

Name: \_\_\_\_\_

**Introduction to Oceanography 112 - M. Yasuda**

Date: October 15, 2009

**Assignment 7**

**Reading – Week 6 - The nature of water**

1. Chapter 7
2. Appendix VIII: Periodic Table of the Elements
3. Chapter 17: 480-481 Freshwater is obtained by desalination

**Vocabulary list (continuation from last week)**

- |                           |                           |                                     |
|---------------------------|---------------------------|-------------------------------------|
| 1. Atom                   | 13. Dissolving            | 25. Vertical density stratification |
| 2. Proton                 | 14. Diffusion             | 26. Freezing                        |
| 3. Neutron                | 15. Chemical precipitaton | 27. Melting                         |
| 4. Electron               | 16. Saturation            | 28. Evaporation                     |
| 5. Ion                    | 17. Cohesion              | 29. Condensation                    |
| 6. Electric charge        | 18. Hydrogen bond         | 30. Heat capacity                   |
| 7. Polarity               | 19. Adhesion              | 31. Sea surface Temperature (SST)   |
| 8. Salt                   | 20. Surface tension       | 32. Salinity                        |
| 9. Crystal or crystalline | 21. Temperature           |                                     |
| 10. Solid                 | 22. Phase change          |                                     |
| 11. Polar molecule        | 23. Density               |                                     |
| 12. Solvents              | 24. Thermocline           |                                     |

**Websites related to lecture**

**Tectonism - Lunar and Planetary Institute**

[http://www.lpi.usra.edu/education/explore/shaping\\_the\\_planets/tectonism.shtml](http://www.lpi.usra.edu/education/explore/shaping_the_planets/tectonism.shtml)

**Plate tectonics on Mars? - NASA**

[http://science.nasa.gov/newhome/headlines/ast29apr99\\_1.htm](http://science.nasa.gov/newhome/headlines/ast29apr99_1.htm)

**LCROSS – Looking for water on the Moon**

[http://www.nasa.gov/mission\\_pages/LCROSS/searchforwater/index.html](http://www.nasa.gov/mission_pages/LCROSS/searchforwater/index.html)

**NASA Scientists Find Evidence for Liquid Water on a Frozen Early Mars**

[http://www.nasa.gov/topics/moonmars/features/mars\\_freeze\\_052709.html](http://www.nasa.gov/topics/moonmars/features/mars_freeze_052709.html)

**Why is the ocean salty?**

[http://www.palomar.edu/oceanography/salty\\_ocean.htm](http://www.palomar.edu/oceanography/salty_ocean.htm)

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**GOALS**

**The chemistry of seawater**

1. Be able to identify the major solvent and the major solutes in seawater
2. Be familiar with the definition of an ion
3. Be able to cite important consequences of the polarity of the water molecule
4. Be able to identify sources of dissolved solids (ions) in seawater
5. Know the definition and units of salinity
6. Know the basic parts of an atom
7. Know what constitutes any particular element
8. Be able to identify the hydrogen bond and its consequences

