Proportional Density (by Mary Burr)

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| **Overview** |
| **Prerequisite Skills:** * Calculate constant of proportionality from a table.
* Write/graph equations in the form y= kx.
* Optional: students are familiar with Google classroom and Geogebra. (If not, worksheet and graphs can be completed on paper instead of electronically).
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| **Learning Goal:** Students will be able to use tables, graphs, equations, and slope to represent and compare proportional relationships.  |
| **Florida Math Standards:**MAFS.7.RP.1.2: Recognize and represent proportional relationships between quantities; Decide whether two quantities are in a proportional relationship…by graphing on a coordinate plane.MAFS.8.EE.2.6: Derive the equation y=mx for a line through the origin**Mathematical Practices:** 1. Make sense of problems and persevere in solving them2. Reason abstractly and quantitatively4. Model with mathematics.5. Use appropriate tools strategically **Florida Science Standards:** SC.912.P.8.3: Explore and describe the densities of various materials through measurement of their masses and volumes. |
| **Materials:** * PhET *Density* simulation:
* <http://phet.colorado.edu/sims/density-and-buoyancy/density_en.html>
* Computers/Tablets/Chromebooks for each student or pair of students
* Smartboard/Smart Slate
* Document Camera
* Proportional Density Activity Sheet (1 per student)
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| **Estimated Time:** Approximately two 45-minute class periods |
| **Proportional Density - Day 1** |
| **Warm Up** | **15 minutes** |
| Activate prior knowledge using this problem as a warm-up (displayed on Smartboard): 1. Is this a proportional relationship? How do you know? Can you write an equation for the relationship? What will its graph look like?

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| Acres  | 5 | 8 | 15 |
| Bushels of wheat  | 140 | 224 | 420 |

1. Predict: Which material has the highest density: brick, Styrofoam, wood, aluminum or ice? With your group/partner, order the materials from the least density to the highest density.

Teacher & students review warm up answers before moving into simulation. Students should share their predictions and write it down for future reference (can be written down on the board as a class summary). |
| **Simulation Introduction** | **10 minutes** |
| *Teacher will…* | *Students will…* |
| * Play video on Smartboard to introduce concept of density; stop video at about 2:25. (During video, distribute activity sheet)

<https://www.youtube.com/watch?v=dcQR6vV1Sqo>* Ensure all student pairs have found the Density simulation and corresponding worksheet through Google classroom.
* Encourage students to take a few minutes to explore the Density simulation, letting them know they will be looking at the mass and volume of wood, ice, brick, and aluminum for today’s lesson. (Tell students to keep the radio button on the right on “custom” for today).
* **Circulate the room** and ask students:
1. What does the green triangle do?
2. What happens to the volume as you change the mass?
3. What happens to the density as you change the mass or volume?
4. What does the water level start at each time?
5. Which material do you think has the highest/lowest density?
6. Under “My Block” can you create a block with a very high density? Very low density? What do you notice about the mass/volume?
* Ask students to briefly share what they wrote down for #1 on the activity sheet, and discuss any of the questions above.
 | * Explore the simulation, looking at the mass, volume, and density of whichever items they choose.
* Respond to teachers’ informal questioning.
* Jot down discoveries as #1 on the activity worksheet.
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| **Guided Exploration** | **15 minutes** |
| *Teacher will…* | *Students will…* |
| * Assign each student group a material to investigate.
* Encourage students to begin working on the activity sheet in pairs. Try to give them at least 5 minutes where **the teacher is silent** before probing/aiding.
* **Circulate the room** to be available for questions and ask probing/pushing questions, such as:
1. Do you add, subtract, multiply or divide?
2. Do you think this material’s density (mass/volume of wood, Styrofoam, ice, aluminum) is a proportional relationship? Can you identify the constant of proportionality? Is density always proportional?
3. Does it matter what ordered pairs you create for the rest of your table? If you have different ordered pairs than another group of students, will you still get the same density?
4. Looking at the sliders, what can you tell is going to be the constant of proportionality? Does a material’s density ever change?
5. How can you find the mass of an object if you know its density?What is the format for a proportional relationship? (y=kx) How would you find the mass of a material if given its volume?
 | * Complete #2-4 on the activity sheet.
* Respond to teacher questions.
* Ask questions or ask for help as needed.

