

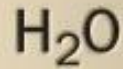


Properties of Water

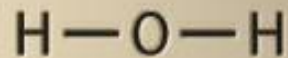
Reference: Textbook Pages 41 - 49

Unusual Properties of Water

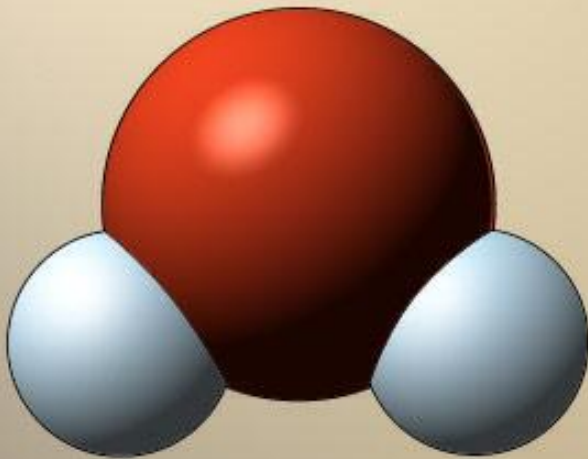
Molecular formula



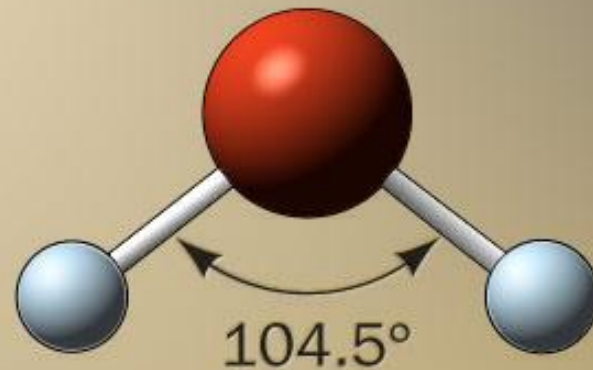
Structural formula



Molecular models



Space filling

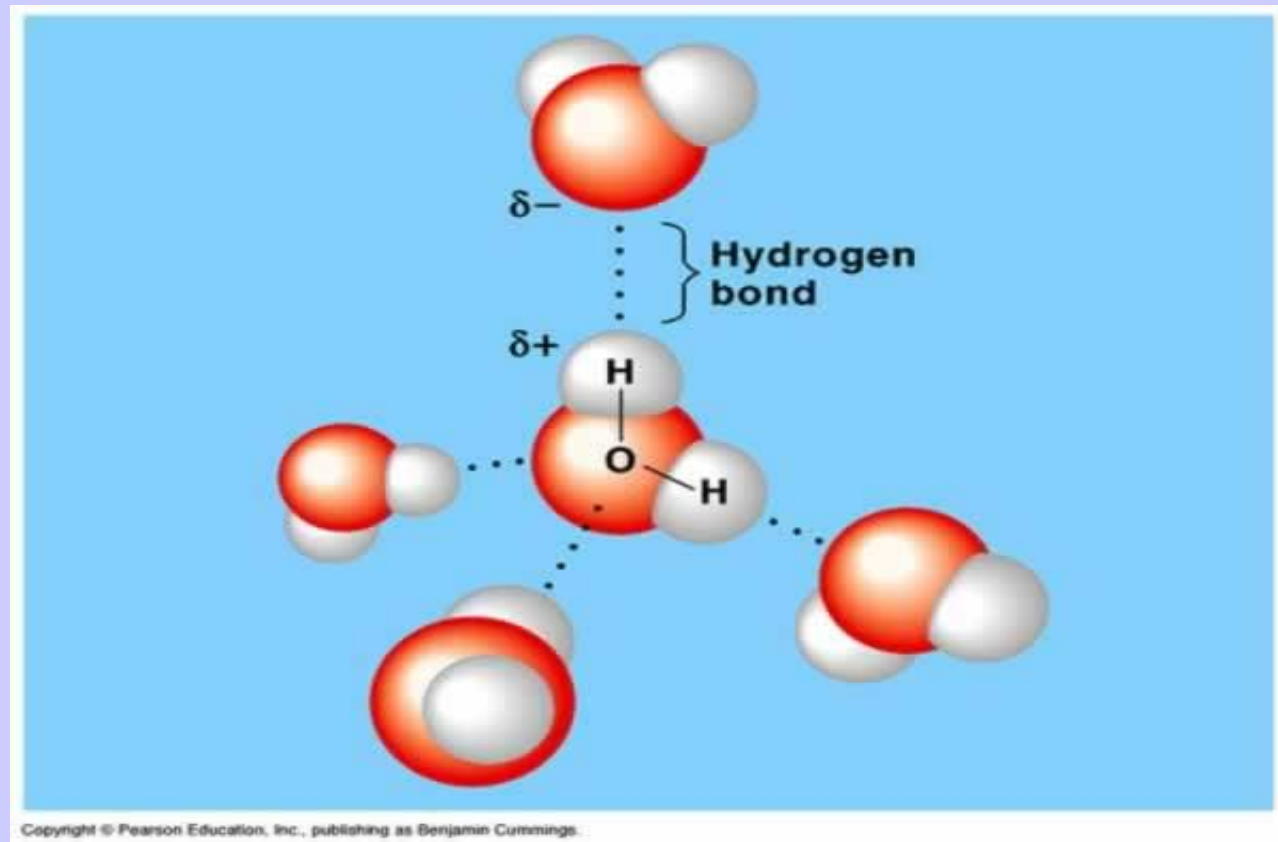


Ball-and-stick

WATER

Video Clip of Hydrogen Bonds

<http://www.youtube.com/watch?v=Ikl5cbfqFRM>



