IB Biology A1.1 Water Worksheet 02 - Structure, Polarity and Hydrogen Bonding

Trimester assessment practice with IB-style multiple choice, short answer, data response / case study, and extended response.

Level	Focus	Recommended time	Total marks
SL core / HL compatible	A1.1.2 - Polar covalent bonds, partial charges and hydrogen bonding	35 to 40 minutes	25

Instructions: Answer all questions. Use precise biological vocabulary. Working should be shown where calculation or reasoning is required. These worksheets are original IB-style practice materials for classroom use.

Question mix: 4 multiple choice questions, 3 short-answer questions, 1 data response / case study question, and 1 extended response.

Section A - Multiple choice

Choose the best answer for each question. [1 mark each]

Q1. Why are the bonds within a water molecule described as polar covalent? [1]

A. The atoms share protons equally

B. Electrons are shared unequally between oxygen and hydrogen

C. Water molecules form ionic bonds with one another

D. The molecule is linear

Q2. Which end of a water molecule carries a partial negative charge? [1]

A. The oxygen end

B. The hydrogen end

C. Both ends equally

D. Neither end

Q3. A hydrogen bond in liquid water forms between ... [1]

A. two hydrogen atoms in the same molecule

B. the oxygen and hydrogen within one covalent bond

C. the hydrogen of one water molecule and the oxygen of another

D. two oxygen atoms in neighboring molecules

Q4. The bent shape of water is important because it ... [1]

A. cancels all charge separation

B. separates positive and negative regions of the molecule

C. prevents hydrogen bonding

D. makes water non-polar

Section B - Short answer

Q5. Distinguish between a polar covalent bond and a hydrogen bond in water. [4]

Q6. Explain why oxygen is delta negative and each hydrogen is delta positive in a water molecule. [3]

Q7. State two conventions used when representing several water molecules joined by hydrogen bonds in a diagram. [3]

Section C - Data response / case study

A student compared three small molecules to investigate how molecular structure influences physical properties.

Substance	Relative molecular mass	Permanent polarity	Boiling point (°C)
Methane	16	No	-161
Water	18	Yes	100
Hydrogen sulfide	34	Yes	-60

Q8. Use the data to explain why water behaves unusually for such a small molecule. [6]

(a) Identify the molecule with the highest boiling point. [1]

(b) Explain why water has a much higher boiling point than methane despite their similar relative molecular masses. [3]

(c) State one biological advantage of water remaining liquid over a wide temperature range. [2]

Section D - Extended response

Q9. Explain how the structure of water molecules gives rise to hydrogen bonding and why this is biologically important. [8]

Link molecular structure to at least two biological consequences.

Answer key and marking guidance

Award credit for scientifically accurate equivalent wording unless the markscheme specifies otherwise.

Section A answers

Question	Answer	Guidance
Q1	B	Oxygen attracts shared electrons more strongly, giving unequal electron distribution.
Q2	A	The oxygen atom has greater electron density and is delta negative.
Q3	C	Hydrogen bonds are intermolecular attractions between adjacent polar water molecules.
Q4	B	The bent geometry leaves a partially negative oxygen side and partially positive hydrogen side.

Section B guidance

Q5. Distinguish between a polar covalent bond and a hydrogen bond in water. [4]

Award up to [2] for polar covalent bond points and up to [2] for hydrogen bond points. Polar covalent bond: unequal sharing of electrons within a water molecule between O and H; it is an intramolecular bond. Hydrogen bond: weak attraction between a delta positive hydrogen of one water molecule and a delta negative oxygen of another; it is an intermolecular attraction.

Q6. Explain why oxygen is delta negative and each hydrogen is delta positive in a water molecule. [3]

Award [1] for each valid point up to [3]. Oxygen is more electronegative than hydrogen; shared electrons spend more time near oxygen; the oxygen side therefore has greater electron density / partial negative charge; each hydrogen has reduced electron density / partial positive charge.

Q7. State two conventions used when representing several water molecules joined by hydrogen bonds in a diagram. [3]

Award [1] for each valid convention up to [3]. Accept: use delta plus and delta minus to show partial charges; show covalent O-H bonds within each water molecule; show hydrogen bonds as dotted or dashed lines between molecules; orient molecules so a hydrogen bond links H of one molecule to O of another.

Section C guidance

Q8. Use the data to explain why water behaves unusually for such a small molecule. [6]

Award marks as indicated. (a) [1] Water. (b) Award up to [3]. Water is polar; hydrogen bonds form between neighboring water molecules; energy is required to break many hydrogen bonds before molecules separate into gas; methane lacks hydrogen bonding / is non-polar. (c) Award up to [2]. Accept: water remains liquid in many environments, so it can act as the medium for metabolism, transport and habitats.

Section D guidance

Q9. Explain how the structure of water molecules gives rise to hydrogen bonding and why this is biologically important. [8]

Indicative content includes: one oxygen covalently bonded to two hydrogens; unequal sharing of electrons because oxygen is more electronegative; water is bent and therefore polar; oxygen is delta negative and hydrogens are delta positive; hydrogen bonds form between neighboring molecules; although individually weak they occur in large numbers; these interactions underpin properties such as cohesion, adhesion, solvent effects, stability of liquid water and biological structures.

Extended response markband

Marks	Descriptor
0	No relevant biological knowledge or no creditworthy response.
1-2	Limited knowledge. A few isolated facts may be stated but links to the question are weak or unclear.
3-4	Some correct biological ideas are included. Explanation is partial and may lack precision or development.
5-6	Clear understanding with relevant biological detail. Uses appropriate terminology and links most ideas to the question.
7-8	Accurate, well-structured and comprehensive response. Ideas are logically linked and supported with relevant examples or applications.