Eureka – Archimedes Principle Worksheet 2  

Name__________________________________

Discovering buoyant force (volume of water displaced) and calculating what displacement volume is needed to float a boat.

Your group will need: 1 scale, 1 graduated cylinder, collection of plastic bottle boats filled with various materials (water, oil, glass marbles, and steel marbles), 1 sheet of aluminum foil, 1 worksheet per student, and results from Part I.

You will need to record the densities for all of the material you have (some of these values you can get from the data that other groups calculated).

<table>
<thead>
<tr>
<th>Material:</th>
<th>Density:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>1 g/cm³</td>
</tr>
<tr>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>__________</td>
<td>__________</td>
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<td>__________</td>
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</tbody>
</table>

Measure the weight of each of the boats and record it below:

<table>
<thead>
<tr>
<th>Material:</th>
<th>Weight:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>__________</td>
<td>__________</td>
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<td>__________</td>
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</tbody>
</table>

Put the water filled boat into the graduated cylinder and record the displacement here.

Displacement Volume: ________________

How does this compare with the volume of water in the boat?

________________________________________________

Now predict how much water each of the other boats will displace.

<table>
<thead>
<tr>
<th>Material:</th>
<th>Displacement Volume:</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________</td>
<td>________________</td>
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<td>__________</td>
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</tbody>
</table>
Explain your predicted amounts. What is your reason and how did you arrive at this?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

Now put each boat in the graduated cylinder and record the displacement here.

Material: ___________ Displacement Volume: _______________

Material: ___________ Displacement Volume: _______________

Material: ___________ Displacement Volume: _______________

Material: ___________ Displacement Volume: _______________

Did it agree with your predictions? __________ Why do you think it did or did not?

____________________________________________________________________

Calculate the apparent density of the boat hull under water (weight of boat/displacement volume). Note: this is the average density of the boat hull, air, and inner material.

Material: ___________ Water Displacement Volume: _______________

Material: ___________ Displacement Volume: _______________

Material: ___________ Displacement Volume: _______________

Material: ___________ Displacement Volume: _______________

How does this quantity compare to the density of water? Why is this?

____________________________________________________________________

Will the displacement change if your boat is floating upright or lying on its side? Why?

____________________________________________________________________

Try floating the boat in both orientations. What are the displacement volumes?

____________________________________________________________________

Now measure the volume of the aluminum foil sheet and record this below.
Length: _______ Width: _______ Height: _______
Volume: _________________________
Density (from part 1): _______________

Does the aluminum foil sheet float?
_____________________________________________________________________

Now fold the aluminum sheet into a boat hull shape and put on the water.
Does it float? _________ Why does it float now?
_____________________________________________________________________

**Final Project**
Your group can now calculate the displacement of some big ships (car ferry, wheat barge, or oil tanker). Using resources (internet, engineering book or information from teacher), gather necessary data for design parameters for your ship. Calculate the displacement volume for your ship for dry weight (empty) and maximum load. Assuming a barge bottom (rectangular or trapezoidal) calculate the dimensions of the hull below the water line. Present the group findings to the class. **SHOW ALL WORK and EXPLAIN how understanding these principles of materials can help engineers in the design of a boat.**