

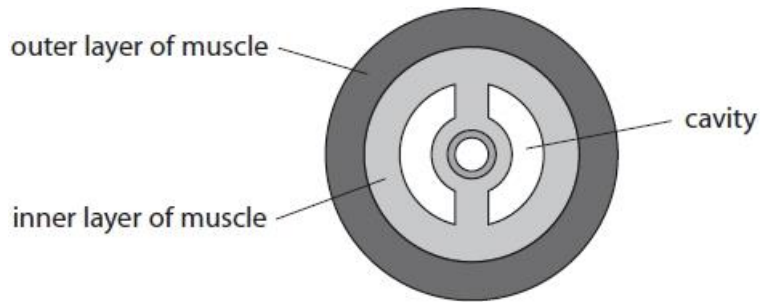
Questions

Q1.

Some animals, such as earthworms, have a hydrostatic skeleton.

A hydrostatic skeleton consists of a cavity filled with a water-based fluid, surrounded by two layers of muscle.

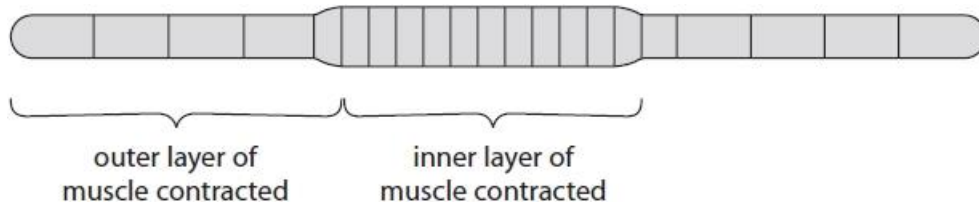
The diagram shows a section through an earthworm.



When the outer layer of muscle contracts in one section of the earthworm, this section becomes longer.

When the inner layer of muscle contracts in one section of the earthworm, this section becomes shorter.

The diagram shows the shape of an earthworm when each layer of muscle contracts.



Explain how the dipole nature of water enables the muscle layers to push against the fluid in the cavity and change the shape of the earthworm.

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(Total for question = 3 marks)

Q2.

A student planned to keep two species of fish in an aquarium.

One species of fish should be kept at a minimum temperature of 25 °C. The other species requires a minimum concentration of oxygen of 7.5 mg dm⁻³ water.

Explain why the student chose to keep these two species of fish in an aquarium at 30 °C.

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(Total for question = 4 marks)

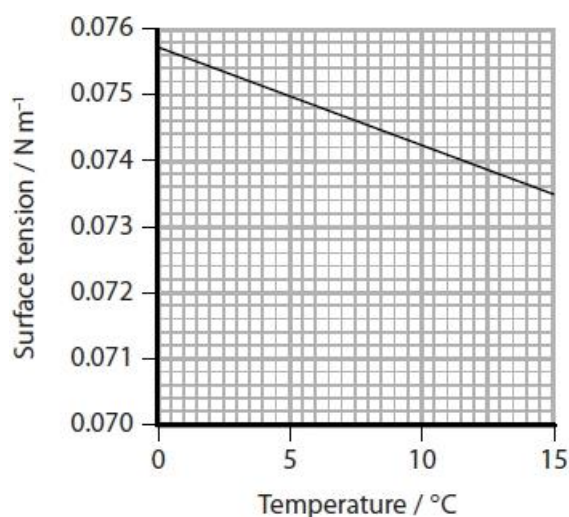
Q3.

Pond skaters are insects. They can move on the surface of water due to the high surface tension of water.

The photograph shows four pond skaters on the surface of water.



The graph shows the effect of temperature on the surface tension of water.



A pond skater has a mass of 0.02 g and has a length of 20 mm in contact with the surface of the water.

The force that this pond skater exerts on the surface of the water can be calculated using the equation:

$$\text{force in newtons} = \text{mass in kilograms} \times 9.8$$

(i) Calculate the force exerted by the pond skater for each millimetre length of contact with the surface of the water.

Give your answer in standard form.

(3)

Answer

(ii) This pond skater can stay on the surface of water even on a hot day in summer.

Use your calculated value and the graph to explain why this pond skater can stay on the surface of water.

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(Total for question = 6 marks)

Q4.

Answer the questions with a cross in the boxes you think are correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Acute respiratory distress syndrome (ARDS) is a condition that can occur in babies.

In ARDS, cells in the alveoli do not produce enough of a substance called surfactant.

The alveoli cannot expand sufficiently when the baby inhales.

The diagram shows the alveoli of a baby with ARDS and the alveoli of an unaffected baby.



Alveoli of a baby with ARDS



Alveoli of an unaffected baby

The surfactant in the alveoli reduces the surface tension of water.

(i) Which bond is responsible for the cohesive forces between water molecules that contribute to the surface tension of water?

(1)

- A covalent
- B ionic
- C hydrogen
- D hydrophobic

(ii) Surfactant contains phospholipid molecules.

How many of the following components are found in phospholipids?

