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Decomposition of sodium bicarbonate lab answers

I understand that the correct equation is to be the first in which sodium carbonate was produced. However, using the calculation of the relationship between the reacter and the solid product, my experiment showed that equation 2, in which sodium oxide was produced, was to be correct. So now you're dealing with a decision. You can either: Massage the result of the experiment until you see the answer you think you want to be correct. Report the result of the experiment as it happened. If you choose the first way, I'm sure we can come up with convincing explanations. Maybe your initial sodium bicarbonate contained water (so it wasn't 100% clean) and that water was pushed back in heating. Maybe you spilled some how to put it in the crucible. Perhaps part of the mixture in the crucible was sprayed during the reaction. Maybe you're reading the scale badly. Perhaps there is another reaction that is also happening, perhaps involving air, crucible or gas from the bunsen burner. But I think it would be much more honest to report your result as it happened. Your data support the hypothesis that sodium bicarbonate breaks down into sodium oxide. In fact, the agreement with this hypothesis is quite strong, and the agreement with the supposedly correct hypothesis is terrible. This may be due to a mistake you made... or maybe stupid sodium bicarbonate didn't get the note that according to the teacher (or text or Wikipedia or whatever), it was going to decompose into sodium carbonate, so i just went ahead and spread it all the way to sodium monoxide. I realize that you are probably worried about the fact that you will be marked in a laboratory report, because you have come to the wrong conclusion. Any decent teacher, though, gives far more credit for correctly interpreting the data and coming to a conclusion based on the data, even if it's wrong, than to massage the data to support the hypothesis in advance. During our stand-up unit, I wanted my students to take part in an engaging investigation. Many of the stoichiometric labs I've done in the past have followed a more traditional structure that includes something like: Here's the reaction... predict how much... or reaction... compare with prediction... % efficiency. While the merits of such a lab can be argued, I really wanted to immerse my students in a real study that more accurately reflects the scientific skills that I'm trying to support – experimental design, data collection, analysis, creating arguments from evidence, engaging in arguments, etc. To achieve this, I opened an argument-Driven Query in Chemistry (ADI) book and happened to find a wonderful example. Which balanced chemical equation best represents the thermal decomposition of sodium bicarbonate?1 Although I used a version of sodium bicarbonate decomposition in the laboratory a stoichiometric unit for years, with consistent results, what the ADI book provided was a surprisingly different and more creative approach. Students receive four different balanced chemical equations that can explain how atoms are altered during this decomposition. Option 1: $NaHCO_3$ (s) à NaOH (s) + CO_2 (g) Option 2: $2NaHCO_3$ à Na_2CO_3 (s) + CO_2 (g) + H_2O (g) Option 3: $2NaHCO_3$ (s) à Na_2 O s) + $2CO_2$ (g) + H_2O (g) Option 4: $NaHCO_3$ (s) à NaH (s) + CO (g) + O_2 (g) Their task: Calculate which balanced chemical equation accurately reflects the decomposition of sodium bicarbonate. At first glance, the ingenuity of this challenge was not entirely obvious to me. As chemistry teachers, the depth of our content knowledge allows us to systematically rule out three reactions without even conducting an experiment. Even if we had to conduct a study ourselves to determine the right equation, our lab experience and overall scientific skill allows us to easily come up with a plan and identify exactly what we should be looking for. However, our students are novices. They lack knowledge of the content and certainly lack the laboratory skills to easily generate an evidence-based response plan. While they may be lacking in these areas, they are not completely clueless. They know enough to successfully complete their task, even if they don't immediately start connecting to content already learned. At the same time, their lack of knowledge prevents them from knowing the correct response before the test. After thinking about it a little bit, there were at least five different features that convinced me to run this lab. 1) Their lack of prior knowledge makes all four options seem plausible. We had just finished our reaction unit, so everyone was familiar with the generalized pattern to which the decomposition reaction occurs. AB à A+B For students, this reagent is a complete curveball. As novices, they have no idea how to confidently predict the products of such a reaction. You know that their gut instinct will suggest that it breaks down into sodium and bicarbonate. As absurd as it seems to you and me, it seems believable to many of them. Although I could give them a brief explanation of why something like this doesn't break down that way, I didn't have to because it's not even offered as a potential equation, away from bicarbonate! 2) Use of stoichiometry Because we were approaching the end of our stoichiometry unit, it was an ideal application. some products can be easily determined qualitatively, stoichiometers will have to be used when trying to identify a solid product that remains. The use of stoichiometry to generate sufficient evidence to support their final conclusion will be the meat of their argument. 3) Application of qualitative evidence During our reaction unit, they learned about testing certain gases using a flame test. For this reason, many of them remembered that they could identify the presence of CO_2 and O_2 based on what happened when the lighted rail was placed in a tube. 4) Developing an argument from evidence Sometimes it is difficult to reduce, let alone eliminate, earlier concepts and prejudices when they ask students to develop an argument from the evidence. However, since any reaction seems equally likely from the student's point of view, this meant that the evidence gathered was the main driver of their argument. They could not rely solely on prior knowledge simply because they did not have sufficient prior knowledge to allow them to know what products should be, even without an investigation. 