

Structured Questions: Paper 2

2.1 Metabolism & Water

2.1.1 Molecules / 2.1.2 Metabolism / 2.1.3 Hydrogen Bonds / 2.1.4 Water

Easy (5 questions)	/43
Medium (5 questions)	/46
Hard (5 questions)	/51
Total Marks	/140

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Easy Questions

1 (a) Define hydrophilic.

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.....
(1 mark)

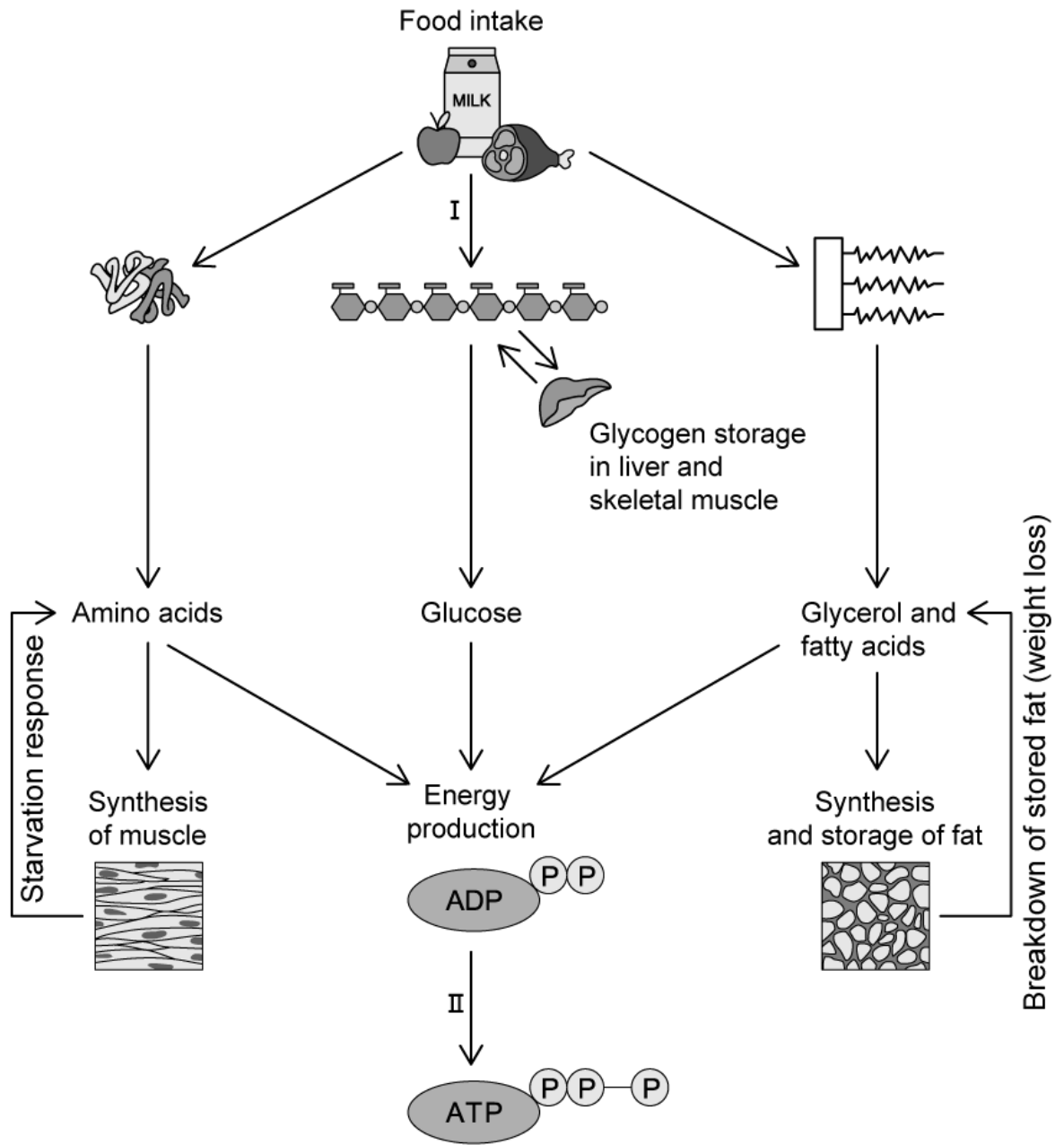
(b) State two advantages of a carbon atom being able to form four bonds to neighbouring atoms.

