Why are there so many pieces of apparatus for measuring volume? 14–16

Education in Chemistry
Hazards, Safety and apparatus
June 2018
rsc.li/2JfJMyj

In every school laboratory there is a huge variety of pieces of equipment for the simple process of measuring the volume of a liquid. In lots of experiments you will be told which to use. As you get more skilled in chemistry, you will need to understand more about the factors that determine which piece of apparatus is needed for a particular purpose.

Theory

All liquids have a specific density. This is the mass of 1 cm^3 of the liquid. This means we can use mass as an accurate way of determining volume.

In this experiment, you must try to measure 25.0 cm^3 of water. The density of water is 1.00 gcm^{-3}. If exactly 25.0 cm^3 of water has been measured, the mass of water measured would be 25.0 g.

Method

1. Measure out 25.0 cm^3 of water using one of the pieces of apparatus listed in the table.
2. Place an empty cup on the balance and tare the balance.
3. Transfer the water you have measured into the cup and record the mass in the table.
4. Measure the temperature of the water and record it in the table.
5. Repeat the experiment for the other pieces of apparatus. Think carefully about how you will use each piece of equipment. You may need to use a piece of equipment more than once in order to get the volume needed.

Measuring apparatus	**Measured mass of water (g)**	**Temperature of water (°C)**	**True mass of 25.0 cm^3 of water (g)**	**Percentage difference (%)**
Big (250 cm^3) beaker				
Small (100 cm^3) beaker				
Measuring cylinder (5 cm^3 size)				
Measuring cylinder (10 cm^3 size)				
Measuring cylinder (25 cm^3 size)				
Measuring cylinder (50 cm^3 size)				
Measuring cylinder (100 cm^3 size)				
Small conical flask				
Burette				

Follow up questions

1. Use the information provided in the table below to determine the true mass of 25.0 cm^3 of water in each case. Decide on an appropriate number of significant figures to record.

Temperature (°C)	Density of water (g cm^{-3})
16	0.998970
17	0.998802
18	0.998623
19	0.998433
20	0.998232

Temperature (°C)	Density of water /(g cm^{-3})
21	0.998021
22	0.997799
23	0.997567
24	0.997326
25	0.997074

The accuracy of a measurement can be quantified by calculating the percentage difference of the measurement compared to the true value. This is calculated using the equation:

$$\text{Percentage difference \%} = \frac{\text{Measured value} - \text{True value}}{\text{True value}} \times 100$$

2. Complete the table by calculating the percentage difference for each measurement.

3. Which pieces of apparatus were most difficult to use? Give reasons for your answer.

4. Which piece of apparatus gave the most accurate measurement? How do you know?

5. Why might using a piece of apparatus a number of times be a disadvantage?

6. Why did you not need to dry the cup in between each measurement? [Hint: How was this accounted for when you processed your data?]