Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Settling rates lab**

Settling rate is a result of several forces acting on a particle inside a fluid. The main forces to consider are the downward force of gravity, the upward force of buoyancy, and the force of drag which opposes the particle’s motion through the fluid.
 The larger the object is, and the denser it is, the greater the gravitational force acting downward on it. The force of buoyancy on the object is how much the water pushes it upward. If the particle is denser than water, its gravitational force is greater than its buoyancy force and the particle moves downward.

The greater the mass of the particle, the faster this speed will be at which drag strops further acceleration. The larger the particle, the greater the force of drag at a given speed. So if two objects have the same density but different sized, the larger one settles faster. If two objects have the same size but different densities, the denser one settles faster.

**Vocabulary**

 Density

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Buoyancy

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Settling rate

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Objective**

 Students will investigate the effects of size, shape and density on the settling rates of various objects.

**Materials**

 Tube filled with water

 3 different size beads

 Pennies

 3 blocks of different densities

 Stop watch

Triple beam balance

1000ml graduated cylinder

**Length of tube from top of water to bottom of water \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_cm**

Part 1 Comparing Sizes and Settling Rates

 Measure the mass of each bead. Drop one bead at a time into the tube of water, using the stop watch to time how long it takes each bead to settle on the bottom of the tube. Repeat this 2 more times and find an average for the settling time for each size bead. Use the average settling time to find the settling rate for that size bead. (To find settling rate use the rate of change equation.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bead Diameter (mm) | Mass(grams) | Settling time(seconds) | Average settling time(seconds) | Settling rate(cm/sec) |
| 6 mm |  |  |  |  |
| 6 mm |  |  |
| 6 mm |  |  |
| 8 mm |  |  |  |  |
| 8 mm |  |  |
| 8 mm |  |  |
| 14 mm |  |  |  |  |
| 14 mm |  |  |
| 14 mm |  |  |

Part 2 Comparing Shapes and Settling Rates

Holding one penny vertically, draw a picture of the penny as it looks when you look down on it in the table, drop the penny into the tube of water. Use the stop watch to time how long it takes the penny to settle on the bottom of the tube. Repeat this 2 more times and find an average for the settling time for pennies that are held vertically. Use the average settling time to find the settling rate for the vertically held penny. Repeat this process 3 more times holding the penny horizontally.

|  |  |  |  |
| --- | --- | --- | --- |
| PennyDrawing | Settling time(seconds) | Average settling time(seconds) | Settling rate(cm/sec) |
|  |  |  |  |
|  |
|  |
|  |  |  |  |
|  |
|  |

Part 3 Comparing Densities and Settling Rates

 Find the volume of each block.

Measure the mass of each block

Find the density of each block

Drop one block at a time into the tube of water. Use the stop watch to time how long it takes each block to settle on the bottom of the tube. Repeat with each block. Find the settling rate for each block.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Block | Volume cm3(L x W x H) | Mass(grams) | Density(cm3/g) | Settling time (sec) | Settling rate(cm/sec) |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**Questions**

1. What is the relationship between particle ***size*** and the rate at which particles settle? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the relationship between particle ***shape*** and the rate at which particles settle?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What is the relationship between particle ***density*** and the rate at which particles settle? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Which particle out of all the particles tested had the fastest settling rate? Why (at least 2 reasons)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_