

I.

a. Water is made up of two elements

i.

ii.

b. The chemical symbol for water is _____

i.

- ii. Substances that do not separate into ions can still dissolve in water through other mechanisms
 - 1. Ex. Sugar is not ionic but can dissolve in water when it is broken down into its individual

4. Brine Water (areas with high evaporation and little inflow of freshwater or where salt domes dissolved on the seafloor – Gulf of Mexico) – Saturated or nearly saturated

- a. _____: The properties of a liquid that may be altered by the presence of a solute
- i. The strength of the colligative properties depends on the quantity of solute
- b. _____:
- i. Raised Boiling Point – _____ of seawater is slightly higher than pure fresh water
 - ii. Decreased Freezing Temp – freezing point of seawater is slightly _____ than that of pure fresh water
 - iii. Ability to Create Osmotic Pressure –
 - iv. Electrical Conductivity – Salts act like conductors and conduct _____
 - v. Decreased Heat Capacity – It takes less heat to raise the temperature of seawater than to raise freshwater
 - vi. Slowed Evaporation– The attraction between salt ions and water keeps seawater from evaporating as fast as freshwater
 - vii. Ability to Create Osmotic Pressure
 1. Osmosis: Movement of water through a semi-permeable membrane from areas of HIGH concentration to areas of LOW concentration
 2. Crucial to many biological processes
- c. Principle of Constant Proportions
- i. _____: _____
 1. Only the amount of _____ (and therefore the salinity) changes
 2. _____: Dissolved Salts
 3. No matter how much the salinity varies, the proportion of key elements and compounds don't change
 - a. Useful b/c if you know the amount of one element, you can determine how much there is of others.
- d. Dissolved Solids in Seawater
- i. Besides hydrogen and oxygen (H₂O) the most abundant chemicals in seawater are:
 1. Chloride 18.98 g
 - 2.
 3. Sulfate 2.65 g
 - 4.
 5. Bicarbonate 0.14 g
 - 6.
 7. Potassium 0.38 g
 - 8.
- e.

- a. Example: You have a seawater sample that tests 19.2 ‰ chlorinity – What is the salinity of this water sample?
 - b. Salinity ‰ = 1.80655 x 19.2 ‰
 - c. Salinity ‰ = 34.68 ‰
- iii. Likewise, when you know salinity you can determine chlorinity:
 1. Example: You have a seawater sample that tests 34.68 ‰ salinity – What is the chlorinity of this water sample?
 - a. 34.68 ‰ = 1.80655 x chlorinity ‰
 - b. 19.2 ‰ = chlorinity ‰
- f. Determining Salinity, Temperature, and Depth
 - i. Scientists measure salinity, temperature, and depth using special instruments and procedures:
 1. _____: Determines the electrical conductivity of water
 2. Conductivity, Temperature, and Depth Sensor (CTD): Sensor that can be attached to a submersible or deployed by itself to profile temperature, depth and salinity. Data are transmitted to a ship/vessel
 3. Temperature and salinity are used to determine _____
- g. Salinity, Temperature, and Water Density
 - i. Most of the ocean's surface has an average salinity of _____ ‰
 - ii. Waves, tides, and currents _____ waters of varying salinity and make them more _____ – so, even surface salinity varies with the season, weather (especially rainfall and evaporation), and location (bays, semi-enclosed seas, and mouths of large rivers)
 - iii. Rainwater and water flowing from freshwater rivers _____ salinity while evaporation _____ salinity
- h. Salinity and temperature also vary by depth
 - i. Density differences cause water to separate into _____
 - ii. High density layers lie _____ lower density layers
 - iii. Warmer, lower density surface waters are separated from cool, high density deep waters by the thermocline
 - iv. Thermocline: _____
- i. Acidity and Alkalinity
 - i. Acidity and alkalinity are measured on the _____ Scale.
 1. The pH scale measures the amount of positive hydrogen ions (H⁺) and negative hydroxide ions (OH⁻) in a liquid
 - a. Acid: A solution high in H⁺ ions is considered (0-7)
 - b. Base: A solution high in OH⁻ ions is considered to be alkaline (7-14)
 - ii. pH of Seawater:
 1. Pure water has a pH of _____
 2. Typical seawater has a pH range of _____
 3. Carbon dioxide in seawater acts as a buffer and prevents changes in the pH of the ocean
 - iii. Carbon Compensate Depth
 1. Although seawater pH is relatively stable it changes with depth b/c the amount of carbon dioxide varies by depth

