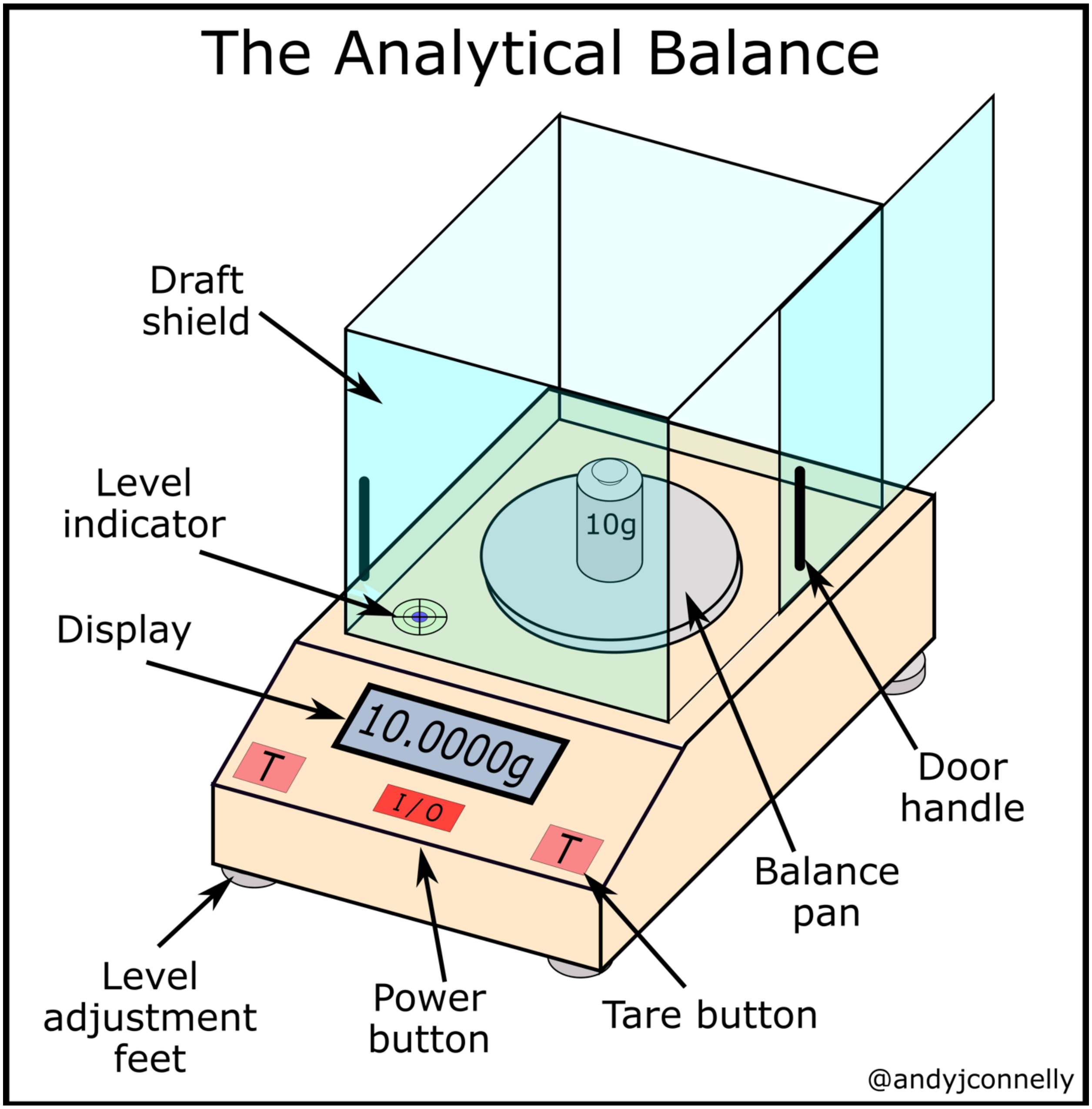
The Analytical Balance
Draft shield
Level indicator
Display
10.0000g
10g
T
I/O
T
Door handle
Balance pan
Level adjustment feet
Power button
Tare button
@andyjconnelly

Introduction

The laboratory balance is so often the forgotten object that sits in the corner of the laboratory. Forgotten, that is, until it is called on to give an accurate measurement. Then all hell breaks loose as it is found to be dirty and the mass just will not settle, it just keeps wondering. Eventually it is given up as a bad job and forgotten about again. There are few things more frustrating than a balance that is not behaving itself and usually this is due to neglect.

