

STUDY GUIDE - Ch. 3.2 Part 2 - 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. a. Complete this quote from your textbook reading regarding **water's density as a solid versus a liquid.**

"While other materials _____ and become _____ when they solidify, **water** _____ !"

b. What intermolecular interaction is the **cause of this unusual behavior of water molecules?**

2. a. In what **phase of matter** (solid, liquid, or gas) **is water most dense?**

b. At what **temperature is water the most dense?**

c. In what **phase of matter** would you say given your experience with ice, liquid water, and steam/water vapor, **is water the least dense?**

3. Explain how and why the **density of water is different as its temperature is changed from 40°C to 4°C to 0°C.** by expanding on the topics listed below.

Water at 40°C

- Describe the relative locations and movement of water molecules
- Describe the amount and duration of hydrogen bonds between water molecules

Water at 4°C

- Describe the relative locations and movement of water molecules

- Describe the amount and duration of hydrogen bonds between water molecules

Water at 0°C

- Describe the relative locations and movement of water molecules
- Describe the amount and duration of hydrogen bonds between water molecules

4. How much less dense is ice than liquid water at 4°C?

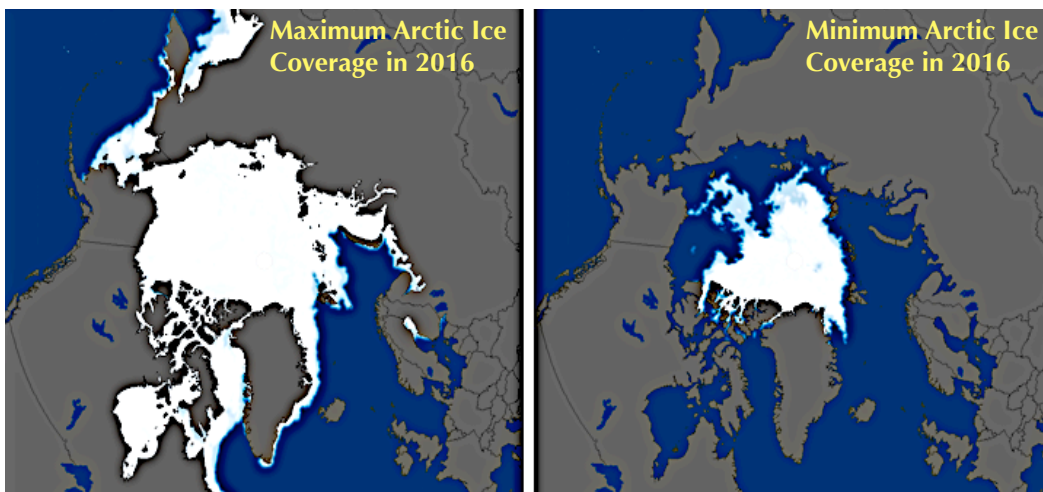
5. Explain how the freezing of liquid water in the ground can crack boulders. *(Check your answers by going to the Ch.3.2 Concept Check Question #3 in Appendix A of your textbook)*

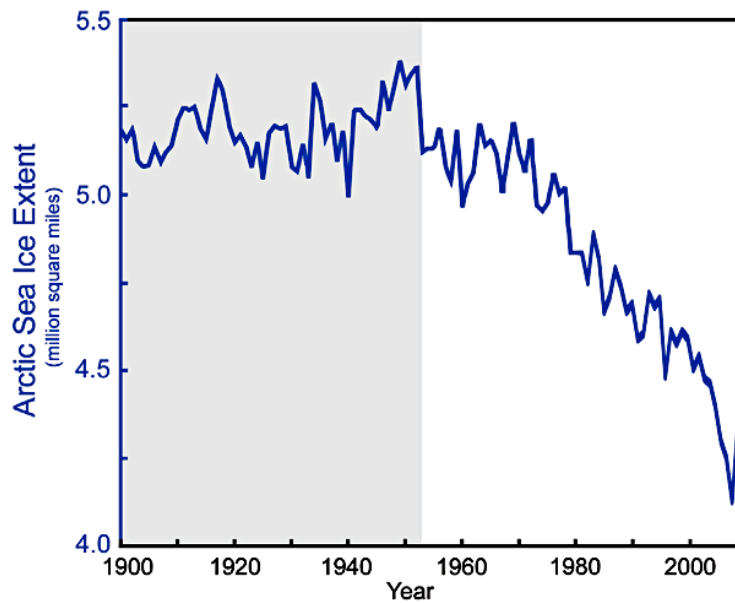
6. Describe two reasons why the fact that ice floats is so important to life on Earth?

1.

2.

