

STUDY GUIDE - Ch. 3.2 Part 1 - Four emergent properties of water contribute to Earth's sustainability for life.

NAME: _____

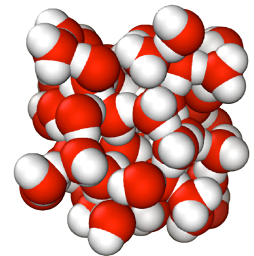
- **PHYSICALLY PRINT OUT** this PDF and **HANDWRITE** (with a black or blue pen) your answers directly on this PDF. Typed or digitally-written work is **not** be accepted. Do **not** answer questions on separate paper.
- **Importantly, study guides are NOT GROUP PROJECTS!!!** You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** AP essay readers and I will skip grading anything that cannot be easily read so start perfect your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** Avoid uploading dark, shaded, washed out, side ways, or upside down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** *First*, read a section quickly to get an overview of the topic covered. Then, read it a *second* time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a *third* time as you answer the study guide questions if assigned and to start building your memory. Try to write answers out in your own words when possible and to purposefully and accurately use all new terminology introduced.

1. What are the four **emergent properties of water** that help it contribute to Earth's fitness for life?

1. _____
2. _____
3. _____
4. _____

2. Describe the **behavior of water molecules when in a liquid state.**

Liquid Water



3. Define the term **cohesion.**

4. a. **The large amount of cohesion between water molecules results in liquid water exhibiting particularly high surface tension compared to many other liquids.** What is meant by the term **surface tension**?

b. Why does **water exhibit such high surface tension**?

5. Define the term **adhesion.**

6. a. *Think:* After it rained, you notice some water droplets hanging off a plank of wood. Given your understanding of water's properties and the fact that wood is made of cellulose, which is a polar substance, **describe the kinds of behavioral interactions taking place between the water molecules and water and cellulose molecules.**



- b. When it comes to water drops sticking to wood, **list the names of properties the water molecules are exhibiting** (cohesion, adhesion, and/or surface tension) and the **location these properties are witnessed.**

Properties Displayed By Water	Location Where Property of Water is Displayed

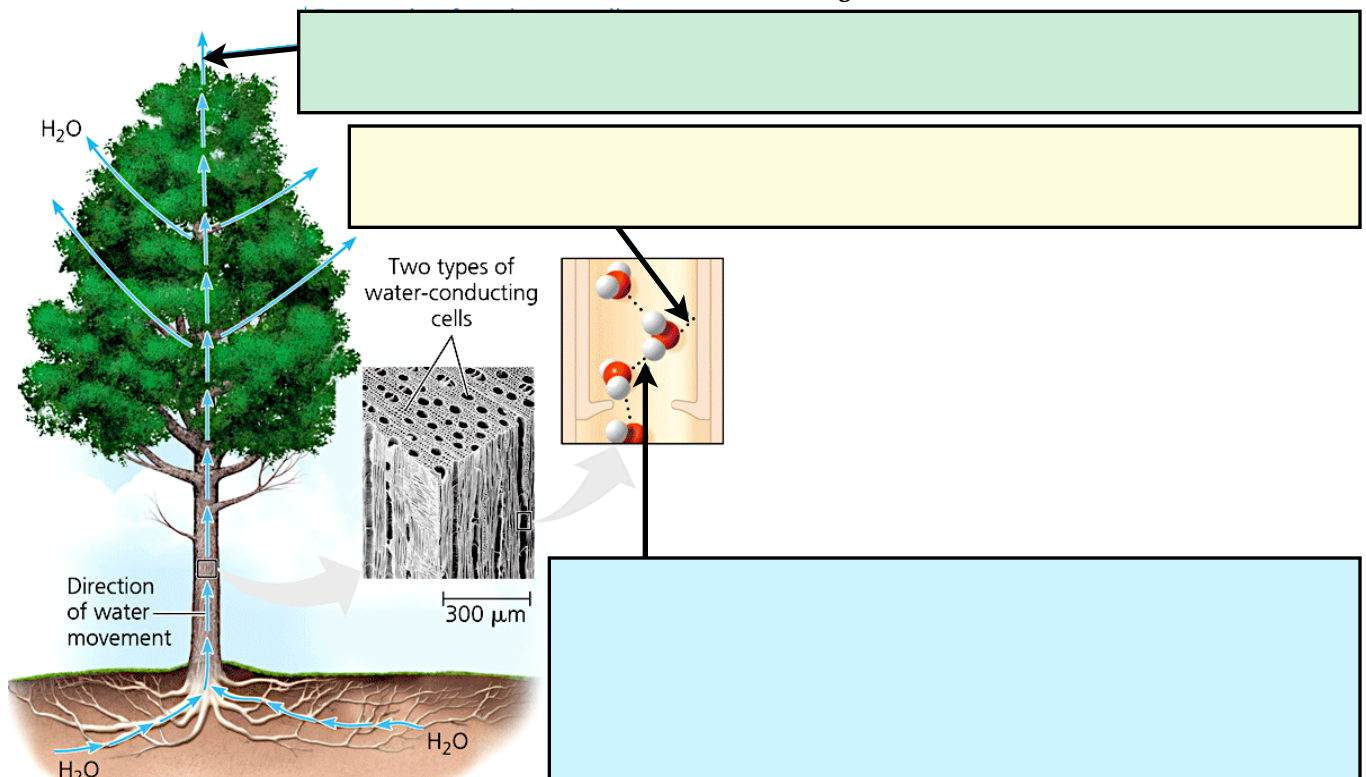
7. a. *Think:* Water striders' feet are coated in nonpolar molecules. Describe the **kinds of behavioral interactions taking place between the water molecules and the water and feet of the insect** that allow the strider to walk on water?



