



*Drexel-SDP GK-12 ACTIVITY*

## **Activity: Density and Archimedes' Principle**

**Subject Area(s)** Measurement, Physical Science

**Associated Unit** Measurement, module 2

**Associated Lesson**

**Activity Title** Density and Archimedes' Principle

**Grade Level** 6 (3-8)

**Activity Dependency** None

**Time Required** 60-100 minutes

**Group Size** 2

**Expendable Cost per Group** None

### **Summary**

Students will explore the concept of density and predict whether materials will sink or float. The ideas of buoyancy force and Archimedes' Principle will be discussed. Students will construct a boat out of a ball of modeling clay.

### **Engineering Connection**

Naval engineers, those professionals that work on the design and construction of seafaring military vessels, work on a daily basis with the concepts of density, buoyancy and Archimedes' principle. A naval engineer must always ensure that her design can rise, sink, and remain neutrally buoyant in the water with the aid of some controls that utilize the principles above.

### **Keywords**

Measurement, density, Archimedes, buoyancy, naval engineer

## Educational Standards

Pennsylvania Standards

3.2.7 Inquiry and Design

3.2.7.B. Apply process knowledge to make and interpret observations.

3.7 Technological Devices

## Pre-Requisite Knowledge

None.

## Learning Objectives

- To understand the concept of density and how to calculate it.
- Students will be able to write and verbally explain why a particular object/item will sink or float.
- Students will also be able to understand that the buoyant force on an object is equal to the weight of the fluid it displaces.

## Materials List

- Listed with each procedure below.

## Introduction / Motivation

Naval engineers, those professionals that work on the design and construction of seafaring military vessels, work on a daily basis with the concepts of density, buoyancy and Archimedes' principle. A naval engineer must always ensure that her design can rise, sink, and remain neutrally buoyant in the water with the aid of some controls that utilize the principles above.

(Review the background material with the students, discuss the vocabulary, then begin the activity.)

## Vocabulary / Definitions

Word	Definition
Density	Mass (m) per unit volume (V) — the ratio of the amount of matter in an object compared to its volume.
Archimedes' Principle	Any object wholly or partly immersed in fluid will be buoyed up by a force equal to the weight of the fluid displaced by the object.
Displacement	Occurs when an object is immersed in a fluid, pushing the fluid out of the way and taking its place.
Buoyancy	The upward force upon an object produced by the surrounding fluid.

## Procedure

## **Background**

Density is the relationship between an object's volume and its mass. Volume is the amount of space the object occupies, and mass is a measurement of the amount of matter in the object. Water has a property called buoyancy which means that water pushes up against objects that are placed on its surface. Buoyant force is the upward force that keeps things afloat. The buoyant force is equal to the weight of the water the boat displaces.

If you place something in the water that is less dense than the water, it will float. However, if you drop something into the water that has a mass that is greater than the mass of the water, it will sink. Another background idea is Archimedes Principle and displacement which is what occurs with ships in the water. The ships are made of materials that are denser than water, yet they float. This is because of the water that the ship displaces.

### **Before the Activity**

Collect and distribute materials.

### **With the Students**

Procedure:

#### **DAY 1: Sink or Float**

##### **Materials**

- Scale
- Ruler or tape measure
- Basin to hold water

##### **Procedure**

1. Teacher: Collect common materials that sink and float. They should be square or rectangular in shape.
2. Organized in groups, the students will measure each object and determine the volumes of each object.
3. Students will use the scale and record the mass of each object.
4. Students will predict whether or not the object will float.
5. Students will test their predictions by putting each object in the water basin and record their observations.
6. The students will discuss within their group why some objects float and other objects don't.
7. The groups will share their conclusions with the class, and each conclusion is discussed.
8. From the students' conclusions, the teacher should be able to lead into the idea of density.
9. Students will determine the density of the materials using the formula:  $\text{Density} = \text{mass} / \text{volume}$ .
10. Students will write up this experiment following the scientific method for homework.

#### **DAY 2: Archimedes' Principle**

## **Materials**

- Beaker with overflow spout
- Graduated cylinder
- Basin to hold water
- Modeling clay

## **Procedure**

1. Read the story of Archimedes' and the Crown to the students (available online).
2. The students will refer back to the data from Day 1 for the objects that floated. They should be organized into the same groups.
3. The students will determine the water displacement of the objects using the beaker with the overflow spout and a graduated cylinder.
4. They will then compare the weight of displaced water to the weight of the object (these should be approximately equal).
5. Give each group a ball of modeling clay. Have the students determine if the clay is less dense or more dense than water.
6. Challenge the students to use the modeling clay to construct a boat (that floats!) and will hold the most "passengers" (pennies).
7. Test the boats by loading them with pennies.
8. After the students clean up, the entire class will discuss findings.
9. Have the students write in their journal about why a material can both sink and float depending upon its shape.

## **Safety Issues**

- None.

## **Troubleshooting Tips**

- Perform a demonstration of how the activity should be performed before turning it over to the students.

## **Investigating Questions**

Have student groups complete the following worksheet.



## **Assessment**

### **Pre-Activity Assessment**

None

### **Activity Embedded Assessment**

Have the student groups complete the worksheets.

### **Post-Activity Assessment**

Each student must write up the Day 1 experiment for homework. For the Day 2 activities, the teacher will evaluate the students' journal entries.

### **Activity Extensions**

Change the density of water (with salt) to determine its effects on the way things float. Also, the teacher could demonstrate the difference in densities of liquids (oil, water, maple syrup) by layering one on top of the other.

### **Owner**

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### **Contributors**

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