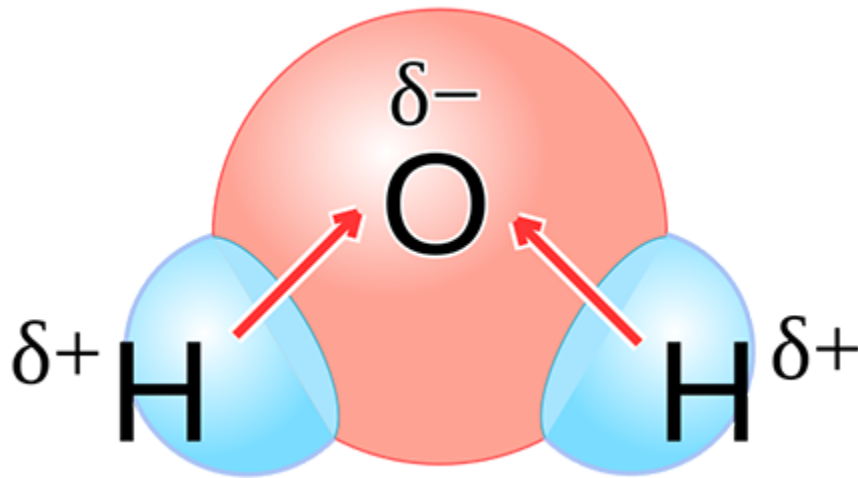


Year 12 HL

IB BIOLOGY

A1.1 Water



Name:

Teacher: Mr Trent

A1.1 Water

Understandings:

A1.1.1—Water as the medium for life

A1.1.2—Hydrogen bonds as a consequence of the polar covalent bonds within water molecules

A1.1.3—Cohesion of water molecules due to hydrogen bonding and consequences for organisms

A1.1.4—Adhesion of water to materials that are polar or charged and impacts for organisms

A1.1.5—Solvent properties of water linked to its role as a medium for metabolism and for transport in plants and animals

A1.1.6—Physical properties of water and the consequences for animals in aquatic habitats

A1.1.7—Extraterrestrial origin of water on Earth and reasons for its retention

A1.1.8—Relationship between the search for extraterrestrial life and the presence of water

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The Properties of Water

c	d	n	s	e	s	o	c	u	l	g	y	h	p	n
a	i	o	o	i	n	o	i	i	h	c	e	o	o	n
p	p	i	l	o	t	o	p	y	n	a	l	i	o	c
i	o	s	v	n	p	i	d	e	t	a	s	i	c	i
l	l	e	e	s	d	r	r	c	r	n	t	n	i	b
l	a	h	n	s	o	a	a	m	e	a	t	o	l	o
a	r	o	t	g	p	p	o	t	r	e	h	i	i	h
r	i	c	e	s	a	l	e	o	b	v	e	s	h	p
y	t	n	n	c	e	c	p	d	o	i	r	e	p	o
a	y	a	i	c	a	a	n	e	n	t	m	h	o	r
c	r	t	u	f	v	s	i	b	d	i	a	d	r	d
t	y	l	r	e	t	a	e	w	s	s	l	a	d	y
i	e	u	s	e	i	t	r	e	p	o	r	p	y	h
o	s	c	o	o	l	a	n	t	s	p	l	i	h	g
n	n	e	l	a	e	s	u	c	s	i	n	e	m	s

Significance of Water Observation Lab

It has been said that “the chemistry of life is water chemistry.” Because of its chemical properties, water is the medium in which most of life’s chemical reactions occur. Life first evolved in water, it resided there exclusively for three billion years, most life is now concentrated in water-rich areas, and the cells of organisms are about 70 to 90 percent water.

Because of its polarity, water molecules attract to each other forming hydrogen bonds. This attraction of like molecules is called cohesion. Because water is cohesive, it remains liquid at normal temperatures over much of the Earth. Cohesion allows water to move up a plant stem and it results in the tension that allows some organisms to live on the surface of water. Water’s polarity results in many important characteristics, such as adhesion, high heat capacity, and versatility as a solvent.

Rotate through the lab stations and perform the activities outlined below. Then, complete the table. Try to use the keywords you found in the wordsearch to help you write your responses.

Station Number and Activity	Observations (include a diagram where appropriate)	Explanation (why does this happen?)
1. Build water molecules and identify how many hydrogen bonds each water molecule can form.		
2. Can you make a staple and a paper clip float on water?		
3. How many drops of water can you put on a penny?		
4. Sprinkle powder on the surface of water in a beaker. Touch the surface with a bar of soap.		
5. Mix a spatula of salt with some water in a test tube.		
6. Mix 1ml of water with 1ml of oil and shake. Record your observations.		
7. Put a drop of water and a drop of propanone on your hand.		
8. Add an ice cube to a beaker of water.		
9. Make water move against gravity in a capillary tube.		

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The significance of water in living things

Use the links below to complete the section below.