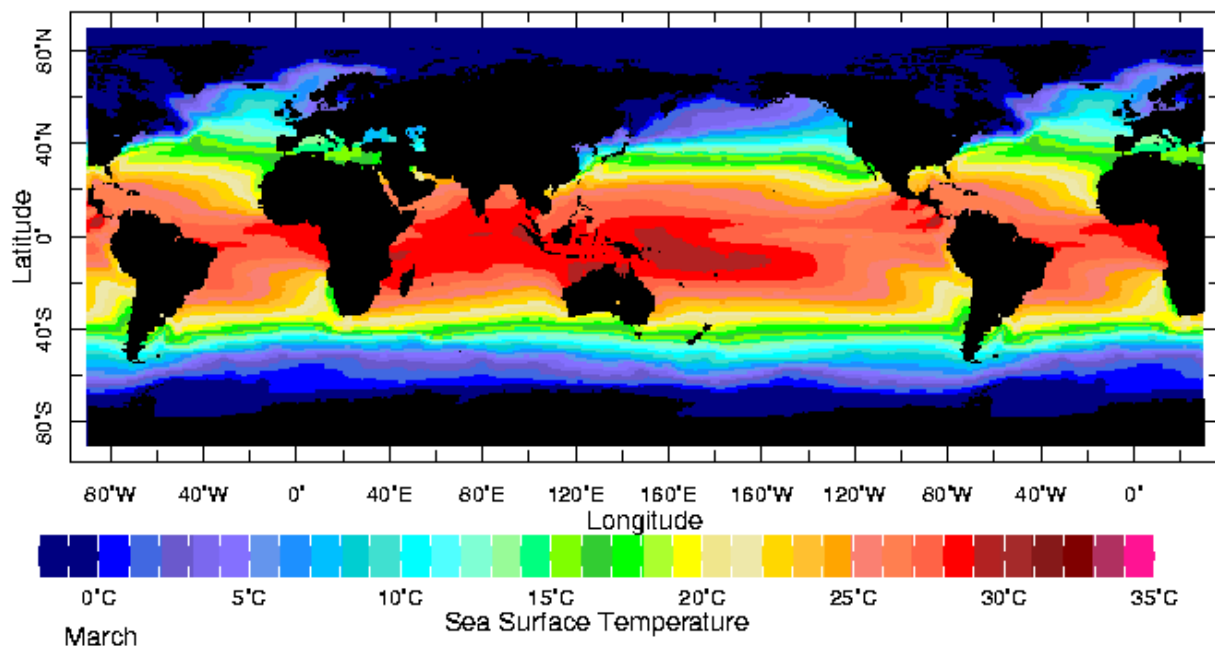
## In-class/homework activities

### Homework questions

Type your answers on a separate sheet of paper, double-spaced with wide margins so I have space to write comments. No credit for essay answers that are not typed. Where an essay answer is required, make sure to write out a complete and logical explanation using the best grammar and spelling that you can.

## A. Temperature

1. Describe the “first-order” pattern of sea surface temperature (SST).
2. Where is the largest pool of the warmest surface water on Earth located? Be specific and answer in a complete sentence.
3. What is the sea surface temperature in the warm water pool?
4. Look at the SST across the Pacific at the equator. Is the water the same temperature all the way across or significantly warmer or cooler on one side? We'll discuss why later.
5. What heats the sea surface?



## B. Salinity

1. Describe the first-order pattern of sea surface salinity. We'll discuss the reasons for this pattern next time.
2. Which water is denser? Choose one.
  - a. Higher salinity water of higher temperature
  - b. Higher salinity water of lower temperature
  - c. Lower salinity water of higher temperature
  - d. Lower salinity water of lower temperature