7. The effects of **Global Warming**, one aspect of Climate Change, can be seen in the amount of sea ice present in the Arctic (North Pole), where the average air temperature has risen 2.2°C and the average surface area of ice coverage has decreased over the last 60 years. Ice forms later in the year, melts earlier in the year, and covers a smaller area today. Glaciers are also melting at faster rates today. **Study figure 3.7 in your text and the two figures provided below.**





Changing temperatures as well as patterns and amounts of ice coverage affect entire ecosystems. Summarize **how** some species are *harmed* by the loss of Arctic sea ice while others are currently *benefitting*.

Examples of arctic species harmed by rising temperatures and less ice coverage =

Examples of arctic species benefitted by rising temperatures and less ice coverage =

8. Read through the interview of Susan Solomon in order to understand climate change better. Based on her interview...
 - a. Why are we lucky to have **greenhouse gases** (like carbon dioxide, **CO₂**, and methane, **CH₄**) in our atmosphere?
 - b. Though the greenhouse effect is a good thing overall, too many greenhouse gases can lead to the trapping of too much solar radiation in our atmosphere, causing increased global average temperatures (a "hyper greenhouse effect"). How much more CO₂ is there in the atmosphere today compared to the last 800,000 years?
 - c. What are two main **activities that are leading to such elevated concentrations of CO₂ in our atmosphere?**

1. _____

2. _____

9. Briefly define the following important terms:

a. **Solution** =

b. **Solvent** =

c. **Solute** =

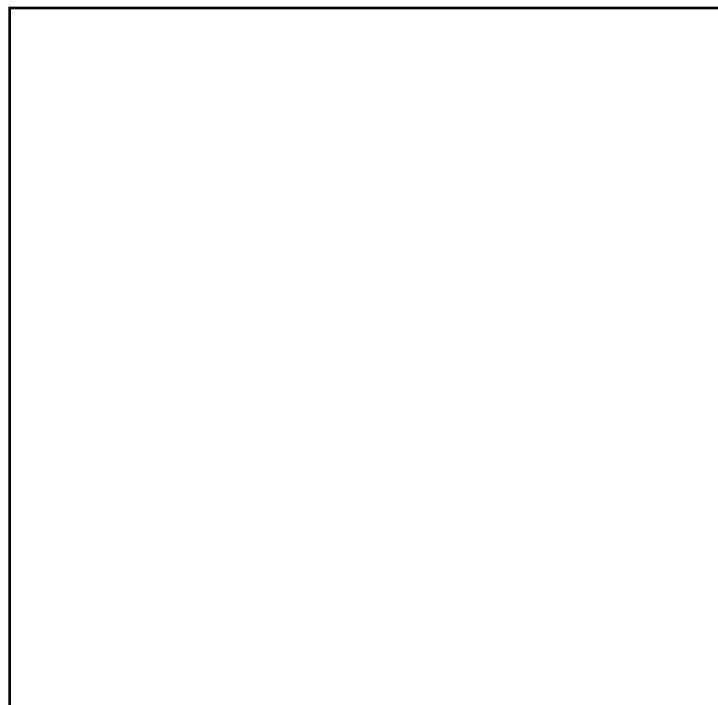
d. **Aqueous solution** =

10. *Let's see if we understand solutions.* Consider a purchased cup of coffee in which you have added table sugar (sucrose molecules). What is the solvent and what is/are the solute(s)?

Solvent =

Solutes =

11. When you mix visible crystals of solid table salt (NaCl) in a glass of water, they seem to “disappear” as they dissolve in the water. Explain what happens at the surface of each salt crystal when it is exposed to an aqueous environment. Be clear about the **interactions taking place between the salt ions and water molecules** **AND** the final **organization of all components within the resulting aqueous salt solution**. Include in the box below a labeled drawing, showing how both positive and negative ions of a salt crystal are carried off into solution by the interaction between water molecules and these charged ions.



12. a. **Water is often referred to as the solvent of life or a “universal” solvent.** What **property of water is the cause for it being such a versatile solvent**, making it so good at dissolving so many varying solutes?

b. Though not all chemicals dissolve in water, **ions, such as those found in ionic compounds, can be dissolved in water due to the attractive forces that arise between the ions and polar water molecules.** Ions, however, are not the only types of substances that can dissolve in water. What **properties must molecules** (*made up of covalent bonds instead of ionic bonds between atoms*) **have to be able to dissolve in water?**

c. What **intermolecular force of attraction** often forms **between water and dissolved ions and molecules?**

13. We often say that a **Hydration Sphere** has formed around a ion or molecules dissolved in an aqueous solutions. What is a Hydration Sphere, sometimes also known as a **Hydration Shell**?

