

Which is more dense - Ice or Liquid Water?

DENSITY is defined as mass of an object divided by its volume. To understand the properties of ice, we need to think in terms of a change in volume with a constant mass.

Does ice float on water or sink in the water?

Everyone knows what happens in the case of ice cubes in a glass of water.

Why does ice float?

What other observations or facts are known?

- * Because ice floats, we can infer that ice must be less dense than water.
- * If water is frozen in a glass jar, the glass jar breaks.
- * If a pop can freezes, it will also burst.
- * From both of the above we infer that the volume of the ice has increased.

Conclusion: The volume of ice must be greater than the same mass of liquid water.

Prove it:

$$D = \frac{m}{V}$$

The density of liquid water at 4 degrees Celsius is 1.00 g/ml

For 100 grams of liquid water, the volume is: _____

The density of solid water (ice) at 0 degrees Celsius is 0.92 g/ml

For 100 grams of ice, the volume is: _____

Why does the volume increase?

Molecular basis for the Volume Increase of Ice:

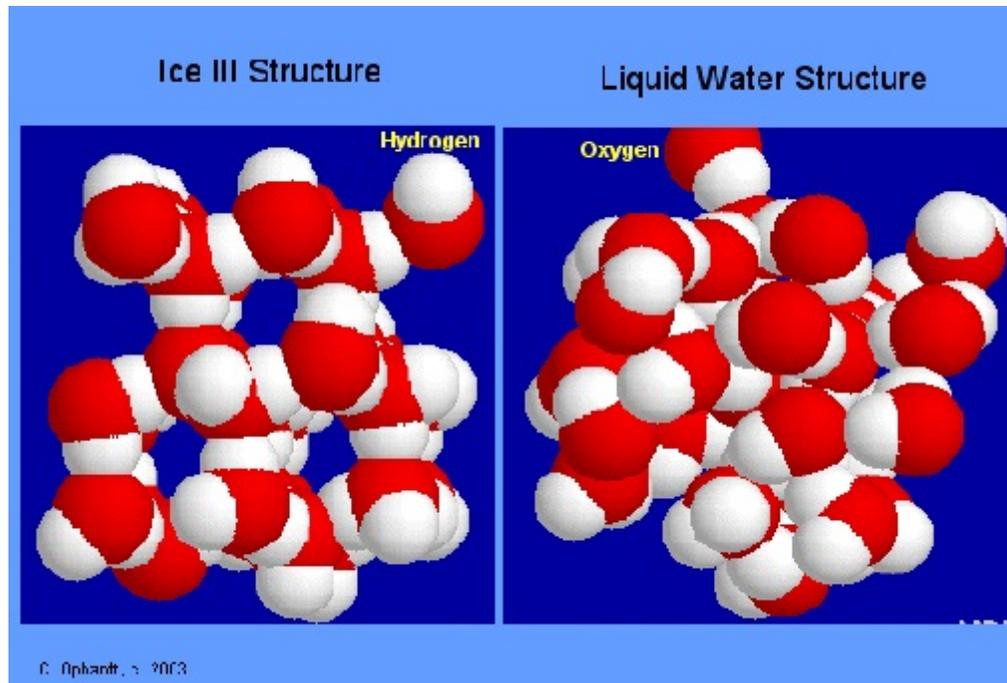
The normal pattern for most compounds is that as the temperature of the liquid decreases, the density increases as the molecules come closer together and become more closely packed.

This pattern does not hold true for ice as the exact opposite occurs!

WHY?

The forces of attraction between the hydrogen and oxygen molecules (called "hydrogen

bonding”) are greater in liquid water than in ice. Thus, there are more spaces between the molecules in ice than in liquid water. In the graphic below, notice the empty spaces within the ice structure. This translates to a more open or expanded structure. The ice structure takes up more volume than the liquid water molecules, so ice is less dense than liquid water.



Hydrogen Bonding in Water

