# M1.2 – Find arithmetic means

## Tutorials

Learners may be tested on their ability to:

* find the mean of a range of data e.g. the mean number of stomata in the leaves of a plant.

## Calculating means

The mean is calculated by adding together all the values and dividing by the number of values.

The symbol for mean is:



As a formula this is written as:

mean equals the sum of all the data values ($x$), divided by the number of data values (*n*):

$$\overbar{x}= \frac{\sum\_{}^{}x}{n}$$

The calculated value for the mean can be quoted to the same number of decimal places as the raw data or to one more decimal place (see section M0.2). Comparing means is very useful for experimental repeats or comparing between different experimental conditions.

## Anomalies

When working with data you need to be able to identify anomalies, or outliers. Anomalies are values which are judged not to be part of the inherent variation. Notice that there is an element of judgement here on the part of the scientist carrying out the investigation and this judgement must be exercised extremely carefully.

You must never discard a value just because it doesn’t fit with what you expect or the rest of the data, especially without knowing more about the experiment itself. In general, if you do not have confidence in the data the best thing to do is to collect more data.

However, anomalies may occur because of a failure of the experimental procedure or because of human error, and in these situations the anomalies should be ignored, particularly if you are using the data to calculate the mean.

For example here are the bubble counts recorded in ten repeats of an experiment in which potato discs are added to hydrogen peroxide:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Repeat | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Bubbles produced in 5 min | 55 | 46 | 62 | 49 | 6 | 53 | 51 | 59 | 49 | 54 |

Repeat 5 has a much lower bubble count than any other repeat.

If there is a reason to think that this repeat might not have been carried out correctly, for example the discs used had been cut and then left out during a pause in the experiment (whereas in all other repeats they were used immediately) and might have become dry, then the experimenter might be justified in excluding this result from the calculation of the mean. If this choice is made it should be clearly recorded:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Repeat | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Mean using all data | Mean excluding repeat 5 |
| Bubbles produced in 5 min | 55 | 46 | 62 | 49 | 6 | 53 | 51 | 59 | 49 | 54 | 48.4 | 53.1 |

**Document updates**

 v1.0 April 2017 Original version.

 v1.1 June 2019 Removed a sentence that implied that mean is the same as average.

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