



Biology

Standard and Higher level

D2.3 Water potential Paper 1A

11 May 2026

Zone A afternoon | **Zone B** morning | **Zone C** afternoon

1 hour [Paper 1A]

Instructions to candidates

- Answer all questions.
- For each question, choose the answer you consider to be the best.
- A calculator is required for this paper.
- This paper generally presents questions in the same order the concepts are presented in the syllabus guide. The earlier questions are usually but not always easier than the later questions. Although most questions focus on this topic only, some are linked to other topics.
- This paper contains challenging IB-style problems. It is meant to enrich your learning and improve your mastery of the concepts presented in this topic after you have studied it.
- Most of the questions here are original and written by me. Several questions are inspired or taken from external sources, which are referenced.
- **None of the questions are from past papers.**
- The maximum mark for paper 1A is **[40 marks]**.

1. What is solvation?
 - A. Covalent interactions between solute and solvent particles
 - B. Ionic interactions between solute and solvent particles
 - C. Chemical interactions between solute and solvent particles
 - D. Non-covalent interactions between solute and solvent particles

2. What is a hydration shell?
 - A. A term given when solvent particles surround a water molecule
 - B. A term given for solvents surrounding solutes when the solvent is water
 - C. A term given when solutes are surrounded by solvent particles
 - D. A term given when water molecules surround each other in a solution

3. Why is the formation of hydration shells important in solvation?
 - A. It maintains solute-solvent interactions in a stable solution
 - B. It prevents re-attraction of free water molecules
 - C. It allows solute-solvent interactions to be in dynamic equilibrium
 - D. It reduces surface tension of the solution to increase its energetic stability

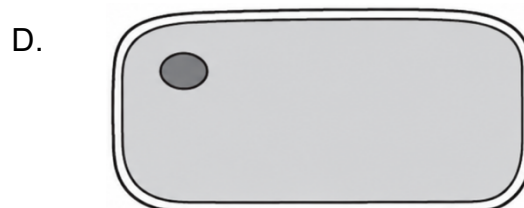
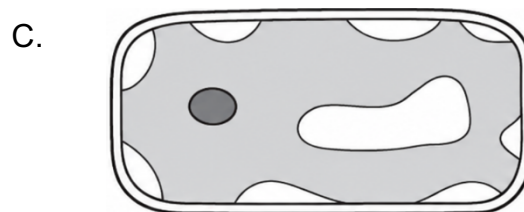
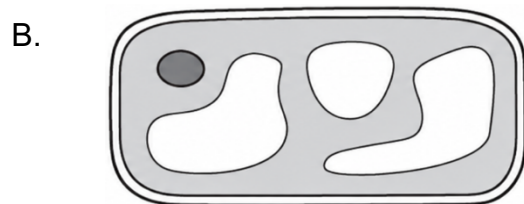
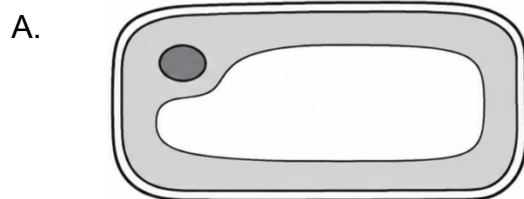
4. What is the nature of interactions between solute ions and water particles?
 - A. Ionic
 - B. Electronic
 - C. Electrostatic
 - D. Covalent

5. What kinds of interactions can water form with solutes?
- I. Ionic
 - II. Covalent
 - III. Polar
- A. I only
 - B. III only
 - C. II and III only
 - D. I and III only
6. What kinds of substances can undergo solvation in water?
- A. Polar and ionic
 - B. Ionic and non-covalent
 - C. Non-covalent and polar
 - D. Non-polar and non-covalent
7. What is **correct** about the process of solvation?
- A. Solute-solute interactions must be stronger than solute-solvent interactions
 - B. Solute-solute interactions must be stronger than solvent-solvent interactions
 - C. Solute-solute interactions must be weaker than solvent-solvent interactions
 - D. Solute-solute interactions must be weaker than solute-solvent interactions
8. What are free water molecules?
- A. Water molecules that interact with particles in the solution
 - B. Water molecules that interact with solute particles in the solution
 - C. Water molecules that are not interacting with particles in the solution
 - D. Water molecules that are not interacting with solute particles in the solution

