ME226 : Homework 1

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Aim : Measure something convenient and learn from the experience.

What do I want to measure?
I wish to measure the radius, volume and area of a ball. Measuring any one of those would help me calculate the other two. So, I chose to measure the volume of the ball.

How did I measure it?
I used the concept that when an object is immersed in a fluid, it displaces fluid of the same volume as the volume of the object.
I took a tumbler and filled it completely with water. I chose a ball which has a density larger than water. I placed the tumbler of water in a larger bowl. This was my initial set up.

Then I dropped the ball into the water. Simultaneously, the water started pouring out of the tumbler and into the bowl. Eureka!

I kept the tumbler along with the ball away and started measuring the water in the bowl with measuring cups. The measuring cups ranges from a volume of 500 ml to 1.25 ml.

I repeated this procedure several times for a better accuracy. I discarded the reading which deviated too much from the others.
Taking the average of all the relevant readings, I got the volume of the ball to be 133.75 ml or 133.75 cm^3.

Sources of error or issues with the procedure :

1. The volume of the smallest measuring spoon in the set is 1.25 ml. This becomes the least count of our measurement.
$$\%\ error\ due\ to\ least\ count = \frac{1.25}{133.75} * 100 = 0.935\%$$
2. Some of the water could pour out of the tumbler due to jerks or due to the splash caused when the ball is dropped into it.
3. Surface tension of water is really high. It has second highest surface tension among all liquids at room temperature. This could result in the water getting held back at the surface when it should actually pour out into the bowl.
4. Losing some volume of water which wets the different utensils used in the experiment.
5. Human error while measuring the volume of water with the measuring cups.

Improvement to reduce the errors :
I made sure I dropped the ball slowly into the water to avoid splashes and jerks. I later replaced the bowl with a larger plate to make sure the water does not fall out of the bowl. I added a little detergent (surfactant) to the water to reduce the surface tension. We could also use a different liquid with a less surface tension value. I made sure the tumbler was filled till the top so that all the water that the ball displaced fell into the bowl. I made sure all the utensils used were clean and made sure I wiped the water off them for every repetition.

Obtaining the quantities of interest :
So we have found, Volume V = **133.75 cm^3**
We know,
$$Volume\ V = \frac{4\pi R^3}{3}$$
We get, Radius R = **3.1731 cm**
We use this radius to find the surface area of the ball.

$$Surface\ Area = 4\pi R^2 = 4\pi(3.173)^2 = \mathbf{26.517cm^2}$$