Measurements: accuracy and approximations

Science

The need for accurate and precise measurements in today's modern world cannot be understated. Every discipline, from the physical sciences to the social sciences requires measurements that are both accurate and repeatable. It must be accepted, though, that any measurement has inherent inaccuracies and imprecision and is indeed an approximation.

Any measuring device has limited accuracy. The inability to read the measurement beyond the smallest division shown on the device creates an approximation. If the smallest division on a ruler is one millimeter, then the accuracy of the measurement will be to the nearest millimeter (Giancoli 2005, p. 5). No measuring device can give absolutely accurate results. There will always be an uncertainty generated with any measurement. The more accurate the device, the less the amount of uncertainty that will be generated, but absolute accuracy will never be obtained. Therefore all measurements will include some error (Giancoli 2005, p. 5).

The awareness of the unit size that is being used to record the measurement and the need for accuracy is a critical aspect of measurement. Measuring an item when accuracy to the nearest kilogram is all that is needed is far easier than measuring the same item to the nearest microgram. The difference, of course, is that in the kilogram example the amount of error is plus or minus one kilogram, and in the second case it is plus or minus one microgram.

Obviously, the second measurement is far more accurate, but harder to obtain. The smaller the unit size that the device is capable of measuring, the greater the accuracy, and normally the more expensive the device. If great precision is not needed, then a less expensive device may be used.

Consider the difference between a scale in a supermarket used to measure vegetables and a scale in a pharmaceutical laboratory that is used to measure drugs. In the first case the scale may be accurate to only one tenth of a pound. This level of inaccuracy is acceptable for vegetables. If you are buying five pounds of tomatoes, it really does not matter if you get 4. 9 or 5. 1 pounds. The laboratory scale, though, must have a higher level of accuracy. Obviously, an error of plus or minus one tenth of a pound is unacceptable in the pharmacy business. In this case, accuracy to the nearest tenth of a milligram would be more reasonable.

Another comparative example of how the awareness of the need for accuracy would affect the level of error is in the measurement of volume. If a contractor is going to repave a stretch of street with asphalt, that contractor would measure the length and width of the road, probably in feet, and the thickness required, probably in inches, and calculate the cubic yards of asphalt needed for the project. The amount of asphalt would be, in all likelihood, measured to the nearest cubic yard. A cook in a restaurant adding water to potatoes is going to measure the amount in cups, with an accuracy that is dependent on the quality of the measuring cup. Obviously the cook has a much greater need for a higher level of accuracy than the contractor.

REFERENCES

Giancoli, D. C. (2005). Physics. (6th ed., pp. 5-7). Upper Saddle River: Pearson Prentice Hall.