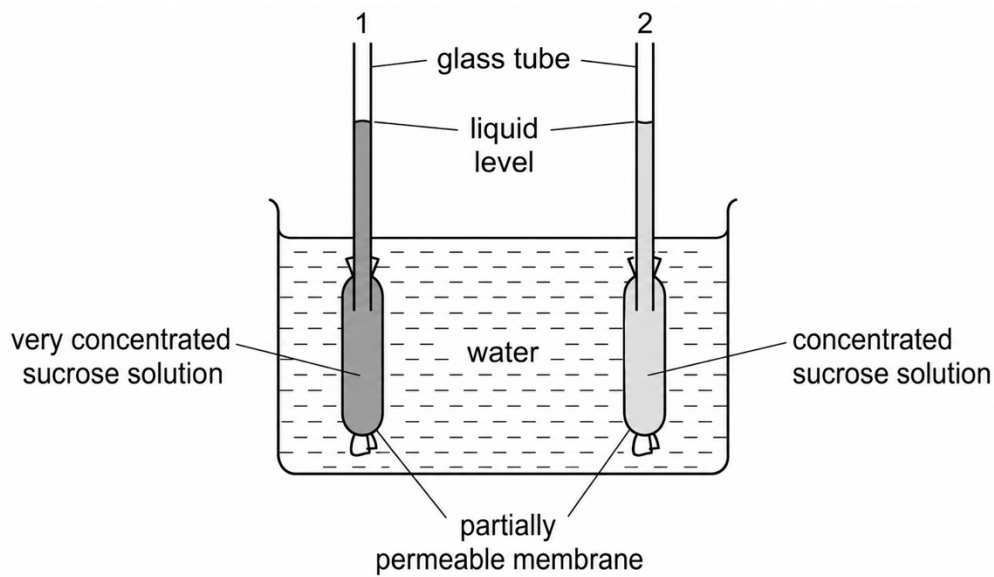
9. What is a semi-permeable membrane?
- A. A membrane that is permeable to some solutes
 - B. A membrane that is permeable to all solutes
 - C. A membrane that is permeable to the solvent but not solute
 - D. A membrane that is permeable to the solute but not solvent
10. Which of the following is most likely to form solute-solvent interactions with an oxygen atom of a water molecule in a solution?
- I. The hydroxyl group of a sugar
 - II. The methyl group of an acid
 - III. The phosphate group of an acid
- A. I only
 - B. III only
 - C. II and III only
 - D. I and III only
11. What is osmosis?
- A. Diffusion of water across a semi-permeable membrane from the solution with higher water concentration into the solution of lower water concentration
 - B. Movement of water across a semi-permeable membrane from the solution of higher concentration into the solution of lower concentration
 - C. Diffusion of solute particles across a semi-permeable membrane from the solution of higher concentration into the solution of lower concentration
 - D. Movement of water across a semi-permeable membrane from the solution of lower concentration into the solution of higher concentration
12. What is dynamic equilibrium?
- A. No water loss between a semi-permeable membranes due to stability
 - B. Net zero water loss between a semi-permeable membrane
 - C. Loss of mass but not volume between a semi-permeable membrane
 - D. Water movement that is constantly being balanced by solute movement

13. How does the rate of water entering a cell compare to the rate of water exiting a cell during dynamic equilibrium?
- A. Entry rate is faster than leaving rate
 - B. Entry rate is slower than leaving rate
 - C. Entry rate is equal to leaving rate
 - D. Water movement stops completely
14. What **correctly** describes a cell in dynamic equilibrium with its surroundings?
- A. Hypertonic
 - B. Hypotonic
 - C. Isotonic
 - D. Tonic
15. What is **correct** about osmosis?
- A. Water moves to the concentrated solution because it is attracted to solutes
 - B. Water is attracted to non-covalent interactions in concentration solutions
 - C. More volume is lost from dilute solutions than concentrated solutions due to random water movement
 - D. Concentrated solutions lose solute mass as they accumulate more free water molecules
16. Which of the following chemicals, if added, will not cause changes to plant cells bathed in an isotonic solution?
- A. Olive oil
 - B. Table salt
 - C. Lactose
 - D. Glucose

17. Which statement is **correct** about turgor pressure?
- A. The pressure of water inside the cells presses inwards on the cell walls
 - B. The pressure of water inside the cells presses outwards on the cell walls
 - C. The pressure of water outside the cells presses inwards on the cell walls
 - D. The pressure of water outside the cells presses outwards on the cell walls
18. Which diagram **correctly** shows the appearance of a plant cell several minutes after it has been placed in a concentrated sugar solution?



