Experiment # 3:

Equilibria

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CHM 1301*Z

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Work Sheet – Experiment 3

Experiment Title: **Equilibria**

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TA (Demonstrator)'s Name: **Luana Porto**

Date Experiment Performed: **October 2019**

Date Experiment Submitted: **October 23, 2019**

(The report for Experiment 3 does not require an Introduction)

Attach here (if required, indicate the appropriate document(s)):

Medical or other Acceptable Document: _____

Change of Lab Day Form: _____

Change of Lab Section Form: _____

Late Pass: _____

Procedure:

Equilibrium Shift As outlined in lab manual. ("What in the World ISN'T Chemistry", General Chemistry Laboratory Manual, Dr. Rashmi Venkateswaran, 2019.)

Multiple Equilibria As outlined in lab manual. ("What in the World ISN'T Chemistry", General Chemistry Laboratory Manual, Dr. Rashmi Venkateswaran, 2019.)

Buffer Solution and blood pH As outlined in lab manual. ("What in the World ISN'T Chemistry", General Chemistry Laboratory Manual, Dr. Rashmi Venkateswaran, 2019.)

Discussion:

Equilibrium Shift

After adding 20 drops of $CuSO_4$ solution into a test tube, the solution started light blue in color. Afterwise, we added 2 drops of NH_3 into the test tube, and the ammonium turned the light blue $CuSO_4$ that was already in the test tube into a very dark blue color. Then, we added 9 drops of HCl into the solution in the test tube, this caused the color to change from a very dark blue to a lighter blue (still darker than the initial 20 drops of $CuSO_4$ solution that we started with). In step 4, we added only 1 drop of NH_3 to set off a reaction, after the 1 drop the solution became a dark blue color again. Finally, we added 5 drops of HCl, the solution had become a slightly more vibrant blue then before and turned light blue in color.

Multiple Equilibria

In step 5, we mixed $NaCO_3$ and $AgNO_2$ in a test tube, this created a dark yellow-brown colored solution. Then in step 7, we proceeded to add 2 drops of HNO_3 into this solution, when we added the nitric acid the new solution in the test tube became clear as it appeared that the acid has "eaten away" at the solution. In step 8, we added 3 drops of HCl. The solution reacted to the chloric acid by turning a milky-white color. After in step 9,we added 5 drops of NH_4 into this milky-white solution and it became clear in color again, as well some condensation occurred within the test tube. Following repeat steps 7-9 the following results occur: after 7 drops of HNO_3, the solution became milky-white in color and there was some fog that appeared in the test tube. Then we added 14 drops of HCl, there was no change in color that we had observed, but we did observe a precipitate form on top of the solution. Then, we added 3 more drops of NH_3, the solution became a clear color once again, and the precipitate stayed on top of the solution for the previous step. In step 11, we added 5 drops of KI to the solution in the test tube, the solution became a yellow-white color and the precipitation still had remained throughout this process, but it was now at the bottom of the test tube. Finally, we added 2 drops of NaS and this created a dark brown-grey color, with a very bad small and was very murky.

Buffer Solution and blood pH

We had measured an initial pH level of 5.86. After adding 2.50g of $NaHCO_3$ (which dissolved into the water) the pH level increased to 8.27; which is a change of 2.41 in pH), and after complete dissolution it increased another 0.6 6o a pH level of 8.33. We added 30ml of HCl to the beaker, the pH dropped to 7.38 (0.95 pH level drop) and bubbles were forming. In step 17, we added 10ml of 0.85% lactic acid to try and stimulate the body, and in doing so the pH dropped by 0.1 to a pH level of 7.28. Then we increased the rate at which the solution was being stirred (the stir rate) and the pH slightly increased to 7.33 (.05 pH level increase) by doing so. In step 19, we added 0.5g $NaHCO_3$ and increased the pH levels to 7.44 (.11 increase of pH level). Following to stimulate if pH level got too elevated we added 0.5g of $NaHCO_3$ again, in which increased the pH levels further to 7.51 (an increase by 0.7). In step 21, we added a pellet of CO_2 (0.85 g of dry ice), and the pH levels increase slightly to 7.54, and with this step, there was steam produced that comes out of the solution when the pellet was added, due to the fact that the dry ice is an extremely cold/freezing temperature and the solution is a warm room temperature, therefore when mixed steam is produced. Finally in step 23, we added 0.40g of NH_4Cl to the beaker, and this decreased the pH level to 7.52 (very small decrease of 0.02 pH level)

Conclusion:

Equilibrium Shift

Throughout the procedure of part 1, Equilibrium Shift, there was only one shift in the equilibrium observed. By adding $CuSO_4$ and NH_4, we were able to observe said shift. After adding HCl, due to Le Chatelier's Principle, the system has to adjust towards a new equilibria. Therefore, there was a single equilibrium shift, as the system adjusted for the added hydrogen ions.

