

CHEMISTRY HONS

CHAPTER 1 : MEASUREMENTS

- 1.1 The scientific method
- 1.2 Units of measurement
- 1.3 Uncertainty in measurement –precision and accuracy
- 1.4 Significant figures and calculations
- 1.5 Dimensional analysis

1.3



1.3 Uncertainty in Measurement

1.3

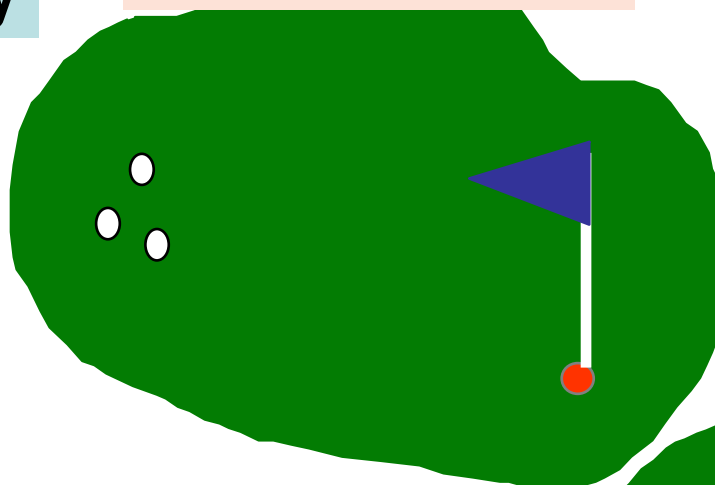


1.3

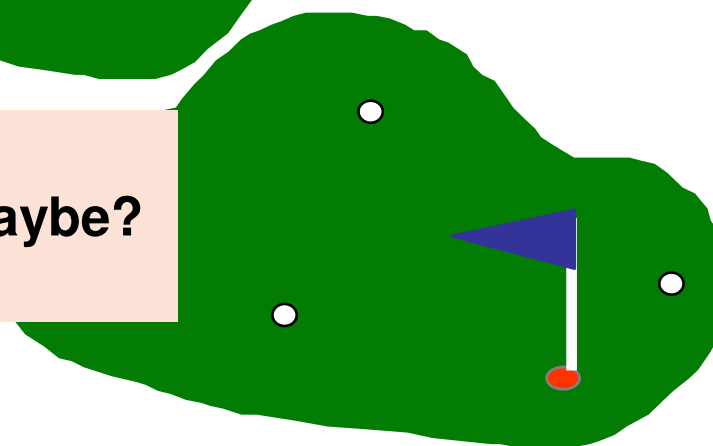
Uncertainty in Measurement

Let's use a golf analogy

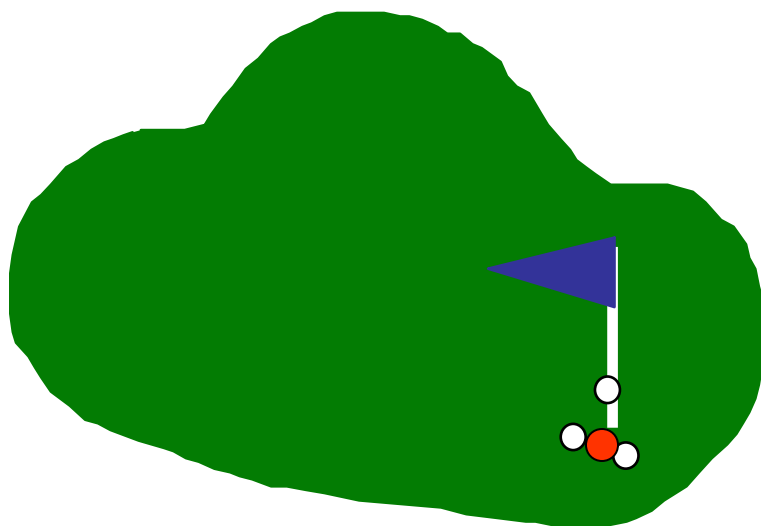
Precise?-Yes
Accurate? No



Precise?-no
Accurate? Maybe?



