

How Cold is Cold: What is Temperature

Temperature can be a challenging concept to convey since our perception is tied to words that are relative to our experience which varies quite a lot. This first segment gives a common place to start, solid H₂O or ice. We don't start with the temperature of the ice but rather its density which can readily be seen in comparison to the surrounding water. If the students have not yet familiar with Archimedes' principle, you can briefly discuss it after the first segment.

Density is something that is more obvious. Ask your students how many have picked up something expecting it to weigh a certain amount but found that it was much heavier or lighter.

Note: in part 2 of How Cold Is Cold: The Properties of Materials we talk about the expansion of water and why it's an important consideration in handling dry ice, liquid nitrogen and other cryogenic liquids.

In segment 2 we introduce some of the common terms that are used to describe temperature. I suggest that you discuss the terms and what they mean among the students before trying the activity.

The absolute temperatures of the water in the three containers is not important other than making sure that there is no danger of burns from water that is too hot or pain from water that is too cold. Having one bath near 0°C and one about 50°C with the center one near the midpoint should allow students to experience the relative terms of warm and cool. Make sure to have plenty of dry towels for the students.

After the cold and hot water activities, the students should be ready to discuss why temperature is important. Segment 3 starts with a discussion that it is not only the temperature of an object but how fast heat flows to or from our body that determines if we call it hot or cold. The class can also discuss how many temperatures scales there are. Most will be familiar with Celsius and Fahrenheit since they are in common usage. Kelvin will also be known to most but it is rare to go beyond these three.

In segment 4 the concept of temperature as the measure of kinetic energy is introduced as well as temperature scales. The reference given in the link on the BLOSSOMS page for this lecture is excellent and provides some detail beyond what is discussed in this video.

Encourage your student to derive the formula that relates Celsius and Fahrenheit rather than just writing it down from memory. Solving the other part of the problem should be an easy algebra problem for most students.

In segment 5, after discussing the questions, we introduce some other common temperatures, stopping with dry ice for a discussion of what it is and what happens when it is dropped in some soapy water. Dry ice is not readily available everywhere but if you decide to bring it to the classroom, please be very careful in handling it with gloves or tongs and ensure that the students are properly cautioned as well.

Most students will know that the transition from solid to gas is sublimation. You can discuss the reverse which many will not know as deposition. Encourage some creative thinking on what will happen to the dry ice in soapy water.

In the next segment dry ice is discussed and what happens to it in water is demonstrated.

Then we move on to the concept of absolute zero and add the Kelvin scale to the slide shown.

The temperatures of some cryogenic liquids are discussed. And various other temperature scales are introduced. With the formulas given, you can explore the numerical values at which the various temperature scales cross.

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The final question is how to tell from visual observation alone which cup contains hot water and which contains liquid nitrogen. The second BLOSSOMS video *How Cold Is Cold: Properties of Materials* picks up at this point.