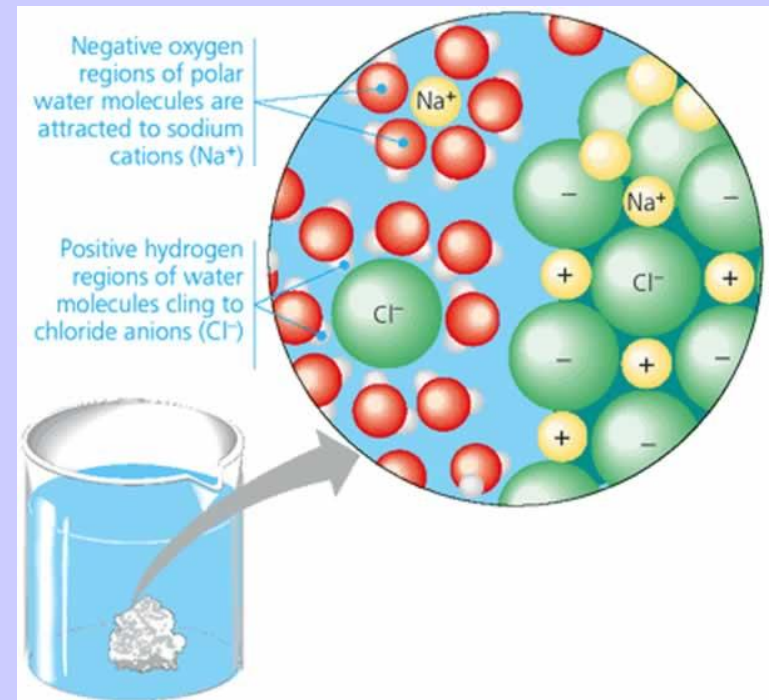
7 Properties of Water

1. Solubility: a good solvent
2. Capillary Action: Cohesion & adhesion
3. Low density solid
4. High specific heat capacity
5. High heat of vaporization
6. High heat of fusion
7. Ionization: determines pH

1. Good Solvent

- Polar covalent bond
- Can dissolve other polar and ionic compounds. How?
- **Hydration Shell**: A sphere of water molecules surround each solute ion
- Video Clip.