- b. When it comes to water strider walking on water, list **the names of properties the water molecules are exhibiting** (cohesion, adhesion, and/or surface tension) and the **location these properties are witnessed.**

Properties Displayed By Water	Location Where Property of Water is Displayed

8. After studying Figure 3.4, test your understanding by adding explaining **how plants use the properties of adhesion and cohesion to move water and dissolved ions - minerals - from roots through the shoots and to the leaves.**



9. Complete this quote from your textbook reading regarding **water's role in moderating temperature changes**:

“Water moderates air temperature by _____ from air that is warmer and _____ the _____ into air that is cooler. Water is effective as a heat bank because it can _____ or _____ a relatively **large** amount of _____ with only a **slight** change in its own _____”

10. **Thermal energy is a type of kinetic energy.** Distinguish between **kinetic energy** and **thermal energy**.

Kinetic Energy =

Thermal Energy =

11. Though related, **Thermal Energy** and **Temperature** are not interchangeable terms. Explain the difference.

Thermal Energy =

Temperature =

12. a. What does the term **HEAT** refer to?

b. **When and in what direction does heat transfer** between two objects or substances?

c. The **calorie and joule are units of heat**. Describe the term calorie further.

Water is able to **prevent large temperature fluctuations** both in the ecosystem as well as within the body and cells of organisms. Water can also help **cool organisms down** when body temperatures rise too high. *Let's see how water does so.*

13. **The temperature of water (in the external environment and in cells) doesn't change easily due to its high specific heat.** Water's **high specific heat** is also the reason water is able to minimize temperature changes in the nearby environment (air).

Define the term **Specific Heat**.

14. a. **Water has a high specific heat** compared to most other substances. What is the specific heat of water?

- b. Recall that water is a **polar molecule**, which causes certain interactions to emerge when many waters are found together. What **intermolecular interaction is responsible for the high specific heat of liquid water**?
- c. **Water is able to regulate ambient (air) temperatures because it can absorb and release a large amount of energy without changing temperature itself much. Therefore, a temperature gradient is maintained for a longer period of time between water and the outside air before temperature equilibrium is reached between the two substances, allowing for an extended period during which thermal energy (heat) can be transferred either into the water or out of the water. Because the specific heats of the gases in the air are so much smaller than that of water, additions and subtractions of thermal energy from the air cause large changes in the air temperature.**

Explain exactly why **when a lot of energy is absorbed by a body of water, the water's temperature only increases by a small amount?**

Explain exactly why **a high amount of heat is released from that body of water when water experiences a small decrease in temperature?**

15. What are **three reasons why water's high specific heat important to life?**

1. Benefit of Water's High Specific Heat to Terrestrial Ecosystems =

2. Benefit of Water's High Specific Heat to Aquatic Ecosystems =

3. Benefit of Water's High Specific Heat to the Cells/Bodies of Organisms =

16. a. *Let's see if you understand how water helps moderate ambient temperatures.* Analyze figure 3.5, noting the temperatures of L.A., Palm Springs, and the water of the Pacific Ocean. Why does air/atmosphere warmup when the summer sun rises for the day?

- b. Explain why L.A. and Palm Springs, despite being almost equal in latitude and the atmosphere in both locations receiving equal amount of solar radiation, do the air temperatures differ so greatly during a typical summer's day in August. **Make sure your answer clearly traces the DIRECTION of heat transfer and the RELATIVE AMOUNT of heat transfer as the day progresses in both locations, and WHY.**

Daytime in coastal L.A. =

Daytime in desert Palm Springs =

- c. Some deserts around the world can fluctuate greatly in daily temperatures. Temperatures in the Sahara, in North Africa, can drop an average of 75 degrees Fahrenheit at night, from an average high of 100 degrees Fahrenheit (38 degrees Celsius) during the day to an average low of 25 degrees Fahrenheit (minus 4 degrees Celsius) during the night (NASA). At night, the sun doesn't shine so radiant energy doesn't get absorbed by the atmosphere and the Earth's surface. Actually, thermal energy in the air transfers out to space instead, which of course leads to air temperatures cooling down. But this loss of heat to space isn't unique to the Sahara. When the sun goes down on a tropical beach of similar latitude as the Sahara, the sun stops shining too and thermal energy from the atmosphere is lost to space too, yet temperatures don't plummet to freezing levels. So, why does this dramatic temperature shift happen at night in arid (dry, low humidity) deserts like the Sahara but not on the tropical island? **Make sure your answer clearly traces the DIRECTION of heat transfer and the RELATIVE AMOUNT of heat transfer as the night progresses in both locations, and WHY.**

Nighttime in the Sahara Desert =

Nighttime on a Tropical Island =

17. a. What has to happen in order for a **molecule of water to escape from a body of liquid**, where it was initially, and **enter into the gas state**?
- b. Does the **vaporization (evaporation) of water molecules** in liquid water only happen when the liquid water is warmed up to water's boiling point? Explain.

