**What does a Kiln have to do with math?**

**Video link:** [**https://youtu.be/il7TRcRzvjU**](https://youtu.be/il7TRcRzvjU)

**Lesson Plan**

**Teacher Note:** Please preview the entire video and pre-work the solutions in order to anticipate students’ needs, misconceptions and materials unique to your classroom.

You will also need to determine the background knowledge of your students regarding the following topics, and decide the best method for providing that background in order to support the conceptual understanding of the mathematics shown in the video.

* Order of Operations
* Rates

**Common Core Mathematical Content Standards**

* 6.NS.3 Fluently add subtract, multiply and divide multi digit decimals using the standard algorithm for each operation.
* 7.RP.3 Use proportional relationships to solve multi step ratio and percent problems.
* 7.NS Apply and extend previous understandings of operations with fractions to add, subtract, multiply and divide rational numbers.

**Common Core Mathematical Practice Standards**

1. Make sense of problems and persevere in solving them.

2. Reason abstractly and quantitatively.

3. Construct viable arguments and critique the reasoning of others.

**Company Information**

Since 1873, Kohler Co. has been improving the level of gracious living by providing exceptional products and services for our customers’ homes and their lifestyles.  We believe better business and a better world go hand-in-hand. [Watch Our World video](https://www.youtube.com/watch?v=wU7sb6UZmS4&rel=0). Whether that is beautiful [kitchen and bath products](https://www.us.kohler.com/us/), [innovative engines and generators](https://power.kohler.com/en/engines), [memorable hospitality offerings](https://www.americanclubresort.com/) or developing clean water, sanitation, and community development solutions around the world. To put it simply, we strive to enhance the quality of life for current and future generations through design, craftsmanship and innovation, fueled by the passion of more than 36,000 associates worldwide.

**Summary**

The process for making sinks, tubs and toilets involves a process in which the ceramic or porcelain is heated to a very high temperature in a device called a kiln. The math involved in this process must be correct so that products are high quality and employees are safe. In this video, you will explore rates while learning about the production of vitreous products using a giant kiln.

**Pre-Activity Discussion:**

* Vocabulary
	+ Kiln – an oven like device that “fires” the ceramic and porcelain products to make them harder, denser and shinier. The kiln at Kohler operates 24 hours a day, 7 days a week.
	+ Vitreous Products – products that need firing in a kiln
	+ Kiln Cars – platforms on wheels that carry the products through the kiln tunnel
	+ Kiln Tunnel – the kiln cars travel through the kiln tunnel to harden them. It is approximately the length of a football field and has a firing zone. This area has temperatures over 2,000 degrees Fahrenheit.

**Differentiation:**

* The questions on the student handout are scaffolded to meet the needs of students who may need extra support.
* Eliminating some of the added questions, and just posing the questions from the video would be a possible differentiation strategy for students who do not need the extra support.
* Students may also benefit by working with others as part of a partner/group investigation.

**Part 1: (0:00 – 1:48)**

BREAK 1

* Problem posed: *How many kiln cars will go through the kiln every day?*
* Information given
	+ It takes 23 hours for a kiln car to pass through the kiln tunnel.
	+ 121 kiln cars fit in the kiln tunnel at one time.
* Have students use part one of student handout to document their calculations and thinking.
* Before showing Part 2, have students share their solution methods.

**Part 2: (1:52 – 2:53)**

 BREAK 2

* Discuss the solution from Part 1 and any calculation errors or misconceptions.
* Problem posed: *How long will it take to heat a piece to 500 degrees Fahrenheit?*
* Information given
	+ The product is 70 degrees when it enters the kiln tunnel.
	+ The heating rate of the piece is 5 degrees per minute.
* Students are asked to answer the question on the student handout.
* Before showing Part 3, have students share their answers and problem solving methods.

**Part 3: (2:56 –3:40****)**

 BREAK 3

* Discuss the solution from Part 2 and any calculation errors or misconceptions
* Problem posed: *If we now want 135 kiln cars to exit the kiln each day, how long would it take each piece to travel through the entire kiln?*
* Information given: No new information
* On the handout, students are asked to MAKE A CONJECTURE before they calculate a solution. *Will it be a longer or shorter time than the original 23 hours?*
* Before showing Part 4, have students share their answers and problem solving methods.

**Part 4: (3:45 – 4:38)**

* Discuss the solution from Part 3 and any calculation errors or misconceptions

**Extension:**

* Refer to the solution from part 3. If the product is in the kiln tunnel for a shorter length of time, what consequences could that have on the quality of the product? What solutions can you think of to counteract those consequences?
* Part 2 of the video discussed the length of time it would take to heat a piece to 500 degrees. If the product is allowed to cool back to 70 degrees after it leaves the kiln, is the cooling rate the same as the heating rate?
* How does too rapid heating or cooling affect vitreous products?
* Explore the history of ceramics. What is the date of the oldest piece of pottery ever discovered? Where was it found?
* Interview a local artist that works with ceramics.

**Student Handout - *What does a Kiln have to do with math?***  Name(s):

**Pre-Video Discussion:**  *Notes on important background information and vocabulary.*

**Break 1:** **Problem:** *How many kiln cars will go through the kiln every day?*

1. List the information given to you in the video.

2. Use the information that was given to you to calculate a solution to the problem

3. Why do you think this would be useful information for the company to know?

**Break 2: Problem:** *How long will it take to heat a piece to 500 degrees Fahrenheit?*

4. List the information given to you in the video.

5. Use the information that was given to you to calculate a solution to the problem.

**Break 3: Problem:** *If we now want 135 kiln cars to exit the kiln each day, how long would it take each piece to travel through the entire kiln?*

6. Make a conjecture about the solution to this new problem. Do you think the product will be in the kiln for a longer time or a shorter time than the original amount of 23 hours for each piece? Why?

7. Calculate the solution to the problem.

8. Does your solution match your conjecture? Why or why not?

**Answer Key *What does a Kiln have to do with math?***

**Break 1:** **Problem:** *How many kiln cars will go through the kiln every day?*

1. List the information given to you in the video.

* + **It takes 23 hours for a kiln car to pass through the kiln tunnel.**
	+ **121 kiln cars fit in the kiln tunnel at one time.**

2. Use the information that was given to you to calculate a solution to the problem

**1 car/23 hours = *x* cars/24 hours**

**1.04 cars in 24 hours**

**121 in kiln x 1.04 = 126.3 cars through the kiln each day**

3. Why do you think this would be useful information for the company to know?

 **Answers Vary**

**Break 2: Problem:** *How long will it take to heat a piece to 500 degrees Fahrenheit?*

4. List the information given to you in the video.

* + **The product is 70 degrees when it enters the kiln tunnel.**
	+ **The heating rate of the piece is 5 degrees per minute.**

5. Use the information that was given to you to calculate a solution to the problem.

 **500 – 70 = 430 degree increase in temperature.**

 **430 degrees / 5 degrees per min = 86 minutes or 1 hour and 26 min**

**(Could use unit analysis here if wanted)**

**Break 3: Problem:** *If we now want 135 kiln cars to exit the kiln each day, how long would it take each piece to travel through the entire kiln?*

6. Make a conjecture about the solution to this new problem. Do you think the product will be in the kiln for a longer time or a shorter time than the original amount of 23 hours for each piece? Why?

**Answers vary. Encourage students to justify their thinking using data from #1 and #2.**

7. Calculate the solution to the problem.

 **121/135 = .896**

 **.896 x 24 hours = 21.5 hours in the kiln tunnel**

8. Does your solution match your conjecture? Why or why not?

 **Answers vary**