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Wedderburn Balance Guide

Your guide to choosing, positioning and maintaining precision balances.



ASSESSING WHAT ACCURACY YOU REQUIRE

- **Realistically estimate the accuracy you require for your overall measurement**
  It is best not to specify an accuracy far in excess of the accuracy required for the measurement. Costs associated with purchasing a balance and maintaining it in calibration increase with the accuracy of the balance
- **If possible ensure that the accuracy of the balance is at least 3 times better than the accuracy required for the measurement**
  It is common to choose a balance having an accuracy 10 times better than that required for the measurement so that the uncertainty in weighing is insignificant. In practice, an accuracy 3 times better than required (i.e. an uncertainty of 1/3 of the required limit) is sufficient to ensure the uncertainty in a weighing is insignificant.
- **Consult documentary standard specifications if available**
  Documentary standard specifications may be misleading, having statements such as “select a balance with a resolution of 0.001g”. This says nothing about the accuracy of a balance, which in some cases can be more than 10 times worse than its resolution.
- **The last decimal place a balance displays is not necessarily its accuracy**
  A factor to consider is the range of masses to be weighed. It may be better to buy one accurate balance to cover the full range rather than two cheaper lower- accuracy balances. Consider the overall cost including future balance calibrations.

  Example. Choosing a suitable balance

  We need to weigh samples from 5g to 100g to a relative accuracy of ±0.01%. What would be a suitable balance? Firstly, 0.01% of 5g is 0.0005g, and 0.01% of 100g is 0.1g. We select the balance based on tightest requirement, which is an accuracy of 0.0005g. Ideally, the accuracy of the balance needs to be 3 times better than the accuracy required, i.e. approximately 0.0002g. A balance reading to 0.0001g should be suitable.

Specifications may change without notice

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THE BALANCE ENVIRONMENT

- **Draught free**
  A balance should be located away from doors, windows and thoroughfares to reduce disturbances due to air draughts. A draught shield may be necessary.

- **Stable temperature and humidity**
  If possible keep the balance away from direct sunlight, lights, bunsen burners, heaters etc. as these may cause heating and possible drift in the balance reading. Fluorescent lamps do not usually cause heating problems. Changes in temperature can cause drift in a balance reading or sensitivity. They can also cause condensation on internal adjustment weights resulting in erratic changes in their mass. Relative humidity should be between 30 & 70%. For humidity below 40% electrostatic charging can be a problem.

- **Clean and dust free**
  Avoid a room where there is excessive dust or grit. Dust or grit falling or collecting on a pan or balance beam can affect a weighing result, particularly for microbalances. Dust or grit can also become trapped around knife-edges, flexure-hinges or damping mechanisms of minute separation and thus cause deterioration in the performance of a balance.

THE WEIGHING BENCH

- **Minimise vibration**
  The weighing bench should be heavy, of solid construction with no sagging so as to reduce vibrations. Concrete benches are preferable but not essential. Concrete benches should have sealed surfaces.

  The weighing bench should be secured against possible movement. A heavy bench standing on the floor is sufficient. It may be secured to a wall. The corner of a room is a good position, as corners are the most rigid positions in a building with the smallest vibrations.

  If the bench is on a wooden floor, try and position it centrally over 1 or more floor beams. If the floor has excessive vibration then a good bench will not necessarily help.

  Choose a room of fewest vibrations. In general a basement will have fewer vibrations than an upper storey. It is difficult to remove the effect of low frequency ground vibrations, which may be caused by passing traffic or heavy industrial machinery. The best one can hope to do is not enhance these vibrations, through proper choice and location of a weighing bench.

- **Anti-static, non magnetic**
  The weighing bench should be protected against electrostatic charges (no plastic or glass) and should be non-magnetic (no steel plates unless made of non-magnetic stainless steel).

MAINTENANCE OF A BALANCE

- **Regular dusting (whenever used)**
  The weighing chamber and pan should be dusted prior to a weighing. (For analytical or microbalances use a clean, fine-haired brush.)

- **Cleaning (when necessary)**
  If necessary, remove spillages or contaminants. (For analytical or microbalances use a clean tissue or fine-haired brush, soaked with alcohol or ether if necessary.)

- **Regular in-service checks**
  Regular in-service checks on a balance ensure the balance is performing to specifications. It will also be necessary to ensure that any test masses are kept in a protected environment.

