

Pre-Class Reading for *Sponges and Bubbles: A Refreshed Investigation of pH and Buffers*

The story below is adapted from “Acids, pH, and Buffers: Some Basic Chemistry for Biological Science” by Terry Platt, Department of Biology, University of Rochester. Originally published May 27, 2010 by the National Center for Case Study Teaching in Science, all rights reserved.



Introduction

Sarah Mathews, an accountant, was sitting with her husband Tom having their after-dinner coffee. She asked, “Another cup, honey?”

“No thanks; more than one seems to bother me these days, especially this late in the evening.”

Sarah was about to express her concern when their son Paul, a high school junior, burst in and said, “Mom, and Dad! Do you know what the pH is of that coffee you’re drinking?”

“What’s pH?” asked Tom.

“C’mon Dad, it’s a measure of acidity—and coffee is like a pH of 5!”

“So, what does that mean, and will it hurt me? Don’t we eat other acid things?” responded Tom.

At this point, Sarah interjected, “But I thought that neutral solutions, like plain water, are pH 7, which doesn’t seem like very far away from 5 to me”

“Yeah, right, Mom; pH 5 is only 100-times more acidic than water. Or try that vinegar we put in our homemade salad dressing—it’s around pH 3, 100 times more acidic than this coffee is!”

His dad asked, “I don’t get it. How can only two units, like the difference between 3 and 5, or 5 and 7, give you 100 times as much?”

“Cause, Dad, it’s a log scale—you know, like earthquakes—and the 2 units mean 2 powers of 10, like 10 squared; that’s where the 100 comes from!”

Sarah, who was better at math than Tom, chimed in. “So you mean if there were 3 pH units difference, that would be 10 cubed, or 1000 times? And if you went from pH 3.7 to pH 6.7, that would also be 1000-fold?”

“Now you’re getting it! And here’s the cool trick we learned today: just like 1.0 pH unit is a factor of 10 in acidity, 0.3 pH units is a factor of 2!”

“Whoa, slow down, Paul,” replied Tom, “you’ve got my head spinning now. Besides, it’s getting late and you have school tomorrow, so off to bed with you!”

The next day brought a beautiful fall afternoon, and the maples were just starting to show their autumn colors. Sarah was enjoying her long late afternoon run and was only a few blocks away from home when she was surprised by the ringtone of her phone.

“Mom, it’s Paul! Get home quick! I was on the computer downstairs, so I didn’t hear Molly fall down in your bathroom—even though she’s only three, she must have managed to climb onto the toilet seat, then the sink, and reach up to the medicine cabinet. She must have thought the pills in there were candy, and I think she started eating a whole bunch of aspirin tablets before she fell! Anyway, I finally heard her crying, and went upstairs where I found her curled up and whimpering on the bathroom floor, with colored pills and cracked bottles scattered around. I don’t think she broke anything, but it looks like she threw up. Oh, no! She just threw up again, this time on me! Hurry, Mom!”

Sarah immediately called 911 for an ambulance, then shifted her running into high gear, since Tom was at work across town. Fueled by adrenalin, Sarah essentially sprinted the rest of the way home, her mind racing as her heart pounded, her lungs ached, and her legs burned from the effort. She berated herself for leaving Molly alone with Paul, not fixing the recently broken latch on the medicine cabinet, and being so far from home without a car. She didn’t know how many tablets of aspirin Molly had consumed, but had recently read that a fatal dose for a child could be as little as 3 gm (ten 300-mg tablets). By the time she arrived home a few minutes later, Molly seemed sleepy, almost lethargic, and Paul said she had vomited several times. Sarah thought that was good, since bits of undissolved tablets could be seen—but just then the ambulance arrived, and after briefly checking Molly’s status, they rushed her to the nearby hospital’s emergency room.