Changes. The variables that depend on my experiment are: • Responsiveness. • Sodium thiosu sulphide volume. The volume of sodium thiosiarcofan will remain intact throughout the experiment, where as I will change the concentrations of hydrochloric acid. The volume of sodium thiosu sulphide will be 50cm^3. Different concentrations of hydrochloric acid are 0.10M, 0.25M, 0.50M, 0.60M, 0.90M and 1.0M. Now I will discuss my predictions of what will happen during ... Whether you're introducing a collision theory or something more challenging than the sequence of reactions, the reaction between sodium thiosiarclan — $Na_2S_2O_3$ and hydrochloric acid can provide a consistent, accurate and engaging opportunity to explore these topics. A few weeks ago, I was looking for a new reaction that could be used to investigate how concentration affects reaction time. In the past I have always used traditional reactions such as magnesium and hydrochloric acid or Alka-Seltzer and hydrochloric acid. Although both served their purpose, there were always groups that did not quite receive data that was consistent with what I knew the relationship was. In most cases, this was due to ambiguous and inconsistent timing methods or simply a question of an experimental error, such as a failure to record, that magnesium remained in acid without lifting upwards. I wanted a reaction that would be more likely to produce consistent results from group to group, easy to perform, and was a bit more exciting than waiting for magnesium or Alka-Seltzer to disappear. Finally, I came across the Flinn[1] experiment, which focused on the reaction between sodium thiosiarclan and hydrochloric acid. $Na_2S_2O_3 (aq) + HCl (aq) \rightarrow 2NaCl (aq) + S (s) + H_2O (l) + SO_2 (g)$ What I liked most about this reaction was the easy and consistent time mechanism that my students provided, which could eliminate the ambiguity and differences in time approaches that lab groups have used in the past. Here's how: As you react, one of the products is sulphur. As more and more sulfur is formed, the solution becomes more cloudy, until eventually the solution is opaque. For this reason, the moment when you can no longer see through the solution can serve as a consistent way to stop time. When I asked my students how we would all consistently decide when the solution was opaque, many of them suggested placing an object on the other side of the bead so that we would all stop the clock when the object was no longer visible. This naturally went to the idea of drawing something on the bead itself (x at the bottom in this case) and applying the same reasoning. This reaction and implementation of this natural clock can be seen below in the Flinn[2] video. Although it's just a matter of changing from visible to opaque, I noticed that waiting for this X to disappear had almost all of my students hovering over their beakers anxiously waiting to stop their clock. It is a. it has reached the point where different groups have started using their phones to make time-lapse videos of their reaction beakers. You can see one below. As a teacher, it was fun to watch their level of excitement over something so seemingly simple. Although I used this experiment to primarily investigate collision theory and various factors that affect the time it takes to complete a reaction, it can be easily used to determine something more complex, such as the order of reaction (see the entire Flinn video from which the clip above originates). I also found this lab to serve as a great opportunity for my students to play a greater role in creating an experimental configuration because there wasn't much complexity to it. I made it easier to design an experiment by asking my students a series of questions that were supposed to give the impression that it was a real conversation between scientists interested in answering the question. The PowerPoint that I used to facilitate this discussion can be found as supporting information at the bottom of this post if you are logged in to ChemEd X, but the general topic after these questions: What is our independent variable? How should we change this? Should the total volume of each bead be the same or different? Why? What is our dependent variable? Are there any variables that we should control? How should we go about the time of our reaction? How should we record and organize our data? How are we going to find out our concentrations in terms of molalarity? How should we record and organize our data? What are we going to do with our data once we have it? Chart it? I don't involve students in these things often enough, and it's important that I continue to remember the beneficial experience that students can provide to better understand how learning works. However, you decide to do this, the general approach to this experiment goes something like this: 1) Using a Sharpie, draw a black X at the bottom (outside) of each bead. 2) The 0.15 M $Na_2S_2O_3$ backup solution is used for 5 different concentrations using different amounts of distilled water, although our tap water worked well. The total volume of each solution should be the same in each bead. 3) Add 5 ml of 2 M HCl to the first beaker to start the reaction. You can give it an initial fuss to distribute the HCl evenly. 