19. The diagram shows an apparatus that can be used to demonstrate osmosis.



After one hour, what will happen to the liquid levels in the glass tubes?

	Liquid level in tube 1	Liquid level in tube 2
A.	Falls	Falls
B.	Falls	Rises
C.	Rises	Falls
D.	Rises	Rises

20. What is **correct** about turgor pressure?

- A. It creates a pull in the xylem which allows water to move upwards
- B. It allows sucrose and amino acids to travel in one direction in the phloem
- C. It is a pressure that is only found in cells containing chloroplasts
- D. It is pressure that helps to provide support for plants

21. Potato cylinders were put into different concentrations of sucrose solution for the same amount of time. The results recorded in the table show the masses of the potato cylinders measured before and after being immersed in the solutions.

Solution	Mass before immersion (g)	Mass after immersion (g)
I.	1.95	1.92
II.	2.05	1.95
III.	2.10	2.13
IV.	2.25	2.20

Which potato cylinder was put into the solution with the highest sucrose concentration?

- A. I.
 - B. II.
 - C. III.
 - D. IV.
22. Many drugs are manufactured as ionic compounds and administered intravenously. What is the main advantage of administering drugs as ionic compounds?
- A. Less toxic
 - B. More water soluble
 - C. More lipid soluble
 - D. Placebo effect
23. What is the most effective treatment for dehydration?
- A. Intravenous administration of pure water
 - B. Intravenous administration of isotonic glucose
 - C. Intravenous administration of hypertonic glucose
 - D. Intravenous administration of hypotonic glucose

24. Seawater has higher solute concentrations than human cells. What is a consequence of drinking seawater?
- A. Hydration
 - B. Overhydration
 - C. Dehydration
 - D. Rehydration
25. In an experiment, a student placed potato slices in sucrose solutions of different concentrations for 60 minutes. The table shows the mean percentage change in mass and the standard error that the student recorded.

Sucrose concentration (M)	Mean percentage change in mass	Standard error (%)
0.20	+5.8	0.6
0.30	+2.7	0.5
0.40	+0.4	0.9
0.50	–2.1	0.4

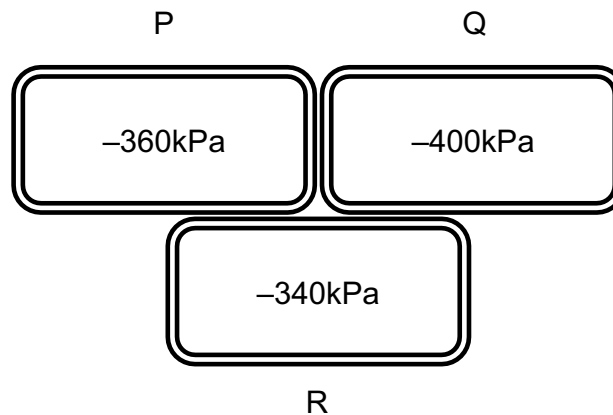
Which conclusion is best supported by the data?

- A. The isotonic concentration likely lies between 0.30M and 0.50M because they have similar standard errors
 - B. The isotonic concentration is 0.50M because the value has the lowest standard error
 - C. The isotonic concentration is 0.40M because its mean is closest to zero
 - D. The isotonic concentration is likely around 0.40M because it resulted in the lowest mean percentage change in mass
26. What is **correct** about osmolarity and tonicity?
- A. Both express the solute concentration of solutions
 - B. Both describe how cell volume changes relative to another solution
 - C. Osmolarity describes how cell volume will change relative to another solution but tonicity expresses concentration
 - D. Osmolarity expresses concentration but tonicity describes how cell volume will change relative to another solution

