SPH3U **Accuracy, Precision, and Significant Digits**

When conducting experiments, all measurements will have a certain amount of uncertainty, which we call ERROR. The error is not a mistake, but rather the result of the limitations of the equipment or experimenter. The uncertainty introduced through measurement must be communicated using specific vocabulary.

Precision vs. Accuracy

Precision and accuracy are not the same thing! An experimental result can be precise but not accurate and vice versa.

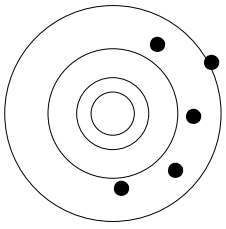
ACCURACY describes how close a measurement is to an actual or accepted value. Accuracy depends on the precision of the measuring instrument and the skill of the person measuring.

PRECISION, loosely, has to do with the number of digits after the decimal. It usually has to do with the smallest units your measuring instrument is calibrated in. In measurements involving the use of scales, the most optimistic reading that can be made is to the nearest 1/10 of the smallest scale division. E.g., if your ruler is in cm, you should be able to measure to the nearest mm. Increased numerical precision usually increases your accuracy – BUT NOT ALWAYS!!

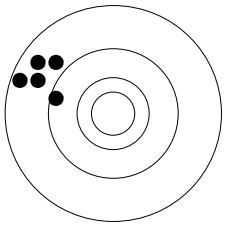
Precision in an experiment describes how exact and repeatable a result is. A tightly grouped set of data is precise.

E.g. A metre stick is measured with an electronic device to be 1.58326 m long. The measurement is precise, but not accurate.

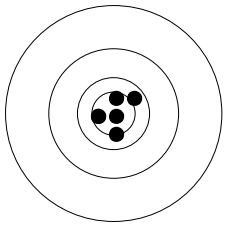
Ex. Compare the value of π to two sets of calculated values: (3.14, 3.17, 3.09) and (3.21, 3.23, 3.20). Are they accurate? Are they precise?



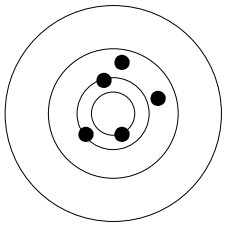
❑ accurate
❑ precise



❑ accurate
❑ precise



❑ accurate
❑ precise



❑ accurate
❑ precise

Measurement

How can you tell how many decimal places to use when measuring or doing calculations?

SIGNIFICANT DIGITS are the # of digits you can be sure of.
E.g. You can use a normal thermometer to find temperature to be 23.5°. You CANNOT get a value of 23.50000°. The thermometer lacks that precision.

Ex. 0.0006: _____ s. d. 100.06: _____ s. d.

3.00×10^3: _____ s. d. 85.300: _____ s. d.

650: _____ s. d. 000.0030: _____ s. d.

ROUNDING OFF NUMBERS
Rules: 1. If discarded digit < 5, round down.
2. If discarded digit > 5, round up.
3. If discarded digit is 5 followed by 0 or nothing, round to nearest even digit.

Ex: Round to three significant digits:

0.365839 = _____ 4.68163 = _____

4.185 = _____ 4.175000 = _____

Calculations Involving Measured Quantities (Weakest Link Rule)

ADDITION/SUBTRACTION: round to fewest number of *decimal places*. The answer can't be more precise than the least precise value.

Ex: Three tables are measured with three different measuring tapes. One is measured to be 6.6 m long, the second is measured at 8.74 m, and the final one is found to be 4.766 m long. How long are all three tables when put end-to-end?

MULTIPLICATION/DIVISION: round to fewest number of *significant digits*.

Ex. A soccer field was measured to be 85.05 m long and 36 m wide. What is the area of the field?

IF THE CALCULATION INVOLVES SEVERAL STEPS round at the end of the calculation to the fewest number of significant digits. TRY NOT TO ROUND IN THE MIDDLE OF THE CALCULATION. Learn to use your calculator efficiently. If you must round a value in the middle of a calculation, CARRY AN EXTRA DIGIT OF PRECISION.