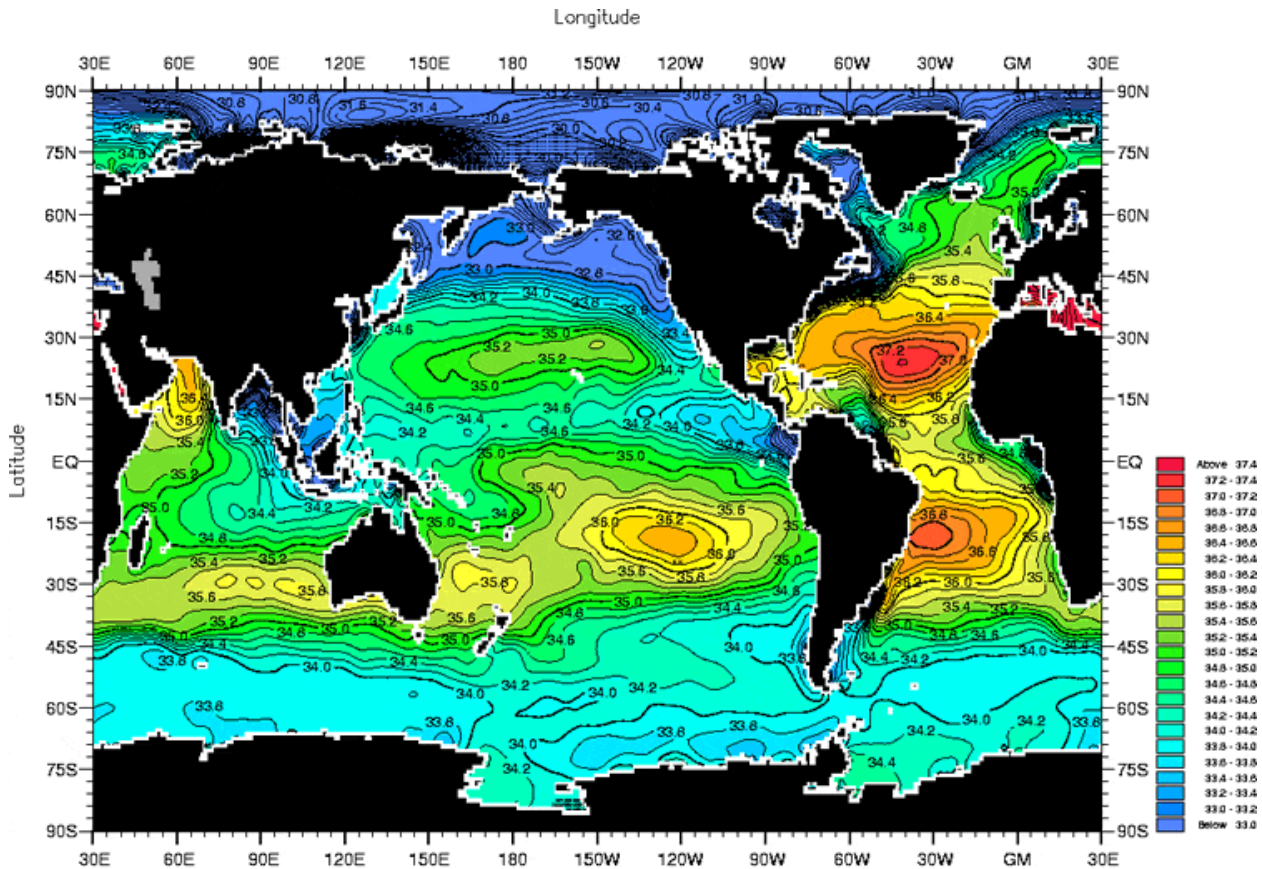


Fig. A2-1. Annual mean salinity (PSS) at the surface .

Minimum Value= 3.57

Maximum Value= 40.02

Contour Interval: 0.20

## C. Chemistry

1. The three main items that make up all atoms (subatomic particles)
  - a. Name them
  - b. Give the atomic weight of each type
  - c. Give their electric charge
  - d. Indicate whether each item resides in the nucleus **OR** orbital of an atom

\* A table is a good way to organize this answer
2. What determines the name of an element? Short answer.

3. **Draw:**

- a. A sodium atom
- b. A chloride ion.

\* Include all key atomic particles and show how they are arranged in space

4. **Bonding**

- a. If you have a single atom of any element, is that atom bonded?
- b. What does it mean for an atom to be bonded to another atom? Explain in your own words.
- c. Describe and distinguish the two main types of bonding that we discussed in class – ionic and covalent.

Note:  $\text{Na}^+$  is bonded to  $\text{Cl}^-$  in the the solid material of table salt. Two hydrogen atoms are bonded to oxygen in water vapor, ice, and liquid water. Bonded atoms are not bonded forever. The forces of attraction that bond one atom to another are only so strong. Bonds break when the forces of separation are greater. Temperature, pressure and the presence of other particular atoms and groups of atoms can exert enough force to cause separation or bonding to materials with greater forces of attraction. In a solution of water, forces exerted by water break apart molecules held together by ionic bonding.