Precise?-Yes
Accurate? Yes

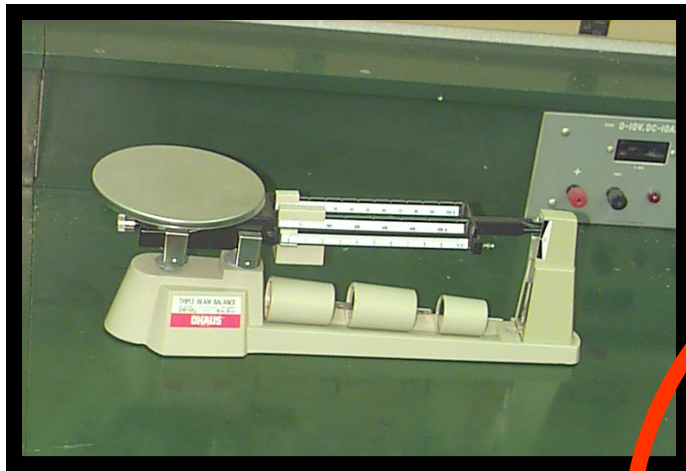


Why Is there Uncertainty?

- **A digit that must be estimated is called uncertain. A measurement always has some degree of uncertainty.**
- Measurements are performed with instruments, and no instrument can read to an infinite number of decimal places

Uncertainty in Measurement

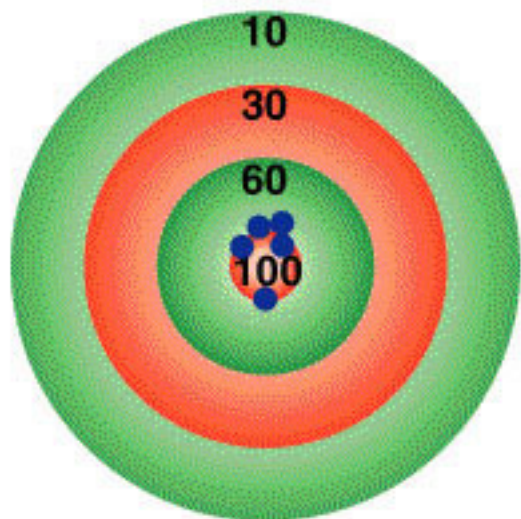
- *Which of the balances below has the greatest uncertainty in measurement?*



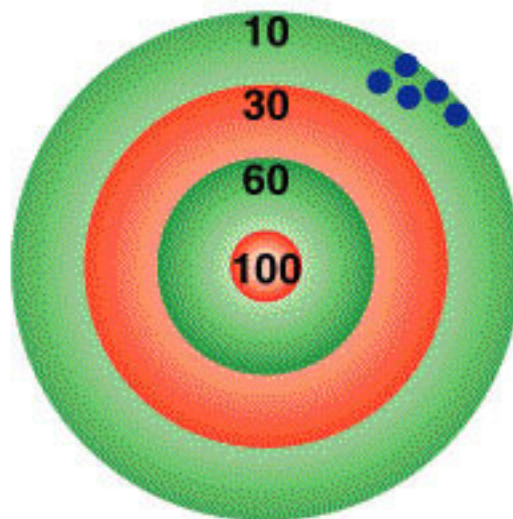
How good are the measurements?

- Scientists use two words to describe how good the measurements are-
- **Accuracy**- how close the measurement is to the actual value.
- **Precision**- how well can the measurement be repeated.
- Accuracy can be true of an individual measurement or the average of several.
- Precision requires several measurements before anything can be said about it.

