Name: _____ Date: _____

Determining Concentration of Solutions

Class Activity Unit 10 - Topic 4

Water and Drinking Water Quality

In a water molecule, the two hydrogen atoms and one oxygen atom share the molecule's electrons in a covalent bond. The atoms are positioned so that the two hydrogen atoms are together at one end of the water molecule and the oxygen atom is at the other end, forming a "V" shape. While the electrons are shared between all three atoms, the oxygen atom holds the electrons for most of the time and the two hydrogen atoms hold the shared electrons only briefly (due the difference in electronegativities of the elements). Also, the oxygen atom has 4 non-bonded electrons in its valence shell. This causes the water molecule to act like a tiny magnet with a mild negative charge at the oxygen end of the molecule and a mild positive charge at the hydrogen end. Because the water molecule exhibits definite positive and negative charged ends it is classified as a polar molecule.

Water is also known as the *universal solvent* because it has the ability to dissolve most of the substances with which it comes in contact. These substances tend to dissolve because they interact with the weak electrical charges on each end of the water molecules.

As water travels through the hydrologic cycle, it binds to various substances from its surroundings and becomes contaminated. Contaminated water travels down rivers and streams carrying the dissolved materials to the ocean. Some dissolved substances contribute to the ocean's salinity (saltiness).

If water is to be used for drinking, it must be cleaned of contaminants to make it suitable for consumption. The federal government and the Department of Health have established regulatory limits for more than 80 known contaminants, and acceptable levels for other parameters such as pH, temperature, and color.

It is not economically feasible to have totally pure water for drinking. Therefore, there are two standards for allowable levels of drinking water contamination. These are called *primary standards* and *secondary standards*. Primary standards directly affect human health, while secondary standards are for more aesthetic qualities such as taste and color. Primary standards can be measured in several ways, one of which is the *maximum containment level*. Maximum containment levels have two categories, *maximum containment level goals* (MCLG) and maximum containment levels (MCL).

MCLGs are not enforceable, and are not associated with adverse health effects from drinking water with this level of contamination. MCLs, on the other hand, are the enforceable standard and are usually set as close to the MCLG as possible. One factor in establishing MCLs is the cost and technology necessary to attain a specific level of purity. In short, an MCLG would represent a perfect world. The MCL is the contamination level which the public water system may not exceed in order to be in compliance with regulations and still provide safe, healthy drinking water. For a chart showing federal standards for MCLGs and MCLs, see www.epa.gov/safewater/mcl.html#mcls.

A water treatment plant is a busy place. Not only is water constantly being cleaned and disinfected, but is also constantly monitored for its quality both entering and leaving the plant. Temperature, pH, and chlorine levels are checked around the clock to ensure proper performance of the treatment process. Other parameters are also checked regularly.

Name: _____ *Date:* _____

Answer the following questions based on the above reading and information provided.

1. Why is water called the 'universal solvent'? _____
   _____
2. Why can drinking water never be totally pure? _____
   _____
   _____
3. Distinguish between MCLG and MCL. _____
   _____
   _____
4. What happens at a water treatment plant? _____
   _____
   _____

Step 2: Calculations. Use the information in the following data table to answer the questions that follow.

Federal Drinking Water Standards for Selected Chemicals & Compounds	***For all calculations, assume 1 mL = 1 g***
	Water Body Volumes
Benzene = 0.005 ppm = 5 ppb	Swimming Pond: 1.238×10^7 Liters
Arsenic, Lead: 0.05 ppm = 50 ppb	Clear Lake: 3.095×10^9 Liters
2,4-D (a weed killer): 0.10 ppm = 100 ppb	Deep Rock Aquifer: 2.377×10^{11}
1,1,1-Trichloroethane (TCE): 0.2 ppm = 200 ppb	
Fluoride: 4 ppm = 4000 ppb	

1. We use *parts per million* to quantify very small amounts of solute in solution. Copy the parts per million equation from Table T of your reference tables. You will use this equation for questions 2-5.

2. The EPA Criminal Investigations Unit is attempting to track down the parties responsible for dumping five gallons (19 liters) of herbicide 2.4-D in Swimming Pond.

   a) If the chemical becomes evenly dispersed, what would be its concentration in ppm?

   b) Should the US EPA restrict access to Swimming Pond? Why?

3. The State Highway Patrol has notified the Department of Environmental Quality that 6 gallons (22.8 liters) of benzene were accidentally spilled into Clear Lake.

   a) If it is evenly dispersed, what would its concentration be in ppm?

   b) Should the residents who depend on the lake for drinking water be notified? Why?

4. An old rusted, unmarked 55-gallon drum (209 liters) was discovered on the property of a resort near clear lake. Although the manager suspects it may contain a hazardous chemical, he asks his assistant to get rid of it any way he can.

   a) Calculate the concentration of contaminant in the ground water if that drum was illegally disposed of in an old well and dispersed evenly throughout Deep Rock Aquifer.

b) What if the same quantity of the chemical was disposed of in Clear Lake? Calculate the concentration.

c) What if the same quantity of the chemical was disposed of in Swimming Pond? Calculate the concentration.

d) Why would it be important to know what the chemical in the drum was?

e) What if the 55-gallon drum contained one of the chemicals from the data table above. Would the concentrations be at safe levels in Deep Rock Aquifer? In Clear Lake? In Swimming Pond? Explain.

5. Suppose a 5,000 gallon (19000 liter) truck loaded with the chemical arsenic ran off the highway and all the chemical spilled into clear lake.

   a) What would be the concentration of chemical in the lake in ppm?

   b) What would it be in ppb? (parts per billion)

c) Does this violate federal standards?

6. Draw the structural formula of 1,1,1-Trichloroethane (Use Tables P, Q, and R for help)

Part 3: Ethics Questions

7. Do you think the public has a right to know about all instances of environmental contamination, whether or not concentrations are below federal standards?

8. What is the best way to inform people of a contamination incident? Who should be told? In how wide an area should information be distributed?

9. Who should be responsible for notifying the public?

10. What are the possible effects of releasing this information? (affects on property values, hysterical reactions, etc.)