I.

a. Water is made up of two elements

i.

ii.

b. The chemical symbol for water is _______

i.

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 (H_2O) 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. <u>Upper Depths</u> - generally 8.5 pH– warmer and have photosynthetic organisms with less CO_2
3. <u>Middle Depths</u> - 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 intro 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. ____________________________

l. 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

b. ______________________ – Organisms that tolerate a wide range of salinities in external environment:

2. short term changes:

   a. estuarine - 10 - 32 ‰, intertidal - 25 – 40‰

3. long term changes:

   a. ______________________________ -spend part of life in salt water, part in freshwater

   b. ______________________– live in freshwater and migrate seaward to spawn ex. eels

   c. ______________________ – born in freshwater, live in sea, migrate up river to spawn ex. salmon and sturgeon

c. Osmoregulators

   i. _____________: Organisms that can ___________ to changes in salinity of the surrounding seawater

   ii. Osmoregulators use active transport to maintain a stable internal salinity so this requires the use of energy

   iii. Helps conserve loss of freshwater from their bodies

      1. Examples include most vertebrate fish, sharks, etc.

      2. B/c they can adapt to changing salinities they survive in variations of salinities…

   iv. Osmoregulation: Sharks vs Bony Fish

      1. SHARKS

         a. Maintain internal salt concentrations lower than seawater by pumping salt out through rectal glands and through the kidneys, yet their osmolarity is slightly hypertonic to seawater.

         b. Sharks retain urea as a dissolved solute in the body fluids.

         c. Sharks also produce and retain trimethylamine oxide (TMAO), which protects their proteins from the denaturation by urea.

         d. Retention of these organic solutes (urea, TMAO) in the body fluids actually makes the slightly hypertonic to seawater.

         e. Do not drink water, but balance osmotic uptake of water by excreting urine.

      2. MARINE BONY FISH

         a. Marine bony fishes are hypotonic to seawater.

         b. Compensate for os05 315.05 Tm7ls[s05 315.05 T-3(u)-4(gh)F2ion e5T/F3 9.9216.05 333r4(e)4(d)-4

1ii.