**Lab 6: Buffers and Bones**

**Data Analysis Sheet (DAS)**

**Please fill out this data sheet during the laboratory. A completed DAS with all post-laboratory questions answered is due next week at the beginning of lab.**

**Part 1: The Preparation and Study of the Carbonate Buffering System**

**The Determination of Bicarbonate Buffering Action Towards Acid: Table 1 +1pts**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Solution # | mL of 0.20M NaHCO3  Acid = “A” | mL of 0.20 M Na2CO3  Base = “B” | Initial pH | pH after 5 drops  0.1M HCl | pH after 5 more drops (10 drops total)  0.1M HCl | pH after 5 more drops (15 drops total)  0.1M HCl | pH after 5 more drops (20 drops total)  0.1M HCl | pH after 20 more drops (40 drops total)  0.1M HCl | Max. pH change |
| 1 | 40.0 | 0 | 8.35 | 8.36 | 8.34 | 8.33 | 8.30 | 8.21 | .14 |
| 2 | 30 | 10 | 9.42 | 9.42 | 9.41 | 9.40 | 9.40 | 9.38 | .04 |
| 3 | 0 | 40 | 11.47 | 11.42 | 11.40 | 11.37 | 11.34 | 11.23 | .14 |
| 4 | 10 | 30 | 10.35 | 10.33 | 10.33 | 10.32 | 10.32 | 10.29 | .06 |
| 5 | 20 | 20 | 9.90 | 9.90 | 9.89 | 9.89 | 9.88 | 9.86 | .02 |
| DI#1 | NA | NA | 9.17 | 4.55 | 3.32 | 3.04 | 2.91 | 2.66 | 6.51 |

Probably contamination of DI by incompletely rinsed pH probe.

**The Determination of Bicarbonate Buffering Action Toward Base: Table 2 +1pts**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Solution # | mL of 0.20M NaHCO3  Acid = “A” | mL of 0.20 M Na2CO3  Base = “B” | Initial pH | pH after 5 drops  0.1M NaOH | pH after 5 more drops (10 drops total)  0.1M NaOH | pH after 5 more drops (15 drops total)  0.1M NaOH | pH after 5 more drops (20 drops total)  0.1M NaOH | pH after 20 more drops (40 drops total)  0.1M NaOHl | Max. pH change |
| 6 | 40.0 | 0 | 8.26 | 8.36 | 8.39 | 8.42 | 8.45 | 8.52 | .26 |
| 7 | 30 | 10 | 9.43 | 9.44 | 9.44 | 9.45 | 9.46 | 9.48 | .05 |
| 8 | 0 | 40 | 11.48 | 11.50 | 11.53 | 11.55 | 11.58 | 11.67 | .19 |
| 9 | 10 | 30 | 10.36 | 10.37 | 10.37 | 10.37 | 10.38 | 10.41 | .05 |
| 10 | 20 | 20 | 9.88 | 9.89 | 9.90 | 9.90 | 9.90 | 9.92 | .04 |
| DI#2 | NA | NA | 9.11 | 10.15 | 10.41 | 10.65 | 10.78 | 11.06 | 1.96 |

Probably contamination of DI by incompletely rinsed pH probe.

# **Part 2: Digestion of Animal Materials +1pts**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Material studied (bone, shell, tendons) | Initial Mass (from last week) (g) | Observations | Initial pH | Final Mass | Final observations (Try to bend, twist bones, tendons) | Final pH |
| Bones | 4.521 | Floats, brittle, reddish | 1.24 | NA | Pliable | 3.70\* |
| Tendon | 5.024g | Yellowish, reddish, papery, stretchy | 1.30 | NA | Slimy, pliable, gross | 1.70\* |
| shell | NA | White shell | 1.27 | NA | Half remains, most is gone | 7.13 |

\*72hr values

**Post Lab**

Answer the following questions in full sentences. Show all work and units in your calculations.

1. From your book, we saw: **+1pts**

[H3O+] = Ka X [HCO3-]/[CO32-]

Using the value of Ka from Table 9.5 in your procedures, calculate the theoretical [H3O+] concentration of solution 5. Then calculate the pH of this solution. What is the significance of this value of [H3O+], i.e. when pH = pKa?

Soln 5: 5.6x10-11 (20/20)= 5.6x10-11 M pH = -log 5.6x10-11 =10.25.Maximum buffering capacity is expected when pH = pKa. Chang has 4.8x10-11. That gives you 10.31.

1. Study this equation. [H3O+] = Ka X [HCO3-]/[CO32-] Which of your buffer solutions would you expect from this equation alone, to show the least change in [H3O+] upon the addition of acid or base? Explain. **+1pts**

The 20/20 solutions, since they have equal amounts of weak acid and conjugate base. Max buffercapacity.

