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How to treat errors in your lab report

1) Uncertainties due to manual measurements

If you measure the height of drop of a ball using a ruler, the minimum uncertainty in its height will be half the smallest graduation of the ruler. Hence, if the height measured is 1,25m and the smallest graduation is 1mm, the uncertainty is *at least* 1,250±0,005m.

In practice however you will often find that this is not realistic – you will need to estimate the uncertainty that you think is reasonable with respect to your experimental setup and justify.

You must quote your result to the same level of precision as your uncertainty – for example 1,25±0,05m not 1,25±0,2m

2) Uncertainties due to electronic measurements

Let's say you are measuring the mass of a ball on an electronic scale. The uncertainty in your measurement is the smallest increment the measuring device gives. For instance, 42,25±0,01g if the scale gives a reading to 0,01g.

3) Uncertainties when doing repeat measurements

When measuring a variable several times, you should use the mean of your results as the value of your measurements and the standard deviation of your results as its associated uncertainty.

For instance, when measuring the time lapsed between two events:

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean	Standard deviation
2,42	2,55	2,45	2,5	2,48	2,48	0,05
2,42	3,14	3,01	1,55	2,28	2,48	0,64

Here results for the first row would be stated as 2,48±0,05 and for the second row 2,48±0,64

Notice how all the results in row 1 are quite close together around the mean, whereas they are spread out more in row 2. This explains why there is a higher standard deviation in row 2 and there is a higher associated uncertainty in the results.

4) Combining uncertainties

Very often you will need to combine uncertainties. For instance, if you have measured mass and height you may want to calculate potential energy. But what is the uncertainty in the potential energy value you have calculated?

$$Ep = m * g * h$$

In this case you must take what we call the fractional error of each quantity first. The fractional error is

$$\Delta = \frac{Uncertainty\ in\ value}{Value}$$

So for instance if m = 0,042±0,005kg the fractional error

$$\Delta m = \frac{0{,}005}{0{,}042} = 0{,}119$$

The fractional error for h = 1,25±0,05m is

$$\Delta h = \frac{0{,}05}{1{,}25} = 0{,}040$$

For quantities that are multiplying or dividing each other, you must add the fractional uncertainties together to get the fractional uncertainty of the new physical quantity.

Here $Ep = m * g * h$, so the fractional error of Ep is :

$$\Delta Ep = \Delta h + \Delta m = 0{,}119 + 0{,}040 = 0{,}159$$

The value of Ep is $Ep = mgh = 0{,}042 * 9{,}81 * 1{,}25 = 0{,}52J$

And $Uncertainty\ in\ Ep = \ \Delta Ep * Ep = 0{,}52 * 0{,}159 = 0{,}08J$

So our final result is $Ep = 0{,}52 \pm 0{,}08J$

Notice that here we are ignoring the uncertainty in g and treating it as a constant. Multiplying physical quantities by a constant does NOT change the uncertainty in a result.