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.....
.....
(2 marks)

(c) List **three** carbon compounds that living organisms are based upon.

.....
.....
.....
(3 marks)

(d) State which part of metabolism is occurring at II in the flowchart below.



(1 mark)

2 (a) State the aspect of the molecular behaviour of water that is used to explain why it is highly important to living organisms.

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.....
.....
(1 mark)

(b) Two of the properties of water are its **cohesive** and **adhesive** forces.

Describe how these properties are useful to living organisms.

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(3 marks)

(c) Both water and methane are small molecules containing single covalent bonds between their atoms.

State two differences between these two molecules that make their physical properties very different.

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(2 marks)

(d) List two physical properties, associated with their state of matter, that differ between water and methane.

.....
.....
(2 marks)

3 (a) Define molecular biology.

.....
(1 mark)

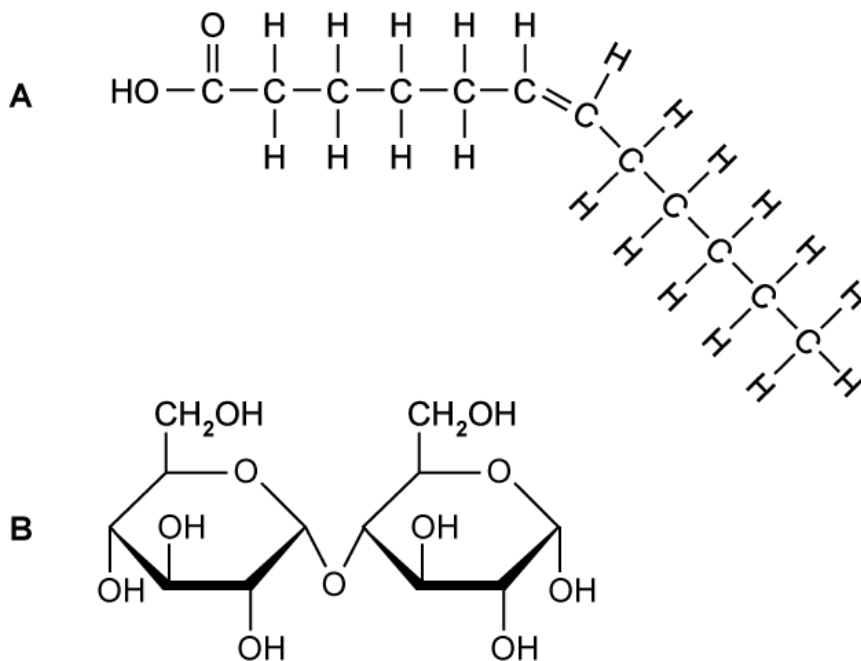
(b) State the name of the compound that was synthesised artificially, providing evidence that living organisms are not required to produce organic compounds.

.....
(1 mark)

(c) Draw a labelled diagram of a water molecule.

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.....
.....
(3 marks)

4 (a) Identify which of the diagrams below is a lipid, giving **one** reason why.



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.....
(2 marks)

(b) Draw a molecular diagram of D-ribose.

.....
.....
(2 marks)

(c) List, using simplified notation, two of the chemical groups found in a generalised amino acid.

.....
.....
(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Outline the theory that states that organic molecules could only be derived from living systems.

(3 marks)

(b) Distinguish between anabolic and catabolic reactions.

Include **one** example of each reaction.

(5 marks)

(c) Describe the properties of water molecules that enable them to transport metabolites, using **four** named examples.

(7 marks)

Medium Questions

1 (a) Which property or properties (**A**, **B**, **C**) explain the ability of water to dissolve solutes?

