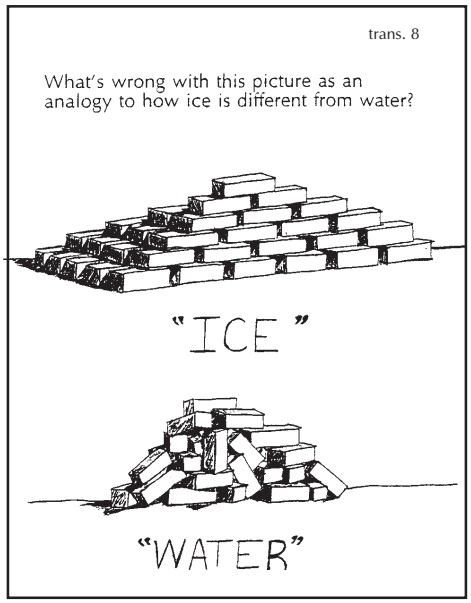
Category IV Physical Science Examples

Representing ideas effectively

Hard as Ice

In attempting to represent the key idea that “in solids, the atoms are closely locked in position and can only vibrate” and the idea that “in liquids, the atoms or molecules…are more loosely connected and can slide past one another,” the unit shows ice as a stack of bricks and water as a random pile of bricks. The text points out differences between the analogy and the real thing. (p. 18t, **transparency 8**)



What is wrong with this analogy: The molecules of ice actually move back and forth (vibrate) a little, which bricks don't do. The molecules of water are moving all the time, slipping and sliding past each other. The bricks just stay in one place.

What is good about this analogy: Molecules that make up solid ice are arranged in a regular, rigid pattern. Ice supports weight, just like the neatly stacked bricks. The molecules of water, on the other hand, are in no particular pattern, and if stepped on, they would slip and slide apart from each other.

2. If you looked at some solid ice from this lake under a very powerful microscope that let you see what the water was made of, what would you see?

You would see water molecules lined up in a rigid pattern, unable to move past each other, held together by some invisible force.

3. How are molecules that make up liquid water different from molecules that make up solid ice?

They are different only in the way they move and the way they are arranged. The molecules themselves are no different from each other — that's why water and ice are the same substance.

4. In your picture of a tiny portion of liquid water from #2 above, what do you think is between the molecules? a. water; b. nothing; c. ice; d. minerals or microbes; e. air.

The correct answer is "nothing", but many students have a hard time believing this. There are minerals and microbes in pond water, but not in pure water; there is dissolved air in water, and the molecules of oxygen, nitrogen, etc. do intermix with the molecules of water. But for the sake of instruction we are suggesting that there is nothing in this water but water.

5. Why can you skate on ice, but not on water? Why can you swim in water, but not in ice? Use ideas about molecules in your answer.

You can skate on ice because it is made of molecules that are held together in a rigid pattern. The molecules can't move, so you can't push down on them or push them apart. That's why you can't swim in them.

To be able to swim, the substance has to be a liquid, because the molecules that make up a liquid are moving and sliding past each other all the time. If you put any part of your body into a liquid, the molecules can move out of the way, allowing you to slip in.

9. Use transparency 8 to help students understand how molecules make up ice and water. Ask:

- *What is wrong with this analogy as an explanation of how ice and water are made up of molecules?*

Appropriate responses are in the margin. You might also ask your students, if it's not clear, what is **good** about this analogy.

10. What's next? *Now we're ready to figure out what happens when water freezes and melts.*