- **Regular servicing and calibration**
  Regular external calibration from a reputable calibration provider on both the balance and any test masses will add another level of confidence as well as satisfy any auditor. Wedderburn are accredited to provide this service.

PRECAUTIONS WHEN USING A BALANCE

- **Balance levelled**
  Ensure that the balance is level prior to a weighing. Most balances have a spirit level attached or built into them.

- **Switch on at least 1 hour before use**
  Mechanical balances with illuminated scales or electronic balances should be switched on at least one hour before a weighing to allow them to stabilise. Many electronic balances can be left on continually in a “stand-by” mode.

- **Exercise the balance before use**
  Exercise the balance before use by applying a mass that is close in weight to the sample you are about to weigh, 3 times. The balance mechanism tends to be more rigid once it sits, and relaxes once it has been used. As a general rule, exercising will improve the repeatability of the balance.

- **Acclimatise sample to ambient temperature**
  A sample taken from a refrigerator or dryer or from a location at a different temperature, should be acclimatised to the temperature of the weighing chamber or room. A hot or cold sample will cause convective air currents, particularly in a weighing chamber, that make the sample appear lighter (for a hot sample) or heavier (for a cold sample).

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PRECAUTIONS WHEN USING A BALANCE CONT.

- **Adjust scale factor prior to weighing**
  If possible adjust the scale factor of a balance immediately prior to a weighing (using Cal mode or Cal function).
- **Use smallest possible weighing vessel**
  In general the reproducibility of a weighing result becomes poorer with increasing size of an object, so when weighing a contained quantity do not choose a weighing vessel larger than necessary.
- **Avoid magnetic materials near the pan**
  Magnetic materials (e.g. Iron samples, magnetic stirrers) on a balance pan may affect the reproducibility of a weighing result. If a sample to be weighed is magnetic, either demagnetise it, distance it from the balance pan when weighing (by means of a nonmagnetic support), or shield it by placing it in a container made of metal.
- **Avoid electrostatic charging**
  A weighing vessel or object made of electrically insulating material such as glass or plastic can become electrostatically charged. This charging occurs primarily through friction due to handling or transport of materials. If the surroundings are also charged then weighing errors can arise due to the forces acting between the vessel or object and the surroundings. These may be particularly significant for analytical and microbalances.

  If charging is a problem use a metal vessel or screen the charge by placing the weighing vessel in a metal container. If the relative humidity is below about 40% discharging is difficult or may take several hours, so ensure that the relative humidity is above this.

  Some balance pans (but not all) have electrical connection to ground, thus eliminating charging of the pan.
- **Reduce evaporation or moisture uptake**
  When weighing samples containing water or volatile liquids evaporation is a concern. For example when calibrating a pipette by filling it with water, discharging the water into a vessel and then weighing the amount of water in the vessel, the evaporation of water from the vessel during discharging and transportation to the balance results in a measured volume of water smaller than that actually discharged.

  To reduce loss due to evaporation use a narrow-necked vessel and keep it covered whenever possible. Placing the open vessel on a balance and observing the balance reading over a set period of time is a convenient way of estimating the amount of evaporation with time. Similar precautions apply to weighing of materials (e.g. silica gel) that take up moisture from the atmosphere.
- **Sample centred on pan**
  When weighing a sample ensure that it is appropriately centred on the pan to reduce pan position error. The sample should be centred with respect to its centre of mass and not its geometrical centre.
- **Monitor balance zero (drift)**

  The reading for a balance with nothing on the pan often changes with time, particularly if the temperature is changing over that period. This is known as drift of the balance zero or baseline drift. It should be corrected for if significant.

  Before correcting for drift it is important to be sure that the balance reading is drifting, which requires monitoring the reading over a sufficient period of time. Often, after removing the load from a balance, the reading will immediately return to within 1 or 2 digits in the last place of zero and after a short time will read zero. This is a “relaxation” phenomenon, common in larger capacity balances, which should not be mistaken as drift.

References

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“Balances and Weighing Workshop Notes”, Lower Hutt: MSL, IRL, 2008.

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“The Calibration of Weights and Balances”, Monograph 4: NML Technology Transfer Series, Third Edition, Sydney: CSIRO, 2003.

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