Property A: Polarity of water molecules

Property B: High specific heat capacity of water

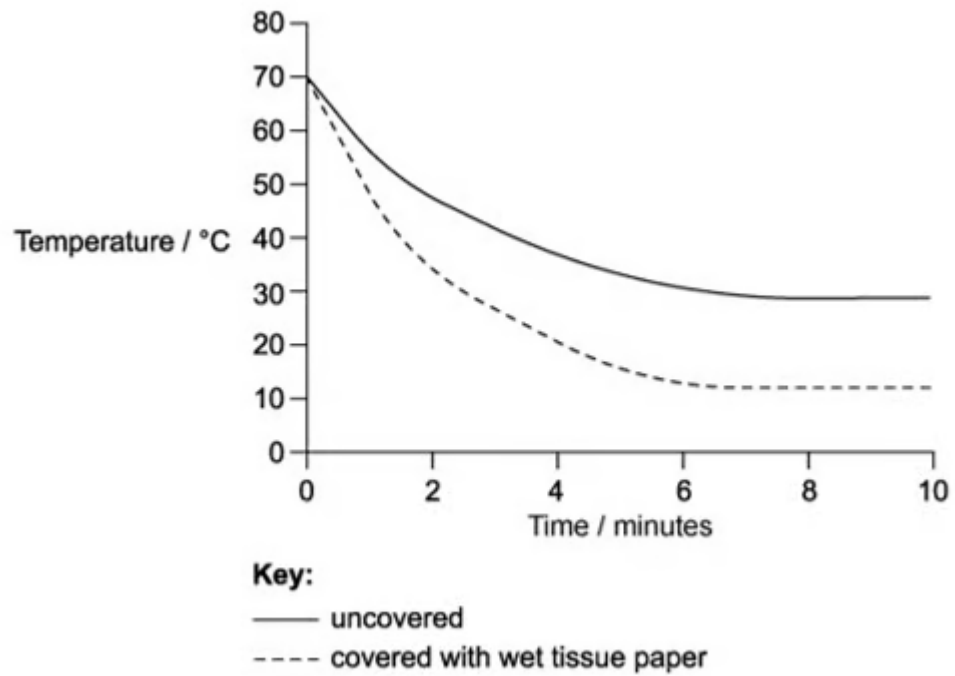
Property C: Hydrogen bonding

(1 mark)

(b) Describe the properties of carbon that make it an ideal element as the basis of living systems.

(3 marks)

(c) A group of students investigated the thermal properties of water. To do this, they poured hot water at 70°C into two thin plastic cups and measured the rate of cooling of each cup. The sides of one cup were covered with tissue paper soaked in hot water. The sides of the other cup were left uncovered. The temperature of the water in each cup was recorded with a thermometer every 2 minutes for 10 minutes. The results are shown in the graph below.



Other than the starting temperature of the water (70°C), give **two** conditions that must be kept the same for each cup throughout the experiment.

.....

.....

(2 marks)

(d) With reference to a thermal property of water, explain how the experiment in part **c** can demonstrate the response of the human body to prevent overheating.

.....

.....

(2 marks)

- 2 (a)** Water plays a very important role within the cytoplasm of cells. Two properties of water that make it an important part of the cytoplasm of cells are its **polarity** and its ability to act as a **universal solvent**.

For each of these **two** properties, explain why this makes water important for the cytoplasm.

(2 marks)

- (b)** The relatively high specific heat capacity of water is of great biological significance to organisms.

State **one** example of how this property is biologically important.

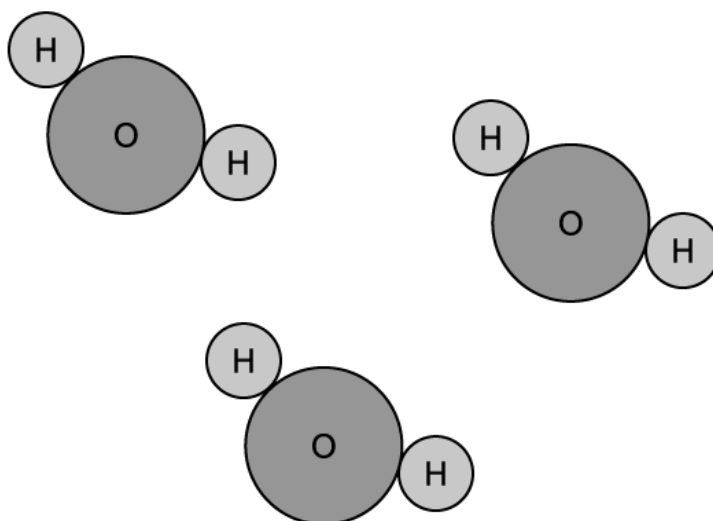
(1 mark)