(1)

- 1 amino acids
- 2 fatty acids
- 3 glycerol
- 4 phosphate

- A one
- B two
- C three
- D four

(Total for question = 2 marks)

Q5.

The photograph shows a wombat, an animal that lives in dry parts of Australia.



Source: © Blue Gum Pictures/Alamy Stock Photo

Wombats are herbivores, feeding on grasses, leaves and bark. Wombats also dig in the soil for roots.

They have behavioural and physiological adaptations to survive periods of severe drought.

The effect of drought on the health of wild wombats was investigated.

Changes in body mass, body condition and the chemical constituents of stomach contents and faeces were recorded.

These changes were related to the changes in the quality and quantity of the food of wombats.

Explain why drought affects the quality and quantity of the food of wombats.

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(Total for question = 5 marks)

Q6.

Leeches are parasites that feed by sucking blood. When they bite, they secrete saliva into the wound. The saliva contains a globular protein called hirudin.

Explain why this protein is soluble in water.

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(Total for question = 3 marks)

Q7.

Pond skaters are insects. They can move on the surface of water due to the high surface tension of water.

The photograph shows four pond skaters on the surface of water.



Explain how the properties of water molecules result in surface tension.

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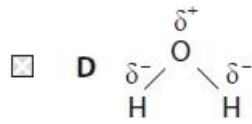
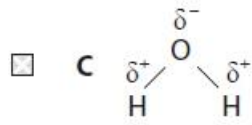
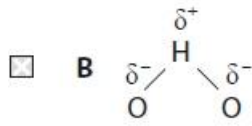
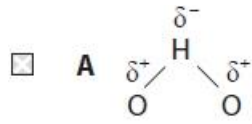
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(Total for question = 3 marks)

Q8.

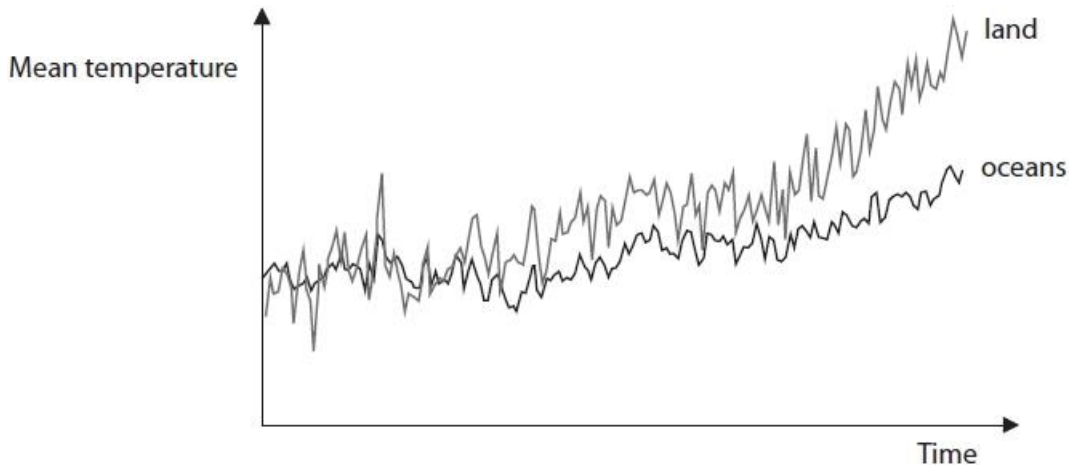
The dipole nature of water gives this molecule properties that are important for living organisms.

Which diagram shows the dipole nature of water?

(1)**(Total for question = 1 mark)**

Q9.

The graph shows the mean temperatures of land and oceans over a period of 70 years.



(i) Explain how the dipole nature of water results in the mean temperature change of the oceans, over the 70 years, being less than that of the land.

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(ii) Explain the importance of this lower change in mean temperature to organisms, such as fish, that live in the oceans.

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(Total for question = 4 marks)

Q10.

Transpiration moves water and mineral ions from the roots to the leaves of plants.

Explain how transpiration depends on the dipole nature of water.

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(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> because water molecules are tightly bonded together (1) by hydrogen bonds (1) so water is incompressible (1) shape of body changes because {pressure increases / volume does not increase} (1) 	<p>ACCEPT water molecules are close together / strong cohesive forces DO NOT ACCEPT adhesive forces</p> <p>ACCEPT so the water molecules cannot be pushed closer together</p>	(3) EXP

Q2.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> because 30 °C is an appropriate temperature for one species and provides enough oxygen for the other species (1) because if the temperature was above {30 / 40} °C there would be less oxygen dissolved in it (1) so there would not be enough oxygen for {respiration / metabolism / ATP production} (1) because if the temperature was above {25 / 30} °C the enzymes would be denaturing (1) because the temperature was below {25 / 30} °C the enzymes would not have enough {kinetic energy / collisions / enzyme substrate complexes} (1) 	<p>Accept because 30 °C satisfies the requirements of both fish</p> <p>Do not accept start to denature</p> <p>Accept for 1 mark 30 °C is close to the optimum temperature for the enzymes</p>	(4)

