611-2155 (30-166) Density Ball

Additional Materials Required

- Water (hot & cold)
- 2000ml Beaker (or medium container, preferably clear)
- Heat source
- Thermometer (°C)
- Table Salt (sodium chloride)
- Hot plate (optional)

Warranty, Replacement Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

Introduction:

The purpose of this device is to demonstrate the effects of temperature and mineral content on density.

The density of water is not constant but depends upon several factors. The effects of salinity and temperature play a large role in the flow of earth's ocean currents. Since mineral content and temperature depend upon solar heat, the surface density of the sea varies widely - some areas of the sea surface are continually sinking due to high mineral content. Later - sometimes in thousands of years - this water will return to the surface by undergoing another change in density caused by temperature.

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Care and adjustment:

The mass of the ball may need to be adjusted for best performance due to inconsistencies in water composition and slight water loss over time. The plug in the side may be unscrewed to add or remove water from the ball. The ball should just break the surface when floating in cold water.

Completely rinse off all salt and dry the ball after use.

How to use:

Change in Temperature

1. Fill a very large beaker with 1500ml of cold tap water (approx 15°C). The beaker should be made of borosilicate glass or a high temperature plastic that can withstand rapid temperature changes.
2. Place the density ball in the water, and allow it to find its own equilibrium. In cold water, the ball will float up and stick out of the water.
3. Mount a thermometer in the beaker water so that it can be read from the side.
4. Begin to slowly heat the water in the beaker. If a high temperature glass beaker is being used, a hotplate may be used to heat the water. If the container cannot take direct heat, hot water will have to be slowly added to raise the temperature around the density ball (it may be necessary to bail out water from time to time).
5. Stir the beaker every couple of minutes to be sure that the heat is distributed in the beaker.
6. As the water approaches 30°C, reduce the speed at which heat is being applied. Either turn down the hot plate, or add hot water slowly.
7. As the temperature approaches 35°C, the ball will begin to sink. The temperature at which the ball sinks will vary depending on what minerals are dissolved in the water.

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(Distilled water works best, but is optional).

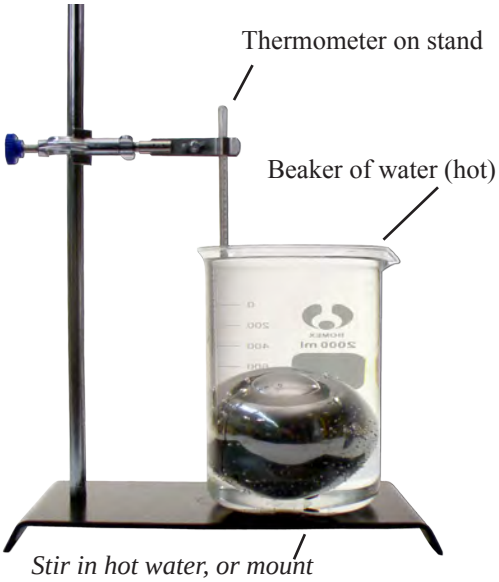
8. If heat is added slowly enough, it is possible to find a point where the ball neither floats or sinks. It is at this point that the density of the ball matches the density of the water, and the ball is suspended at equilibrium.
9. Slowly add a little more heat until the ball sinks to the bottom of the beaker.
10. At this point, cold water can be added, and the entire experiment reversed. Either reverse the experiment, or continue on to the next section while the ball has just touched bottom.

Change in Mineral Content

1. Perform the above experiment until the ball slowly sinks to the bottom.
2. Stir in 10g of table salt. Other salt such as rock salt may be used, but they need more time to dissolve.
3. Continue to add salt to the water 10 grams at a time. Stir the water each time it is added to make sure all the salt is being dissolved.
4. At some point the density of the water will match that of the ball. At this point it will be in equilibrium as in the first experiment.
5. Continue to add salt 10g at a time until the ball floats to the surface.
6. At this point, you may add hot water to make the ball sink again, or add more salt. If more salt is added, go on to the next section.

Saturation of Mineral Content

1. Perform the above experiment until the ball slowly sinks to the surface.
2. Continue to add salt 10g at a time. The ball will rise higher and higher out of the water.
3. At a given temperature and pressure, water will only allow a finite amount of salt to dissolve into solution. When salt begins to collect on the bottom of the container, and can no longer be stirred into solution, the solution has reached it saturation point. At this point, the ball will not float any higher in the water regardless of how much more salt is added. As the salt collects on the bottom of the container, the density of the solution no longer changes.



Stir in hot water, or mount assembly over heat source

Discussion:

Density is defined as mass per unit of volume. In our experiments, we are changing the volume of the water as we add heat to the system, and we are changing the mass of the water as we dissolve salt into it. As heat is applied to the system, the water molecules spread apart from each other. This expands the volume of the water, and thus lowers the density of the water.
The density ball is a solid, and remains at a relatively constant density. The ball rises and sinks in relation to the changing water density.
As the salt (NaCl, sodium chloride) dissolves into the water, the Na (sodium) and the Cl (chloride) split into ions and fill in spaces among the water molecules. It is due to this chemical process that the mass of the water increases while the volume of the water stays relatively constant. This will continue to occur until the water cannot hold anymore salt. This is the saturation point at which any additional salt will precipitate out of the solution. Water will hold a given amount of salt in solution at a given temperature. At the end of our experiment, allow the salt water solution to cool. Water can hold less and less salt in solution at lower temperatures. As the water is cooled, salt will precipitate out of solution.

30-166 Density Ball Curriculum
Content: Physical Science
Structure and properties of matter;chemical reactions; interactions of energy and matter.
Grades 5-8: *Properties and changes of properties in matter.*
Grades 9-12: *Interactions of energy and matter*

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