Multiple Equilibria

As denoted in the name there were multiple equilibrium shifts observed in this section. By adding $NaCO_2$ and $AgNO_3$ a precipitate was formed. After adding HCl, there was the first new equilibrium shift to occur, as the reactions adjusts to the added hydrogen ions. As well, after the addition of the KI and Na_2S, there was another shift in the equilibrium to take place, as the spectator ions from the previous shift reacted into a part of a new chemical reaction. Thus, there were multiple equilibria shifts to occur throughout the procedure of this section of the lab.

Buffer Solution and blood pH

Overall, the results concluded throughout the procedure of said section, were those of that a buffer is a solution that can stop any major changes in the pH levels. If the pH levels were to decrease, and the pH levels in the blood are low to increase these levels you can do so by adding a weak base (sodium bicarbonate). Likewise, if the blood pH levels were to get too high, you can reverse this process, your body will release carbon dioxide by slowing down your respiration.

Reference(s):

1. “What in the World ISN’T Chemistry”, General Chemistry Laboratory Manual, Dr. Rashmi Venkateswaran, 2019

Answers to Questions 1-6:

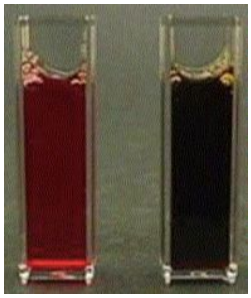
1. a) The ammonium ion is used as the source of acid instead of HCl because the ammonium ions consume those of the hydrogen ions, and this produces ammonia (constituent of the buffer). Therefore, in doing so adding a strong acid will cause a resist in change of pH.

   b) NH_4Cl is used instead of some other ammonium compound (such as NH_4NO_3 or NH_4I) because it is more mild than some of the other ammonium compounds, and it does the desired effect to create a reaction. NH_4Cl is the mixture of a weak base and a strong acid, making it acidic. Weaker bases will will only slightly ionize, and a lower concentration of hydrogen ions.

2. Each time an acidic substance was added to the beaker, I made the observation that the solution had a change in color. As well depending on the acidic substance, there was some heat formed and created a bit of fog within the test tube. All the observations that I was able to observe are those of a physical change, in which, you can tell that a reaction has occurred. As well, the hydrogen ions lowers the pH of the solution.
3. The ability of hemoglobin (Hb) to carry oxygen throughout the body as oxyhemoglobin (HbO_2) is dependent on the pH of the blood. Due to Le Chatelier’s Principle, there is an equilibrium shift to the left, because these hydrogen ions attach to the hemoglobin. In which, will decrease the affinity of the hemoglobin toward the oxygen. There is less oxygen that is attached to the hemoglobin as a result, and so, the transportation of oxygen is reduced. No oxygen reaches the cells because of the shortage of concentration in oxygen that is caused by this.

   $HbH^+ + O_2 \rightleftharpoons HbO_2 + H^+$

4. The solution on the left was made by dissolving several drops of blood in some water. The solution on the right was made the same way except that a small amount of HCl was also added to this tube. Based on my general knowledge about the color of blood and the information in question 3, I can provide an educated proposal of what happened. The color of the blood will change from red to a dark brown when there is a new equilibrium is adjusted and the reaction occurs backwards. The oxyhemoglobin will split into oxygen and hemoglobin molecules. Hemoglobin proteins are made up of iron primarily, in which the outcome makes the blood into a dark brown color.