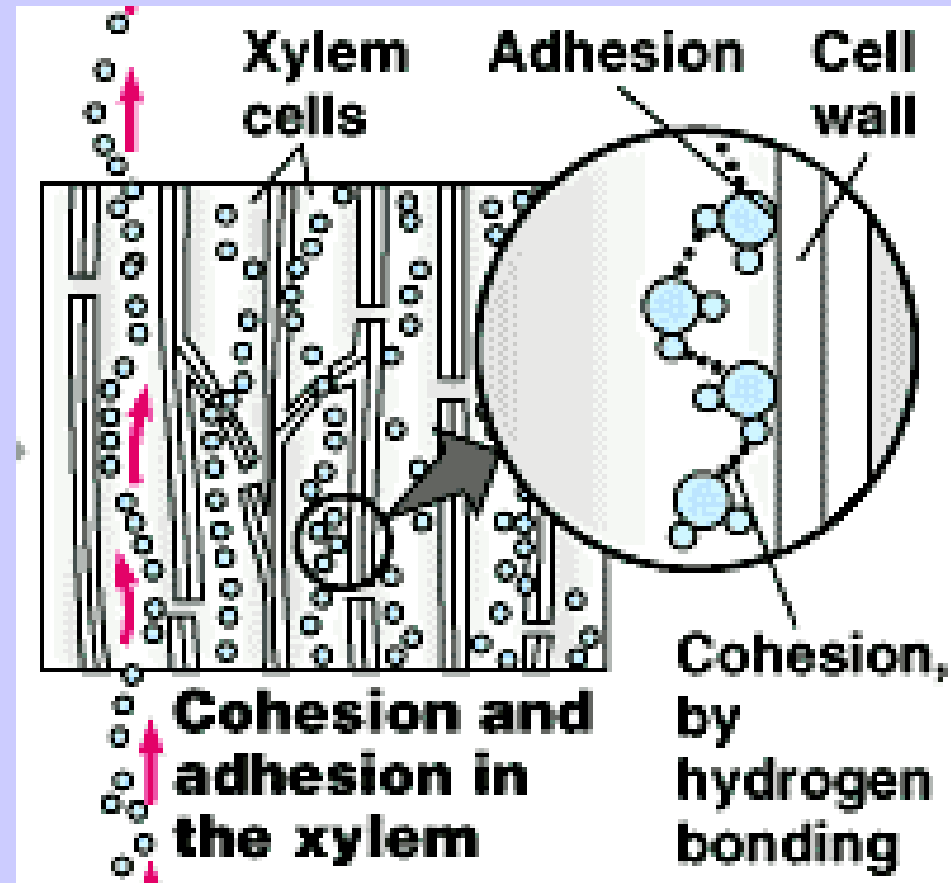
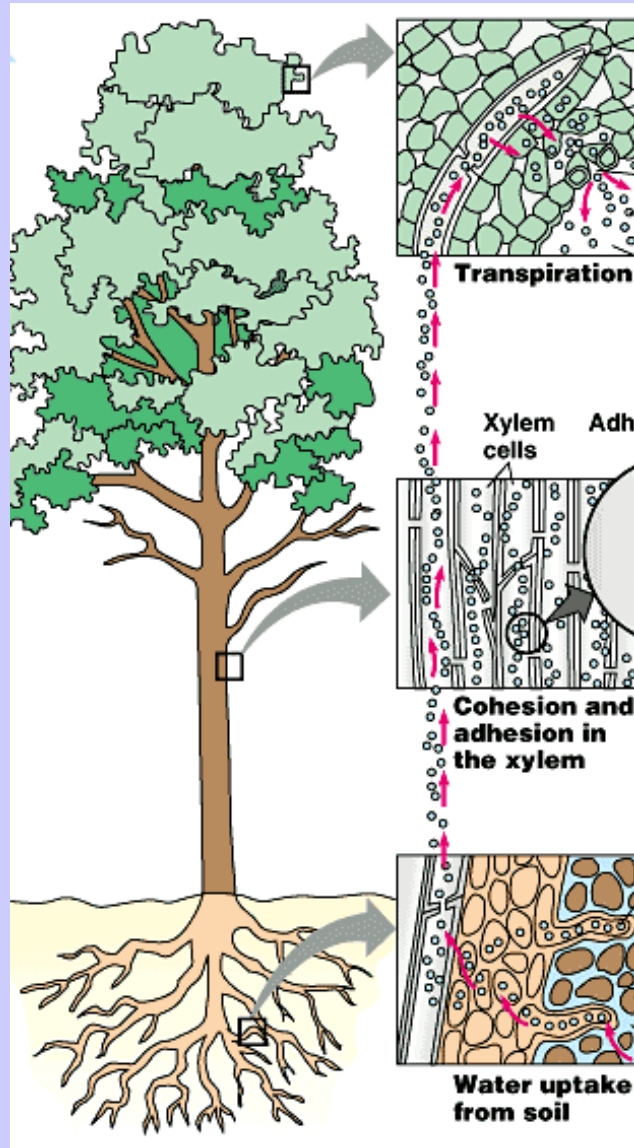
<http://www.youtube.com/watch?v=ETMmH2trTpM>



