PHYSICS 203

Buoyancy Lab

This lab uses The Physics Aviary Force Buoyancy Simulations Lab found at:

http://www.thephysicsaviary.com/Physics/Programs/Labs/ForceBuoyancy/index.html

Procedure

First, some useful information:

Density = mass/volume

Weight = mass x gravity

Weight of a fluid = density x volume x gravity

Density of water = 1,000 kg/m$^3$ = 1.0 kg/L = 1.0 g/cm$^3$

Archimedes Principle

The buoyant force, $F_B$ on an object is equal to the weight of the fluid it displaces when it is submerged in the fluid.

Here buoyant force $F_B = \text{density} \times \text{volume} \times \text{gravity}$.
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When there is no overflow, buoyant force $F_B$ is found from difference between weight in air and weight while submerged in liquid, as shown in illustration above.

1. Force Buoyant vs. Acceleration due to gravity

Click on url to open simulation program.
http://www.thephysicsaviary.com/Physics/Programs/Labs/ForceBuoyancy/index.html

(a) Click on ‘Begin’. Click on ‘Fluid’ until it changes to ‘Gasoline’.
(b) On open program, select Earth, Bottle Volume of 500mL and Mass of 1,000 grams.
(c) Click on ‘Start’ and allow enough time for bottle to be completely submerged and motionless. Graph shows total time as sixteen seconds.
(d) Obtain from your graph values for force in air and force when submerged in fluid. Subtract these forces to get buoyant force.
(e) Click on ‘Location’ to change. Repeat procedure for all other locations available in this simulation. Leave all other parameters unchanged except location. Record data in table below.
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Table 1: Buoyancy Lab – Buoyancy at different locations.

<table>
<thead>
<tr>
<th>Planet</th>
<th>( a_g ) (m/s/s)</th>
<th>Force in Air (N)</th>
<th>Force in Fluid (N)</th>
<th>Force Buoyancy (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>9.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>moon</td>
<td>1.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td>3.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>8.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jupiter</td>
<td>24.79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vesta</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(f) Make a graph of Force Buoyancy vs. \( a_g \). Determine equation of this graph.

2. Force Buoyant vs. Fluid Density
(a) Click ‘Reset’ on the lower right of simulation screen. Select fluid as ‘Gasoline’.
(b) Select location as ‘Earth’, Bottle Volume as 100mL, mass as 2,000 grams.
(c) Start first trial and allow 16 seconds to elapse before you read values off graph. As in previous run, subtract reading of force when in fluid from force when in air to determine buoyant force.
(d) Click on ‘Fluid’ to change fluid. Do not change any other parameter. Now repeat experiment for all available fluids in simulation.
(e) Record data in table below
Table 2: Buoyancy Lab – Buoyancy in different fluids.

<table>
<thead>
<tr>
<th>Planet</th>
<th>density (kg/m³)</th>
<th>Force in Air (N)</th>
<th>Force in Fluid (N)</th>
<th>Force Buoyancy (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>737</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maple Syrup</td>
<td>1333</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude Oil</td>
<td>825</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh Water</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>13,500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(f) Make a graph of Force Buoyant vs. density. Determine equation of this graph.

3. Force Buoyant vs. Bottle Volume
   (a) Click ‘Reset’ on the lower right of simulation screen. Select fluid as ‘Fresh Water’.
   (b) Select location as ‘Earth’, Bottle Volume is 100mL, mass is 1,000 grams.
   (c) Click ‘Start’ and allow 16 seconds to elapse before you read values off graph. As in previous runs, subtract reading of force when in fluid from force when in air to determine buoyant force.
   (d) Click on ‘Bottle Volume’ to change volume of bottle. Do not change any other parameter. Now repeat experiment for seven different ‘Bottle Volumes’ available in simulation.
   (e) Create a data table and record your experimental data.
   (f) Plot a graph of Force Buoyant Vs Volume. Determine equation for this graph.
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