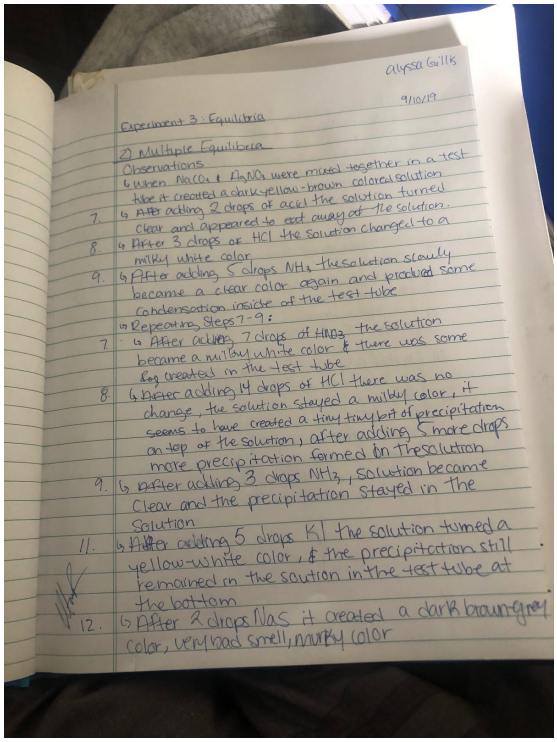


5. A fresh sample of soda had a pH of 2.92. The soda was placed on a magnetic stirrer and made it go flat. The pH is measured again. The pH of the flat soda should be higher than the pH of the fresh soda. The pH of the flat soda should be higher as there is CO2 in that exists within the solution. As the solution is getting stirred, it becomes more in contact with the air surrounding, therefore the concentration of carbon dioxide in the solution is higher than its surroundings, it will then exit the solution. This is when the pH will increase.
6. The bicarbonate/carbonic acid buffer is also present in chickens. However, chickens also combine the carbonate in their blood with calcium ions to make calcium carbonate for their eggshells. Since chickens do not sweat, they pant in hot weather; when they do so they release carbon dioxide into the air. The effects that this would have on the pH of their blood, is that while panting they are releasing this carbon dioxide away from their system and this creates a rise in their pH level of their blood. As well, the strength of the eggshells they produce would become more fragile, because of the depletion of C)2 from panting this creates a shift to the left in the equilibrium. And the decrease in the carbonate will form not as strong egg shells as a result.

$$2H_2O + CO_2 \rightleftarrows H_2CO_3 + H_2O \rightleftarrows H_3O^+ + HCO3^- \rightleftarrows CO3^-2 + H_3O^+$$

Appendix:

Raw Data:


Alyssa Gallis

9/10/19

Experiment 3 - Equilibria

2) Multiple Equilibria

Observations

↳ When $NaCO_3$ & $AgNO_3$ were mixed together in a test tube it created a dark yellow-brown colored solution

7. ↳ After adding 2 drops of acid the solution turned clear and appeared to act away of the solution.

8. ↳ After 3 drops of HCl the solution changed to a milky white color

9. ↳ After adding 5 drops NH_3 the solution slowly became a clear color again and produced some condensation inside of the test tube

↳ Repeating Steps 7-9:

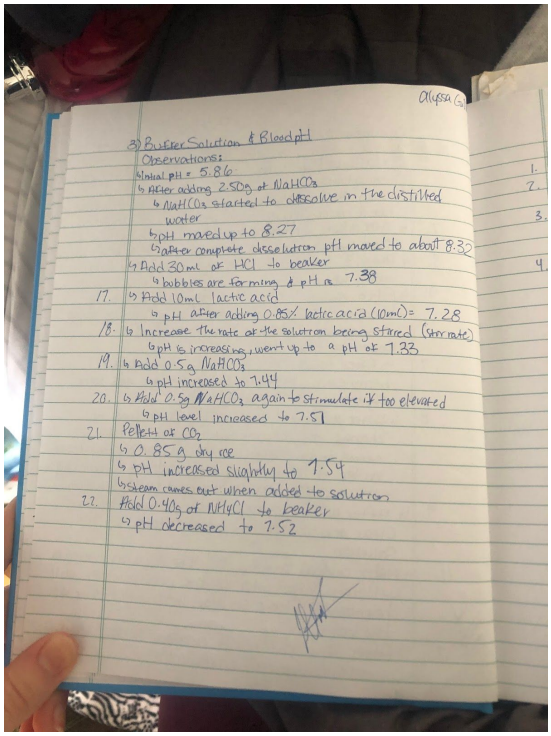
7. ↳ After adding 7 drops of HNO_3 the solution became a milky white color & there was some fog created in the test tube

8. ↳ After adding 14 drops of HCl there was no change, the solution stayed a milky color, it seems to have created a tiny tiny bit of precipitation on top of the solution, after adding 5 more drops more precipitation formed on the solution