- Versatile solvent due to its polarity
- Many molecules are able to dissolve in water if it has ionic and polar regions on its surface.
- Some biologically significant solutes include salts, sugars, proteins, vitamins

2. Capillary Action

- Cohesion: water molecules “stick” to each other
- Adhesion: clinging of water to surfaces.
- Can you think of an example from grade 11 biology?
- Demonstrations: paper towel and water



Cohesion

- A measure of how difficult it is to break the surface of a liquid
- Surface tension is one of the results of cohesion in water
- Water sticks together to form a strong surface.
- That's why you can skip rocks along the surface of the water.

- Demo: pour water in a cup to the rim
- Demo: Penny and eyedropper
- Video clips: lizard and water strider

<http://www.youtube.com/watch?v=45yabrnryXk&ob=av3e>



3. Low Density Solid

- Water is most dense at 4°C
- Ice is less dense than water
- Water is the only type of matter which becomes less dense when it is solid
- Liquid water will expand when heated and contract when cooled.
- At zero degrees water becomes locked in crystalline lattice.

What is the biological significance of this property of water?

Aquatic life

- When the temperature of the atmosphere falls below 0°C , the water at the surface gradually freezes to ice
- The water under the ice remains at 4°C

4. High Specific Heat Capacity

- Amount of heat energy needed to increase the temperature of a substance by 1°C
- Water has a high specific heat capacity:

It has the ability to hold heat without drastically increasing the temperature of the water.



What is the biological significance of this property of water?

- Helps keep the body temperature constant, prevents drastic changes in water temperature, protects aquatic life.
- Large bodies of water have moderating effect on nearby land temperature
- Demo: water balloon and air balloon

