BLOSSOMS NGSS LESSON

Target Grade: High School	**Lesson Title: 3-2-1 Blast-Off: Understanding Reaction Rate To Better Design a Toy Rocket!** **Developed by Emily Berman** **Blackstone Academy Charter School** **Pawtucket, Rhode Island**
Topic: Chemistry - Reaction Rate	

State Standard – NGSS Performance Expectation(s)
HS-PS1-5 Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]

Lesson Performance Expectations

- Students use ***patterns*** in data to explain the ***causality*** of various reaction times.
- Students use ***models*** to describe the factors involved in reaction rate.
- Students apply their understanding to an analogous scenario to demonstrate how the factors ***affecting*** reaction rate determine the speed of the reaction.

Materials

- Claim-Evidence-Reasoning Worksheet (pdf)
- 3-2-1 Blast Off! Student Worksheet (pdf)
- Student Notebooks

(Optional)

- Poster Paper (optional)

Phenomena
Some chemical reactions happen faster than others.

NOTE: Science and Engineering Practices are written in **bold blue font**. Crosscutting Concepts are written in **bold green font**.

ENGAGE PHASE	
In the Classroom (Teacher): *Students are encouraged to* **ask questions** *pertaining to the video. These questions are written down in their student notebooks. The teacher may choose to have students share their questions with the class and record them on chart paper or on the chalk or white board so that students can refer to them throughout the investigation.* *Teachers should "look for" evidence of the following when students are using the practice of* ***Asking Questions.*** ***Evidence Bullets (Look Fors):*** ● *Ts should look for evidence of the following when Ss are engaged in the practice of* ***Asking Questions*** *such as:* ○ *Identify questions relevant to science phenomenon.* ○ *Distinguish between scientific and nonscientific questions.* *Ask questions that arise from phenomena.* *Here are some teacher prompts for students to think about the following questions while watching the video(s) and* ***asking questions*** *about the phenomenon:* • *What* ***patterns*** *do you notice in the video?* *Identify at least one* ***cause and effect*** *relationship that you notice in the video.*	**In the Classroom (Students):** ● Students watch the first segment of the BLOSSOMS Video (**0.00 – 2:0**3). In the video various examples of "reaction rates" (i.e. Rockets, cooking, fireworks, airplanes, combustion within a cylinder of an engine) are shared along with four designs for a toy rocket are described. ● When the video is paused at the **2:03** mark, students are encouraged to **ask questions (**see evidence bullets in the teacher column) in their groups pertaining to the rocket designs. Questions are recorded in their student notebooks.
EXPLORE PHASE	

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In the Classroom (Teacher):	In the Classroom (Students):
Teacher provides students with the [3-2-1 Blast Off! Student Worksheet].. Student groups will ***analyze*** the 2 sets of data provided on the worksheet They will first turn and talk with their group members about the **patterns** they observe in the data sets. Once they have done that, they will then create one **model** per data set to explain the **causes** of the **patterns** they notice as an initial explanation. The students focus should be on what is going on between the atoms/molecules during the reactions in data set 1 and in data set 2. The **models** would serve as their initial explanation to which the students would refer to and revise over the duration of the lesson. Consider using the teacher prompts below: **Teacher prompts using crosscutting concepts to structure student thinking about the phenomenon as they analyze the data sets:** ● What **patterns** do you notice in data set 1? What patterns do you notice in data set 2? ● Do you notice any **cause** and **effect** relationships that might explain the **patterns** in the data sets? ● What would **cause** some reactions go faster than others? Teachers should "look for" evidence of the following when students are using the practice of ***Analyzing and Interpreting Data.*** **Evidence Bullets (Look Fors):** • Teacher should "look for" evidence of the following when students are engaged in the practice of Analyzing and Interpreting Data such as: ○ Compare data to make sense of and explain phenomena. ○ Compare data and use comparisons as evidence. Teachers should "look for" evidence of the following when students are using the practice of ***Developing and Using Models.*** **Evidence Bullets (Look Fors):** • Teachers should look for evidence of the following when Ss are engaged in the practice of Developing and Using Models such as:	● With the video paused at the **2:03** mark, the students are given three prompts which the students will use as they ***analyze the data*** (see evidence bullets in the teacher column). The prompts are: ○ *What **patterns** do you notice in the data?* ○ *What could be possible **causes** for these **patterns**?* ○ *Develop a model to show the **cause** and **effect** relationships you see in this data.* ● Working in groups of four, the students collaborate to ***analyze data*** found in the [3-2-1 Blast Off! Student Worksheet.] ● As the students ***analyze data*** of the time it took for the reaction to take place in the toy rockets students will discuss the prompts with their group partners. The groups record their observations on the worksheet or in their notebooks. ● Student groups then create ***two models***, one model for data set 1 and one model for data set 2, to explain their initial understanding of what is happening at the molecular level within the rockets in each of the data sets. (NOTE

