360Storylines: Acid Rain

Lab 1: Measure Acid Strength

IP: How can acid strength affect a reactions equilibrium? Write a possible explanation of this phenomenon.	**AP:** How does acid rain impact the environment? Based on what you learned in this experiment, try to formulate an explanation to answer this question. What evidence did this experiment supply to aid in your understanding?
Equilibrium is a difficult topic for students to understand. At this[1] point they may only be able to say that adding something to a reaction changes it and the products might be different. The idea of reversible reactions can be challenging. They will know that adding a strong acid changes the reaction, they just may not be able to describe why.	Most students think of acid rain as being very corrosive and something that will burn them if it comes in contact with their skin. They probably do not realize that being acidic only means the rain has a pH less than 7. What students should realize at this point is that the effect of acid rain on the environment is slow. It is not immediately corrosive and damaging, but accumulates its effects.
Revised Explanation: After performing the experiment, what revisions need to be made to your explanation of the ***IP***? What observations did you make that led to these revisions? Write your new explanation.	
Students should hopefully have a better understanding of equilibrium by the end of the lab. A change in pH shifts the equilibrium depending on whether an acid or base is added. They should also conclude that a reactions equilibrium is fluid and can be reversibly altered multiple times.	

Lab 2: Titrations–The Study of Acid-Base Chemistry

IP: Can the concentration of acid rain be measured[2]? Write a possible explanation of this phenomenon.	**AP:** In what way(s) do you think this lab experiment relates back to the anchoring phenomenon? How does the evidence collected in this experiment add to your understanding of acid rain?
Students should be able to answer this based on other things they have learned up until this point. There are a couple ways they might approach this. Some might think you can measure the pH and calculate the concentration if it's a strong acid. Others might remember using titrations in a different unit and conclude that this can be used to determine concentration.	Acids are corrosive regardless of whether they are strong or weak. This means that the concentration of the acid rain will determine what effects it has on the environment. Ideally, they will realize that if they constantly pour vinegar on a metal sheet or plant it will eventually cause damage.
Revised Explanation: After performing the lab experiment, what revisions need to be made to your explanation of the ***IP***? What observations did you make that led to these revisions? Write your new explanation below.	**Working Model[3]:** Apply what you have learned in labs 1–2 to formulate an explanation of the effect acid rain has on the environment.
Hopefully at this point students understand that using pH to determine concentration relies on more math and is really only accurate for strong substances. Titration allows for a more precise concentration determination and should help students be confident that with enough information, the concentration can be measured.	Vinegar is used in cooking all the time to add a little acid to a recipe. Students should be able to conclude that acids are not all dangerously corrosive right away. But all acids are corrosive. The environmental impacts will take time to be apparent and in some cases that might be too late to reverse the effects.

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Lab 3: Analysis of Buffer Solutions and Ranges

IP: How do buffers resist changes in pH? Write a possible explanation of this phenomenon.	**AP:** How can the damaging effects of acid rain be mitigated? In what way(s) do you think this lab experiment relates back to the anchoring phenomenon? How does the evidence collected in this experiment add to your understanding of acid rain?
Buffers will be a new concept for students so they will likely not be able to form a complete conclusion to this question. Hopefully they will be able to understand that there is something about the composition of the buffer that keeps a constant pH. Depending on how in depth you have discussed acids and bases, some students might be able to discuss the buffer "trapping" or "absorbing" the protons.	Students will hopefully take what they learned about buffers and suggest coatings for things that cannot be buffered. Since acid rain effects are slow, a coating can help protect structures for longer periods of time. The goal is to have students think about protection other than umbrella-like protection.
Revised Explanation: After performing the lab experiment, what revisions need to be made to your explanation of the ***IP***? What observations did you make that led to these revisions? Write your new explanation below.	**Working Model:** Apply what you have learned in labs 1–3 to formulate an explanation of the environmental effects of acid rain.
Conjugates is a difficult topic for students. Most students will probably focus on the fact that the buffer components can bond what is added to make sure it can't change the pH. Some students might be able to use more precise language about neutralization of the protons.	At this point, students should start to understand that acid rain affects more than just structures. Acid rain can accumulate in bodies of water and cause damage to both the aquatic ecosystem and the animals that live there. Like people, plants and animals typically have an ideal pH they thrive at. Changing that could be devastating.

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Lab 4: The Quantitative Analysis of Acid Rain

IP: Can different types of acid rain be identified? Write a possible explanation of this phenomenon.	**AP:** Is one type of acid rain more harmful than another? In what way(s) do you think this lab experiment relates back to the anchoring phenomenon? How does the evidence collected in this experiment add to your understanding of acid rain?
Up until this point, most students will probably think acid rain is just one thing, acid rain. They will have trouble answering this question initially. Students will likely say that they can be identified since that is the goal in a lot of chemistry investigations, but might not be able to draw a specific conclusion about why.	Students will immediately think that stronger acids are more harmful. They are partially right. But they will hopefully start to have a better understanding of how concentration plays a role. It is not so much the identity of the acid rain that is key, but what its pH is and how much it rains annually in a specific region.
Revised Explanation: After performing the lab experiment, what revisions or additions need to be made to your explanation of the ***IP***? What observations did you make that led to these revisions? Write your new explanation below.	**Final Model:** Apply what you have learned in labs 1–4 to formulate an explanation of the effects of acid rain on the environment.
Hopefully after the lab students realize that acid rain is made of different acidic compounds that accumulate based on location. That acid rain can be composed of both strong and weak acids. The lower the pH, the more likely the rain is composed of a strong acid like sulfuric acid or nitric acid.	Students should be able to have a pretty clear picture of the damaging effects of acid rain. It damages structures and accumulates in bodies of water. There is also run off from corrosion that can further damage the environment. Acid rain is becoming more acidic as pollution and carbon dioxide continually get pumped into the atmosphere. The environment is slow to show the damage, and by the time it is a problem it may be too late to fix.