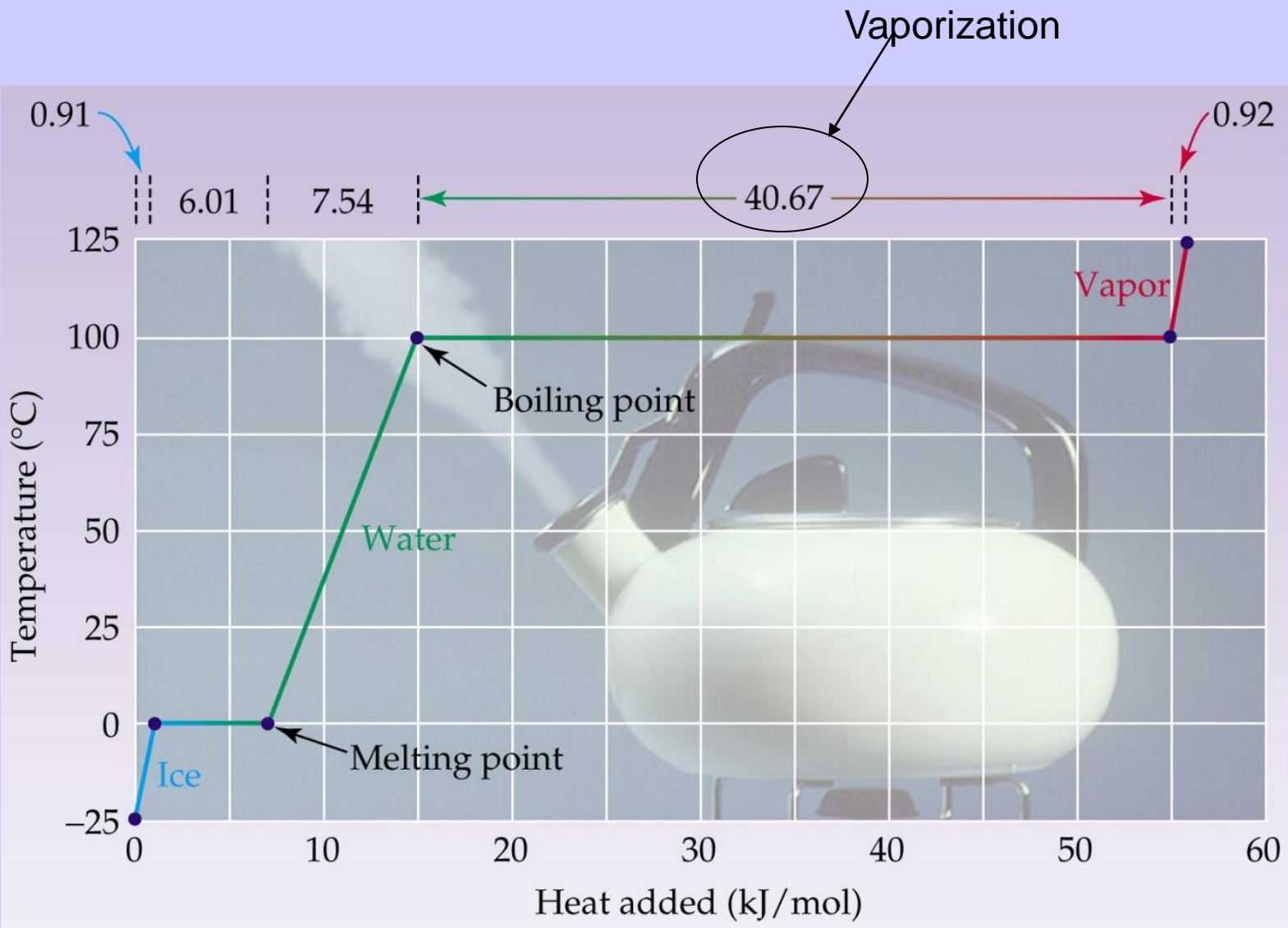
5. High Heat of Vaporization

- Heat of vaporization: amount of heat a liquid must absorb to be converted to a gas
- Water needs a lot of energy to evaporate (40.7kJ/mol)
- Due to intermolecular bonds (hydrogen bonding) water likes to stick together, therefore more energy is required to pull apart the water molecules.

Demo: student holds water and alcohol.

(can feel the coolness of the rubbing alcohol due to the body's temperature evaporating the alcohol at a quicker rate)

