# 360Storylines: Fast & Slow Processes

## Lab 1: Introduction to Chemical Reactions

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| **IP:** How can we tell if a chemical reaction is occurring? Write a possible explanation of this phenomenon. | **AP:** Why are some chemical reactions fast, while others are slow? 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? |
| Students should be able to give several examples of evidence of a chemical reaction. These examples could come from a previous chemistry course or from their own personal experiences. | Student answers will vary. All the reactions that they observed in the lab occurred relatively quickly. However, they might mention that there are many different types of reactions and that some of these are quicker than others. |
| **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 now be able to make a reasonable prediction as to the type of reaction taking place based on their observations. | |

## Lab 2: Kinetics of Crystal Violet Fading

| **IP:** How could you monitor how fast or slow a reaction progresses? 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 fast and slow processes? |
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| Student answers will vary. Depending on what students have been exposed to previously, they may reference measuring the volume of a gas produced at various times during the reaction, or monitoring the mass of a product or reactant as a reaction progresses. | Students will now be able to use some of the correct language to talk about and quantify reaction rates. They still won't have developed an understanding of why the rates are different, but they will be beginning to think about how to investigate it. |
| **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 1–2 to formulate an explanation of fast and slow processes. |
| Students should note, in this lab, that the chemicals were monitored by color change over the course of the reaction time. Different chemical reactions can be monitored differently. Mass change and gas formation are ways to monitor reactions but, for this lab, monitoring the absorbance of the solution containing the reaction worked best. | Students will understand that there are different types of reactions that can proceed at different rates. They will now have an idea of how researchers go about quantifying these rates. |

## Lab 3: Rate of Decomposition of Metal Carbonates

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| **IP:** Over time, why are some compounds more resistant to decomposition than others? Write a possible explanation of this phenomenon. | **AP:** Why do limestone caves slowly form? 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 fast and slow processes? |
| Students answers will vary. Depending on student knowledge, they may reference different bonding types. Compounds with stronger bonds and intermolecular forces may resist change more. | In this lab students observed that calcium carbonate was able to decompose. They should also realize that when sitting around under standard conditions this rate of decomposition is slow. From this they should conclude that, in nature, limestone can slowly decompose, forming caves. |
| **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 fast and slow processes. |
| Students will note that the different species tested decomposed at different rates, or not at all. These differences can be related to the different metal cations involved. | Students will now be able to discuss how the reaction conditions can affect the rate at which the reaction occurs. They also have firsthand experience with chemically similar compounds reacting at vastly different rates. |

## Lab 4: Application of Le Chatelier's Principle

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| **IP:** How can a chemical reaction be reversed? 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 fast and slow processes? |
| Student answers will vary. If they primarily think of a chemical reaction as being an explosion, they will answer no or not easily. However, if they have previously taken a chemistry course, they may mention equilibria and the reversibility of reactions. | Students should note that just because no evidence for a reaction can be seen it doesn't mean that no reaction is taking place. Reactions involving equilibria might appear slow even if the underlying rates are quite fast. |
| **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. | **Working Model:** Apply what you have learned in labs 1–4 to formulate an explanation of fast and slow processes. |
| Students will now be aware of the concept of a dynamic equilibrium. Chemical reactions occurring in both the forward and reverse direction at the same time. Changing the reaction conditions affects the rates of the forward and reverse reactions, resulting in a change in equilibrium. | Student understanding of reaction rates will have progressed to the point that they now understand the importance of reaction conditions. Not only do conditions influence the speed of a reaction, but they can also influence the overall yield. |

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## Lab 5: Reaction Rates — Iodine Clock

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| **IP:** How does changing the concentration of a reactant affect the rate of the reaction? Write a possible explanation of this phenomenon. | **AP:** How can you increase or decrease the size of a campfire? 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 fast and slow processes? |
| Students will most likely say that increasing the concentration of a reactant will increase the rate of a reaction. They may also say that increasing a reactant will shift the reaction to the product side. Increasing a reactant may allow for a greater chance of collisions with the other reactants, thus causing the rate of the reaction to increase. | Students will intuitively know that a large campfire requires a large amount of wood. They should also understand that simply increasing one of the reactants is not enough to ensure a rapid reaction. For this reason, they should also mention needing sufficient oxygen for the campfire to burn. |
| **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. | **Working Model:** Apply what you have learned in labs 1–5 to formulate an explanation of fast and slow processes. |
| Students will note that depending on the reactant that had its concentration modified, the amount by which the rate changed differed. This provides a good first exposure to the idea of reaction mechanisms, which can explain these differences. | Students should now understand that chemical reactions can be complex processes. The speed with which these reactions occur depends on the steps within the process and the ease with which these steps can be taken. |

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## Lab 6: Explore Chemical Equilibrium

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| **IP:** What everyday processes can be changed by altering concentration, temperature, and/or pressure? Write a possible explanation of this phenomenon. | **AP:** How does industry exploit chemical equilibria to manufacture ammonia?<br>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 fast and slow processes? |
| Students answers will vary. One example is a pressure cooker. Cooking can be sped up by using a pressure cooker. These devices decrease cooking time by cooking food at a higher pressure. In past labs, we have studied how temperature and concentration can affect reactions, and this real-world phenomenon adjusts the reaction time by using pressure. | Students' will need to combine everything they have learned during this storyline to answer this question. Not only do they need to consider how to speed up the reaction, but also how to shift the equilibrium towards the products. |
| **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 1–6 to formulate an explanation of fast and slow processes. |
| Student answers will vary. One example is that in this lab we studied how reactions shifted by altering reactants, products, and temperature. We did not perform an experiment with changing pressure. We were able to observe again how to shift an equilibrium. | Students' should now comprehend the vast range of reaction rates. And how changing reaction conditions can influence these rates. Such considerations are important in industry as they need to quickly and efficiently produce commercially relevant materials. |