6-20-2016

Exploring Density

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The density model is designed to allow students to explore how mass, volume, and temperature directly affect the density of an object or liquid. Density is a concept that requires conceptual understanding as well as mathematical precision and computation. Students will use the mathematical formula D= M/V in calculating density. By allowing the students to experiment with the mass and volume variables, they are able to visually see how changing these variables can impact Density. The model is designed so that an object will move to a floating, suspension, or sinking position depending on the density of the object in relation to the density of the liquid. This is both a mathematical concept in terms of ratios/relationships as well as physical science concept relating to matter, space, and movement. The purpose of this model is to combine science and mathematics to provide students with a deeper and higher level of understanding while they make connections across disciplines.

This interdisciplinary class activity requires students to use both mathematics and scientific relationships to gain a deeper level of understanding. The attached worksheet will required student to manipulate the mass and volume of an object. Questions on the worksheet are scaffolded to allow students to discover the concept of density on their own. The order of the questions are designed to build upon prior knowledge as they obtain new knowledge. New = Old + Change. The activity is differentiated further by allowing students to change the temperature which changes the density of the unknown liquid. Questions about the temperature of the unknown liquid require student to analyze the relationship between temperature and density. Line graphs of the density of the object and the density of the unknown liquid are provided on the right side of the model to give another visual representation. Following the activity worksheet, students will watch a three min video to reinforce the mathematics and science knowledge they gained from the model.

Standards

Math:

CCSS.MATH.CONTENT.HSG.MG.A.2

Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

General Science:

3.1h Density can be described as the amount of matter that is in a given amount of space. If two objects have equal volume, but one has more mass, the one with more mass is denser.

3.1i Buoyancy is determined by comparative densities.

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Activity Worksheet

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{\text{g}}{\text{cm}^3} = \frac{\text{g}}{\text{mL}}$$

solids liquids

(note: liquid is unspecified)

1) What is the density of a piece of wood that has a mass of 25.0 grams and a volume of 29 cm^3? (use formula then check answer with model)

2) What happens to density as volume increases/decreases?

3) What happens to density as mass increases/decreases?

4) What happens to density as the liquid temperature changes?

5) What happens when density of the object is equal to density of the liquid?

6) A piece of wood that measures 3.0 cm by 6.0 cm by 4.0 cm has a mass of 80.0 grams. What is the density of the wood?

   a. Would this piece of wood float if the liquid temperature was 30 degrees C?

   Why/why not?

   b. At what temperature would the piece of wood sink in this liquid?

Model Instructions

1) Click setup – this resets model at any time.
   -Find mass slider move arrow to specified mass
   -Find volume slider move arrow to specified volume
   -**click go (forever)**
   -Density will automatically populate in the Density output box.

2) Keeping mass constant, move the volume slider noting the density changes in the output box
3) Keeping volume constant, move the mass slider noting the density changes

   Experiment with mass/volume sliders noting the behavior of the object as it moves up and down in the liquid

4) Keeping the mass/volume constant, move the temperature slider noting the changes in liquid density

5) Experiment with all sliders setting density and liquid density equal to each other – observe the objects' behavior

https://www.youtube.com/watch?v=MzsORE0ae10