<https://www.youtube.com/watch?v=ASLUY2U1M-8>

<https://www.khanacademy.org/science/ap-biology/chemistry-of-life/structure-of-water-and-hydrogen-bonding/v/importance-of-water-for-life>

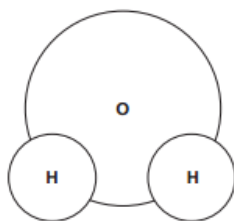
<https://www.khanacademy.org/science/ap-biology/chemistry-of-life/structure-of-water-and-hydrogen-bonding/a/hs-water-and-life-review>

Adhesion		the intermolecular hydrogen bonds between molecules of water at the surface.
Surface tension		hydrogen
partial positive charge in water		attraction between molecules of different substances
cohesion		a liquid or gas that is used to remove heat from something
covalent bond		attraction between molecules of the same substance
coolant		a chemical bond that involves sharing a pair of electrons between atoms in a molecule
polar		water loving
Hydrophilic		oxygen
Hydrophobic		Water fearing
partial negative charge in water		describes a molecule in which the positive and negative charges are separated
High specific heat capacity		Allowing light to pass through
transparent		considerable amounts of heat energy are needed to evaporate water because hydrogen bonds have to be broken
High latent heat of vaporization		Water requires a lot of energy to change temperature

Answer these questions:

1. Why is water a good solvent?
2. What kinds of substances besides water can be involved in hydrogen bonding?
3. What property of water allows it to stick to a dry surface, such as a wooden countertop?
4. How does water help cells keep an even temperature despite temperature changes in the environment?
5. Explain why water forms large, round drops as it falls from a tap with a slow leak.
6. Water is often called the universal solvent because it dissolves most substances that are important to living things. What does this suggest about the properties of those substances?

The diagram below represents a water molecule. Draw 3 more water molecules and used dotted lines to indicate where hydrogen bonds would form between the molecules.



Ringed seal (*Pusa hispida*)



- **Habitat:** Ringed seals are found in the Arctic and sub-Arctic regions of the Northern Hemisphere. They inhabit a variety of icy habitats, including pack ice, fast ice, and areas near the ice edge.
- **Appearance:** Ringed seals are small to medium-sized seals, with adult males typically weighing between 100 and 150 kg (220 to 330 lbs), while females are slightly smaller. They have a sleek, elongated body and are well-adapted for life in icy environments. One of their distinctive features is the dark rings, or "rings," that mark their fur, which gives them their name.
- **Diet:** These seals are primarily carnivorous and mainly feed on a variety of small fish, such as Arctic cod, herring, and smelt. They also consume crustaceans, such as shrimp and amphipods, as well as other invertebrates.
- **Breeding:** Ringed seals have a unique reproductive strategy. They give birth and nurse their pups on sea ice. They create lairs by excavating snow caves on top of the ice, providing shelter for their young. The average gestation period is around 9 to 11 months, and typically, one pup is born per breeding season.
- **Conservation Status:** The global population of Ringed seals is considered stable, and they are not currently listed as endangered. However, they face several threats due to climate change, including habitat loss, reduced sea ice availability, and increased predation from polar bears.
- **Adaptations:** Ringed seals have several adaptations that enable them to thrive in icy environments. They have a thick layer of blubber for insulation and buoyancy. Their nostrils are equipped with muscular flaps that can close tightly, allowing them to breathe while swimming under the ice. They also have strong claws that aid in digging and maintaining breathing holes in the ice.



- **Underwater Abilities:** Ringed seals are well-adapted to life underwater. They can dive to significant depths and stay submerged for extended periods, often reaching depths of around 30 to 50 meters (98 to 164 feet) and staying underwater for up to 30 minutes.

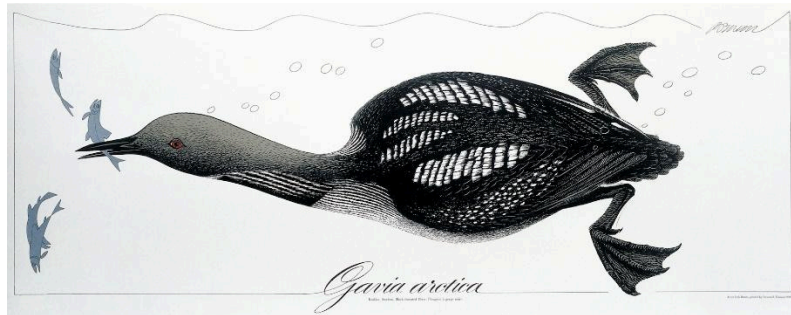
- **Communication:** Ringed seals use various vocalizations to communicate with each other. These include growls, trills, and underwater clicks,

which help them maintain social bonds and locate each other in the vast Arctic environment.

Black-throated loon (*Gavia arctica*)

Habitat: Black-throated Loons are found in the northern parts of Eurasia and North America. During the breeding season, they inhabit freshwater lakes, ponds, and tundra pools. In winter, they can be found in coastal marine environments, such as bays and estuaries.

