2.2C: Water’s High Heat Capacity

Water is able to absorb a high amount of heat before increasing in temperature, allowing humans to maintain body temperature.

Learning Objectives

- Explain the biological significance of water’s high specific heat

Key Points

- Water has the highest heat capacity of all liquids.
- Oceans cool slower than the land due to the high heat capacity of water.
- To change the temperature of 1 gram of water by 1 degree Celsius, it takes 1.00 calorie.

Key Terms

- **heat capacity**: The capability of a substance to absorb heat energy
- **specific heat**: the amount of heat, in calories, needed to raise the temperature of 1 gram of water by 1 degree Celsius
Water's High Heat Capacity

The capability for a molecule to absorb heat energy is called heat capacity, which can be calculated by the equation shown in the figure. Water’s high heat capacity is a property caused by hydrogen bonding among water molecules. When heat is absorbed, hydrogen bonds are broken and water molecules can move freely. When the temperature of water decreases, the hydrogen bonds are formed and release a considerable amount of energy. Water has the highest specific heat capacity of any liquid. Specific heat is defined as the amount of heat one gram of a substance must absorb or lose to change its temperature by one degree Celsius. For water, this amount is one calorie, or 4.184 Joules. As a result, it takes water a long time to heat and a long time to cool. In fact, the specific heat capacity of water is about five times more than that of sand. This explains why the land cools faster than the sea.

\[ C = Q \Delta T \]

The resistance to sudden temperature changes makes water an excellent habitat, allowing organisms to survive without experiencing wide temperature fluctuation. Furthermore, because many organisms are mainly composed of water, the property of high heat capacity allows highly regulated internal body temperatures. For example, the temperature of your body does not drastically drop to the same temperature as the outside temperature while you are skiing or playing in the snow. Due to its high heat capacity, water is used by warm blooded animals to more evenly disperse heat in their bodies; it acts in a similar manner to a car’s cooling system, transporting heat from warm places to cool places, causing the body to maintain a more even temperature.