

1.1 WATER

Learning outcomes:

At the end of this topic, students should be able to:

- Illustrate the structure of water molecule.
- State the properties of water.

a) Illustrate the structure and state the properties of water molecules

Exercise 1.1 (a): Draw the structure of water molecules. Use the information given to label and complete the structure of a water molecule.

Exercise 1.1 (b): Fill in the blanks below to complete the explanation of water structure.



Key:

Covalent
bond
104.5 °
δ⁺
δ⁺
2δ⁻
Oxygen
atom
Hydrogen
atom

STRUCTURE OF WATER

Consists of _____ oxygen atom and two hydrogen atoms.

The three atoms of water molecule form wide _____ shaped structure.

Two hydrogen atoms joined to the oxygen atom by _____

bond. Thus, one water molecule, has two covalent bonds.

The bond angle in water molecule between two covalent bonds is 104.5 °.

Water is **polar molecule**.

Universal Solvent

- Defined as a molecule that carry an _____ distribution of electrical charge such as the opposite ends of the molecule have opposite charge.
- The oxygen region of molecule has a _____ (δ⁻) and each hydrogen has a partial positive charge (δ⁺).
- This unequal sharing of electrons occurs where oxygen atom is more electronegative than hydrogen.
- The polarity of the water molecule can attract other _____ molecules (hydrophilic or water-loving substances e.g. sugar, salt) but it _____ non-polar molecules (hydrophobic or water-hating substances) e.g. oil.
- Polarity of water molecule allows it to form hydrogen bonds with each other. One water molecule able to form _____ hydrogen bonds with another four water molecules.

b) State the properties of water.

Properties of Water

1. _____

2. LOW viscosity

3. High specific HEAT CAPACITY

4. _____

5. High SURFACE TENSION

6. Maximum density at 4°C

➤ Describe the properties of water and its importance.

No.	Properties of Water	Description
1.	_____	<p>➤ Solvent is dissolving agent of a solution.</p> <p>➤ Water is a _____ molecule; that makes it suitable as universal solvent for ions (e.g. Na^+ and Cl^-) and polar molecules.</p> <p>➤ Example : NaCl can dissolve in water</p> <p>➤ Oxygen atoms of water are attracted to the positively charged _____ ions while,</p> <p>➤ Hydrogen atoms of water are attracted to the negatively charged chloride ions.</p> <div data-bbox="632 1473 1299 1756"> <p>The salt NaCl dissolves in water.</p> </div> <p>➤ Water molecules gather around the Na^+ and Cl^- to form _____ separating them from one another.</p> <p>➤ Pulling these ions away from the salt crystal</p> <p>➤ Causes these ions to separate & dissolve.</p>

		<div data-bbox="632 174 1267 741" data-label="Chemical-Block"> <p>Water molecule</p> <p>Crystal of NaCl</p> <p>Hydrated sodium ion</p> <p>Hydrated chloride ion</p> </div> <p>Importance of universal solvent:</p> <ol style="list-style-type: none"> _____ for most solutes Provides an aqueous medium for biochemical reactions. Serves as the body's major transport medium e.g. in blood capillaries and xylem.
2.	_____	<p>➤ Viscosity is a measure of _____ to flow.</p> <p>➤ Water has low viscosity because hydrogen bonds between water molecules are being continually broken & reformed.</p> <p>➤ The less viscous of the fluid the greater its movement (fluidity).</p> <div data-bbox="667 1272 970 1525" data-label="Image"> </div> <div data-bbox="1026 1272 1305 1525" data-label="Chemical-Block"> <p>Liquid water Hydrogen bonds break and re</p> </div> <p>Importance of low viscosity:</p> <ul style="list-style-type: none"> _____ Foods could move easily down the alimentary canal. Synovial fluid within the joints reduces _____ between bone surfaces, thus enables free easy movement. Blood and lymph flow easily in the circulatory system.
3.	_____ _____	<p>Definition:</p> <p>The amount of heat must be _____, to raise the temperature of 1g of water, by 1°C, per calorie (cal) or 1 cal/g/°C.</p>

		<p>➤ Large amount of _____ is needed to increase the temperature of 1g of water by 1°C.</p> <div data-bbox="646 273 1248 555" data-label="Image"> </div> <p>➤ As water absorb heat, _____ bonds between water molecules are broken.</p> <p>➤ Only after hydrogen bonds are broken does heat absorption increase the motion of water molecules, thus the temperature of water increase.</p> <p>Importance of high specific heat capacity:</p> <ul style="list-style-type: none"> • Acts as _____ buffer to prevent sudden body temperature changes in cells of organisms. • Allow ocean to _____ relatively constant temperature.
4.	<p>_____</p> <p>_____</p> <div data-bbox="328 1214 539 1482" data-label="Image"> </div>	<p>Definition:</p> <p>Quantity of heat must be _____ for 1g of water to vaporize liquid to _____.</p> <p>➤ Large amount of heat/energy is used to _____ the hydrogen bonds that link individual water molecule.</p> <p>Importance of high latent heat of vaporization:</p> <p>💧 _____ effect;</p> <p>✓ _____ of water in sweat on skin or in transpiration from green leaves or panting in animals e.g. dog.</p>
5.	<p>_____</p> <p>_____</p> <div data-bbox="300 1671 608 1892" data-label="Image"> </div>	<p>Definition:</p> <p>A measure of how _____ it is to break the surface of a liquid.</p> <p>➤ The stronger the bonds between the molecules in liquid, the _____ the surface tension.</p> <p>➤ Surface tension is related to _____ forces between water molecules.</p> <p>➤ In the body of water, water molecules within are attracted _____ by cohesion.</p>



➤ At the air-water interface, cohesive force only from interior.

➤ Thus, the _____ attraction causes the **inwardly forces** that cause **high surface tension** at the surface of water.

Importance of high surface tension:

- Many small organisms rely on surface tension to settle on water.

E.g.: _____

- Helps in _____ of water in plants.

6.

How do aquatic organisms in ponds and lakes can survive in liquid water during the winter

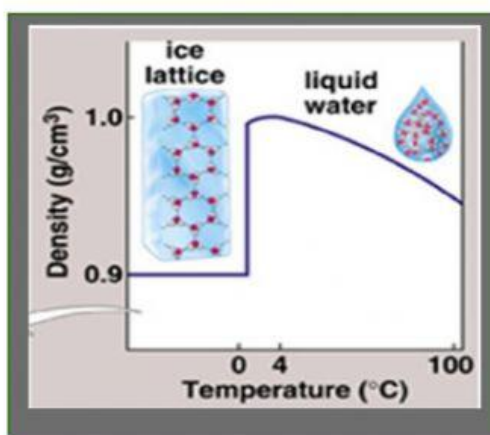
- Water achieves **its highest density at** _____.

- Therefore, **ice (0°C) is less dense** than water and floats on top of water.

- Water _____ on top of lakes and **insulates the layers below from further cooling and freezing.**

- Thus allowing life forms to thrive in the water beneath the ice.

➤ Water achieves its highest density at 4°C.



➤ Therefore, ice (0°C) is _____ than water and floats on top of water.

➤ Water is the only substances whose **solid form is less dense than its liquid form.**