5) Student-based experimental project Although I demonstrated some basic safety tips on how to configure their apparatus and general approach to performing reactions, most of the experimental project was supposed to be on them. For the first time, they had to consider questions such as Figure 1- Sample questions from the ADI book With regard to materials, I gave them the following list of equipment and chemical they intended to consume. Consumables: Solid $NaHCO_3$ Equipment: Bunsen Burner, lighter, tube, glass mixing rod, pliers, electronic scale, periodic table When they were completed, each group was required to produce an array that resembled the following structure: Figure 2 - Arrays of array templates for students While the method used to pass arguments to others could easily vary from teacher to teacher, I decided that groups 2-3 meet and present their findings to each other. It was exciting to listen to their conversations, which sometimes lead to real discourse, as opposed to a one-sided presentation of the results. As a teacher, my favorite scenario was that different groups would have different conclusions and consequently different chemical reactions. Listening to them use their knowledge of stoichiometry to justify why their results made sense or pointing out erroneous reasoning in the results of another group was something I would like to record. I mentioned that one of the features I liked about this lab was the involvement of students in experimental design. Although this feature is a hallmark of any laboratory with a it was still a relatively new experience for me. Approximately 20 20 to come up with an outline of their experimental design. Although I had previously shown them how to safely perform a reaction, I did not give them any indication of what data to collect or even how to collect it. I did not tell them how long to heat the sample or what to look for when determining whether the reaction is complete. It really threw them out and I could feel frustration from several groups, because once I did not feed them every detail of every step in the procedure. Class Discussion Allowing them to take responsibility for their experimental design, a few things happened to some groups that served as a learning experience and an opportunity to discuss the importance of an experimental project in the scientific process. 1. Some groups simply did not heat the sample long enough. This resulted in a much higher mass of the product than anticipated, as sodium bicarbonate was still not found in the tube. In an attempt to explain how their percentage gain was more than 100%, several groups initially struggled to realise that they had simply stopped reacting too quickly. This made a good conversation about an experimental error. 2. I was really amazed at how many groups did take the time to think about how they would collect their bulk data. Everyone knew they needed mass before and after, but several groups never considered exactly how they were going to do it. Some groups registered only the mass of sodium bicarbonate, not taking into account the weight of the tube and the glass mixing rod. This meant that when the reaction was complete, they had to empty the contents of the tube into a plastic weighing container to collect the final weight. What they did not think that the contents of their tube will still be very hot. So, when they moved their product to a container that was on the scale, their product literally melted into the container! (See below) Now there was a product all over the scale and on the table. The groups that did this immediately recognized the flaw in their experimental project, and I honestly considered it a great opportunity to learn. Figure 3 - Hot samples melt plastic. 3. Some groups have literally filled half of the tube with sodium bicarbonate. In this way, the reaction seemingly lasts forever. Moreover, since they started with such a large reaction, they never considered reducing the likelihood of using all their reactions effectively. In conclusion, while most groups conducted the experiment without major flaws, I was reminded of the importance in giving them experiences that offer opportunities for failure and reflection in the laboratory. Students need to experience the fact that learning is not just a linear process driven by a thorough understanding of what to do and what to expect step of the road without hiccups. Sometimes our experiments fail or produce results that don't make sense. When that happens, we think about how we can improve the experiment and do it all over again. After taking into account our mistakes, if we are still surprised by the results, perhaps there is something new to learn about the nature of reality! In general, the lab itself took anywhere from 20-30 minutes to set up and execute. Students had the remaining 20-30 minutes of class to analyze their results and develop their initial argument; to be finalised and forwarded the following day. Whether you want to add a bit more research to your labs or just look for a great stoichiometric lab that you can add to your collection, I encourage you to try something like this with your students! While you will need to purchase an argument-driven inquiry in the Chemistry book to access the full teacher flyer and notes, you can find a free student-lab version of the online handout. I also included it in the supplementary information below. Editor's Note: Readers may be interested in reading Pick about the Argument-Driven Query in Chemistry posted by Chad Bridle. Resources 1 Argument-Driven Query in Chemistry. Stoichiometers and chemical reactions: Which balanced chemical equation best represents the thermal decomposition of sodium bicarbonate? NSTA Press, 2015, p. 426 – 441. Sodium Bicarbonate Laboratory - Student Handout Analyzing Data in 9-12 is based on K-8 and proceeds to introduce more detailed statistical analysis, compare datasets for consistency, and use 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 Solutions? What are the limitations? Other questions arise when generating 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. Mathematical and computational thinking at levels 9-12 is based on the K-8 and proceeds to use algebraic thinking and analysis, a range of linear and nonlinear functions, including trigonometric, lining and logarithm functions, and computational tools for statistical analysis for data analysis, representation and modeling. Simple calculation simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena to handle claims. Claims.

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