Cartesian Diver Lab

**Background:** Cartesian divers have been around since the early 1600’s when they were invented by and named after the famous French mathematician Rene des Cartes. They allow us to take a fun dive into the world of physical science! Some factoids on Buoyancy, Density, Volume, Mass, & Boyle’s Law:

Whether an object floats or sinks depends on an object’s **buoyancy**. An object floats if it has positive buoyancy. In other words, its density is less than the density of the fluid it is placed in. Negative buoyancy is just the opposite. If an object is more dense than the fluid it is placed in, it sinks.

**Density = Mass(g)/Volume(mL).** So, if you add mass to an object without changing its volume, the object’s density will increase. You can also increase the density of an object by keeping the mass constant while you decrease the object’s volume.

Boyle’s Law on Pressure & Gas Volume says pressure & volume are Inversely proportional! This means:

a. As the **pressure on a gas increases**, the gas’s volume decreases! (with temperature constant).

b. As the **pressure on a gas decreases**, the gas’s volume increases! (with temperature constant).

Hmm…obviously Bobby Boyle’s Law won’t work for things that are solid and liquid!

**Purpose:** How do the concepts of mass, volume, and density relate to buoyancy?

**Hypothesis:** Write out an explanation as to why you think the Cartesian Diver sinks when the bottle is squeezed. Be sure to include the terms mass, volume, density, & buoyancy!

**Materials & Procedure:** None needed! See the directions taped down to the lab station.

**Data:**

<table>
<thead>
<tr>
<th>Diver #</th>
<th>Total Mass of Diver”</th>
<th>Total Volume of Diver</th>
<th>Density of Diver (D=m/V)</th>
<th>Buoyancy of Diver (+/−)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Operators:  Recorder:  Technicians:

* All mass measurements in grams (g)
** All volume measurements in milliliters (mL)
“ Total Mass = Mass of Diver + Mass of Water (Volume of water x 1.0 g/mL)
[Mass of air is negligible]
Ω Buoyancy = 1.0 g/mL − Density of Cartesian Diver
Cartesian Diver Lab

**Conclusion**: Answer the following questions based on your scientific knowledge using Complete, Quality, and Correct (CQC) sentences on a separate sheet of paper.

a. The Cartesian Diver Lab is a system made up of air, water, and the diver (consider the entire diver – plastic, nut, and inside – as a single unit). Which of these parts – air, water, and/or diver – is compressible?

b. Look closely at your Cartesian Divers while squeezing the 2L bottle. Describe any changes you see occurring to each part of the system (air, water, and diver).

c. Tell if there will be an increase or a decrease in the density of an object if you somehow you only increased its volume, but kept the mass the same. Consider the density equation, Density = Mass/Volume (which reads density equals mass divided by volume) when determining your answer.

d. Tell what must happen to the buoyancy of the diver in order for it to sink.

e. Density = Mass/Volume. Obviously the density of the diver must increase for it to sink. Explain if there is an increase or decrease in the diver’s mass OR if there is an increase or decrease in the diver’s volume when you squeeze the 2L bottle.

f. Explain why the Cartesian Diver sinks using the words mass, volume, density, buoyancy, and pressure.

g. Detail the steps used in determining the buoyancy of an object such as the Cartesian diver – be sure to include how to obtain the mass, volume, density, and comparison of buoyancy.

**Extra Credit**:
Think what would happen if you were to take your 5 divers and placed them in 2-L bottle with hot water. Predict what would happen to the buoyancy of the diver relative to the hot water.