Fundamental (SI) and Derived Unit

Fundamental Unit		
Quantity	**Name**	**Symbol**
Temperature	Kelvin	K
Distance	Meter	M
Electric Current	Ampere	A
Time	Second	S
Amount of substance	Mole	Mol
Mass	Kilogram	Kg
Intensity	Candela	cd

- All units are derived unit expect for the sever fundamental units

Significant Figure

Counting Significant Figures

Why	Number	Significant Figures
In an integer, all digits count if the last digit is not zero.	123	3
Zero at the en does not count because its reliability is uncertainty.	100	1
Zero at the end count, those at the front does not count	0.00100	3
Cuase 8.38485 has six significant digits	8.38485×10^5	6

Addition and Subtraction	Multiplication and Division
Round the answer to the same decimal places as the value with its rightmost significant figures in the greatest decimal places	Round the answer to the same number of significant figures as the value in the problems with the least number of significant figures

Addition and Subtraction

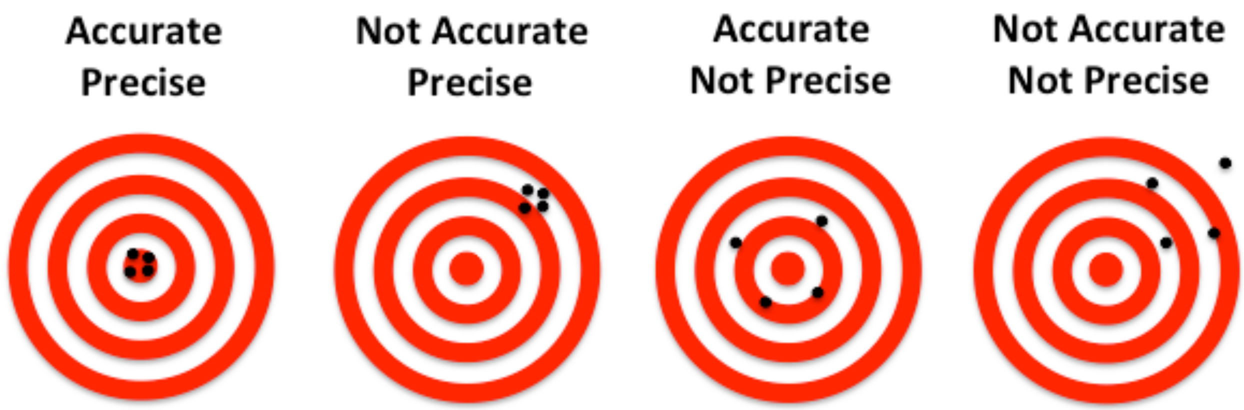
For example: $25.00 + 0.7384 = 25.74$
$\begin{array}{r} 25.00 \\ + \quad 0.7384 \\ \hline 25.7384 \end{array}$
The answer without significant figures is equal to 25.7384
The answer is equal to 25.74 since 8 is greater than 5

Multiplication and Division

For example: $3.456 \times 2.70 = 9.33$
$\begin{array}{r} 3.456 \\ \times \quad 2.70 \\ \hline 9.3312 \end{array}$
The answer without significant figures is equal to 9.3312
3.456 has 4 significant figures, and 2.70 has 3 significant figures, so the final answer will also have 3 significant figures, giving an answer of 9.33

Accuracy and Precision

- Accuracy describes the closeness of the experimental result and the theoretical value
- Precision describes the closeness of measurement



"Precision and Accuracy." *DNA Software*, 8 Nov. 2019, https://www.dnasoftware.com/our-products/copycount-qpcr-analysis-copynumber/precision-and-accuracy/.

Random and Systematic Error

Random Error

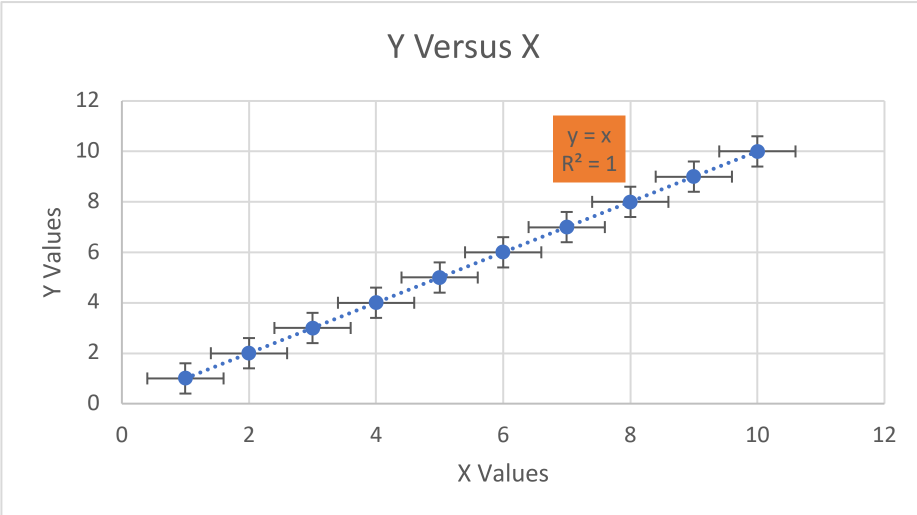
- Random errors in experimental measurements are caused by unknown and unpredictable changes in the experiment. These changes may occur in the measuring instruments or in the environmental conditions. Examples of random errors are human reaction time, air fluctuation.
- Random error can be reduced by taking an average measurement from a set of measurements, increasing sample size, repetitious experiment, repetitious readings, increasing precision of measurement, etc

