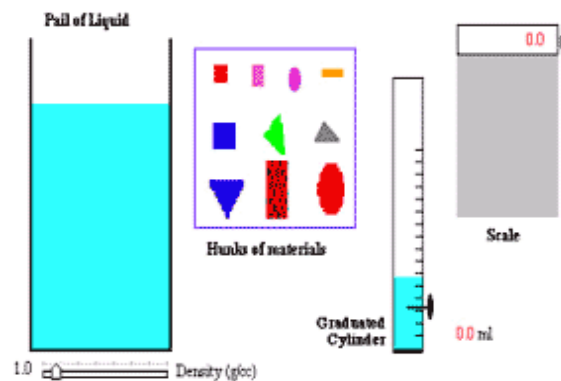




## Exploring Buoyancy and Density With an Online Simulation

### *Activity Overview*

With the Density Lab simulation at [www.ExploreLearning.com](http://www.ExploreLearning.com), students can use virtual tools to determine the mass and volume of different objects. Since students can easily change the density of the liquid in the test container on the simulation, they can discover the relationship between the calculated density of each item and the floating or sinking behavior of the object in ways that are not easily done with a hands-on activity.



### *Advantages of Technology*

This computer-based simulation allows students to quickly explore and develop understanding of the relationship between the floating and sinking behavior of an object, the density of the object, and the density of the medium. The simulation maximizes the opportunity for exploration and minimizes cleanup time and consumable materials cost.

Although hands-on manipulation is important for any exploration of density, this simulation makes an effective reinforcement or extension. Its most useful feature is the ability to change quickly the density of the liquid, something not easily accomplished in the science lab.

## *Educational Standards*

### **Virginia Standards of Learning**

**Chemistry.1** The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated, produce observations and verifiable data. Key concepts include:

- Multiple variables are manipulated with repeated trials;
- Accurate recording, organizing, and analysis of data through repeated trials

**Physical Science.1** The student will plan and conduct investigations in which:

- Length, mass, volume, density, temperature, weight and force are accurately measured and reported using the International System of Units (SI - metric)

**Physical Science.2** The student will investigate and understand the basic nature of matter. Key concepts include:

- Characteristics of matter based on physical and chemical properties (shape, odor, shape, density, solubility, odor melting point, boiling point)

## *Materials*

### **Technology:**

- Computer with Internet connection.
- Shockwave, a free browser Plug-In, previously installed (can be downloaded from the ExploreLearning website).

ExploreScience URL: [www.ExploreLearning.com](http://www.ExploreLearning.com)

(**Note:** ExploreLearning.com is a subscription site, but at the current time you can obtain a free 30-day trial subscription.)

## *Procedure*

### **NOTE TO TEACHERS:**

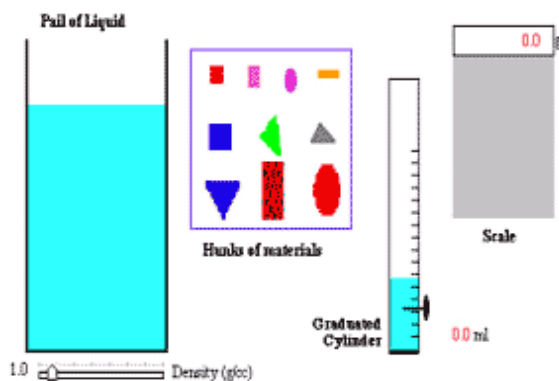
These procedures are written to show you how you might use these technologies to teach science concepts. Suggested questions, approaches, and expected answers are all provided. Therefore, these activity descriptions should be used as a guide for your instructional planning, rather than as a step-by-step activity guide for students.

## Getting Started

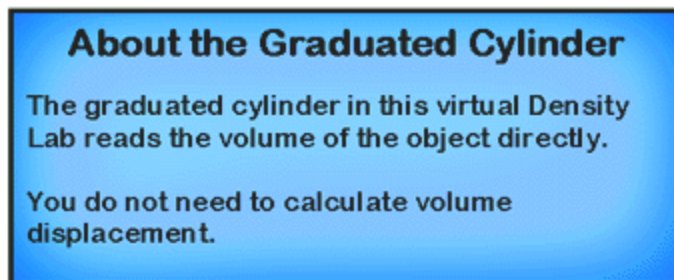
*What determines whether an object floats or sinks?*

This activity is a virtual experiment designed to help you answer this question.

From the Science menu on the homepage of [www.explorelearning.com](http://www.explorelearning.com), select Chemistry, then Physical Properties of Matter, then launch the Density Lab gizmo. (Note that there is also a Density "Laboratory" gizmo, but it is not the simulation described in this activity.)