Types of balance

Analytical balances are designed to measure small masses from around 320g to sub-milligram. They are very sensitive pieces of equipment so need to be treated with care. The main types of laboratory balance are (masses stated are general values only):

- Top-pan balance (200g – 0.001g)
- Analytical balance (320g – 0.0001g)
- Microbalance (6g – 0.000001g)
- Ultra microbalance (6g – 0.0000001g)

Here we will mainly look at analytical balances as see in Figure 1. These are sensitive enough that they normally require a transparent enclosure which blocks air currents and prevents dust collecting (see Figure 1). To perform well they have to be level and so are fitted with level indicators (usually a spirit level). Apart from these two important factors the basic operation is very similar to your electronic kitchen balances at home.

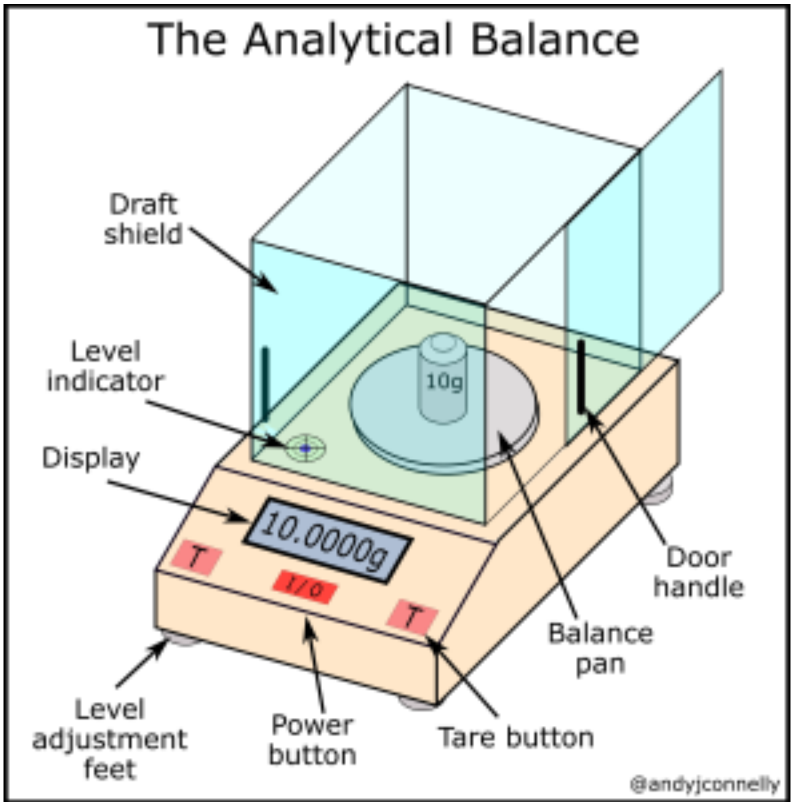

Figure 1: The analytical balance.

Operating principal

Balances do not directly measure mass; they measure the force (weight) that acts downward on the balance pan. Most analytical balances are electromagnetic balances and so measure this weight using an electromagnet. Figure 2 shows the electromagnetic servomotor which generates a force counter the weight of the mass being measured. The electrical current required to generate this force is proportional to the weight and so can be used, with appropriate calibration, to calculate the mass. This mass is then displayed on the screen. To signal when the weight and electromagnetic forces are equal many balances have a “null detector” that uses a light source and detector.

The use of the electromagnetic means that balances that have been turned off (at the wall) should not be used straight away after turning back on. You should wait at least thirty minutes for the electromagnetic field to stabilise (times may vary depending on manufacturer and model). It also means that placing any magnetic materials or magnets near the balance could cause problems for the balance.

