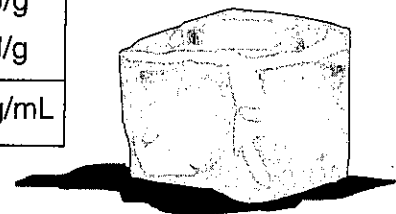


Properties of Water



Heat energy gained during melting	334 J/g
Heat energy released during freezing	334 J/g
Heat energy gained during vaporization	2260 J/g
Heat energy released during condensation	2260 J/g
Density at 3.98°C	1.0 g/mL



Overview:

When ice absorbs heat (measured in joules) its temperature increases until it reaches 0°C. At this temperature, it undergoes the phase change of melting. Now, as in all phase changes, the temperature remains the same until the phase change is completed. When the ice has completely melted, and heat is still being applied the temperature of the water will increase as the water absorbs this heat. At 100°C (at sea level) the water has reached its boiling point and begins to boil. It will stay at this temperature during this phase change while continuing to absorb heat. During the phase changes of condensation and freezing, heat is released. It seems strange that as ice freezes it releases heat, but this is exactly what happens. In fact, within a hurricane tremendous amounts of heat is released when water vapor condenses. This is a major source of energy for the hurricane.

The Chart:

For ice to melt (S→L), it must absorb heat. The chart shows that 334 joules are absorbed or gained for every gram of ice that melts. For water to freeze (L→S), it must release or lose 334 joules for every gram of water that freezes. Notice that in these two phase changes, the number of joules are the same, but the difference is whether energy is being absorbed or being released. Both of these phase changes occur at 0°C, and the temperature remains the same while the phase change is occurring.

In vaporization (boiling or evaporation), a liquid is changing into a gas (L→G). For vaporization of one gram of water, the chart shows that 2260 joules are absorbed. When condensation occurs (G→L), each gram of water vapor releases 2260 joules as it changes back to liquid water. Both of the phase changes occur at 100°C (at sea level), and the temperature remains the same while the phase change is occurring.

The density value of water is 1.0 g/mL. The chart shows this occurs at 3.98°C, which can be rounded up to 4°C. When water warms up from this temperature, its density decreases. This is why warm water will rise, being displaced upward by the cooler denser water.

Additional Information:

- Any substance that has a density less than 1 g/cm³ will float in water, while a substance with a density more than 1 g/cm³ will sink when placed in water.
- Ice floats in water since its density is .9 g/cm³. (note: g/mL = g/cm³)

Set 1 — Properties of Water

1. Which phase change requires water to gain 2260 joules per gram?
(1) solid ice melting
(2) liquid water freezing
(3) liquid water vaporizing
(4) water vapor condensing 1 _____

2. During which phase change of water is the most energy released into the environment?
(1) water freezing
(2) ice melting
(3) water evaporating
(4) water vapor condensing 2 _____

3. How many joules are required to evaporate 1 gram of boiling water?
(1) 1 J (3) 334 J
(2) 80 J (4) 2260 J 3 _____

4. Which statement best explains why water in a glass becomes colder when ice cubes are added?
(1) The water changes into ice.
(2) Heat flows from the water to the ice cubes.
(3) Water is less dense than ice.
(4) Ice has a higher specific heat than water. 4 _____

5. What is the total number of joules required to melt 100 grams of ice at 0°C to liquid water at 0°C?
(1) 5,400 J
(2) 8,000 J
(3) 33,400 J
(4) 80,000 J 5 _____

6. The cartoon below presents a humorous look at science.

CALVIN & HOBBS



The correct explanation of why ice floats is that, compared to liquid water, solid ice
(1) has less mass (2) has more mass (3) is less dense (4) is more dense 6 _____

Set 2 — Properties of Water

7. Which process requires water to gain 334 joules of energy per gram?

- (1) vaporization
- (2) condensation
- (3) melting
- (4) freezing

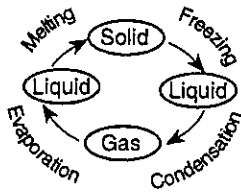
7 _____

8. Which process requires the most absorption of energy by water?

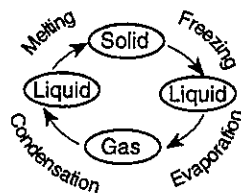
- (1) melting 1 gram of ice
- (2) condensing 1 gram of water vapor
- (3) vaporizing 1 gram of liquid water
- (4) freezing 1 gram of liquid water

8 _____

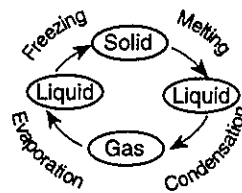
9. Which diagram correctly shows the processes that change the states of matter?



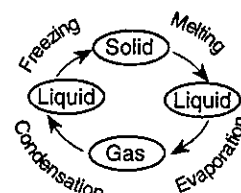
(1)



(2)



(3)



(4)

9 _____

10. When water at 90°C is cooled down to 4°C its density would slightly

- (1) increase
- (2) decrease
- (3) remains the same

10 _____

11. Give the two phase changes that release energy.

_____ and _____

12. Give the two phase changes that gain energy.

_____ and _____