

# OBSERVE THE UNIQUE PROPERTIES OF WATER IN EVERYDAY LIFE

## Answer Key and Teaching Notes

### AUDIENCE

This activity is designed to be used during the first few weeks of the semester in a freshman-level introductory oceanography class for nonscience majors, taught in a large (100+) lecture hall format.

### ACTIVITY

#### Format of Activity

This activity is designed to be formative assessment. Students work through scenarios of water behavior that they may have experienced in real life, making notes about why they chose the answers they did. The activity can be handed out as a worksheet, or can be done one question at a time using PowerPoint. The instructor then polls the class on each question, identifying and discussing common misconceptions. For scenarios when more than one answer is correct, students give the answer they feel most sure about, followed up by identifying other potential answers. The students correct their own work, making notes about the explanations given by the instructor. The entire activity is designed to fit into a 50-minute class window, with approximately 20–25 minutes each for student group work and follow-up discussion as an entire class with the instructor.

A slide show and video covering the basic properties of water are available in the online supplemental materials and can be assigned for pre-class viewing.

As a follow up to the activity, when important oceanographic concepts center on understanding the properties of water, the instructor reminds students of these scenarios. Associating common, every day phenomena with more complex hydrosphere/atmosphere/lithosphere interactions helps students understand these concepts more fully.

To begin the activity, students are presented with the following summary of the properties of water.

- A. H<sub>2</sub>O molecules form hydrogen bonds with each other. They are **cohesive**.
- B. H<sub>2</sub>O molecules like to bond with ions or other charged molecules. They are **adhesive**.
- C. Because water bonds easily with other ions, it is the “universal solvent.”
- D. Water has a high specific heat.
- E. Water has a high heat of vaporization.
- F. Water’s greatest density is at 4°C. Above or below that temperature it becomes less dense.
- G. Water has a low viscosity.

### Scenarios

Each scenario provides an opportunity to review one or more basic property of water, an opportunity to identify and address common misconceptions, and an opportunity to draw parallels between these scenarios and complex oceanographic phenomena discussed later during the semester.

**1. It is a sweltering day at an outdoor concert. You walk through a misting booth, which sprays fine water droplets onto you, and for a few minutes afterward you feel much cooler.**

**ANSWER:** E. As the water evaporates, you feel cooler, because you are losing heat to the evaporating water. Some students may confuse the latent heat of vaporization with the closely related, broader concept of specific heat, presenting an opportunity to review the two concepts and how they are related.

**CONNECTIONS TO COURSE MATERIAL:** When discussing the condensation of water droplets in Earth’s atmosphere, students can be reminded that this is the opposite process as described here and asked to predict how condensation would affect the temperature of the surrounding atmosphere.

**2. You're on a road trip through the desert. You stay in a hotel with a swimming pool. Even though it's been scorching hot all day, you dive in without fear.**

**ANSWER(S):** D, E. Water has a high specific heat, and therefore it changes temperature very slowly. The water is cooler than the highest air temperature experienced during a given day, because it is subjected to these elevated temperatures for a limited time each day. Also E, because water is evaporating from the pool throughout the day, and the high latent heat of vaporization leaves the water cooler.

**CONNECTIONS TO COURSE MATERIAL:** This analogy is useful when discussing the moderating effects of ocean currents on coastal landmasses.

**3. You go for a hike and decide to add a powdered energy drink to your water bottle. You sprinkle in the powder and it quickly dissolves.**

**ANSWER(S):** C, B

**CONNECTIONS TO COURSE MATERIAL:** Students can recall this phenomenon as they learn about the salinity of ocean water or try to understand how dissolved ions in the ocean originate from chemical weathering on land, or the release of ions at mid-ocean ridge smokers. This analogy is also useful when discussing the role of water in living things, and when discussing dissolved nutrients in seawater.

**4. In chemistry class, you pour water into a graduated cylinder. You carefully take note of the meniscus that forms at the top.**

**ANSWER:** B. The meniscus forms because the water molecules are attracted to the glass cylinder, exhibiting adhesion.

**CONNECTIONS TO COURSE MATERIAL:** When discussing benthic communities and infaunal habitats, adhesion is important in understanding that seafloor sediment includes seawater. Why is the sediment wet? Why is it mixed with seawater? How can animals live in seafloor sediments?