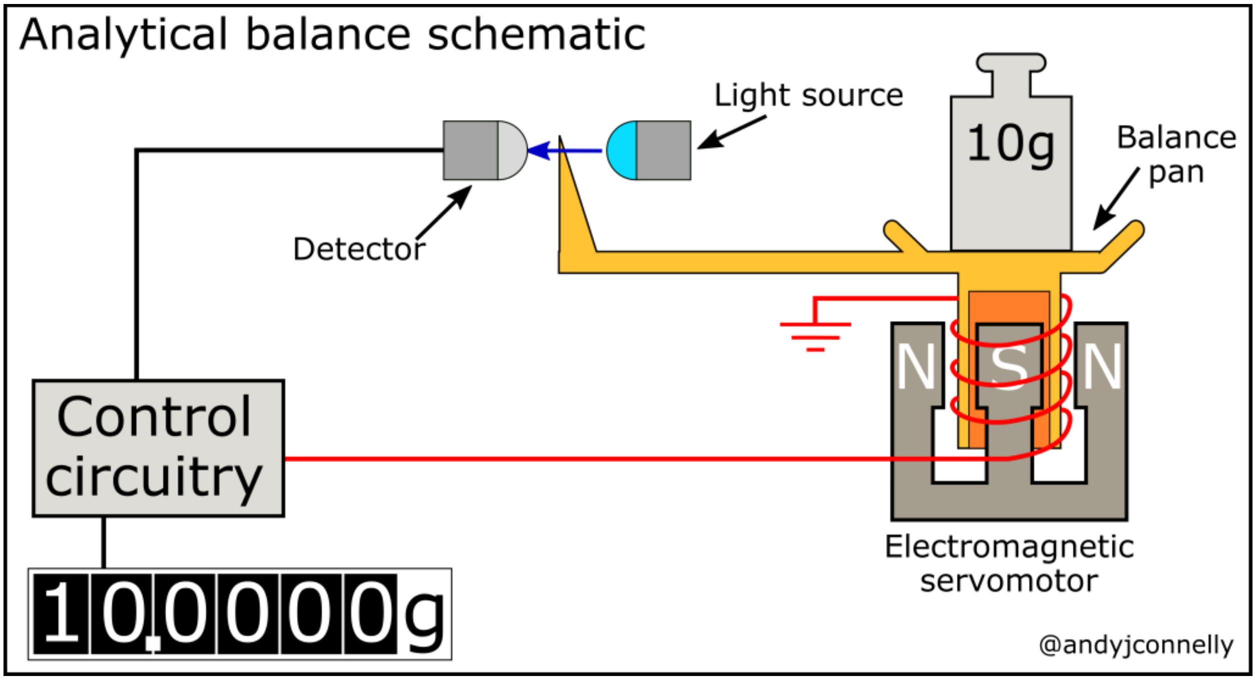

Figure 2. The operation of a modern analytical balance.

Operating an analytical balance

The following is a basic procedure for using an analytical balance. Before using a balance it is a good idea to check the calibration with a check weight (see below).

- Check the balance is level using the level indicator (see Figure 1). If the bubble is not in the center adjust the level, normally by twisting the feet, until the bubble is in the center of the inner circle.
- Check that the balance is on and that the door is closed. Press the “Tare” button and wait 5-10 secs for a ‘*’ or similar symbol to appear in the upper left/right hand corner of the display, and the mass to read 0.0000 g.
- Open the door and place a weigh boat, weight paper, or other container on the center of the balance pan (ideally with tweezers or similar).
- Close the door and wait for the digital readout to stabilize (‘*’).
- If you do not wish to include container mass in your measurement then press “TARE” to reset the mass to zero (see Step 2 above),
- Remove the container from the balance and add the substance to be weighed. Avoid adding substances on the balance pan as this can result in contaminating the balance.
- Return container to balance and wait 5-10 secs (may take up to a minute) for the mass reading to settle.

- If the mass reading is unstable it may be due to static electricity build up or other issues– see trouble shooting section.