14. What is the difference between a **hydrophilic** versus a **hydrophobic** substance?

Hydrophilic substances =

Hydrophobic substances =

15. Though hydrogen bonds form between water and any polar or ionic substance (and thus *water molecules are always attracted to any charged ions and fully or partially charged regions of molecules*), **do all hydrophilic substances dissolve in water?** Explain.

16. What **property do hydrophobic substances share?** Explain.

17. Define **mole (mol)**, a unit of **quantity!**

18. Define **molarity (M)**, a unit of **concentration!**

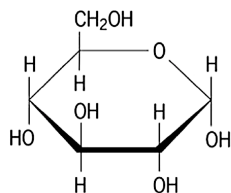
19. a. What is the difference between a substance **molecular mass (or molecular weight)** versus **molar mass?**

Molecular Mass (a.k.a. molecular weight) =

Molar Mass =

- b. The **Atomic Mass** of a particular isotope of an element can be used to calculate the mass of a molecule and also the mass of a mole of molecules made up of these isotopes. A related term, **Atomic Weights**, the weighted averages of the atomic masses of all isotopes of an element, are provided on the Period Table, and can also be used to calculate molecular weights and molar weights of molecules made up of particular elements.

Hydrogen 1 H 1.00794	Helium 2 He 4.002602	Lithium 3 Li 6.941
Carbon 6 C 12.011	Nitrogen 7 N 14.00674	Oxygen 8 O 15.9994



To your right are the entries from the Period Table for some elements, including carbon, hydrogen, and oxygen.

The molecular formula for the sugar glucose is $C_6H_{12}O_6$. Describe the steps in words and show the calculations that you would make to **determine glucose's molecular weight**? Show all calculation work, step-by-step.

Description of Process:

Calculation:

- c. Next, **describe the steps** you would make, using glucose's molecular weight, to determine how much glucose you should weigh out if you want to end up with one mole of glucose (**glucose's molar mass**)?



- d. Finally, write out the steps you would take to make a **1 molar (1M) glucose solution** (to make one liter (1L) of an aqueous solution containing 1 mol of glucose)?



Before moving on to Ch.3 Section 3, let's check your concept understanding...

20. a. In the question #7 of the Ch.3.2 Part 1 Study Guide, you learned that the water striders' feet are coated in nonpolar molecules which, along with the cohesion holding water molecules together at the surface of the water leading to water's high surface tension, allowed the the water strider to walk on water. What might be **the benefit of the water strider coating its feet in a layer of hydrophobic molecules**?



- b. What would happen if the substance were hydrophilic instead?

(Check your answers by going to the Ch.3.2 **Concept Check Question #4** in Appendix A of your textbook)

21. *Think:* As you learned, water expands when its temperature is elevated **above 4°C (moving towards 100°C)**, yet it also expands when its temperature is dropped **below 4°C (moving towards 0°C)**. Though in both cases, the density of water decreases, the reason for the decrease differs. **Explain the different reason(s) for the decrease in liquid water's density above and below 4°C.** Your answer should include discussions of the relative *average thermal energy of the water molecules*, thermal energy's effect on the relative *kinetic motion of water molecules*, the relative *duration hydrogen bonds* between water molecules, and the relative *organization and location of water molecules* in space.

As water temperature moves above 4°C =

As water temperature moves below 4°C =

22. **Always remember, the unit of concentration M (molarity) is equivalent to the unit mol/L.**

The concentration of the appetite-regulating hormone ghrelin is about 1.3×10^{-10} M in the blood of a fasting person. How many molecules of ghrelin are in 1 L of blood? In Chemistry, you learned how to use **Dimensional Analysis** to show your work, calculate your answers, and ensure you were left with the proper final units. *Use Dimensional Analysis to solve this problem as well.*

Set up hint: Since $X \text{ M} = X \frac{\text{mol}}{1\text{L}}$, $X \frac{\text{mol}}{1\text{L}} \times \frac{\text{Avogadro's Number of Molecules}}{1 \text{ mol}} = ? \frac{\text{molecules}}{1\text{L}}$

23. a. Is there is a difference in concentration between 1 L of a 0.5 M solution and 0.5 L of a 0.25 M solution? **Explain.**

b. Is there is a difference in concentration between a solution with 5 moles of solute in 1 L of liquid and one with 2.5 moles of solute in 0.5 L of liquid? **Explain.**

c. 1000 filled buckets of solution are needed to fill a swimming pool. If I have a 2M solution in swimming pool, and I scoop out 1 bucket of the solution, what concentration will the solution in my bucket have? **Explain.**