**5. An Arctic blast comes through town. The next day, the plumbers are busy as pipes burst all over town.**

**ANSWER(S):** F. Although almost everyone has observed the expansion of water when it freezes in everyday life, many students seem conditioned to assume that solids are always denser than liquids.

**CONNECTIONS TO COURSE MATERIAL:** This is a helpful analogy when discussing the formation of sea ice or the links between climate change, melting sea ice, and sea level.

**6. You have a fishing pond full of catfish. The winter is unusually cold and the pond ices over and stays that way all winter. The next spring the ice melts and the pond is still full of live fish.**

**ANSWER(S):** D, F. The pond never completely froze due to the high specific heat of water. As the pond started to freeze, the less dense ice stayed at the top, insulating the rest of the water.

**CONNECTIONS TO COURSE MATERIAL:** This is a helpful analogy in understanding why the ocean does not completely freeze, even in the Arctic Ocean. It is also helpful in understanding how life survives in the ocean, even in extreme climates.

**7. While sitting by the edge of a stream, you observe that some insects can walk on the surface of the water without falling through.**

**ANSWER(S):** A. Although surface tension is not one of the choices on the list of water properties, students should understand the underlying reason why water has surface tension, which is cohesion.

**CONNECTIONS TO COURSE MATERIAL:** This scenario is useful as a reminder of cohesion, and of surface tension when discussing the phenomenon as a restoring force for waves.

**8. You touch the edge of a paper towel to a puddle of water. Very quickly the paper towel absorbs the water.**

**ANSWER(S):** A, B. This occurrence is due to both adhesion and cohesion. Students are generally evenly split as to which is correct, with a few having determined that both are involved. The absorption is the result of capillary action, a concept not previously introduced. The instructor can take the opportunity to introduce this new concept, or merely lead the students through understanding how the two can work together. The polar water molecule easily adheres to other substances (making them “wet”), and because water also is cohesive, the water molecules “pull” each other into the paper towel.

**CONNECTIONS TO COURSE MATERIAL:** Capillary action is how water and dissolved nutrients move within plant tissues. Capillary action is also why water will absorb into even very fine sediments such as clay minerals.

**9. You can't get the last little bit of ketchup out of the jar. You decide to add a little water to help.**

**ANSWER(S):** B, C, G. Two obvious phenomena work together in this situation. Like the energy drink powder, water, the universal solvent, reacts quickly with compounds that make up ketchup, dissolving them. Viscosity plays a role here as well, as the low viscosity of water, compared to that of ketchup, enables that last little bit to escape from the jar. A third factor at work in this scenario is that the last little bit of ketchup is difficult to get out of the jar partly because ketchup is a water-based substance and therefore exhibits adhesion to the jar. When very little ketchup is left, the force of the adhesion is stronger than the force of gravity. A question for discussion is "What are we trying to accomplish when we shake the ketchup jar?"

**CONNECTIONS TO COURSE MATERIAL:** The ability of water to dissolve and mix with ketchup is a useful analogy for discussing dissolved ions in ocean water. The addition of the ketchup to the water changes the water's viscosity. This is a useful concept to review when discussing density differences in water of various salinities.

**10. As raindrops fall on a solid surface, they quickly tend to form beads or drops.**

**ANSWER(S):** A. As the raindrops land on the solid surface, the cohesion of the water molecules causes the drops to form. Students may also mention adhesion as being a reason the water droplets may stay in one place, even on a vertical surface. If students do not mention this, the question can be posed as to why this phenomenon occurs.

**CONNECTIONS TO COURSE MATERIAL:** Understanding the cohesiveness of water molecules helps explain the large amount of energy needed to cause liquid water to evaporate into a gas.

## POTENTIAL MODIFICATIONS TO ACTIVITY

**ONLINE:** Because the questions are essentially multiple choice, they could easily be used in an online course, with carefully written feedback for right and wrong answers taking the place of classroom discussion.

**CULTURAL:** The scenarios were written for a student population from a primarily rural or small-town background in the south. The scenarios could be rewritten to resonate more with an urban population. For instance, instead of going for a hike, the student who is mixing a powdered energy drink could be engaged in a sports activity. The catfish pond could instead be a goldfish pond in the park. In warmer climates, the frozen pipes could be replaced with a soda put into the freezer and then forgotten. The scenarios could also be adapted to reflect life experiences common to specific underrepresented populations.

**ACCESSIBILITY:** If the class included students with visual impairment, the scenarios could be rewritten to emphasize non-visual interactions with water.