5. **Electrons**

- a. Do chemical reactions involve changes to the nucleus or electron orbitals?
- b. What type of bonding occurs when a valence shell is nearly full or nearly empty?

6. **Dissolving (breaking bonds in a solution)**

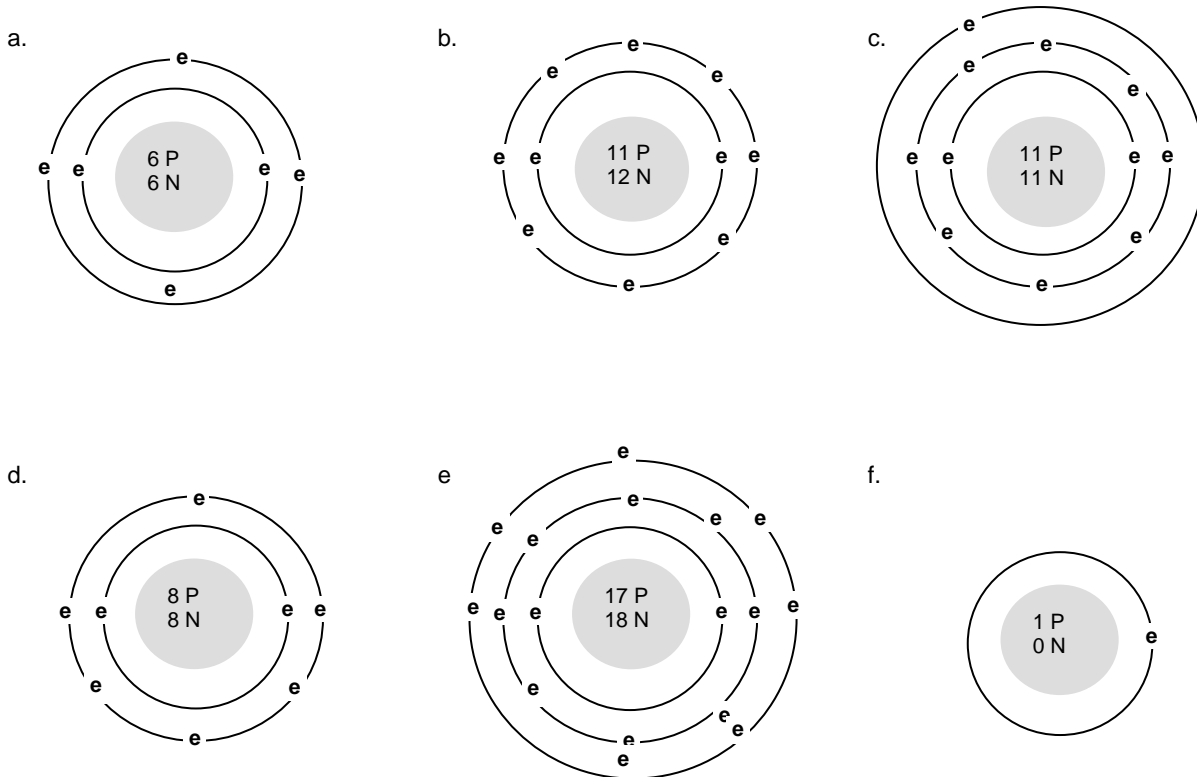
- a. Many solids are “crystalline” in detail. For example, the substances that make up ice, table salt, pyrite (fool’s gold) and the mineral quartz are said to be “crystalline.” Some solids such as glass and opal (the material that makes up the shells of radiolarians and diatoms) are technically not crystalline.  
  
Nearly all of the solids that precipitate from seawater, such as table salt are crystalline.  
  