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	<ul style="list-style-type: none"> the correct calculation of force (1) division by 20mm or multiplied by 50 (1) answer expressed correctly in standard form with suitable units (1) 	<p><u>Example of calculation</u> $0.00002 \times 9.8 = 0.000196$</p> <p>$0.000196 \div 20 = 0.0000098 \text{ (Nmm}^{-1}\text{)}$ $0.000196 \times 20 = 0.00392 \text{ (Nm}^{-1}\text{)}$ Allow ECF from calculation of force</p> <p>Correct answer with units scores all 3 marks $9.8 \times 10^{-6} \text{ Nmm}^{-1}$ $9.8 \times 10^{-3} \text{ Nm}^{-1}$</p> <p>Allow $9.8 \times 10^{-6} \text{ N}$ Correct answer but incorrect units or no units scores 2 marks</p>	(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> the surface tension is above $0.070 \text{ (Nm}^{-1}\text{)}$ (1) which is greater than the force exerted by the pond skater (1) even if temperatures were hotter (than 15°C) the surface tension of water would still be greater (1) 	<p>Allow figure between 0.070 and 0.074 for interpretation of warm day</p> <p>Consequential error from part (i)</p>	(3)

Q4.

Question Number	Answer	Mark
(i)	The only correct answer is C hydrogen <i>A is incorrect because covalent bonds do not form between neighbouring water molecules</i> <i>B is incorrect because ionic bonds do not form between neighbouring water molecules</i> <i>D is not correct because hydrophobic bonds do not form between neighbouring water molecules</i>	1

Question Number	Answer	Mark
(ii)	The only correct answer is C three <i>A is incorrect because there are three components</i> <i>B is incorrect because there are three components</i> <i>D is incorrect because amino acids are not a component</i>	1

Q5.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to five of the following:</p> <ul style="list-style-type: none"> because there would be less water to take up from the soil (1) therefore there will be fewer {mineral ions / minerals} (transported to the rest of the plant / taken up) (1) example of a mineral ion deficiency on the plant explained (1) there will be less water for {photolysis / light-dependent reaction / photosynthesis} (1) therefore there will be less GALP produced in the {light-independent reaction / Calvin cycle} (1) therefore less {NPP / plant biomass} (1) 	<p>ACCEPT plants will {wilt / die} without water</p> <p>ACCEPT less glucose produced</p>	(5)

Q6.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> • this protein is folded so that hydrophilic groups are on the outside (and hydrophobic on the inside) (1) • these exposed R groups are { polar / ionic } (1) • therefore they form hydrogen bonds with water (1) • because water is a polar solvent (1) 	<p>accept description of dipolar nature of water / ability to form hydrogen bonds with {charged / polar} molecules</p>	(3)

Q7.

Question Number	Acceptable Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • water molecules are polar (1) <p>Any two from the following:</p> <ul style="list-style-type: none"> • therefore form hydrogen bonds (1) • therefore are cohesive (1) • which results in a (net) inward force at its surface (1) 	<p>Allow dipolar Allow description hydrogen slightly positive and oxygen slightly negative Reject hydrogen positive or oxygen negative</p> <p>IGNORE adhesion</p> <p>Allow description e.g. at air water interface more hydrogen bonding is into the water</p>	(3)

Q8.

Question Number	Answer	Additional Guidance	Mark
	<p>The only correct answer is C</p> <p><i>A is incorrect because water is H₂O</i> <i>B is incorrect because water is H₂O</i> <i>D is incorrect because the H has the slightly positive charge and O has the slightly negative charge</i></p>		(1) COMP

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> because water forms (many) hydrogen bonds (1) (which gives it a) high specific heat capacity (1) so the temperature of the water rises less than the temperature of the land for the same input of energy (1) 	<p>ACCEPT H bonds / strong cohesive forces / very cohesive</p> <p>ACCEPT a lot of energy needed to raise temperature of water</p> <p>NB a lot of energy needed to break the H bonds to raise temperature of water = 2 marks (p 1 and 3)</p>	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(ii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> because the (body) temperature of a fish {fluctuates with {external / water / ocean} temperature / cannot be regulated} (1) need appropriate (body) temperature for {enzyme activity / metabolism} (1) if temperature increased there would be less oxygen (dissolved) in the water for the fish (1) 	<p>ACCEPT organisms for fish throughout</p> <p>ACCEPT cold-blooded / poikilothermic helps keep fish' temperature constant</p> <p>ACCEPT temperature change could denature enzymes</p> <p>ACCEPT constant temperature maintains levels of prey for the fish</p>	(2) EXP

Q10.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the three of the following:</p> <ul style="list-style-type: none"> • water has a (small) positively charged {hydrogen / end} and a (small) negatively charged {oxygen / end} (1) • therefore hydrogen bonds form (between water molecules) (1) • therefore water moved due to {cohesion / cohesive forces} (between water molecules) (1) • (because of) {adhesion / adhesive forces} between water and xylem (1) 	<p>ACCEPT cohesive properties</p> <p>ACCEPT adhesive properties</p> <p>water moves due to adhesive and cohesive forces =1 mark if no other mark awarded</p>	(3)