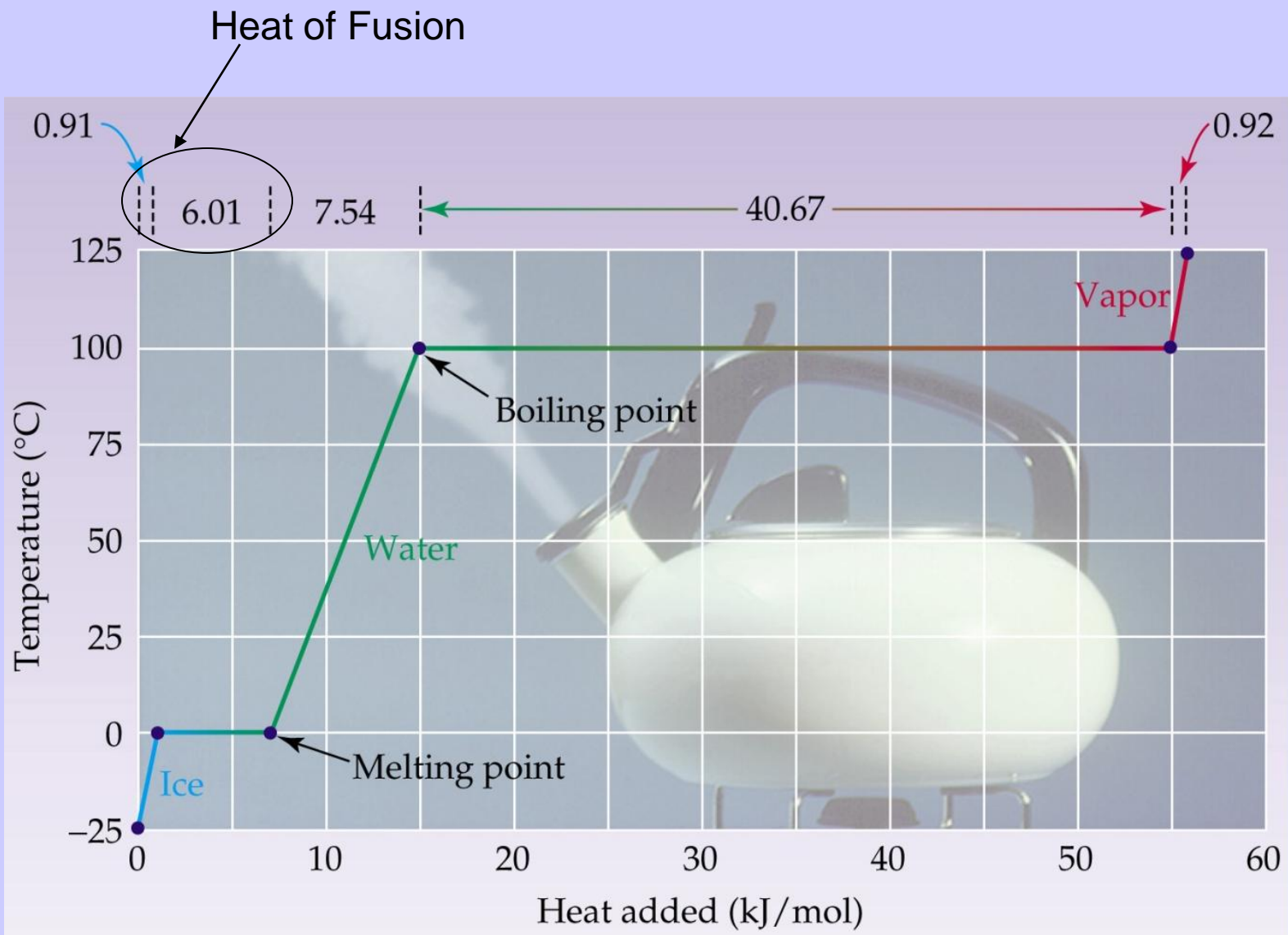
Biological Significance: Sweat



6. High Heat of Fusion

Heat of fusion: amount of heat a solid must absorb to be converted to a liquid

- A lot of energy is needed to melt ice.
- Only about 15% of the H bonds are broken when ice melts.



7. Ionization: Determines pH

- $\text{H}_2\text{O} \rightarrow \text{H}^+ + \text{OH}^-$
- Dissociation of water is rare and reversible
- H^+ and OH^- very reactive, can disrupt pH balance
- $\text{pH} = -\log[\text{H}^+]$
- Relevance: Organisms are very sensitive to pH changes

- Substances that minimize changes in the concentrations of H⁺ and OH⁻
- accepts H⁺ from solutions when in excess and donate H⁺ to solutions when depleted

Example: Human blood pH maintained by carbonic acid

To increase pH of solution

To reduce pH of solution