This screen shows a simulated container of liquid, a graduated cylinder for measuring volume, and a scale for measuring mass. There is also a collection of objects of different shapes, sizes, and densities.



The default liquid in the "Pail of Liquid" has the same density as water (1.0 g/cc).

### Exploring Size and Buoyancy

Look at the "hunks of materials" on the virtual Density Lab screen.

*Which of these objects do you think will float in water?*

*Which do you think will sink? Explain your reasoning.*

One possibility is that floating and sinking is related to the size of an object, with smaller objects floating and larger objects sinking.

*How could you design a virtual experiment to test this possibility?*

One approach would be to first measure the volume of each object and rank them from smallest to largest. This would enable you to easily see whether the smallest objects float and the largest objects sink.

To measure the volume, drag and drop each object into the graduated cylinder. Record the volume of each object on a scrap sheet of paper. (Remember to remove each object from the graduated cylinder before adding a new object.)

Fill in a table like the one below, ranking the objects from smallest to largest.

**Table 1. Rank Order of Objects by Size**

<b>Object</b>	<b>Volume (ml)</b>	<b>Observation: Did the Object Float or Sink ?</b>

Now drag and drop each item in the container of liquid and record the actual sinking and floating behavior in the table.

[View completed table in the online version.](#)

*Do your results indicate a clear relationship between size (volume) and buoyancy? Explain your reasoning.*

If buoyancy were related to size, there would be some point in the ranked listing at which all objects above would float and all objects below would sink. Since this is not the case, buoyancy must not be related to size alone.

*What is another possibility?*

### **Exploring Mass and Buoyancy**

*What about mass? Is there a relationship between mass and buoyancy?*

Measure and record the mass of each object, then rank them from lowest to highest mass in a table like the one below.

To measure the mass, drag each object to the gray area of the scale, record the mass, then remove the object. Use your data from the previous table to fill in the last column.

**Table 2. Rank Order of Objects by Mass**

<b>Object</b>	<b>Mass (g)</b>	<b>Observation: Did the Object Float or Sink ?</b>

[View completed table in the online version.](#)

*Do your results indicate a clear relationship between mass alone and buoyancy? Explain your reasoning.*

As with size, if buoyancy were related to mass alone, there would be a point on the table above which all objects would float and below which all objects would sink.

*What about using size and mass in combination?*

Of course, we're talking about density, which is defined as mass per unit volume and calculated by dividing the mass by the volume. (**Note:** Remember that in measuring volume 1cc = 1 ml, so the units can be used interchangeably.)

*How can you test this relationship using the data in Tables 1 and 2?*

Calculate the density for each object. Record the results in rank order in a table like the one below.

**Table 3. Rank Order of Objects by Density**

Object	Density (g/cc)	Observation: Did the Object Float or Sink ?

[View completed table in the online version.](#)

*Do you see a relationship between density and buoyancy? Explain your reasoning.*

Every object with a density below 1.0 floats. Everything with a density above 1.0 sinks. In other words, objects with a density less than that of the liquid in the pail float, and objects with a density greater than that of the liquid in the pail sink.

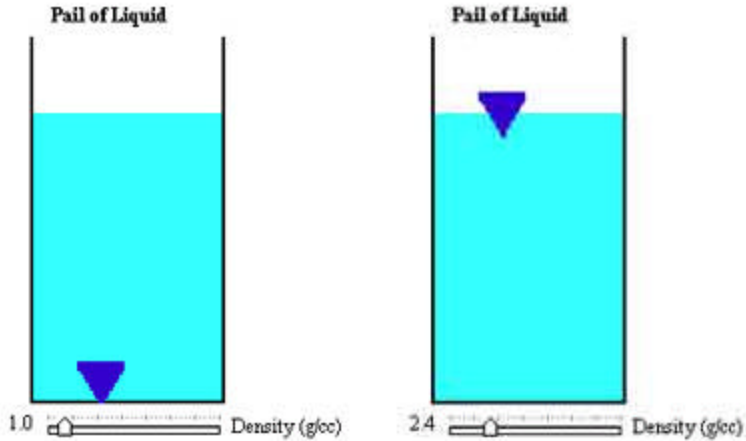
*Do you know any liquid that has a density of 1?*

### **Experimenting With Other Liquids**

*How would the floating and sinking behavior of the objects you ranked by density change if you could change the density of the liquid in the pail?*

Choose one of the objects that sank in water and place it in the liquid. Now increase the density of the liquid by moving the slider to the right.

