IB Biology SL • Trimester Assessment Worksheet 02

Structure, Polarity, and Hydrogen Bonding

Topic coverage: A1.1.2

Name: _____	Class: _____
Date: _____	Time guide: 35 minutes
Total marks: 27	Level: SL

Focus for this worksheet

• Topic focus: covalent bonding within the water molecule, unequal electron sharing and polarity, hydrogen bonds between water molecules.

• Use IB-style command terms and support explanations with biological reasoning.

• Answer directly in the spaces provided or on separate paper if more space is needed.

Section A: Multiple choice [4 marks]

1. A covalent bond in water is a bond in which atoms [1]

A. transfer protons completely
B. share pairs of electrons
C. gain identical partial charges
D. form only between different molecules

2. The oxygen atom in water carries a partial negative charge because oxygen [1]

A. contains fewer electrons than hydrogen
B. attracts shared electrons more strongly than hydrogen
C. forms ionic bonds with both hydrogen atoms
D. is positioned in a straight line with the hydrogens

3. The approximate bond angle in a water molecule is [1]

A. 90°
B. 104.5°
C. 120°
D. 180°

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

A. the oxygen atom and both hydrogens in the same molecule
B. the nucleus of oxygen and a free electron
C. a partially positive hydrogen of one molecule and a partially negative oxygen of another
D. two oxygen atoms in adjacent molecules

Section B: Short answer [8 marks]

5. State the bond type within a water molecule and identify the partial charge on oxygen. [3]

6. Explain why water is described as a polar molecule. [3]

7. Distinguish between a covalent bond and a hydrogen bond in water. [2]

Section C: Data response / case study [9 marks]

Stimulus 8. Data response: boiling points of small molecules

A student compared the boiling points of several small molecules.

Molecule	Boiling point / °C
Methane (CH_4)	-161.5
Ammonia (NH_3)	-33.3
Hydrogen sulfide (H_2S)	-60.3
Water (H_2O)	100

8a. Identify the molecule with the highest boiling point. [1]

8b. Explain why water has a much higher boiling point than methane. [3]

8c. What do the data suggest about the strength of intermolecular attractions in water? [2]

8d. Predict which substance would require the most energy to separate its molecules completely, and justify your answer. [1]

8e. Explain why hydrogen bonds in liquid water are described as temporary. [2]

Section D: Extended response [6 marks]

9. Explain how the structure and polarity of water molecules lead to biologically important properties of water. [6]

End of student response section.

Answer Key and Marking Guidance

Worksheet 02: Structure, Polarity, and Hydrogen Bonding

General marking notes

• Award [1] for each valid point unless otherwise indicated.

• Accept equivalent wording when the biological meaning is clear.

• For explanation questions, credit the biological link or cause–effect statement, not just a list of terms.

• Do not double-credit repeated ideas expressed in different words.

Section A: Multiple-choice answers

Question	Answer
1	B
2	B
3	B
4	C

Section B: Short-answer markscheme

5. State the bond type within a water molecule and identify the partial charge on oxygen. [3]

• Bond type within the molecule is covalent / polar covalent.
• Oxygen has a partial negative charge.
• Hydrogen atoms have partial positive charges.

6. Explain why water is described as a polar molecule. [3]

• Oxygen is more electronegative / attracts shared electrons more strongly.
• This creates unequal electron distribution / partial charges.
• The bent shape means positive and negative regions are separated.

7. Distinguish between a covalent bond and a hydrogen bond in water. [2]

• Covalent bonds are strong bonds within a water molecule between O and H.
• Hydrogen bonds are weaker attractions between neighbouring water molecules.

Section C: Data response / case-study markscheme

8a. Identify the molecule with the highest boiling point. [1]

• Water / H_2O.

8b. Explain why water has a much higher boiling point than methane. [3]

• Water molecules are polar and form hydrogen bonds with each other.
• Methane is non-polar / does not form hydrogen bonds.
• More energy is needed to separate water molecules.

8c. What do the data suggest about the strength of intermolecular attractions in water? [2]

• Water has stronger intermolecular attractions than the other molecules shown.
• These attractions are due largely to hydrogen bonding.

8d. Predict which substance would require the most energy to separate its molecules completely, and justify your answer. [1]

• Water, because it has the highest boiling point.

8e. Explain why hydrogen bonds in liquid water are described as temporary. [2]

• Molecules in liquid water are constantly moving.
• Hydrogen bonds form and break continuously.

Section D: Extended response

9. Explain how the structure and polarity of water molecules lead to biologically important properties of water. [6]

Indicative scientific content:

• water has one oxygen and two hydrogens joined by covalent bonds
• oxygen is more electronegative so electrons are shared unequally
• oxygen becomes partially negative and hydrogens become partially positive
• the bent shape separates charge and makes the molecule polar
• polarity allows hydrogen bonds between neighbouring molecules
• hydrogen bonding contributes to solvent properties, cohesion, and stabilisation of biological structures

Marks	Descriptor
5–6	Accurate, relevant and well-organised response with several linked biological ideas and appropriate terminology.
3–4	Some accurate biology with partial development or limited linkage between ideas.
1–2	A small number of correct ideas, often brief, vague, or weakly linked to the question.
0	No relevant creditworthy content.