Chemistry Self Assessment Test

Purpose

In HBY350 Physiology, students are expected to be able to solve freshman-level chemistry problems. As a self assessment of your skills in chemistry, try to solve the following problems. If you can solve these problems with ease (with the aid of a chemistry textbook or other reference), you will have no problem with quantitative chemistry-related problems in the course. If you find the problems challenging, then spend some time over the summer "brushing up" on your chemistry.

A real-life situation

It is recommended that all males over the age of 50 should be screened for colon cancer. The accepted outpatient procedure is colonoscopy, which involves inserting a fiber optic colonoscope (an endoscope) into the rectum, and snaking the device along the entire length of the colon. The gastroenterologist visually inspects the lumen of the colon, and can use the device to excise biopsy specimens and actually perform minor surgical procedures—like removal of polyps. The procedure is quite innocuous, requiring roughly 30 minutes while the patient is under light sedation.

As one might expect, it is important to flush the colon of all fecal contents prior to the procedure. This is started the day before the procedure, where the patient is instructed to consume only clear liquids. In addition, the evening before the procedure, the patient consumes an oral solution that rapidly produces a watery diarrhea, further cleaning out the colonic contents.

The problems below deal with the chemistry of the oral solution.

The solution

A common solution that produces the watery diarrhea is called Fleet Phospho Soda®. The package lists the contents of the solution:

> "Each teaspoon (5 mL) of Fleet Phospho Soda contains 2.4 grams of monobasic sodium phosphate, and 0.90 grams of dibasic sodium phosphate."

The dosage of the solution necessary to clean out the colon is 3 tablespoons (9 teaspoons) of the solution taken orally with a glass of water.

Questions:

1. What are the chemical formulas for mono- and dibasic sodium phosphate? How do these salts ionize in solution?

2. What are the molar concentrations (moles per liter) of the two salts in the solution? (Consult a periodic table if you don't know the molecular weights of the elements in question.)

3. The mixture of the two phosphate salts forms a hydrogen-ion (pH) buffer solution, with one of the phosphates acting as an acid, and the other acting as a base. Which phosphate species is the acid, and which is the base?

4. The normal pH of extracellular fluids (e.g., blood plasma) is 7.4. What is the pH of the ingested solution? Note that the pK_a of the phosphate buffer is 6.9.

5. How many grams of <u>sodium</u> are consumed when drinking the 3 tablespoons of the solution? Note that less than 2 grams of sodium daily is the dietary restriction in patients who have heart disease.

6. How many osmoles (total moles of osmotic particles) are consumed when drinking the three tablespoons of the solution?

Fortunately, only negligible amounts of the phosphate are absorbed into the body by the intestinal tract. Little of the sodium is absorbed as well (for reasons that will be discussed in class). Thus, the sodium and phosphate remain within the lumen of the intestines and colon. The intestines secrete enough water (from body fluids) into the lumen in order to render the lumen osmolarity equal to that of the other body fluids. This water causes the diarrhea that subsequently flushes out the colon.

7. The osmolarity of nearly all body fluids is 300 mOsm (300 milliosmoles per liter). How much water is secreted into the intestinal lumen to dilute the sodium and phosphate to a total osmolarity of 300 mOsm? (Ignore the volume of water ingested with the solution.)

8. After consuming the solution and visiting the bathroom the requisite number of times, <u>if you consumed nothing else</u>, how do you think you'd feel (subjectively)?

9. (Optional) You are working in a chemistry laboratory and decide to make the phospho soda solution yourself from scratch. You find that your chemical stock room has plenty of monobasic sodium phosphate on the shelf, as well as a jar of sodium hydroxide pellets, <u>but no dibasic sodium phosphate</u>. How would you construct a liter of the phospho soda solution using these reagents? (Note: the lab has an analytical balance, a pH meter, and all the requisite glassware.)