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| **Student Presentations and Discussions**  | **10 minutes (finish on day 2)** |
| *Teacher will…* | *Students will…* |
| * **Facilitate a class discussion** to bridge an understanding across representations. Remind students to cover their laptop screens with their worksheets so they are not distracted. Use an established teaching strategy such as pulling name sticks, or small group discussions (print out or display questions and have groups talk to each other and write down consensus for the “speaker” to share aloud with class). Students may want to present their worksheets using document camera as they make their points. Sample questions include:
1. What equation did we come up with for ice, wood, Styrofoam, aluminum?
2. How is the equation/constant of proportionality related to the density?
3. What does the density or constant of proportionality mean including units?
4. Will two students’ equations or graphs look the same for wood even if they created different ordered pairs?
5. Are there any other discoveries we haven’t yet discussed?
 | * A representative from groups for each materials will share their table and findings.
* Answer questions and question answers: students should be able to determine if they agree/disagree with others’ claims and justify their own responses.
* Complete #5 on the activity sheet as groups present.
* Some students may go to the board to share findings (share a google doc with the teacher), and then all students should summarize and record main ideas.
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| **Proportional Density - Day 2** |
| **Warm Up** | **10 minutes** |
| Activate prior knowledge using this problem as a warm-up (displayed on Smartboard): 1) Is this a proportional relationship? How do you know? Can you write an equation for the relationship? What will its graph look like?

|  |  |  |  |
| --- | --- | --- | --- |
| Mass, y  | 2 | 4 | 6 |
| Volume, x | 5 | 9 | 13 |

2) Graph the line using Geogebra (you might need teacher’s help here!). (or can use paper)Teacher & students review warm up answers before moving into simulation. |
| **Simulation Review and Complete Presentations** | **20 minutes** |
| *Teacher will…* | *Students will…* |
| * **Facilitate a discussion** reviewing what students completed on day 1 of the activity. Discuss what the density simulation did and the findings from each group.
* Allow any groups that have not yet presented findings to share.
* Encourage students to complete #5-7 on the activity sheet and submit work.
 | * Complete #5-7 on the activity sheet and submit work through the Google classroom.
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| **Discussion and Summary** | **15 minutes** |
| *Teacher will…* | *Students will…* |
| **Facilitate a class discussion** to bridge an understanding across representations.1. How are the graphs similar/different?
2. What are the characteristics of a proportional relationship when it is graphed?
3. Why do both graphs make a straight line? (constant rate/density)
4. Why do both graphs pass through the origin?
5. How is the constant of proportionality related to the steepness of the graph? (perhaps tell the students now that this is also referred to as the slope of a line).
6. Why does a higher density create a steeper line?
 | * Respond to teacher questions and discuss graphs, equations, slope, and proportionality.
* Ask questions or ask for help as needed.

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| **Informal Assessment** | **5 minutes** |
| *Teacher will…* | *Student will…* |
| **Wrap up the lesson by asking students:** 1) Why is density a proportional relationship? What does that mean about the mass and the volume of the materials? Collect student worksheets to assess learning. | * Participate in wrap up discussion.
 |
| **Going forward…** |
| * Emphasize interpreting unit rate/constant of proportionality/slope.
* Explore calculating constant rate of change and slope even when the relationship is not proportional.
* Refer back to density simulation when discussing steepness.
* Explore relationships with a negative slope.
* Graph equations in the form of y=kx or y=mx + b on graphing calculators.
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# Exploring Density

**Learning Goal:** Student will be able to use tables, graphs, equations, and slope to represent and compare relationships.

1. **Explore** the Density simulation for a few minutes, looking at the mass, volume, and density of whatever objects you choose. Write 1-3 observations you have about density.

2. **Choose one material:** wood, ice, Styrofoam, aluminum or brick**.** (Highlight your selected material). **Complete** the table below.

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| --- | --- | --- | --- | --- | --- |
| **Mass** | 1 | 2 |  |  |  |
| **Volume** |  |  | 10 |  |  |

3. Determine if there is a **proportional relationship**. How do you know?

4. If possible, write an equation to determine the mass of a material if given its volume for the **wood, ice, Styrofoam, aluminum or brick**. (Highlight your selected material). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\*Your group should be prepared to share your findings\*

5. During group presentations, **write the density equation of each material**. Order the materials from **least dense to most dense.**

6. **Graph** the lines for each equation using **Geogebra**. Use a **different color** for each material. Insert your **screenshot** below. (The table will help you create and organize your graphs). (Can also be graphed on graph paper, if necessary).

|  |  |  |
| --- | --- | --- |
| **Material** | **Equation** | **Line color** |
| Wood |  |  |
| Ice |  |  |
| Styrofoam |  |  |
| Aluminum |  |  |
| Brick |  |  |

7. How does the **steepness** of the lines relate to the **density** of each object?