- (c)** With reference to bonding, explain how the relatively high specific heat capacity of water enables it to buffer temperature changes.

(2 marks)

- (d)** The diagram below shows three water molecules in close proximity to each other. Using a dotted line, draw a hydrogen bond between water molecules. Also use the symbols δ^+

and δ^- to indicate small electrostatic charges on the appropriate atoms.



(3 marks)

3 (a) Distinguish between anabolic reactions and catabolic reactions.

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.....

.....

(3 marks)

(b) Complete the table with tick marks (✓) in the appropriate boxes.

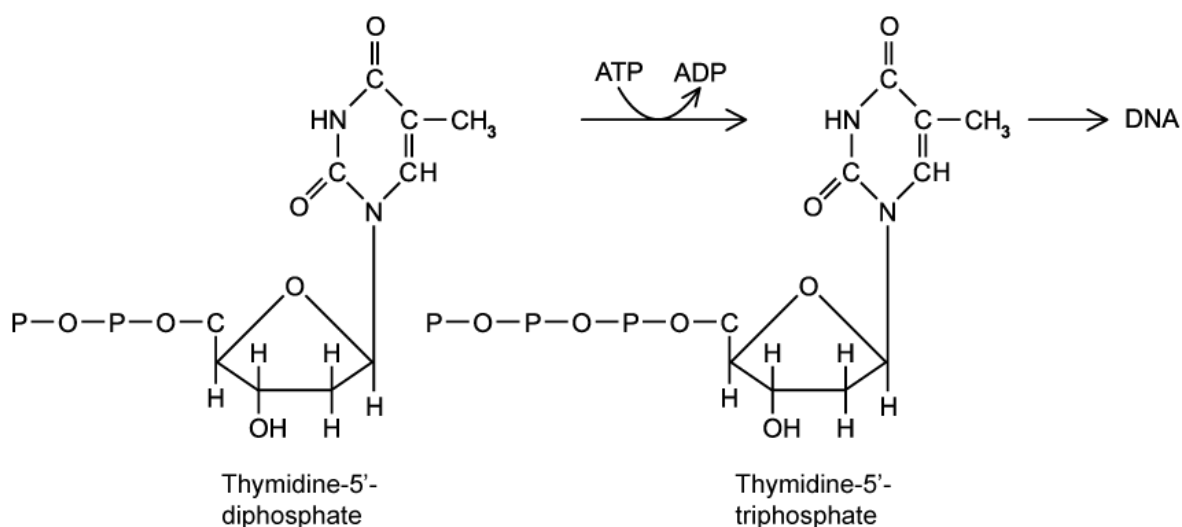
Cellular reaction	Anabolic	Catabolic
Fats → fatty acids and glycerol		
Accumulation of starch from sugars in plants		
Anaerobic respiration in yeast cells		
Hydrolysis of polypeptides into amino acids		

.....

.....

(2 marks)

(c) The diagram below shows part of a biochemical pathway that takes place commonly in cells.



