

Task: Ceramic Cores
6th Grade Math

Alcoa Howmet's casting support operation in Morristown is a top supplier of complex ceramic cores, which form the internal cooling passages of investment-cast turbine airfoils used in the aircraft engine and industrial gas turbine industries. At the core's beginning is a process of mixing specific elements to create a hardened material capable of withstanding extreme temperatures and wear. John, a highly trained employee, knows he has to mix 2 specific ingredients at just the right ratio to form the hardened material. He always uses the same ratio of 1 part wax to 3 parts sand.

- A. If a batch requires John to use 50 parts of wax, how many parts of sand will be needed to create a mixture with the same ratio of 1:3? Show a ratio of the new amounts and label each component.
- B. Find a way to record the relationship between the wax and the sand as you make multiple batches of material. Describe any patterns you see.
- C. In order to make a new material with the ability to reduce expansion, the manufacturer adds a metal alloy as a third ingredient. For every unit of 1 part wax to 3 parts sand they will use 2 parts metal alloy. Create a table using all 3 ingredients and describe the relationship between each ingredient to each other.
- D. If John makes a batch of the new material with 12 parts sand how many parts of wax and metal alloy will he need to create the same ratio of 1 part wax to 3 parts sand to 2 parts metal alloy. (1:3:2) Explain how you determined your answer.

Common Core State Standards

6.RP.1

1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak," "For every vote candidate A received, candidate C received nearly 3 votes"*

6.RP.2

2. Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. For example, “This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is $\frac{3}{4}$ cup of flour for each cup of sugar.” “We paid \$75 for 15 hamburgers, which is a rate of \$5 per hamburger.”

3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

a. Make tables of equivalent ratios relating quantities with whole number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.

Common Core State Standards for Mathematical Practice

- **Make sense of problems and persevere in solving them.**
- **Reason abstractly and quantitatively.**
- **Construct viable arguments and critique the reasoning of others.**
- **Model with mathematics.**
- **Use appropriate tools strategically.**
- **Attend to precision.**
- **Look for and make use of structure.**
- **Look for and express regularity in repeated reasoning.**

Essential Understandings

- **Reasoning with ratios involves attending to and coordinating two/three quantities.**
- **A ratio is a multiplicative comparison of two/three quantities, or it is a joining of two/three quantities in a composed unit.**
- **A proportion is a relationship of equality between two ratios.**

Possible Solutions/Solution Paths

A. Student may say that because the wax part is going from 1 part to 50 parts and the ratio is 1:3 they should explain that the wax can be multiplied by 50 so the sand should be multiplied by 50. There should be an answer of, *“for every 50 parts of wax there should be 150 parts of sand.”* They could also show a ratio of 50:150

B. Students may record a table, horizontally or vertically

Wax	Sand
1	3
2	6
3	9
4	12
5	15

- Depending on values in the table, student may recognize that the sand column is always 3 times the amount in the wax column.

how students record the table, student may recognize

C. Students may record a table, horizontally or vertically

Wax	Sand	Metal Alloy
1	3	2
2	6	4
3	9	6
4	12	8
5	15	10

Depending on how students record the values in the table,

- student may recognize that the sand column is always 3 times the amount in the wax column and the metal alloy is 2 times the wax amount.
- Student may recognize the relationship between the sand and the metal alloy as (wax amount(X) times 3) – X = metal alloy

D. Student should be able to extend the ratio from unknown wax and unknown metal alloy to known wax and known metal alloy by using the known sand amount and the reasoning used in part C.

Additional Teacher Information
This lesson could be concluded with creating a “Goop” compound using ratios of school glue, Borax, and water.