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EXPLAIN PHASE

In the Classroom (Teacher):	In the Classroom (Students):
At the pause of the video (**3:37**) the teacher will distribute copies of the Claim-Evidence-Reasoning Worksheet. Students will then share their group's ***models*** to the entire class, using evidence from their ***model*** to explain the ***causes*** behind the different reaction times. The group's ***arguments*** should be focused on **evidence** supporting their ***explanations*** of why some rockets reacted faster than others. • At the culmination of all groups presenting their ***models*** the class, as a whole, should come to consensus about why some rockets took less time to react than others. • As result of class consensus, groups will then revise their initial models and explanations based upon the feedback received during the discussion. • Finally, student groups will write a CER paragraph, using the Claim-Evidence-Reasoning Worksheet to scaffold their writing. Teachers should "look for" evidence of the following when students are using the practice of ***Developing and Using Models.*** **Evidence Bullets (Look Fors):** • Teachers should look for evidence of the following when Ss are engaged in the practice of Developing and Using Models such as: ○ Relate useful models to simple phenomena. ○ Make sense of representations that describe phenomena. Use and/or construct models to predict and to test ideas about phenomena. *Teachers should "look for" evidence of the following when students are using the practice of* ***Constructing Explanations***. ***Evidence Bullets (Look Fors):*** ● Revise causal explanations that are supported by data and relate these explanations to current knowledge. ● Explain science observations using evidence. ● Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. ● Reflect on the best evidence to support a specific explanation.	● Students watch the second segment of the BLOSSOMS video (**2:16 – 3:37**). At the **3:37** mark the video is paused and details three directional prompts for the students: ○ Explain and share your group's ***model*** with your classmates. ○ Use feedback from your classmates to revise your ***model***. ○ Write a CER paragraph to respond to the question: What ***causes*** some rockets to react faster than others? ● Students present their ***models*** with the class, sharing the ***evidence*** behind their group's ***explanations*** for the ***causes*** for differences in reaction rates. Students should be encouraged to incorporate feedback from their classmates to revise their ***models.*** ● Once the students have revised their ***models*** each group will engage in the practice of ***argument from evidence*** by producing a paragraph using Claim-Evidence-Reasoning Worksheet to explain the ***causes*** of the differences in reaction rates based on their ***revised models.***

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ELABORATE PHASE

In the Classroom (Teacher):	In the Classroom (Students):
Teacher should pause video at the **6:00** minute mark and have the students read the directional prompts. Point out to the students that page 3 of the [3-2-1 Blast Off! Student Worksheet] will provide them with a scaffold to address the 2nd bullet point on the video. **SUGGESTION:** Teacher may want to replay the video from **4:13 – 5:04** so that the students can become more familiar with the factors behind reaction rate (concentration, temperature, and surface area). When the students are revising their ***models***, the teacher should allow students to recreate the revisions using poster paper or other materials. Teachers should "look for" evidence of the following when students are using the practice of ***Developing and Using Models.*** **Evidence Bullets (Look Fors):** ● Relate useful ***models*** to simple phenomena. ● Make sense of representations that describe phenomena. ● Use and/or construct ***models*** to predict and to test ideas about phenomena. ● Ts can prompt students ○ How can you incorporate this new information into your model? ○ How does this apply to other topics in your life? ○ What is another example where reaction rate is something to consider? After their groups' models are completed students will work on **designing** the optimal rocket based upon what they have learned. **SUGGESTION:** Teacher should focus the groups on improving the rocket fuel (Alka-Seltzer and water). If groups want to incorporate other substances as their fuel, they would have to provide evidence of how the new substances will perform and the safety factors involved. Teachers should "look for" evidence of the following when students are using the practice of ***Designing Solutions.***	● In the third segment (**3:37 – 6:00**) the BLOSSOMS video teacher shares with the students the factors affecting reaction rate. At the 6:00 mark the students are introduced to three directional prompts: ○ Revise ***models*** for a third time to incorporate this new information. ○ ***Design*** an improved Alka Seltzer rocket that would react even faster that the rockets in Data Tables 1 and 2 and ***argue from evidence*** why your ***design*** is improved. ○ Try to apply knowledge to an analogous situation to make predication about rockets used by NASA. ● Student groups will revise their ***models*** using information shared in the video of how of concentration, temperature, and surface area ***effects*** the speed of the reaction. ● Once their models have been revised student groups will ***design*** the optimal rocket integrating their understanding of the factors that affect reaction rate. ● Student groups will share their ***designs*** with the class and ***argue from evidence*** to ***explain*** how their ***designs*** will optimize the rocket performance. ● The class should arrive at consensus about which ***design*** has the greatest potential for optimum performance and be able to cite evidence based on

EVALUATE PHASE	
In the Classroom (Teacher): In a similar manner to what is found on page 4 of the 3-2-1 Blast Off! Student Worksheet provide the students with an analogous phenomena to the NASA rocket scenario and have them use evidence to demonstrate their understanding of reaction rate. A sample student performance is shown in the student section on the right, but teachers are encouraged to create their own evaluation. This assessment should be provided to individual students as a metric of their understanding of the lesson. This evaluation could be administered as a formative assessment or as a summative assessment.	**In the Classroom (Student):** Individual students will address the following prompt: **Develop a model** which shows how the surface area of a reactant **effects** the rate of reaction.

The 5E Instructional Model (Bybee, 2015)

Engage	The teacher or a curriculum task assesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Explore	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified, and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explain	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaborate	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluate	The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

Bybee, R. (2015). *The BSCS 5E Instructional Model: Creating Teachable Moments.* Washington, DC: NSTA Press