Why are there so many pieces of apparatus for measuring volume? Teacher notes

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

Use this activity to introduce students to the different factors that scientists take into consideration when choosing apparatus.

Pupils use the mass of the water they measure to decide what the best piece of apparatus to measure 25 cm^3 of water accurately is. The activity is simple to set up and carry out and gives good results. It is ideal for a single 50–60 minute lesson.

Key concepts covered

- The apparatus chosen for measuring must be matched to the scale of the measurement.
- Using a piece of equipment more than once for one final measurement multiplies the error.
- The accuracy of a piece of equipment can also depend on the skill of the user.

Teaching tips

- The flow of the activity depends on the number of balances you have available, so use as many as you can gather. Balances that give readings to one decimal point are fine.
- Emphasise that pupils will need to use some pieces of equipment (eg a 5 cm^3 measuring cylinder) more than once to measure 25 cm^3. When using some other equipment (eg a 250 cm^3 beaker), they may need to estimate.
- Burettes may be unfamiliar to younger pupils. Demonstrate how they work and how to read the scale before starting the activity.

Follow up questions, 11–14 worksheet

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

   This can be quite personal to the pupils. Some will give very scientific responses about how easy it is to read between the divisions of the scale on the apparatus while others will concentrate on whether they were physically able to manipulate the apparatus. If the idea about reading the scale does not come up from your pupils this will need probing in discussion.

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

   In most cases the burette gives the result closest to 25.0 g although this can depend on the skill of the pupil. The 25 cm^3 measuring cylinder also generally gives a result close to 25.0 g.

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

   Discuss the fact that each measurement taken has an error, and that these multiply by the number of measurements taken, if measurements are added together – eg measuring 25 cm^3 out 5 cm^3 at a time. Stress this is different from minimising errors by taking a measurement multiple times, and calculating a mean average measurement.

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

   The first measurement (the mass of the cup and any residue) is subtracted from the final measurement. This calculation will always give a final value that is just the mass of the water.

Additional follow up questions, 14–16 worksheet

The extended version of this worksheet, suitable for an older class or high achieving students, asks students to record the temperature of the water as well as its mass.

1. Question one asks students to calculate the true mass of water at the temperatures measured using the equation mass = density x volume and the values for density at different temperatures given in the table.

2. Students then calculate the percentage difference between the true value for the mass of water and their measured value using the equation:

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

Questions 3–6 repeat questions 1–4 above.