**What does Manufacturing Waste have to do with math?**

**Video:** [**https://youtu.be/Mv4lCY0xJzw**](https://youtu.be/Mv4lCY0xJzw)

**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.

* Metric and customary units of measure

**Common Core Mathematical Content Standards**

* 6.RP.3c – Find a percent of a quantity as a rate per 100.
* 6.RP.3d – Use ratio reasoning to convert measurement units. Manipulate and transform units appropriately when multiplying and dividing quantities.
* 7.RP.3 – Use proportional relationships to solve multi step ratio and proportion problems.

**Common Core Mathematical Practice Standards**

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

2. Reason abstractly and quantitatively

3. Attend to precision.

**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 and fueled by the passion of more than 36,000 associates worldwide.

**Summary**

This video discusses the overall process and the mathematics used at the Kohler Wastelab to develop a high quality tile from waste materials that would normally end up in a landfill. Just because waste material is used to create it, doesn’t mean the resulting tile can’t be strong, durable and beautiful!

**Pre-Activity Discussion:**

* What types of waste would be produced when making sinks, bathtubs, & toilets?
* What things could affect the quality of a product (like tiles) made out of clay?
* Vocabulary
  + Waste Stream – the life cycle of waste, from its source through to final disposal
  + Clay cull - Material rejected as below the desired or stated grade of stone.
  + Slag - stony waste matter separated from metals during the smelting or refining of ore.
  + Waste glaze & enamel – material left over from the glazing (seals porous material) and enamel (protective coating) process.
  + Virgin material – material that has not been previously used or consumed, or subjected to processing other than for its original production.

**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 – 2:04)**

BREAK 1

* Information given in the video
  + Waste material needed for one tile - 1.2 kg
  + Proportion of the waste material needed
    - Clay cull – 75%
    - Waste glaze – 15%
    - Slag – 2%
    - Waste enamel – 8%
* Students will calculate the amount of each waste material needed on the student handout.
* The solutions shown after the break are in grams vs. kilograms.
* Before showing Part 2 have students share their answers and problem solving methods. Discuss which unit of measure (g or kg) is most useful

**Part 2: (2:07 – 2:54)**

BREAK 2

* Discuss any errors or misconceptions in student thinking and calculations from Part 1.
* Information given in the video
  + Amount of waste material available
    - Clay cull – 83 tons
    - Waste glaze – 5.3 tons
    - Slag – 1700 pounds
    - Waste enamel – 2400 kg
* Students will calculate the number of tiles that can be made using each waste material on the student handout.
* Conversion factors needed
  + 1 ton = 2000 lb.
  + 1lb = 0.45 kg
  + 1kg = 1000g
* Before showing Part 3 have students share their answers and problem solving methods.
* Discuss possible reasons why three different units of measure are used by the company when working with these quantities.

**Part 3: (2:56 –** **3:16)**

BREAK 3

* Discuss any errors or misconceptions in student thinking and calculations from Part 2.
* Students will calculate how much of each waste stream is needed to make the 11,250 tiles that we calculated we have enough waste enamel for from Part 2.
* Before showing Part 4 have students share their answers and problem solving methods.

**Part 4: (3:18 – 3:55)**

* Solutions are shown
* Discuss any errors or misconceptions in student thinking and calculations from Part 3.

**Extension:**

* If the tiles are 4in x 4in, how many tiles would you need to buy cover your classroom floor?
* If 1 million tiles are made every year, how much waste material has been saved from going into a landfill?
* Investigate cost comparisons between tiles made of recycled or waste materials versus those made with virgin materials.

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

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

**Problem:** *How many tiles can we manufacture given the waste materials that we have available?*

**Break 1:**

* Waste material needed for one tile - 1.2 kg
* Proportion of the waste material needed
  + Clay cull – 75%
  + Waste glaze – 15%
  + Slag – 2%
  + Waste enamel – 8%

1. How much of each waste material is needed per tile? Show your work. Final answers should be in grams.

**Break 2:**

* Amount of waste material available
  + Clay cull – 83 tons
  + Waste glaze – 5.3 tons
  + Slag – 1700 lb.
  + Waste enamel – 2400 kg
* 1 ton = 2000 lb.
* 1lb = 0.45 kg
* 1kg = 1000g

2. Calculate the number of tiles that can be made using each waste material.

Clay Cull:

Waste Glaze:

Slag:

Waste Enamel:

3. How many tiles are we able to manufacture?

**Break 3:**

4. Calculate how much of each waste material is needed to make the number of tiles we figured out in problem #3 above.

**ANSWER KEY – What does a waste material have to do with math?**

**1.** How much of each waste material is needed per tile? Show your work. Final answers should be in grams.

1 tile – 1.2 kg or 1200 grams

Clay Cull: 75% of 1200g = 900g

Waste Glaze: 15% of 1200g = 180g

Slag: 2% of 1200g = 24g

Waste Enamel: 8% of 1200g = 96g

**Break 2:**

* + Amount of waste material available
    - Clay cull – 83 tons
    - Waste glaze – 5.3 tons
    - Slag – 1700 pounds
    - Waste enamel – 2400 kg
  + 1 ton = 2000 lb
  + 1lb = 0.45 kg
  + 1kg = 1000g

2. Calculate the number of tiles that can be made using each waste material.

Clay Cull: 83 tons \* 2000lb/ton = 166000 lb

166000 lb \* 0.45kg/lb = 74700 kg

74700 kg \* 1000g/kg = 74700000 g

74700000 g \* 1tile/900g = 83000 tiles

Waste Glaze: 5.3 tons, same process as above until last step \*1tile/180g = 26500 tiles

Slag: 1700lb \* 0.45 kg/lb \* 1000g/kg \* 1tile/24g = 31875 tiles

Waste Enamel: 2400 lb, same process as above until last step \* 1tile/96g = 11250 tiles

3. How many tiles are we able to manufacture?

11,250 tiles

**Break 3:**

4. Calculate how much of each waste material is needed to make the number of tiles we figured out in problem #3 above.

Waste Enamel – all 2400 kg that we have

Clay Cull

11,250 tiles \* 900g/tile \* 1kg/1000g \* 1lb/0.45kg \* 1 ton/2000lb = 11.25 tons needed

Waste Glaze

11,250 tiles \* 180g/tile \* (rest is same as above) = 2.25 tons needed

Slag

11,250 tiles \* 24g/tile \* 1kg/1000g \* 1lb/0.45kg = 600 lb needed