Appearance: Black-throated Loons are large diving birds. They have a sleek and streamlined body with a black head, neck, and throat, which gives them their name. Their back and wings are dark gray, and their underparts are white. They have a sharp, pointed bill and red eyes. During the breeding season, their plumage becomes more vibrant.



Diet: These loons are piscivorous, meaning their diet primarily consists of fish. They dive underwater to catch their prey, which includes small to medium-sized fish, such as perch, trout, and sticklebacks. They may also consume crustaceans, insects, and amphibians.

Breeding: Black-throated Loons are monogamous and form pairs during the breeding season. They construct their nests near the water's edge, typically on islands or floating vegetation. The female lays one to three eggs, which are incubated by both parents for about 25 to 30 days. After hatching, the chicks are fed and cared for by both parents until they fledge at around 60 to 70 days old.

Vocalizations: Black-throated Loons are known for their haunting and eerie calls. They produce a variety of vocalizations, including wails, yodels, and tremolos. These calls serve as territorial displays, as well as a means of communication between mates and parents and offspring.

Diving Abilities: These birds are excellent divers and can swim underwater for extended periods. They use their wings and feet to propel themselves underwater, reaching depths of up to 60 meters (200 feet) in search of prey. They have specialized adaptations, such as dense bones and air sacs, that help with buoyancy and diving.

Migration: Black-throated Loons are long-distance migrants. In the northern breeding areas, they raise their young during the summer, and then they migrate to their wintering grounds in coastal marine areas. Some individuals travel long distances, moving from the Arctic to more temperate regions in Europe and North America.

Conservation Status: The global population of Black-throated Loons is relatively stable, and they are not currently considered threatened. However, they face certain threats, including habitat degradation, pollution,



and disturbance from human activities, as well as climate change impacts on their breeding and wintering grounds.

1. Blood is a water-based transport medium. Which property of water makes it a good transport medium?

- A. High specific heat
- B. Transparency
- C. Versatility as a solvent
- D. It has its greatest density at 4°C

(Total 1 mark)

2. Which of the following are connected by hydrogen bonds?

- A. Hydrogen to oxygen within a molecule of water
- B. Phosphate to sugar in a DNA molecule
- C. Base to sugar in a DNA molecule
- D. Hydrogen to oxygen between two different molecules of water

(Total 1 mark)

3. What is a difference between cohesion and adhesion?

- A. Only adhesion is involved in transpiration pull.
- B. Only cohesion is involved in the movement of water in soil.
- C. Only cohesion involves the interaction of water with soil mineral particles.
- D. Only adhesion involves the interaction of water with xylem.

(Total 1 mark)

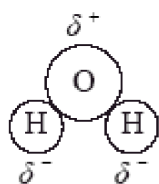
4. Which statement about water is correct?

- A. The atoms within a molecule of water are held together by hydrogen bonds.
- B. Water has a low heat capacity allowing enzymatic reactions to happen at a wide range of temperatures.
- C. Water molecules are polar, therefore fatty acids do not dissolve.
- D. Ice has a higher density than liquid water, therefore some organisms can live under the ice.

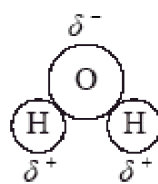
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5. Which diagram represents the polarity of a water molecule?

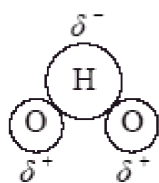
A.



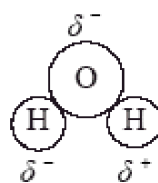
B.



C.



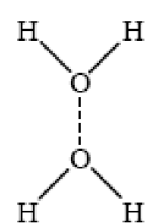
D.



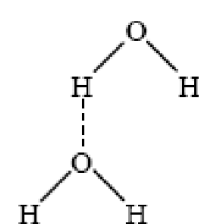
(Total 1 mark)

6. Which diagram best illustrates the interactions between water molecules?

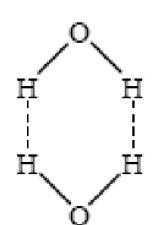
A.



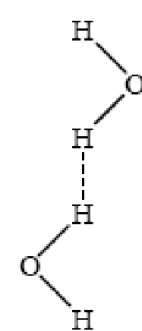
B.



C.



D.



(Total 1 mark)

7. Describe how the structure of a water molecule causes differences between the thermal properties of water and the similar sized molecule methane.

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| 1. | C | [1] |
| 2. | D | [1] |
| 3. | D | [1] |
| 4. | C | [1] |
| 5. | B | [1] |
| 6. | B | [1] |

7. water molecules are polar (whereas methane molecules are not);
(this causes in) hydrogen bonding between water molecules;
breaking (hydrogen bonds) needs/removes energy/heat;
water therefore remains a liquid at higher temperatures;
hydrogen bonds must break when water evaporates/vaporizes;
therefore water has a higher boiling point;
and resulting in a much higher specific heat capacity for water;
making water (unlike methane) a good coolant / another valid example; 5 max