4) Looking down at the beakers, stop the clock when you see the X completely disappear from view. 5) Do it for all the samples and start analyzing your data After completing the experiment and analyzing the results, I was delighted to see that the data from each group created a chart that showed the relationship I was looking for. No group had one strange outlier or chart with seemingly random points anywhere! Some groups even paid enough attention to the fact that the bead had different levels of opacity to them. It was a great opportunity to talk about the benefits of qualitative evidence as well. I attribute these consistent results to two basic things: 1) A consistent measuring mechanism that each group can easily reproduce 2) It is almost impossible to spoil this reaction - you just pour HCl into the $Na_2S_2O_3$ solution. Minimising the chances of an experimental error was huge. Although I don't always shoot consistent data between groups when we do a lab, I knew the arguments would vary between groups, trying to explain why their experiment showed the relationship they did. These are the arguments that interest me most in development after students have completed data analysis. The students were tasked with developing a preliminary argument using the claim framework, evidence, reasoning (CER). Although most boards had similar claims, they often differed in what evidence they chose to provide. Everyone had access to the same evidence, and yet different groups deliberately omitted some evidence—why? Where their boards differed the most in their reasoning, which is to justify why their evidence makes sense based on known scientific principles. It should be mentioned that the students were not presented with anything about the theory of collision before this laboratory, and yet many of them were able to come up with an important explanation for the particle, while others either circled around ambiguity, lacked detail, or simply displayed some form of misconception. An important part of this was that they tried their best, based on the models that were running in their heads, to explain this phenomenon, and they knew it was up to the scientific community (our class) to act as a filter to sort important explanations from those that either had no details or could not fully take into account the evidence. This is the process that I love to do the most. The lab itself took about 30 minutes, but since I engaged them in an experimental configuration and took the time to construct the arguments that were presented, discussed and refined, the whole process took 3 periods (1 hour each). I want to thank Flinn for the inspiring idea of the experiment in the first place and the NSTA book Argument-Driven Inquiry in Chemistry[3] for providing the framework that I used to set up and make sense of the investigation. Resources 1 Reaction rate of sodium thiosiarclan and hydrochloric acid. E.p.: Flinn Scientific, n.d. Pdf. 2 Rate of Reaction of Sodium Thiosullfate and Acid Sochloric Acid... 20 Dec. 2012, & . Accessed 17 Jan 2017. 3 NSTA Science Store: Argument-Driven Inquiry into Chemistry: Lab.... 1 October 2014, Accessed 17 Jan 2017. Assistance in facilitating discussion in the laboratory Data analysis in 9-12 is based on K-8 and to introduce a more detailed statistical, statistical and statistical analysis datasets for consistency and the use of models to generate and analyze data. Asking questions and defining problems in classes 9-12 is based on experience and progress in classes K-8, as well as formulating, improving, and evaluating empirically verifiable design questions and problems using models and simulations. Explanation: Scientific questions arise in different ways. They can be driven by curiosity about the world (e.g. Why is the sky blue?). They can be inspired by a model or prediction theory or attempt to expand or refine a model or theory (e.g. How do the particle model of matter explain liquid inaccuracies?). They may also be due to the need to provide better solutions to the problem. For example, the question of why you can't siphon water above 32 feet height led Evangelista Torricelli (17th century barometer inventor) to make his discoveries about the atmosphere and the identification of vacuum. Questions are also important in engineering. Engineers must be able to ask probing questions to define an engineering problem. For example, they might ask: What is the need or desire that underpins the problem? What are the criteria (specifications) for a successful solution? What are the limitations? Other questions arise when generating possible solutions: Will this solution meet the design criteria? Can you combine two or more ideas to create a better solution? The construction of explanations and design of solutions in 9-12 is based on the K-8 experience and goes to explanations and projects that are supported by many and independent sources of evidence generated by students, in accordance with scientific ideas, principles and theories. Modeling in 9-12 is based on the K-8 and proceeds to use, synthesize, and develop models to predict and show the relationship between variables between systems and their components in natural and designed worlds. The construction of explanations and design of solutions in 9-12 is based on the K-8 experience and goes to explanations and projects that are supported by many and independent sources of evidence generated by students, in accordance with scientific ideas, principles and theories. Engaging in arguments with evidence in 9-12 is based on K-8 experiences and proceeds to use relevant and sufficient evidence and scientific reasoning to defend and criticize claims and explanations about natural and designed worlds. Arguments can also come from current scientific or historical episodes in science. Planning and conducting research in 9-12 is based on the experience and progress of the K-8 to include studies that provide evidence and test conceptual, mathematical, physical and empirical models. Assessment limit: The assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration and speed data; and qualitative relationship between speed and temperature. Explanation: Emphasis the reasoning of the student, the student, the number and energy of collisions between molecules. Molecules.