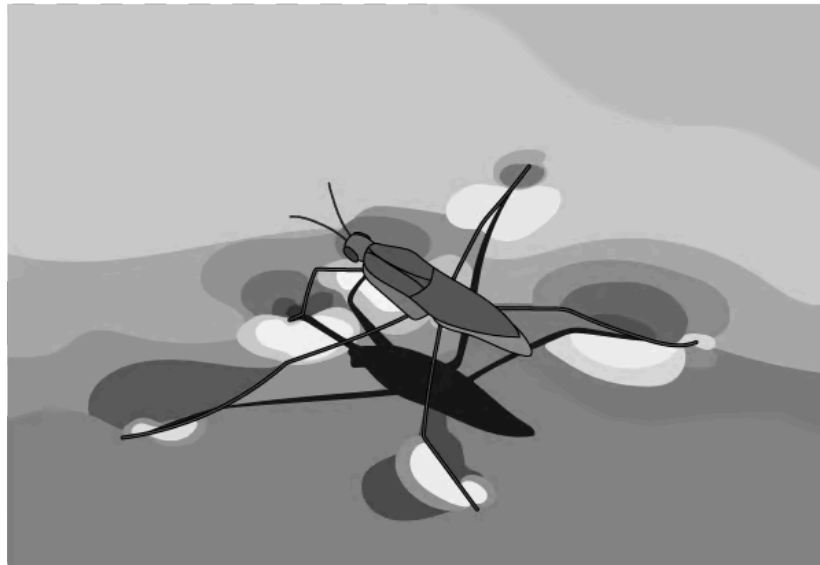
Deduce whether the pathway is anabolic or catabolic and give evidence from the diagram for your answer.

(2 marks)

4 (a) Compare and contrast the terms **adhesion** and **cohesion** in the context of water molecules in biological tissues.

(3 marks)

(b) The diagram shows a pond skater (or water strider).



Certain small animals such as pond skaters and fisher spiders can walk across bodies of water without breaking the surface.

Use your knowledge of water's properties to suggest how detergent pollution contaminating ponds and lakes can have a detrimental effect on these small animals.

(3 marks)

(c) Outline how vasodilation affects the volume of water lost as sweat in humans.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Explain the importance of hydrogen bonding in biological molecules.

(7 marks)

(b) Compare and contrast the structures of water (H₂O) and methane (CH₄) and use any structural differences to account for the differences in the two compounds' chemical and physical properties.

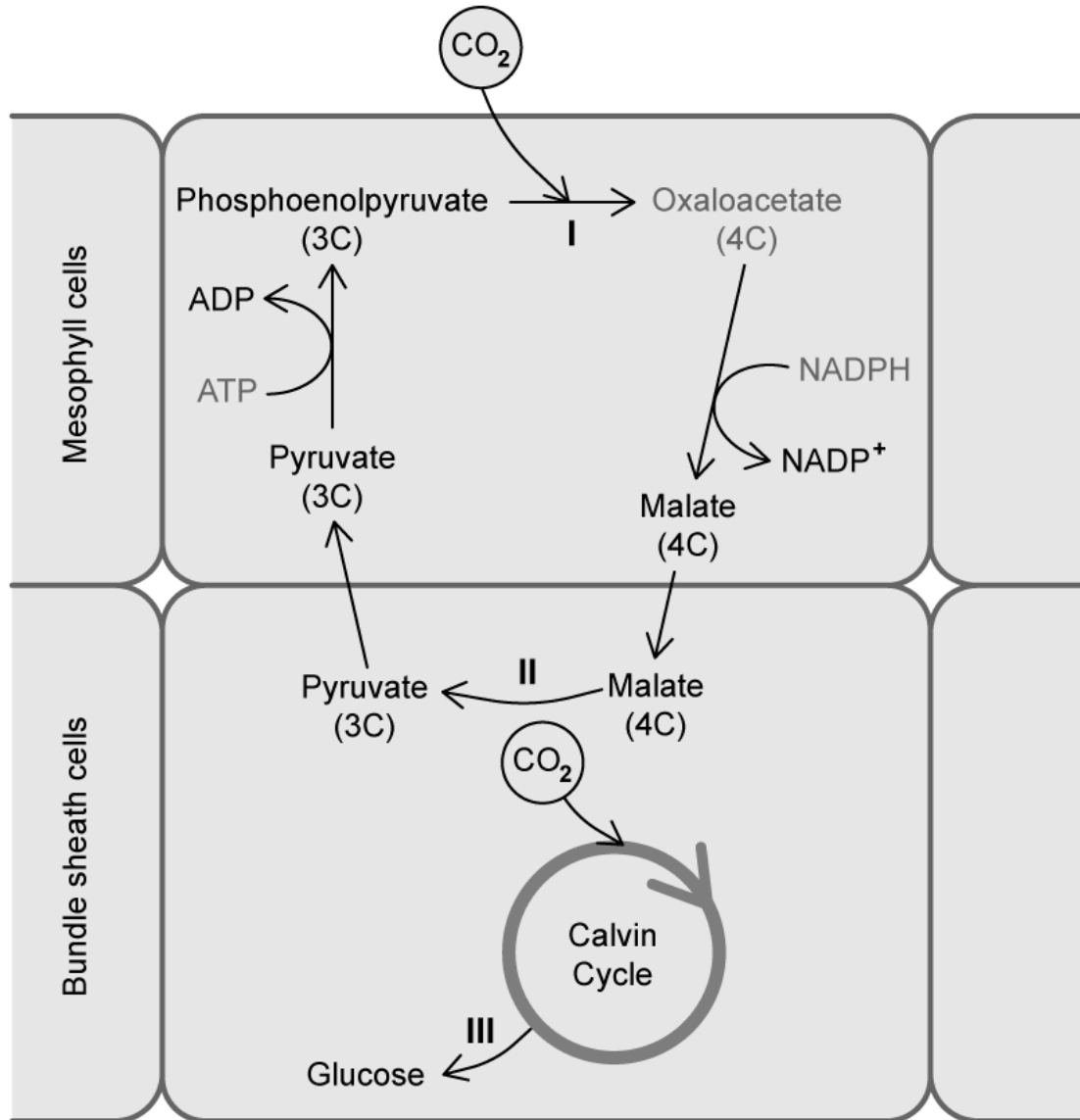
(4 marks)

