



bio letters

A1.1 Topical Questions Markscheme

Biology

Standard and Higher level

Paper 2

Question			Answers	Total
1.	a		polar covalent bonds form due to unequal sharing of electrons between atoms	1
1.	b		a. hydrogen bonds are a specific type of intermolecular attraction that occurs between a δ^+ hydrogen in one molecule & a δ^- oxygen or δ^- nitrogen in a different molecule b. in water, the oxygen atom strongly pulls electrons away from hydrogen, resulting in a particularly strong polar covalent bond with a strong δ^- on oxygen & strong δ^+ on hydrogen c. the strong O–H polar covalent bond results in strong intermolecular attractions between water molecules (i.e. hydrogen bonds)	2
1.	c		[1] mark for correct structure of <u>both</u> water molecules (bent) [1] mark for correct hydrogen bonding (dashed) [1] mark for correct hydrogen bonding (between O and H) [1] mark for correct partial charges on <u>both</u> water molecules	4

Question			Answers	Total
2.	a		a. cohesion occurs when water molecules attract each other by <u>hydrogen bonding</u> (do not accept “intermolecular forces” because the question specifically mentioned cohesion of water molecules) b. adhesion occurs when water molecules attract different molecules by intermolecular forces or hydrogen bonding	1
2.	b		a. surface tension is the tendency of a liquid’s surface to resist rupture against an external force b. water molecules at the surface of liquid water form hydrogen bonds with each other c. since they have fewer neighboring water molecules to hydrogen bond with (because they are exposed to air on one side), they will form stronger hydrogen bonds with nearby water molecules d. the resultant surface tension allows water to support the movement of some organisms on its surface like basilisk lizards & water striders	2

Question			Answers	Total
2.	c		a. transpiration transports water up xylem vessels under tension (negative pressure) b. the water stream moving upwards is continuous due to cohesion between water molecules (it does not break under tension) c. water molecules are attracted to the polar inner walls of xylem vessels, so they adhere (stick) to these narrow walls during transpiration d. adhesion prevents the water column from slipping downwards when the rate of transpiration decreases at night (when stomata are closed)	2
2.	d		a. hydrophobic molecules do not form interactions with water (i.e. do not dissolve) and instead associate with other hydrophobic molecules b. association of hydrophobic molecules with each other drives the formation of barriers like the phospholipid bilayer, which allows for compartmentalization c. association of hydrophobic molecules can also protect organisms from losing water, for example waxy cuticles on plant leaves d. association of hydrophobic molecules enables quick chemical signalling by steroid hormones in animals Accept other valid biological examples of the role of hydrophobic molecules.	3

Question			Answers	Total
3.	a		Goldilocks zone is the region around a star (e.g. sun) where a planet's surface temperature allows for liquid water to exist on its surface	1
3.	b		a. water is the universal medium for life because the first cells originated in aqueous media b. it is thus intuitive to search for extraterrestrial life where liquid water can exist	2
3.	c		a. the strong gravitational field of Earth prevents most of the water from escaping into space b. temperatures on Earth allow water to be condensed to a liquid, which due to hydrogen bonding is much easier to retain than water vapor inside Earth's atmosphere	2

Question			Answers	Total
4.	a		a. cohesion occurs when molecules of the same kind attract each other by intermolecular forces b. water exemplifies strong cohesion due to hydrogen bonding, which has consequences for organisms c. surface tension is the tendency of a liquid's surface to resist rupture against an external force d. water molecules at the surface of liquid water form hydrogen bonds with each other e. since they have fewer neighboring water molecules to hydrogen bond with (because they are exposed to air on one side), they will form stronger hydrogen bonds with nearby water molecules f. the resultant surface tension allows water to support the movement of some organisms on its surface like basilisk lizards & water striders g. transpiration transports water up xylem vessels under tension (negative pressure) h. the water stream moving upwards is continuous due to cohesion between water molecules (it does not break under tension)	4
4.	b		a. adhesion occurs when molecules of a different kind attract each other by intermolecular forces b. water exemplifies adhesion due to hydrogen bonding, which impacts capillary action c. capillary action is the movement of fluid through narrow or porous spaces against gravity d. water molecules are attracted to the polar inner walls of xylem vessels, so they adhere (stick) to these narrow walls during transpiration e. this prevents the water column from slipping downwards when the rate of transpiration decreases at night (when stomata are closed) f. soil is porous because it contains charged particles within many narrow gaps g. water is attracted to these charged particles which helps it stick to the soil against the pull of gravity, creating soil moisture for plant root access	4

Question			Answers	Total
4.	c		Opportunities: a. buoyancy supports organisms against gravity b. high specific heat capacity creates stable habitats c. cohesion of water molecules creates water surfaces as habitats d. cohesion of water molecules enables transport in organisms e. adhesion of water molecules enables capillary action in plant transport f. adhesion of water molecules enables capillary action in soil g. polarity creates biological opportunities for polar and non-polar molecules Challenges: h. high water viscosity requires specific adaptations to reduce drag i. high specific heat capacity increases heat loss j. high thermal conductance increases heat loss	7

Question			Answers	Total
5.	a		Black throated loon: a. the bird relies on water buoyancy to stay afloat at the surface b. the bird's webbed feet and streamlined body helps it overcome water's viscosity c. the bird has oil glands that reduce the amount of heat lost by conduction to water d. the temperature of the water remains relatively stable when the air is cool due to its high specific heat capacity, which enables the bird to continue living within its range of tolerance Ringed seal: e. the seal is buoyant enough to keep its snout above water in order to breathe air f. the seal's paddle-like feet and streamlined body help it overcome water's viscosity g. the seal has thick blubber (fatty layer) which reduces heat lost to the water h. the relative stability of water temperature due to its high specific heat capacity enables the seal to continue living within its range of tolerance	7

Question			Answers	Total										
5.	b		<table><tr><th>Water</th><th>Air</th></tr><tr><td>Buoyancy significantly offsets weight, letting organisms float more easily.</td><td>Buoyancy is negligible so organisms need to generate lift (i.e. by wings) to stay aloft.</td></tr><tr><td>Organisms moving through water experience more resistance than in air since water is more viscous.</td><td>Organisms moving through air experience less drag than through water since air is less viscous.</td></tr><tr><td>Water has a higher thermal conductivity.</td><td>Air has a lower thermal conductivity compared to water.</td></tr><tr><td>Water has a higher specific heat capacity compared to air.</td><td>Air has a lower specific heat capacity compared to water.</td></tr></table>	Water	Air	Buoyancy significantly offsets weight, letting organisms float more easily.	Buoyancy is negligible so organisms need to generate lift (i.e. by wings) to stay aloft.	Organisms moving through water experience more resistance than in air since water is more viscous.	Organisms moving through air experience less drag than through water since air is less viscous.	Water has a higher thermal conductivity.	Air has a lower thermal conductivity compared to water.	Water has a higher specific heat capacity compared to air.	Air has a lower specific heat capacity compared to water.	4
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5.	c		a. water is polar so it interacts with and dissolves ions and polar molecules b. this keeps metabolic reactants dissolved in aqueous media within cells c. dissolved molecules can move freely and collide with one another, increasing opportunities for reactions to occur d. most enzymes catalyse reactions in aqueous solution, so water provides the medium in which enzyme-controlled metabolism occurs	4										