Chemistry Lecture #6: Accuracy & Precision; Percent Error

Accuracy & Precision

When we measure things in chemistry, we want the measurement to be precise and accurate.

Precise: A series of measurements are close in value.

Suppose I have a bathroom scale and I want to weigh myself. I step on the scale four times. Here are the measurements I obtain each time I step on the scale:

146.1 lbs 146.2 lbs 146.0 lbs 146.1 lbs

0.2 lb difference

These measurements seem to be relatively close together. The maximum difference between two measurements is 0.2 lbs, which is not a significantly big difference. These data are precise.

Now suppose I step on a different bathroom scale. I take four measurements. Here are the measurements obtained:

146.1 lbs 164.8 lbs 147.5 lbs 178.6 lbs

32.5 lb difference

Compared to the previous scale, we have a big difference between measurements. The maximum difference between two measurements is 32.5 lbs, which is pretty big. Each time we step on the scale, we get values that are significantly different from previous values. These data are imprecise.

We don't want imprecise data. We should get the same value when we measure something, no matter how many times we measure it. If we get different values, it means that there is something wrong with our measuring device, or something wrong with our technique.

Accurate: A measurement is close to the actual value.

Suppose that I am measuring my temperature. I measure it four times. Here are the values I obtain:

98.6 °F 98.5 °F 98.7 °F 98.5 °F

0.2 °F difference

These values seem to be close together. The greatest difference between the temperatures is 0.2 °F. But suppose the thermometer is broken, and my actual temperature is 105 °F! That's 6.4 °F higher than a normal 98.6 °F temperature. So since the measured temperature is not close to the actual temperature, the data is not accurate. Overall, these data are precise but not accurate.

We want our measurements to be accurate and precise.

Try this question:

You measure the air pressure in an automobile tire four times with an air pressure gauge. The air pressures obtained are-

36.0 psi 36.0 psi 36.1 psi 35.9 psi

The actual air pressure is 36.0 psi (pounds per square inch). These data are

A. not accurate and not precise.
B. not precise but accurate.
C. not accurate but precise.
D. precise and accurate.

Answer: D

Percent error

Sometimes we want to know how far a measurement is from the accurate, true value. We don't care whether the measurement is above or below the true value, we're just interested in the amount of error.

Percent error gives the deviation of a measurement from what should be the accepted, true value.

$$\text{Percent error} = \frac{|\text{accepted value} - \text{measured value}|}{\text{accepted value}} \times 100\%$$

Try this problem:

The true mass of a bag of potatoes is 10.2 lbs. A scale in a grocery store measures the mass as 10.4 lbs. Find the percent error.

Accepted value = 10.2 lbs measured value = 10.4 lbs

$$\text{Percent error} = \frac{|\text{accepted} - \text{measured}|}{\text{accepted}} \times 100\%$$

$$= \frac{|10.2 - 10.4|}{10.2} \times 100\%$$

$$= \frac{|-0.2|}{10.2} \times 100\%$$

$$\text{percent error} = \frac{0.2}{10.2} \times 100\% = 1.96\%$$

Looks like whoever used that scale to buy the potatoes got ripped off. If the scale is off by 1.96%, the customer paid 1.96 percent too much. If hundreds of customers use the scale, the store could end up stealing a lot of money!