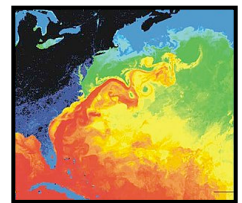
c. Why does heating up a liquid, cause its molecules to more quickly enter the gas phase?

18. Define the term **Heat of Vaporization**.

19. a. What is the **heat of vaporization of 1g of liquid water at 25°C?**

b. Using the knowledge you have learned so far from your chapter reading, explain **why water** (at the molecular level) **has such a relatively high heat of vaporization** compared to most other substances of equal molecular size?

20. The Gulf Stream is one example of a strong ocean current that brings warm water (heated by solar energy near the equator) from the Gulf of Mexico into the Atlantic Ocean. It extends all the way up the eastern coast of the United States and Canada. The Gulf Stream helps moderate temperatures on the East Coast of North America and West Coast of Europe. How does **water's high heat of vaporization help moderate Earth's climate?**



21. a. Based on the example of steam burns given in your text, is a **high amount of heat energy released or absorbed when steam condenses** (when water enters the liquid state after cooling down enough due to the water losing enough thermal energy)?

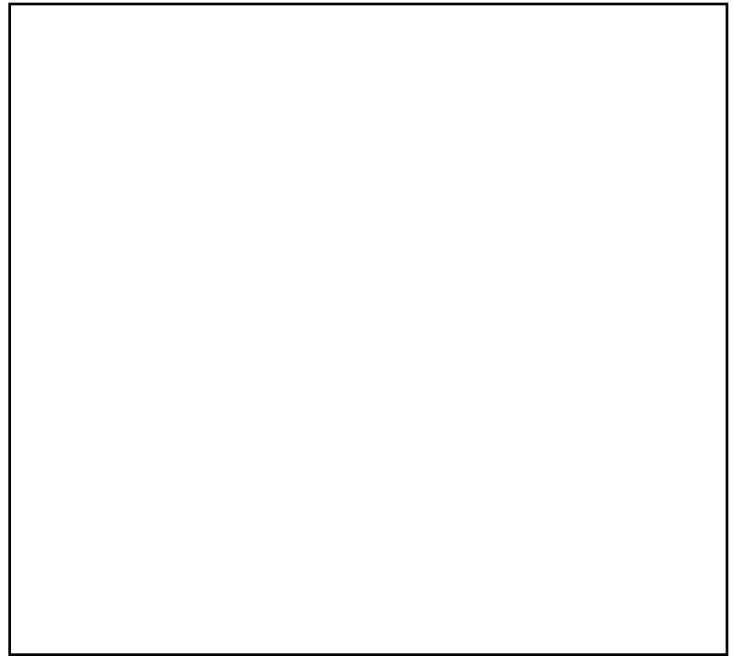
b. Based on your knowledge of water and phases of matter, what would you say is happening between water molecules in condensed water that was not able to happen often when water was in gas form at even higher temperatures?

22. **Evaporative Cooling** occurs when a layer of liquid evaporates from a surface of an object and the object (which could be anything from a large body of water like a pond to the body of an organism) **is left at a lower temperature than it was before. Why does evaporative cooling decrease the temperature of an object?**

23. *Think:* Water is especially good to use for Evaporative Cooling. How does **water's effective use in Evaporative Cooling depend on the high heat of vaporization of liquid water?**

24. Plants have pores, called **stomates**, in their leaves that allow water to evaporate. Earlier in this chapter, you learned that **plants use the transpiration (evaporation) of water from leaves to cause the movement of water (and therefore any ions - minerals - dissolved in this water) up from the soil to the leaves, allowing cells along the way to access these needed water and minerals.** What other benefit might the plant gain by allowing water to evaporate from leaves (as long as there is enough water in the soil to replace the water being lost by the leaves)?

25. a. As a person sits in the hot summer sun, the thermal energy in their body increases and their body temperature begins rising. If body temperature increases too much, it could prove damaging to the organism so the body will try to cool itself back down. In the space on the left below, discuss the step-by-step **transfer of thermal energy AND the subsequent consequence to body temperature** when a human starts sweating after sitting in the summer sun for long enough. *Include in the box a labeled drawing to accompany your explanation, in which you use arrows to indicate the movement of thermal energy (heat) from the person, into the sweat, and into the water vapor.*



b. High humidity on a hot day increases our discomfort. It's often said that "it's not the heat, it's the humidity." Explain the biology behind this saying and **how humidity affects our ability to effectively cool our body down using evaporative cooling.** *(Check your answers by going to the Ch.3.2 **Concept Check Question #2** in Appendix A of your textbook)*