1. In Part 1 of today’s experiments, HCl was added by drops to a buffer solution, as well as to deionized water. Compare the changes in pH observed with each drop of acid added to the buffer and to the deionized water. Did the buffer minimize changes in pH with each addition compared to water? If it did, explain in general terms how the buffer was able to do it. **+1pts**

Yes it did. Quite amazingly. Small changes, esp. 20/20, only saw 0.02 or 0.04. DI changed 6.51 with acid and 1.96 with base. With the buffer, the carbonate absorbed HCl and the bicarbonate neutralized the NaOH.

1. In Part 1 of today’s experiments, NaOH was added by drops to a buffer solution, as well as to deionized water. Compare the changes in pH observed with each drop of acid added to the buffer and to the deionized water. Did the buffer minimize changes in pH with each addition compared to water? If it did, explain in general terms how the buffer was able to do it. **+1pts**

Yes it did. Quite amazingly. Small changes, esp. 20/20, only saw 0.02 or 0.04. DI changed 6.51 with acid and 1.96 with base. With the buffer, the carbonate absorbed HCl and the bicarbonate neutralized the NaOH.

5. From your results in this experiment, determine which solution of those you tested had the greatest buffer capacity, i.e. resisted pH changes the best when acid or base was added. **+1pts**

a. Which solution minimized the pH changes the best when strong acid as added? Explain your reasoning, referring back to your data for emphasis. The 20:20 system. It had the smallest change 0.02pH units. The carbonate absorbed the acid.

b. Which solution minimized the pH changes the best when strong base was added? Explain your reasoning, referring back to your data for emphasis.

The 20:20 system. It had the smallest change 0.04pH units. The bicarb absorbed the base.

Le Chatelier’s principle can be used to explain the action of buffer systems. Review CH6 sec. 5,6, and CH9 sec 11 before answering the following questions.

1. Certain conditions, such as asthma, pneumonia, emphysema, and smoke inhalation, lead to decreases in the rate of breathing. This results in an increase in dissolved CO2 in the blood. Using the equation below and Le Chatelier’s principle, explain whether this would result in a decrease or an increase in blood pH (referred to clinically as acidosis or alkalosis, respectively). **+1pts**

H2O(l) + CO2(g) 🡸🡺 H2CO3(aq) 🡸🡺 HCO3-(aq) + H+(aq)

An increase in CO2 would drive the equilibrium to the right, resulting in more H+ and a lower pH.

1. Metabolic acidosis is the decrease in blood pH that occurs when excessive amounts of acidic substances are not removed from the blood. This can occur with diabetes, prolonged physical exertion, or restricted food intake.
2. If [H+] in the blood increases, in which direction will the equilibrium for the preceding reactions shift? Explain fully. **+1pts**

High H+ will shift the equilibrium to the left in an effort to increase the blood pH. This would form more carbonic acid.

1. How will this shift affect CO2 levels? Explain fully. **+1pts**

Higher levels of carbonic acid will shift the second equilibrium to the left, resulting in higher CO2 levels.

1. If breathing rate controls the amount of carbon dioxide exhaled as carbon dioxide gas, will breathing rate increase or decrease in metabolic acidosis in an attempt to return blood pH to appropriate levels? Explain fully. **+1pts**

The breathing rate will increase, as more CO2 is expelled via the lungs.

1. Why can the pH of freshly boiled deionized water slowly become more acidic when left exposed to the atmosphere? **+1pts**

The DI will absorb CO2, which will form carbonic acid, which will dissociate, forming some H+, and a lower pH.

1. What does pH tell us? (Whether a solution is neutral, an acid, or a base.) It gives us the H+ concentration. **+1pts**
2. What did an increase in pH mean in our digestion chambers (jars)? (That the solution was becoming less acid. The acid was being used up.) **+1pts**
3. What did the decrease in mass mean? (The amount of material being weighed was getting smaller each time.) **+1pts**
4. How does bone seem to differ from shell? What are the main components of bone and of shell? (Play on the observation that when the bone was digested a rubbery material was left behind. When the shell was digested nothing was left.) **+1pts**
5. What does the material left from the bone look and feel like? What might this mean? (It will often feel and look like rubber or the tendon or cartilage.) **+1pts**
6. What could have happened to the material in the shells and bone that seems lost? (The material may have gone off as a gas, or it may have gone into the solution, or both.) **+1pts**

On a separate sheet, submit Calculations and Theory section for a formal typed report. Double space.

**Practice writing a formal typed report: Calculations +1 pts**

**SAMPLE CALCULATIONS**: Show one sample calculation using the equation shown below. Your answer to #1 of the DAS will suffice. You will need to type this equation into your report. Explain this equation. What does it represent? What is Ka? What does the ratio represent in this calculation? Explain fully. Show all work and numbers used. Show and use your conversion factors throughout.

*example The equation shown below was used to calculate the hydronium ion concentration of the buffer solutions prepared. This was a necessary, since the pH of the buffer is equal to the negative log of the hydronium ion concentration. Ka is...*