(c) Explain how certain biological molecules are hydrophilic, some are hydrophobic and others are amphipathic. Use named molecules as examples in your answer.

(4 marks)

Hard Questions

1 (a) Suggest, with a reason, which label (I, II, or III) indicates a catabolic reaction.



(2 marks)

(b) The diagram in part (a) illustrates how life is based on certain biochemical compounds.

Identify which major group of carbon-containing compounds is dominant in this diagram.

.....
(1 mark)

(c) Fats and cholesterol are essential to structures and functions in the bodies of animals and therefore need to be transported in blood.

Discuss how these molecules are transported.

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.....
(3 marks)

(d) Draw a labelled diagram of a generalised amino acid.

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.....
.....
.....
(4 marks)

2 (a) Eastern collared lizards and pigs are two examples of animals that pant to keep cool.

Suggest how panting helps these animals to cool down.

(2 marks)

(b) Methane is a product of the incomplete breakdown of dead organic matter. Methane can be seen bubbling out of the water in volcanic springs.

Explain why, once methane has been produced, it bubbles off the water.

(2 marks)

(c) Draw a labelled diagram showing cohesive forces between three water molecules.

(3 marks)

3 (a) Outline the significance of the surface tension of water to living organisms.

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(2 marks)

(b) Using your knowledge of the properties of water, explain why dilute aqueous solutions (eg. glucose solution) are clear.

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(2 marks)

(c) Explain the relationship between the osmolarity of a solution and its water potential.

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(3 marks)

(d) Explain how water's high specific heat capacity helps to keep environmental conditions constant for organisms.

.....

.....

(2 marks)

4 (a) Water exists in all three of its physical states in Nature.

Give an example of each physical state of water that exists in Nature and how it affects organisms and ecosystems.

(6 marks)

(b) Compare and contrast the properties of methane and water.

(2 marks)

(c) Explain why a methane molecule (CH_4) forms a tetrahedral shape.

(2 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Multiple pieces of evidence are required for scientists to falsify theories.

Discuss the evidence that scientists used to falsify the theory of vitalism.

(3 marks)

(b) Deamination (the removal of an amino group from a molecule) and gluconeogenesis (the production of glucose from non-carbohydrate sources) are two reactions that occur in the liver.

From the information given, suggest with reasons, which metabolic reactions these are classified as.

(4 marks)

(c) Explain the properties of water that are key for the survival of an oak tree.

(8 marks)