Name: _____ Date: _____

CONTENT 21.2

21.2 Salinity and Concentration Problems

READ CPO Science

Bodies of water like ponds, lakes, and oceans contain solutions of dissolved substances. Often these substances are in small quantities, measured in parts per thousand (ppt), parts per million (ppm), and parts per billion (ppb). This skill sheet will provide you with practice in using these quantities and in doing calculations with them.

Unit conversions

Table 1 below provides unit conversions that will be helpful to you as you complete this skill sheet.

Table 1: Unit Conversions

Milligrams	= Grams	= Kilograms	= Liters of water
1	0.001	0.000 001	0.000 001
10	0.01	0.000 01	0.000 01
1,000	1	0.001	0.001
1,000,000	1,000	1	1
1,000,000,000	1,000,000	1,000	1,000

Review: working with small concentrations

When working with small concentrations, remember that the units of the numerator and denominator must match, as shown in the examples below.

A. Parts per thousand (ppt)

Example: 0.009 grams of phosphate in about 1000 grams of oxygenated water makes a solution that has an phosphate concentration of 0.009 ppt.

$$\frac{0.009 \text{ grams}}{1{,}000 \text{ grams}} = 0.009 \text{ ppt}$$

B. Parts per million (ppm)

Example: A good level of oxygen in a pond is 9 ppm. This means that there are 9 milligrams of oxygen for every one liter (1000 grams) of oxygenated water.

$$\frac{9 \text{ milligrams}}{1 \text{ liter}} = \frac{9 \text{ milligrams}}{1{,}000 \text{ grams}} = \frac{9 \text{ milligrams}}{1{,}000{,}000 \text{ milligrams}} = 9 \text{ ppm}$$

C. Parts per billion (ppb)

Example: The concentration of trace elements in seawater is very low. For example, the concentration of iron in seawater is 0.06 ppb. This means that there are 0.06 mg of iron in 1,000 liters of water. One thousand liters is equal to 1,000 times 1,000 grams of seawater.

$$\frac{0.06 \text{ milligrams}}{1{,}000 \text{ liters}} = \frac{0.06 \text{ milligrams}}{1{,}000 \times 1{,}000 \text{ grams}} = \frac{0.06 \text{ milligrams}}{1{,}000{,}000 \text{ grams}} = \frac{0.06 \text{ milligrams}}{1{,}000{,}000{,}000 \text{ milligrams}} = 0.06 \text{ ppb}$$

EXAMPLES

Work through these example problems and check your answers. Then you will be ready to try the practice problems on your own.

- There are 16 grams of salt in 984 grams of water. What is the salinity of this solution?

  Solution:

$$\text{salinity} = \frac{16 \text{ grams salt}}{984 \text{ grams water} + 16 \text{ grams salt}} = \frac{16 \text{ grams salt}}{1{,}000 \text{ grams solution}} = 16 \text{ ppt}$$

- A liter of solution has a salinity of 40 ppt. How many grams of salt are in the solution? How many grams of pure water are in the solution?

  Solution:

$$40 \text{ ppt} = \frac{40 \text{ grams salt}}{1{,}000 \text{ grams solution}} = \frac{40 \text{ grams salt}}{40 \text{ grams salt} + x \text{ grams water}}$$

$$1{,}000 \text{ grams solution} = 40 \text{ grams salt} + x \text{ grams water}$$

$$1{,}000 \text{ grams solution} - 40 \text{ grams salt} = 960 \text{ grams water}$$

- You measure the salinity of a seawater sample to be 34 ppt. How many grams of salt are in this sample if the mass is 2 kilograms?

  Solution: First, remember that there are 1,000 grams per kilogram. If a solution is given in parts per thousand, you can think of it as "grams per 1,000 grams" or "grams per kilogram." Therefore, you can set up a proportion like this:

$$\frac{34 \text{ grams salt}}{1 \text{ kilogram solution}} = \frac{x \text{ grams salt}}{2 \text{ kilograms solution}}$$

  Next, solve for x.

$$x = \frac{34 \text{ grams salt} \times 2 \text{ kilograms solution}}{1 \text{ kilogram solution}}$$

$$x = 68 \text{ grams salt}$$

PRACTICE

For each problem, show your work.

1. Complete Table 2 below:

Table 2: Salinity of Famous Places

Place	Salinity (ppt)	Amount of salt in 1 liter (grams)	Amount of pure water in 1 liter (grams)
Salton Sea California	44		
Great Salt Lake Utah	280		
Mono Lake California	210		
Pacific Ocean	87		

2. How many grams of salt are in 2 liters of seawater that has a salinity of 36 ppt?

3. A one-liter sample of seawater contains 10 grams of salt. What is the salinity of this sample?

4. You want to make a salty solution that has the same salinity as the Dead Sea. The salinity of the Dead Sea is 210 ppt. Write a recipe for how you would make 2 liters of this solution.

5. Five kilograms of seawater contains 30 grams of salt. What is the salinity of the volume of seawater?

6. You measure the salinity of a seawater sample to be 30 ppt. How many grams of salt are in this sample if the mass is 1.5 kilograms?

7. A solution has 2 grams of a substance in 1,000,000 grams of solution. Would you describe the concentration of the substance in solution as 2 parts per million or parts per billion?

8. A solution has 5 grams of a substance in 1,000,000,000 grams of solution. Would you describe the concentration of the substance as 5 ppb or 5 ppm?

9. Menthol is a substance that tastes sweet and minty and causes a cooling effect on your tongue. The taste threshold for menthol is 400 ppb. Could you taste menthol if there were 400 milligrams in 1,000,000 grams of menthol solution? Could you taste menthol if there were 400 milligrams in 1000 liters of menthol solution?

10. Above-ground pipelines are used to transport natural gas, an important energy source. Gas leaks are potential problems with the pipelines. German Shepherd dogs can be trained to detect the gas leaks. The dogs sniff along the pipeline and then indicate a leak by perking up their ears or pawing the ground. The most sensitive electronic devices can detect gas leaks as low as 50 ppm. A German Shepherd can detect a gas leak as low as 1 ppb. How many times more sensitive is the dog as compared to the electronic device?