9. ↳ After adding 3 drops NH_3, solution became Clear and the precipitation stayed in the solution

11. ↳ After adding 5 drops KI the solution turned a yellow-white color, & the precipitation still remained on the solution in the test tube at the bottom

12. ↳ After 2 drops Na_2S it created a dark brown/gray color, very bad smell, murky color


Alyssa G

3) Buffer Solution & Blood pH

Observations:

↳ Initial pH = 5.86

↳ After adding 2.50g of $NaHCO_3$

↳ $NaHCO_3$ started to dissolve in the distilled water

↳ pH moved up to 8.27

↳ after complete dissolution pH moved to about 8.32

↳ Add 30 mL of HCl to beaker

↳ bubbles are forming & pH is 7.38

17. ↳ Add 10mL lactic acid

↳ pH after adding 0.85% lactic acid (10mL) = 7.28

18. ↳ Increase the rate of the solution being stirred (stirrate)

↳ pH is increasing, went up to a pH of 7.33

19. ↳ Add 0.5g $NaHCO_3$

↳ pH increased to 7.44

20. ↳ Add 0.5g $NaHCO_3$ again to stimulate if too elevated

↳ pH level increased to 7.51

21. Pellet of CO_2

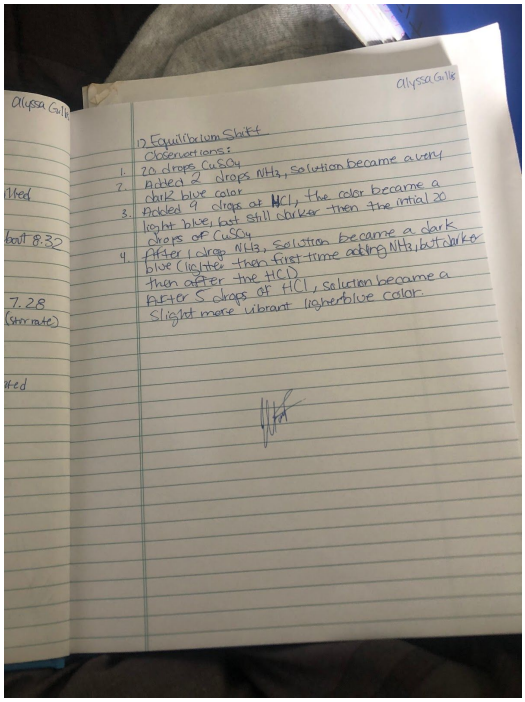
↳ 0.85g dry ice

↳ pH increased slightly to 7.54

↳ steam comes out when added to solution

22. Add 0.40g of NH_4Cl to beaker

↳ pH decreased to 7.52


Alyssa Gallis

1) Equilibrium Shift

Observations:

1. 20 drops $CuSO_4$
2. Added 2 drops NH_3, solution became a very dark blue color
3. Added 9 drops of HCl, the color became a light blue, but still darker than the initial 20 drops of $CuSO_4$
4. After 1 drop NH_3, solution became a dark blue (lighter than first time adding NH_3, but darker than after the HCl)

After 5 drops of HCl, solution became a slight more vibrant lighter blue color

Table 1. Reactions Being Studied

$[Cu(H_2O)_4]^{2+}$ (aq) + 4 NH_3 (aq) ⇌ $[Cu(NH_3)_4]^{2+}$ (aq) + 4 H_2O (l)
2$AgNO_3$ (aq) + Na_2CO_3 (aq) ⇌ Ag_2CO_3 (s) + 2 $NaNO_3$ (aq)
2 H^+ (aq) + CO_3^{2-} (aq) ⇌ H_2CO_3 (aq) ⇌ H_2O (l) + CO_2 (g)
Ag^+ (aq) + Cl^- (aq) ⇌ AgCl (s)
Ag^+ (aq) + 2NH_3 (aq) ⇌ $[Ag(NH_3)_2]^+$ (aq)
H^+ (aq) + NH_3 (aq) ⇌ NH_4^+ (aq)
Ag^+ (aq) + I^- (aq) ⇌ AgI (s)

$2Ag^{+}\,(aq) + S^{2-}\,(aq) \rightleftharpoons Ag_2S\,(s)$
$2\,H_2O\,(l) + CO_2\,(g) \rightleftharpoons H_2CO_3\,(aq) + H_2O\,(l) \rightleftharpoons HCO_3^{-}\,(aq) + H_3O^{+}(aq)$