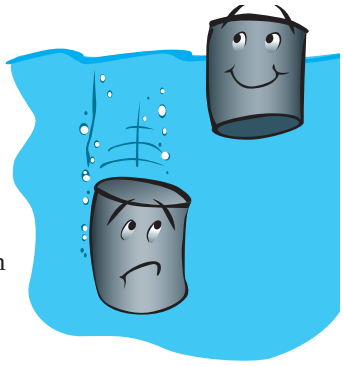
# Density Challenge

## Introduction

Demonstrate your mastery of density by determining the maximum amount of sand that can be placed in a plastic vial and still allow the vial to float in water. Calculate the amount carefully—you only get one chance!

## Concepts

- Density
- Volume



## Materials

| | |
|---|---|
| Water, large container | Plastic vial with cap or plastic film canister |
| Balance, 0.1-g precision | Sand |
| Forceps | Scoop or spatula |
| Metric ruler | |

## *Safety Precautions*

*Although the materials in this demonstration are considered nonhazardous, please follow all normal laboratory safety procedures.*

## Procedure

*The goal of this activity is to make the heaviest floating vial without having it sink.*

1. Obtain a plastic vial with a cap and metric ruler.
2. Measure and record the mass of the empty vial and cap.
3. Measure the base diameter and height of the vial and calculate its volume. Assume the vial is a cylinder, $V = \pi r^2 h$.
4. Determine the maximum amount of sand that theoretically can be added to the vial and still allow the vial to float in water. Remember, in order to float in water, an object's density must be less than 1.0 g/cc.
5. Use the balance to measure and add the calculated amount of sand to the vial.
6. Seal the vial with the cap.
7. Take the sand-filled vial to your instructor. Allow the instructor to weigh the sand-filled vial and cap.
8. Carefully lower the sealed vial into the water using forceps. If the vial sinks, it is eliminated from competition. The heaviest floating vial wins the competition.



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## Tips

- Copy page 1 for the students.
- Set up a density tank and a balance near your desk. The density tank can be a dishpan or any large container.
- Weigh the sand-filled film vial before the students place it in your density tank.
- Do not allow the students to practice floating the vial prior to the competition.
- The maximum amount of sand that can be added to the vial may actually be slightly greater than calculated due to the buoyant effect of any air remaining in the vial. If students add sand so the total mass of the filled vial is slightly less than or equal to the correctly calculated volume, the vial will still float, which is the goal of the challenge. Students may won der if more sand may be added as they observe some vials floating lower in the water than others. This would be a good opportunity to discuss sources of error such as the effect of the cap on the calculated volume, measurement errors and limits of measuring instruments, as well as the buoyant effect of the air in the vial.

## Discussion

An object with a density just under 1.0 g/cc will float in water. Density is an object's mass divided by its volume. The density of the vial is adjusted by adding just enough sand to make its density slightly less than 1.0 g/cc. Measure the outer diameter and height of the vial in centimeters. Calculate the volume (V) of the vial:

$$V = \pi r^2 h$$

where $\pi = 3.14$

$r$ = radius = diameter/2

$h$ = height

For the density to equal 1.0 g/cc, the maximum total mass of the vial and sand in grams must equal the volume of the vial in milliliters or cubic centimeters (cc). A slightly lighter total mass is desirable to be sure the vial will float.

## Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

***Unifying Concepts and Processes: Grades K–12***
Evidence, models, and explanation
Constancy, change, and measurement
***Content Standards: Grades 5–8***
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
***Content Standards: Grades 9–12***
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter

## Acknowledgment

Flinn Scientific would like to thank Mike Roadruck, Ottawa Hills High School, Toledo, Ohio for providing us with the instructions for this activity.

## Materials for *Density Challenge* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|---|---|
| S0003 | Sand, 500 g |
| AP5387 | Ruler, Metric/English, Clear, 15 cm |
| AP4663 | Vials with Snap-On Cap, 5 cm × 2.5 cm, 25 mL |
| AP9250 | Vials with Snap-On Cap, 6.5 cm × 3 cm, 50 mL |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.