Essay 2.1.6. : **Explain The Significance To Organisms of Water As a Transport Medium and Habitat, In Terms Of Its Properties**

Water is essential to life, without water life on Earth would not exist. Water is a major component of cells, typically forming between 70 and 95% of the mass of the cell. This means that we are made from approximately 80% of water by mass and some soft bodied creatures such as jellyfish are made up from up to 96% water. Water also provides an environment for organisms to live in, since 75% of the Earth is covered in water. Water is a simple molecule, which is made up of two hydrogen atoms and one oxygen atom, forming H_2O. Each hydrogen shares and electron pair with the oxygen to form a covalent bond between hydrogen and oxygen. Theoxygen has two unshared electron pairs not involved in bonding. Though, these lone pairs cause two O-H bonds to be at an angle rather than in a straight line, at the angle of 104.5°.The sharing of electrons between the two atoms are uneven; the large number of protons in the oxygen nucleus have a stronger attraction for these shared electrons than the comparatively tiny hydrogen nuclei. This pulls the electrons slightly close to the oxygen nucleus and away from the hydrogen so that the oxygen develops a slight negative charge and the hydrogen's a slight positive charge. This makes the water molecules polar.

This slight charge means that when water molecules are close together the positively charged hydrogen atoms are attracted to the negatively charged oxygen atoms of another water molecule to form a weak hydrogen bond. The bonds are weak individually but the sheer number of them means that the total force keeping the molecules together is considerable. A water molecule can form hydrogen bonds with up to four nearby water molecules, but the number of bonds formed depends upon the temperature; the hotter the water, the fewer the bonds. At 25°C each water molecule is hydrogen-bonded to an average of 3.5 others; none are hydrogen bonded at 600°C. Water is an unusual substance, mostly due to its hydrogen bonds; its properties allow it to act as a solvent, a reactant, as a molecule with cohesive properties, as an environment and as a temperature stabiliser. Water can dissolve polar or ionic substances, and are able to keep them in solution due to water's own properties.

Substances that dissolve in water are known as hydrophilic substances. Ionic substances such as sodium chloride (NaCl) are made up of positive and negative ions. Sodium chloride is held in its structure by the strong attraction between the positive sodium ions and the negative chloride ions. Normally these ionic attractions require a large amount of energy to break, but when the compound is placed in water; due to water's polar nature the negatively charged oxygen clusters around the positive sodium ions, while the positive hydrogen atoms cluster around the negative chloride ions. The attraction between the Sodium and Chloride is weakened as the ions are separated. Water's properties as a solvent are vital to life as most biochemical reactions such as respiration occur in solution. This is why cell cytoplasm contains about 90% water. Water cannot dissolve hydrophobic substances such as fats and oils; these are used by organisms as cell membranes to separate cells and also as waterproofing as they prevent water from entering the organism if it is covered in a hydrophobic substance.
Water is an excellent solvent. Many substances dissolve in water. Sugar, for example, is soluble in water. Substances such as glucose dissolve in the water of the blood, which then allow it to be carried around the human body, such as in the excretory system where toxic urea and ammonia are removed from the body in water. In plants, the most commonly transported substance is sucrose, which is also soluble in water, along the phloem; or in the xylem where water dilates the mineral salts such as nitrates (for

growth) and transports them from the roots to the leaves. As well as this water also plays a key role in the metabolic breakdown of such essential molecules as proteins and carbohydrates, called hydrolysis where the molecules are split up. This is essential to animals and plants because it allows them to utilise stored foods that are in long chains by breaking off smaller molecules. Respiration produces water as a by-product, since a large amount of energy is produced by oxidising hydrogen, which contains so much energy it is an explosive gas, into water. Photosynthesis uses water as a source of hydrogen atoms, which are needed to produce glucose, which is then stored in the plant cells as starch or used for respiration. With out water these two essential reactions would not occur and life would not be able to continue. An important property of water is also its transparency, it allows sunlight to pass through it so aquatic plants can photosynthesise; as well as this it is the main reason life on earth began since life began with organisms which relied on sunlight for photosynthesis.

Water has many thermal properties as a temperature stabiliser. Water has a boiling point of 100°C and a melting point at 0°C, this is unusual for a molecule of it's size with a relative atomic mass of 18; since other molecules of a similar size such as carbon dioxide and ammonia are all gaseous at room temperature whereas water is a liquid. This is due to the hydrogen bonds holding the water molecules in a liquid state. Water also has a high specific heat capacity; the result of this is that it takes 4.2 Joules of energy to raise one gram of water by 1°C. This means that it takes a lot of heat energy to raise the temperature of water significantly, but once warm it cools slowly. This is essential to life where internal body temperature has to be maintained at a constant temperature and fluctuations can result in a breakdown of essential processes such as enzyme activity. Large bodies of water will remain at an almost constant temperature with only very gradual changes that makes temperature regulations for organisms far more straightforward especially to aquatic life, which is mostly poikilothermic so that the rate of metabolism will depend on the changes on external temperature such as fish.

Due to the large number of hydrogen bonds holding water molecules together, so in turn water has a high latent heat of vaporisation of 2268 J, which is the energy needed to convert liquid water into steam. Animals use this property of water by using excess body heat to evaporate water from their surfaces, resulting in them transferring a lot of energy into the environment but only losing a little water. Sweating and panting are based on this principle. Plants also use transpiration in the same manner in order to stop them from overheating. Water also has a high latent heat of fusion from solid to liquid requiring 300J per gram of ice to melt it to water. This means that water stays in a liquid state. This is very important as water is less likely to freeze, which is vital in the case of cytoplasm in cells; since a large percentage of a cell is water and if the water froze it would cause the cells to be irreparably damaged. The freezing point of water is also decreased by solutes by disrupting the hydrogen bonds. In the cytoplasm, there are many solutes and so the water freezes at a temperature below 0°C. As water cools, its density increases, though ice floats on water since water is at its most dense at 4°C which is when its bonds are closes together. When water freezes the lattice arrangement of its structure move apart slightly and it floats on the surface. Thisallows aquatic life to continue since the layer of ice insulates the water below which stays at 4 °C.

Water molecules are highly cohesive because of the hydrogen bonds between the molecules. The cohesive property of water allows plants to pull up water through xylem vessels from the roots to the leaves called the transpiration stream. This also causes the water molecules when they come into contact with air will be held tightly together and the water molecules below them, forming an elastic film known as surface

tension. Organisms such as water skaters can move across the surface of the water since they have hydrophobic feet, and a small body mass spread over a large surface area. The surface tension of the water also provides support for plants such as water lilies that rely on water to keep them afloat. Water also has strong hydrostatic forces making it incompressible. This provides support for soft bodied creature such as worms, slugs and jelly fish which therefore due not require a supporting skeletal system also allowing plants to support themselves.