27. **[AHL]** What is the usual unit used to measured water potential?
- A. kg
 - B. kPa
 - C. mPa
 - D. Pa
28. **[AHL]** What are the reference conditions of water potential?
- I. Temperature of 20°C
 - II. Pressure equal to the atmosphere
 - III. A solute concentration of 1M
- A. I only
 - B. III only
 - C. I and II only
 - D. I and III only
29. **[AHL]** What is **correct** about assigning pure water a relative potential energy of zero?
- A. Pure water contains no hydration shells so it is less stable than a solution
 - B. It is an arbitrary decision made by biologists due to scientific debate
 - C. Values other than zero cannot be used as the potential energy of pure water
 - D. It does not represent the actual value of potential energy in pure water
30. **[AHL]** Can solute potential change without a change in the amount of dissolved solute?
- A. It depends on whether the solute is an ionic or polar particle
 - B. It depends on whether the solvent is a polar or non-polar particle
 - C. No because solute potential is always negative in any solution
 - D. Yes because solute potential depends on concentration not mass

31. **[AHL]** What is the pressure potential of a solution in an open beaker?
- A. Negative because the solvent is exposed to air
 - B. Zero because no pressure above atmospheric pressure is applied
 - C. Positive because atmospheric pressure is applying force on the solution
 - D. More information is needed to determine the extent of turgor pressure
32. **[AHL]** What is the pressure potential in animal cells?
- A. Positive but close to zero
 - B. Zero
 - C. Negative but close to zero
 - D. It does not apply to cells that lack a cell wall
33. **[AHL]** What is the consequence of storing water in vacuoles?
- I. ψ_p of the cell increases
 - II. ψ_s of the cell decreases
 - III. ψ_s of the cell increases
- A. I only
 - B. III only
 - C. I and II only
 - D. I and III only
34. **[AHL]** How is dynamic equilibrium reached in plant tissue that is bathed in hypotonic solution?
- A. ψ_p of the cell increases
 - B. ψ_p of the cell decreases
 - C. ψ_s of the cell remains unchanged
 - D. ψ_s of the cell becomes more negative

35. **[AHL]** What is the water potential of a cell with a solute potential of -0.67 kPa and a pressure potential of 0.43 kPa?
- A. $+1.10$ kPa
 - B. -1.10 kPa
 - C. $+0.24$ kPa
 - D. -0.24 kPa
36. **[AHL]** A student measures the water potential of an onion cell to be -0.24 kPa. If the pressure potential of the cell is 0.46 kPa, what is the solute potential?
- A. $+0.70$ kPa
 - B. -0.70 kPa
 - C. $+0.22$ kPa
 - D. -0.22 kPa
37. **[AHL]** The diagram shows the water potential of three plant cells P, Q and R.



What is the immediate movement of water that will occur between these cells?

- A. From Q to P and R, and from P to R
- B. From Q to P only
- C. From P to Q, and from R to P and Q
- D. From R to Q only

38. **[AHL]** An uncooked piece of potato was placed in a solution. After two hours the size of the piece of potato decreased. Which row explains why and how the potato changed?

	Water potential		Potato cells become
	Potato cells	External solution	
A.	Higher	Lower	Flaccid
B.	Higher	Lower	Turgid
C.	Lower	Higher	Flaccid
D.	Lower	Higher	Turgid

39. **[AHL]** Water in a xylem vessel has a ψ_s of -100kPa and a ψ_p of -700kPa . An adjacent companion cell has ψ_s of -900kPa and ψ_p of $+300\text{kPa}$. Which statement **correctly** describes the direction of water movement?

- A. From xylem to companion cell because the cell has a lower ψ_s
- B. From xylem to companion cell because xylem has a lower ψ_w
- C. From cell to companion xylem because the cell has a higher ψ_p
- D. From cell to companion xylem because xylem has a higher ψ_s

40. **[AHL]** How does vasopressin (ADH) reduce urine volume?

- A. ADH reduces ψ_w of the medulla to drive water out of the collecting duct
 - B. ADH increases ψ_s of the collecting duct to draw water into the medulla
 - C. ADH makes the ψ_p of the collecting duct less negative to draw water out of it
 - D. ADH provides a pathway for water to travel down the ψ_w gradient
-

References:

1. <https://pmt.physicsandmathstutor.com/download/Biology/GCSE/Topic-Qs/CIE-IGCSE/3-Movement-in-and-out-of-Cells/Set-B/MCQ/3.2%20Osmosis%20MCQ%20QP.pdf>
2. <https://bit.ly/4xI0MoE>

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