

Chapter 1 - Water (AICE)

AI-Generated Study Guide

Subject: science

Grade Level: 11th

Format: flashcards

Generated: September 10, 2025

AICE Science Study Guide: Water - Chapter 1

Grade 11 Flashcards (Intermediate Level)

Note: This study guide is based on available content from the provided materials and supplemented with key water concepts essential for AICE Science.

MOLECULAR STRUCTURE & PROPERTIES

Q: What is the molecular formula of water and describe its basic structure?

A: H_2O - consists of two hydrogen atoms covalently bonded to one oxygen atom, forming a bent/angular molecular geometry with a bond angle of approximately 104.5° .

Q: Why is water described as a polar molecule?

A: Water is polar because oxygen is more electronegative than hydrogen, creating partial negative charge (δ^-) on oxygen and partial positive charges (δ^+) on hydrogen atoms, resulting in an uneven distribution of electron density.

Q: What type of intermolecular force exists between water molecules and why is it significant?

A: Hydrogen bonding occurs between the partially positive hydrogen of one water molecule and the partially negative oxygen of another. This gives water its unique properties like high boiling point and surface tension.

Q: Define hydrogen bonding in the context of water molecules.

A: Hydrogen bonding is the attractive force between a hydrogen atom bonded to oxygen in one water molecule and the lone pair of electrons on oxygen in another water molecule.

PHYSICAL PROPERTIES

Q: What is the density of water at 4°C and why is this temperature significant?

A: Water has maximum density of 1.00 g/cm³ at 4°C. This is significant because water expands when it freezes, making ice less dense than liquid water, allowing ice to float.

Q: Explain water's unusually high boiling point compared to other similar-sized molecules.

A: Water's boiling point (100°C) is much higher than expected due to extensive hydrogen bonding between molecules, which requires additional energy to break during the phase transition from liquid to gas.

Q: What is surface tension and how does it relate to water's molecular structure?

A: Surface tension is the cohesive force between liquid molecules at the surface. Water has high surface tension due to hydrogen bonding, allowing some insects to walk on water and water to form droplets.

Q: Define specific heat capacity and state water's value.

A: Specific heat capacity is the amount of energy required to raise the temperature of 1g of a substance by 1°C. Water has a high specific heat capacity of 4.18 J/g°C due to hydrogen bonding.

CHEMICAL PROPERTIES**Q: What is meant by water's amphoteric nature?**

A: Water is amphoteric, meaning it can act as both an acid (proton donor) and a base (proton acceptor) depending on the reaction conditions.

Q: Write the equation for water's autoionization and state the ion product constant.

A: $\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{OH}^-(\text{aq})$ or $2\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq})$

$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$ at 25°C

Q: What is the pH of pure water and why?

A: Pure water has a pH of 7.0 because $[\text{H}^+] = [\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$, making it neutral.

Q: How does water participate in hydrolysis reactions?

A: In hydrolysis, water molecules break chemical bonds by donating H^+ and OH^- ions to the products, effectively splitting larger molecules into smaller ones.

BIOLOGICAL IMPORTANCE

Q: List three crucial roles of water in biological systems.

A: 1) Solvent for biochemical reactions, 2) Transport medium for nutrients and waste, 3) Temperature regulation through high specific heat capacity and evaporation.

Q: Why is water called the "universal solvent"?

A: Water dissolves many ionic and polar substances due to its polar nature, allowing it to surround and separate ions or polar molecules through hydration.

Q: Explain how water's density anomaly is crucial for aquatic life.

A: Ice floats on water because it's less dense, creating an insulating layer that prevents water bodies from freezing completely, allowing aquatic life to survive underneath.

Q: What is osmosis and how does it relate to water movement in cells?

A: Osmosis is the movement of water across a selectively permeable membrane from an area of lower solute concentration to higher solute concentration, crucial for maintaining cell volume and nutrient transport.

ENVIRONMENTAL SIGNIFICANCE

Q: Describe the water cycle and name its main processes.

A: The water cycle is the continuous movement of water through Earth's systems via evaporation, condensation, precipitation, and collection, driven by solar energy.

Q: What is hard water and what causes it?

A: Hard water contains high concentrations of dissolved minerals, primarily Ca^{2+} and Mg^{2+} ions, typically from groundwater passing through limestone or chalk deposits.

Q: How do hydrogen bonds contribute to water's role in climate regulation?

A: Hydrogen bonding gives water high specific heat capacity and latent heat of vaporization, allowing oceans to absorb and release large amounts of energy, moderating Earth's temperature.

Q: What is the significance of water's triple point?

A: The triple point (0.01°C , 611.657 Pa) is where solid, liquid, and gas phases coexist in equilibrium, used as a standard reference point in thermodynamics.

STUDY TIPS FOR AICE EXAM:

- Focus on connecting molecular structure to macroscopic properties
- Practice calculating pH, concentration problems, and thermodynamic values
- Understand both qualitative explanations and quantitative relationships
- Be prepared to explain biological and environmental applications
- Review intermolecular forces and their effects on physical properties

Remember: AICE exams often require you to apply concepts across different contexts, so practice explaining how water's properties relate to various biological, chemical, and environmental phenomena.