Dense Rocks

I want to know how much the huge rock behind my house weighs. The shape of the rock is like a cube. I took a smaller similar rock (same shape) and submerged it in water. I weighed the water that was displaced. I also know that this kind of rock is 2.7 times as dense as water. I also know that the rock in my backyard is 15 times taller than the smaller rock.

Find the weight of the rock in my back yard. Do not forget to explain your reasoning and show all your work (especially if you use a calculator) so I will be confident that your answer is reasonable.

Use the information below:

Weight of water displaced by smaller rock = 64.9 grams

Density of this rock = 2.7 grams/cc

Big rock is 15 times taller than smaller rock

Density = weight/volume

Grade Levels 6 - 8

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Context

I teach sixth grade math and science which gives me the opportunity to apply some of the scientific concepts in more practical problems often times employing a good deal of important mathematics.

The class had been studying density. First investigating the formula for finding the volume of rectangular solids, then prisms and then displacing water to find the volume of irregular shaped objects. Then we found the density of different materials such as glass, iron, paraffin, wood, copper, aluminum and water by dividing their mass (weight) by their volume.

I invited a guest engineer into the class to demonstrate how scientists can use the concept of density to estimate the weight of dinosaurs. I wanted to assess my students' knowledge of using density, how volume increases as the lengths increase and the idea of ratio to estimate the weight of the rock in my backyard. Although all my students were engaged in this task, it was very challenging and many did not complete the whole task, but great thinking and discussions were taking place.

What This Task Accomplishes

This task makes students engage in some of the more difficult aspects of density and its uses.

It also has students using algebra and geometric concepts. They need to keep track of the units they are working with in order to know where they are and where they want to proceed.

What the Student Will Do

Because I knew this was a challenging task and that the strength of the problem would be in the discussions students would have with one another - trying to sort out their knowledge of density and their beginning feeling for ratios and geometry. I encouraged students to work together.

The first thing they did was gravitate to a group they were comfortable with and began talking about the information that was given to them and where they wanted to begin. After each step, they seemed to need to review what they did and what they found in order to decide what to do next.

Time Required for Task

45 - 60 minutes

Interdisciplinary Links

There is a strong link to the study of density.

Teaching Tips

When I arranged the students at tables, I made sure there was at least one student at each table that I felt had a strong grasp of density. I imagined that they would help guide the discussion with the other students. However, I quickly found out that this problem was so engaging that the whole class was a buzz and soon the students that had a good grasp of the problem were all working together. The students seemed to gravitate to a group in which they felt academically comfortable with the discussion.

Suggested Materials

- Calculators
- I had the actual smaller rock that I had found the density of. (It made the problem more real.)
- I also had a chart hung up that gave the conversion of 2.5 pounds = 1 kilogram.

Possible Solutions

Multiply the weight of the water displaced by the small rock by the density of the rock to find the weight of the small rock. (I could have given them the weight of the small rock, but I wanted to see if they remembered that the density of water is 1 so all other materials can be compared to water.) Since the rock is a cube, then the weight of the big rock will be 15 cubed heavier than the small rock. So far we have 2.7 x 64.9 grams = 175.23 grams (weight of the small rock) x 15 x 15 x 15 = 591401.25 grams. This is an acceptable answer. However, I really cannot get a feel for the weight. An Expert would find out how to change it to a more understandable unit of weight. Dividing by 1,000 to change it to kilograms is a beginning. So the rock weighs 591.40125 kilograms. Knowing or looking up the fact that 2.5 pounds = 1 kilogram makes the rock weigh 591.40125 x 2.5 = 1478.5031 pounds.

Benchmark Descriptors

Novice
This student is applying inappropriate concepts. S/he multiplies the weight of the displaced water by the increase in the height of the rock. This reasoning will not solve the problem. There is no explanation or labeling to indicate the student's thinking.

Apprentice
This solution is not complete and it is obvious that some of the concepts are not understood. However, there is some indication that the student understands that the weight of the small rock will be multiplied by the density of the rock, and then increased by how much bigger the real rock is. However, the student fails to cube the increase of the rock's length because it needs to stay a cube. The explanation is incomplete and lacks evidence of complete understanding of the problem.

Practitioner
This student has a good understanding of the problem and the major concepts needed to solve the problem. S/he uses a strategy that leads to a solution using effective mathematical reasoning. There is a fairly clear explanation of the solution. Some ideas are not completely explained like, why multiply by 15 x 15 x 15 and why divide by 1,000? I try to encourage students to label their numbers so a written explanation can be short. This student leaves the answer in kilograms.

Expert
This solution shows a deep understanding of the problem including the ability to identify the appropriate mathematical concepts. S/he uses an effective strategy and employs refined reasoning in bringing his/her answer to a convenient unit of measure of pounds. There is a clear and effective explanation detailing how the problem is solved. There is precise and appropriate use of mathematical terminology and notation.