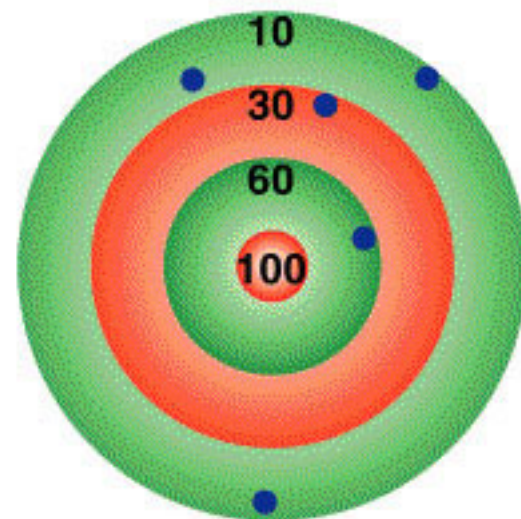
Accuracy vs Precision



accurate
&
precise



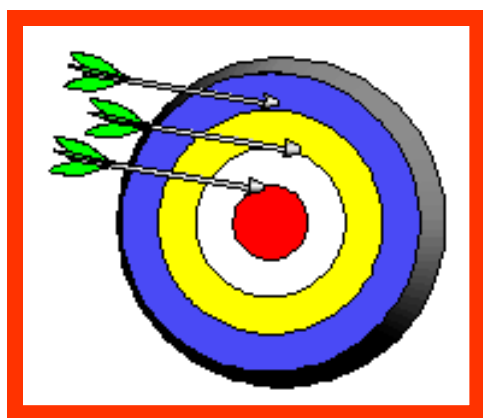
precise
but
not accurate



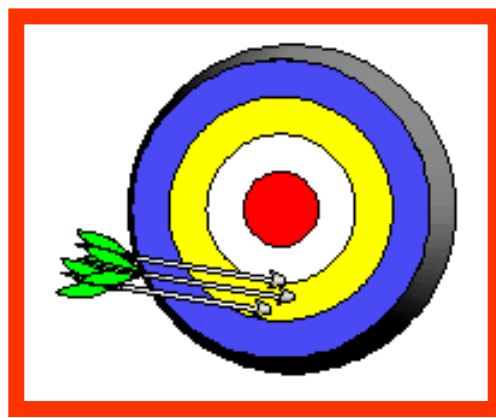
not accurate
&
not precise



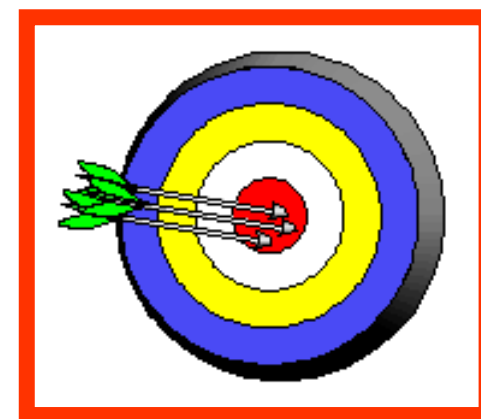
Precision and Accuracy



Neither
accurate
nor precise



Precise,
but not
accurate



Precise
AND
accurate

Accuracy, Precision, and Error

- **Accepted value** = the correct value based on reliable references
- **Experimental value** = the value measured in the lab
- **Error** = accepted value – exp. value
 - Can be positive or negative
- **Percent error** = the *absolute value* of the error divided by the accepted value, then multiplied by 100%

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



Types of Error

- **Random Error** (Indeterminate Error) - measurement has an equal probability of being high or low.

Systematic Error (Determinate Error) - Occurs in the **same direction** each time (high or low), often resulting from poor technique or incorrect calibration. This can result in measurements that are precise, but not accurate.

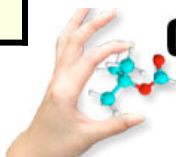
Practice problems

- 1 Three students measure the volume to be 10.2 ml, 10.3 ml and 10.4 ml .
- If the actual value of volume is 10.5ml
 - Were they precise? No
 - Were they accurate? No

weighing	Result
1	2.486g
2	2.487g
3	2.487g
4	2.487g
5	2.487g

2 Are these values precise?
Yes

High precision among several measurements is an indication of accuracy only if systematic error is absent .



Practice problem

To check the accuracy of a graduated cylinder , a student filled the cylinder to the mark of 25ml Using a buret. following are the results of five trail :

Trial	Volume shown by graduated cylinder	Volume shown by the Buret
1	25ml	26.54ml
2	25ml	26.51ml
3	25ml	26.49ml
4	25ml	26.60ml
5	25ml	26.57ml
Average	25ml	26.54ml

Is the graduated cylinder accurate?

The results are very good in precision. However ,the average value of the buret is very different from the 25ml .

Thus the graduated cylinder is not very accurate.



Percent Error vs. Percent Difference

- Percent Error:

- Measures the accuracy of an experiment
- Can have + or – value

$$\frac{\text{accepted} - \text{experimental}}{\text{accepted}} \times 100\%$$

- Percent Difference:
- Used when one isn't "right"
- Compare two values
- Measures precision

$$\frac{|\text{value 1} - \text{value 2}|}{\text{average of value 1 and 2}} \times 100\%$$



Practice problems

1 Measured density from lab experiment is 1.40 g/mL. The correct density is 1.36 g/mL.

$$\% \text{ error} = \frac{1.36 - 1.40}{1.36} \times 100 = -2.94\%$$

- Find the percent error.

2 Two students measured the density of a substance. Sally got 1.40 g/mL and Bob got 1.36 g/mL.

$$\% \text{ difference} = \frac{|1.40 - 1.36|}{\frac{1.40 + 1.36}{2}} \times 100 = 2.90\%$$

- Find the percent difference

1.3