Systematic Error

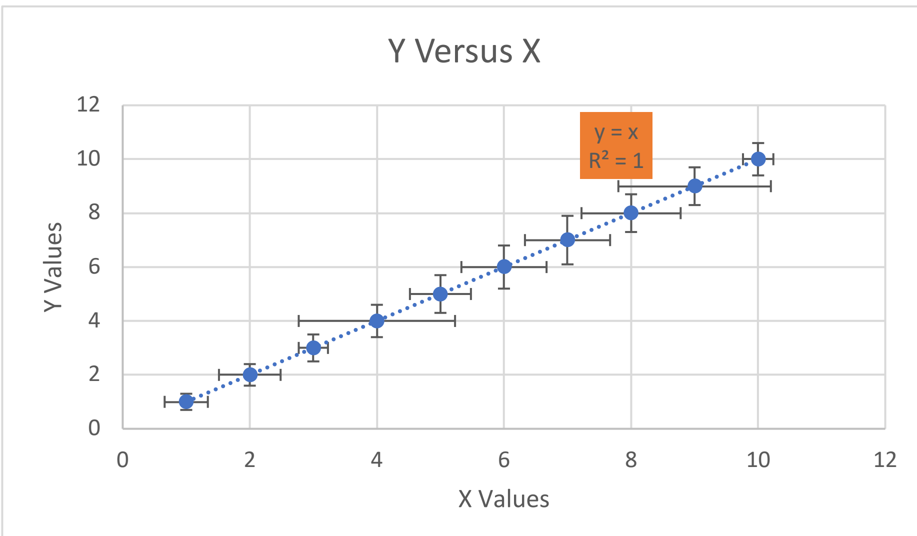
- Systematic errors in experimental observations usually come from the measuring instruments. For example, procedure of an investigation, calibration mistakes.
- Systematic error can be reduced by changing the procedure of the experiment, changing the measurement, etc

Graph, Uncertainty, and Error

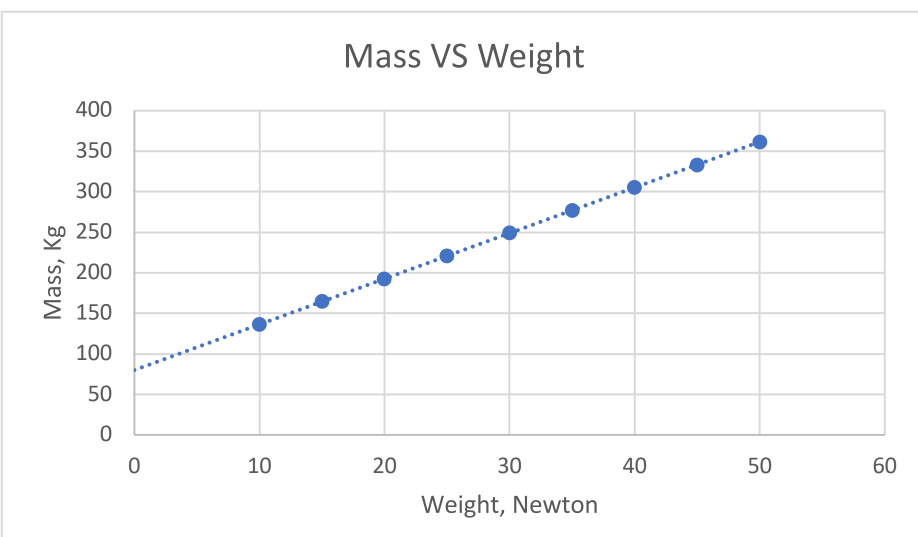
- In data analysis problems, there are few key features that need to be focused on, the error bar, graphical relationship (is it linear, quadratic, inverse?), and the y and x-intercepts. A non-zero intercept might suggest a large systematic error, and constant range of an error bar suggests a small random error and vice versa.



The error bars of the graph have a constant range, demonstrating a high precision, which means the investigation produces small random error.



The error bars of the graph do not have a constant range. The range fluctuate, demonstrating a low precision, which means the investigation produces large random error.



The graph has a non-zero y-intercept, meaning that when mass is 60kg, the weight is zero, demonstrating a large systematic error.

<u>Uncertainty</u>

- Uncertainty can be seen as a method to express errors in an investigation. It is equal to the smallest precision divided by two.

- For example, the beaker has a smaller precision of 100mL, and the reading of the liquid is between 900mL and 100mL. The uncertainty is equal to 100/2 = 50mL, so the reading value is going to be $900mL \pm 50mL$

"1000ml Low Form Graduated Glass Beakers, Qty. 1." *Med Lab Supply*, https://www.medical-and-lab-supplies.com/med-lab-supply-beaker-1000ml-qty-1.html.

- $Best\ estimate \pm absolute\ uncertainty$. The decimal place of the best estimate has to be consistent with the absolute uncertainty.

<u>Scalar and Vector Quantities</u>

Scalar and Vector Quantities	
Scalar quantities contain magnitude only with no direction	Vector quantities contain both magnitude and direction
Distance	Displacement
Speed	Velocity
Mass	Weight/Gravity
Energy	Acceleration
Work	Force (all forces are vectors, such as friction)
Density	Impulse
Length, Area, Volume	Momentum
Time	Electric field
Temperature	Drag force