*At what liquid density did the object change from sinking to floating?*



Choose one of your objects that floated in water and place it in the liquid. Move the liquid density slider to the left to decrease the density.

*At what liquid density did the object change from floating to sinking?*

Try this with at least five objects and complete a table like the one below.

**Table 4. Explorations of Different Liquid Densities**

Object	Object Density (g/cc)	Liquid Density at Which Object Changes From Floating to Sinking (g/cc)	Liquid Density at Which Object Changes From Sinking to Floating (g/cc)
1.			
2.			
3.			
4.			
5.			

*Now that you have collected this data, go back the original question and see if you can answer it.*

**Challenge Question:**

*How do objects like aircraft carriers, which are made of materials with densities greater than water, float?*

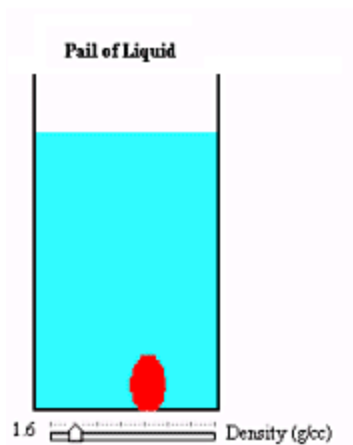
This makes a great segue into Archimedes Principle, which can be explored at the following website:

<http://home.a-city.de/walter.fendt/physengl/buoyforce.htm>

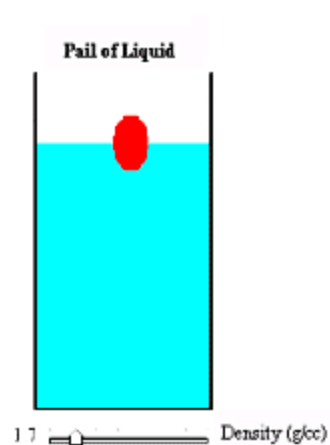
**Assessment Strategies**

Ask your students to study the images shown below and draw conclusions about the density of the object they see sinking and/or floating in each set of pictures. Note that the same object is shown sinking in the first image and then floating in the second. The density slider indicates the density of the liquid in each image.

**Example 1.** Predict the density of the oval object in the figures below.



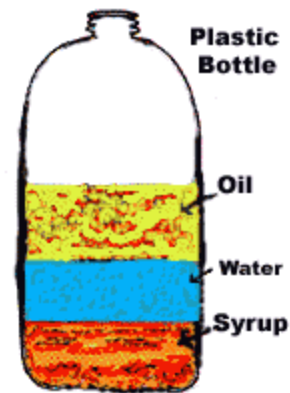
**Liquid density = 1.6 g/cc.**



**Liquid density = 1.7 g/cc.**

As another possible assessment strategy, have students make predictions about the density of three different liquids in your classroom such as vegetable oil, water and syrup. Students could then observe the arrangement of these liquids when they are combined in a density column. Ask students to explain the relative densities of these liquids based on their positions in the column.

Additionally, you can have your students drop small objects in the liquids above and predict in which layer the objects will float, if at all.



## Resources

### Curriculum Connections

#### Ocean salinity and density:

[http://paos.colorado.edu/~toohey/ATOC\\_L15.html](http://paos.colorado.edu/~toohey/ATOC_L15.html)

Explore the relationship between salinity, temperature and density of saltwater at this site.

#### Buoyant force in liquids:

<http://home.a-city.de/walter.fendt/physengl/buoyforce.htm>

Use this java applet to explore the buoyancy in a liquid and Archimedes principle.

#### The physics of underwater diving:

<http://www.uncwil.edu/nurc/aquarius/lessons/buoyancy.htm>

What keeps this diving scientist from floating to the surface or even sinking to the bottom? Try this experiment making ping-pong divers to learn more about buoyancy.

**The neutral buoyancy simulator:**

<http://www.msfc.nasa.gov/NEWSROOM/background/facts/nbs.htm>

Learn about the NASA Neutral Buoyancy Simulator at this URL. Since the late 1960s, the Marshall Space Flight Center's Neutral Buoyancy Simulator (NBS) has provided NASA investigators and astronauts with the closest simulation of microgravity available on Earth.

**Hydrostatic pressure in liquids:**

<http://home.a-city.de/walter.fendt/physengl/hydrostpr.htm>

Students can explore the relationship between depth, density, and pressure in a liquid.

**Chem finder:**

<http://chemfinder.cambridgesoft.com/>

Use this Internet database to locate physical properties for chemicals including density values.

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