What characteristic of solids makes them crystalline? Explain.
- b. If you drop a crystal of table salt into a glass of water, it’s likely to dissolve.
  1. Name the elements that are bound together in solid table salt.
  2. Name the type of bonding.
  3. When you drop that solid into a solution of water, what exerts the forces that pull the solid structure of table salt apart? Main focus of the reading.
  4. Is that force as effective in dissolving materials that are covalently bonded?
- c. Does solid table salt,  $\text{NaCl}$ , have a net electrical charge?
- d. What key characteristic do all ions possess?
- e. The substances that make makeup salinity are ions – true or false?
- f. The dissolved ions in seawater are always single atoms – true or false?
- g. Sulfate (sulphate or  $\text{SO}_4^{2-}$ ) is a major dissolved component of seawater. Is sulphate an ion?
- h. Are the forces of typical seawater enough to break apart sulphate?
- i. Are the forces that hold together calcite in shell material (calcium carbonate or  $\text{CaCO}_3$ ) sufficient to

resist being dissolved by seawater? Explain.

7. **Draw a water molecule.**

- Include all protons, neutrons and electrons and show they are arranged in space.
- Indicate the polarity with + and – symbols
- What kind of bond holds the hydrogens to oxygen within a water molecule?
- What term describes the forces that attract one water molecule to another?

8. **Diagrams for the questions below:**



- Which of these drawings shows an atom of oxygen? \_\_\_\_\_
- Which pair of drawings show identical elements? \_\_\_\_\_
- Which of these drawings shows chloride? \_\_\_\_\_
- Which of these drawings shows an ion? \_\_\_\_\_
- Which of these drawings shows isotopes of a single element? \_\_\_\_\_

9. Salinity

- a. What is salinity?
- b. What are the units of salinity?
- c. Which statements are true about the salinity of seawater? Circle the true statements.
  1. All of the dissolved components that contribute to the salinity of seawater are charged ions
  2. Dissolved gases such as O<sub>2</sub> are part of salinity
  3. Dissolved gases are charged ions
  4. Dissolved salts and dissolved solids are solid

10. Saturation state

Water at a particular temperature and pressure, containing particular concentrations of dissolved ions will dissolve a particular amount of solid before it hits a saturation point and cannot dissolve any more. Answer the following questions involving saturation issues. Circle the answer(s).

1. Much less gold dissolves in seawater than table salt. It is because:
  - a. Water becomes saturated with gold at low concentrations of dissolved gold ions.
  - b. Water becomes saturated with gold a high concentrations of dissolved gold ions.
2. Seawater above the CCD is:
  - a. Saturated with respect to calcite
  - b. Saturated with respect to table salt
  - c. Undersaturated with respect to calcite
3. Solids precipitate from seawater when:
  - a. Water becomes undersaturated with respect to that precipitate
  - b. Water becomes saturated with respect to that precipitate
4. Many chemical precipitates form in evaporative settings when:
  - a. The ratio of water to dissolved ions increases
  - b. The ration of water to dissolved ions decreases
5. Hydrogenous materials form in seawater that is:
  - a. Saturated with respect to crystalline compounds such as those that make up manganese nodules
  - b. Undersaturated with respect to crystalline compounds such as those that make up manganese nodules
6. Increased temperatures usually:
  - a. Raise the saturation point and allow more solid to dissolve
  - b. Lower the saturation point and cause less solid to dissolve
7. Calcium carbonate behaves in the opposite manner relative to most solids. It tends to dissolve more easily when:
  - a. Temperature and pressure are low, in the polar surface ocean
  - b. Temperature is low and pressure is high, in the deep ocean
  - c. Temperature is high and pressure is low, at the equatorial surface ocean
8. Some dissolved solids enter the ocean via rivers. Freshwater dissolves rocks because:
  - a. Carbonic acid increases its acidity and increases the power of freshwater to dissolve rocks
  - b. Freshwater is undersaturated with respect to some minerals that make up rocks