extension:

1. Students could hypothesize the point on the side of a full bottle where a hole would shoot water the farthest. Experiment to find this spot. When the spot is found, place a single hole there. Then make two holes equidistance from the first hole; place one immediately above and one immediately below. When the bottle is full, note the distance water travels from the top and bottom holes. Have students hypothesize why the distances are the same.
2. Hypothesize the effect of elevation on this experiment. Would the same bottle shoot water from the holes with different force if the experiment was done in Houston and in Denver? Areas of lower elevation have higher air pressure, which students can simulate by blowing into the opening at the top of the bottle.
3. Have students research the French physicist Edme Mariotte, who first developed this experiment.

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