2. Upper Depths - generally 8.5 pH- warmer and have photosynthetic organisms with less CO₂
3. Middle Depths - more carbon dioxide present from respiration of marine organisms – more acidic with lower pH

- iv.
- v. The silicon Cycle
- i. The circulation of chemicals in these biogeochemical cycles and interactions between cycles are _____ for the maintenance of terrestrial, freshwater and marine ecosystems. Global climate change, temperature, precipitation and ecosystem stability are all dependent upon biogeochemical cycles
- j. Nitrogen Cycle
 - i. Organisms require nitrogen for organic compounds like _____, DNA, and chlorophyll (the plant pigment used in photosynthesis)
 - ii. Nitrogen makes up ____% of the air and _____% of all dissolved gasses in seawater...gaseous nitrogen must be converted into a chemically usable form before living things can use it
 - iii. Nitrogen Fixation: _____ in the soil can convert gaseous nitrogen into ammonium (lightning also fixes small amounts of nitrogen)
 - iv. _____: Nitrifying bacteria convert ammonium ions into nitrite and nitrate (some plants can use ammonium ions others need nitrates)
 - v. _____: Breaking down nitrogen compounds in the remains of organisms into ammonia – this is preformed by decomposers
 - vi. _____: Conversion of ammonia, nitrite, or nitrates into N₂ gas. Denitrifying bacteria take nitrogen compounds in the soil and convert them into free nitrogen/N₂ gas
- k. Carbon and Oxygen Cycle
 - i. Carbon Cycle
 - ii. The main phases of the cycle are:
 1. _____: During this process plants and algae take in carbon dioxide and release oxygen gas
 2. Cellular respiration: During this process organisms take in oxygen and release carbon dioxide
 3. Decay/Decomposition: When organisms die they are decomposed and any remaining carbon atoms are released into the atmosphere/ground
 - a. Fossil Fuels: _____
 - b. Combustion: Burning of plant or animal matter, burning of fossil fuels, volcanic eruptions, etc. releases gasses into the atmosphere, ocean, and ground
 - c. Ocean Storage: Large amounts of carbon are stored in the ocean in various forms
 - iii. Carbon in the Ocean
 1. Seas have plenty of carbon in many different forms:
 - a. Carbon dioxide in the _____ dissolves into the ocean
 - b.

c. _____

I. Water Cycle

i. Main Phases:

1. _____: Liquid water stored in lakes, rivers, streams, and oceans is heated and forms water vapor
2. _____: Water Vapor in the atmosphere attaches to particles in the atmosphere like dust and condenses to form liquid water droplets
3. _____: Water in form of rain, snow, sleet, hail etc. fall from clouds
4. _____: Precipitation infiltrates the soil/rocks and is stored in the ground
5. _____: Precipitation that is not absorbed into the ground flows into rivers, lakes, streams, and the ocean
6. _____: Water is taken up by the roots of plants and can be used to cool the plant as it evaporates from small holes in the leaves of plants

m. Silicon Cycle

- i. About three quarters of the primary production in coastal and nutrient replete areas of the world oceans is carried out by diatoms.
 1. _____: A _____ that needs silicon (Si) for the build up of their opaline (silicate) shells.
 2. In low nutrient areas diatoms still contribute to about one third of the marine primary production.
 - 3.

a. _____ Mechanisms that protect an animal's internal environment from harmful