Trouble shooting

The accuracy and precision of an analytical balance must be guarded and checked at regular intervals. There are many factors that govern whether an analytical balance behaves itself:

- **Gravitational acceleration** differences across the globe mean that the balances calibration may require local adjustment.
- **Temperature**: Balances take time to equilibrate to laboratory temperature changes. Also, hot or cold objects can create convection currents in the air which can cause variation in mass measured. For these reasons it is important to let the balance and objects equilibrate to the same temperature.
- **Moisture**: Objects or materials that absorb moisture can appear to gain weight. This may particularly be an issue for objects that have recently been removed from a desiccator. Other materials may evaporate or sublime during measurement.
- **Air flows**: Air movement in the laboratory across the pan will cause variations in the measurement. A draft shield reduces this but it will take time for the air within the draft shield to stabilize once the door is closed. Changes in air temperature within the draft shield will also cause air movement. These changes can be due to the temperature of the mass, hands, etc. Reducing air flow incident on the balance in the laboratory is key to reducing this issue and ensuring all items entering the draft shield are equilibrated to ambient temperature – using tweezers, not your warm hands, to move items can help.
- **Static electricity**: This can be one of the biggest causes of frustration when using a balance. If the mass you are measuring wonders up or down and will not stabilize then there is a good chance that you have a static issue. The static-electrical field interferes with the electromagnetic field of the balance. To prevent this you can use an anti-static device which will “fire” positive and negative ions at the weight boat, powder, etc. to neutralize the static charge. The good anti-static system are incredibly effective and can save hours of pain and frustration. Anti-static plastic weigh boats or metal weigh weight boats can also help.

Drift in Measurements with Analytical Balances

Pharmaceutical laboratories and bioscience research institutes make extensive use of analytical balances that are highly sensitive. These analytical balances are greatly affected by their environment and also by the way they are installed and handled. This is why it is important to assess the lab environment to make the required on-site adjustments.

The weighing equipment you use in a lab should always deliver accurate results and all the elements that can cause any discrepancies should be eliminated. The opening and closing of a freezer door can cause the temperature to fluctuate and this should not occur for optimal conduction of weight measurements.

Analytical balances are designed to deliver extremely precise results — as low as 1 millionth of a gram and hence they are in use for quality checks in the production processes of many pharmaceutical manufacturing companies.

What Causes Drift in Analytical Balances & How to Avoid It

The phenomenon of drift can occur adversely affecting analytical balances when weighing compounds. It refers to unstable weight readings, which typically occur due to static charge and inconsistent temperatures. Drift can cause changes in the measurements and leads to imbalances in displays. If enough static electricity is present in the environment, readings also become unstable. Even if not applying any weight.

Pharmaceutical production lines areas are generally kept clean under highly controlled conditions. The humidity levels are generally below 20% with 24-hour air conditioning. This creates a dry environment and hence any movement of objects can cause friction. The friction can create static electricity which can lead to considerable errors and discrepancies in weighing measurements ranging up to dozens of milligrams.

Ways to Avoid Analytical Balance Drift

In order to keep static electricity from building up and causing the drift effect, it is essential to ensure that humidity levels for weighing equipment are raised to 40% at the time of installation. Despite that, if the static energy keeps accumulating and the rate of electrical discharge is slow, weighing operations should not be made until the electrical charges are eliminated from the weighing sample. After weighing samples should not be stored in plastic containers as they are porous and operators should always conduct weighing operations while standing on anti-static flooring.

Another external factor that has a dramatic impact on the accuracy and stability of analytical balances is temperature. Temperature control is crucial in avoiding the drift phenomenon. This includes maintaining constant temperatures in the environment as well as for your weighing equipment. The best way to ensure temperature stability is to maintain a variation of not more than two degrees round the clock. Also the weighing instrument should remain on at all times so that the temperature remains consistent.

Evaluating the Performance of Analytical Balances

You need to evaluate analytical balances regularly to determine whether they need any on-site modifications, repairs, or calibration. Problems can occur due to defective components or because of how users operate them. You should test them for repeatability to ensure that they are delivering accurate results consistently for a given object.

- The best test of repeatability is to use a solid, non-magnetic and non-porous container. Or use a test weight and weigh it repeatedly after returning to zero at the end of every weighing cycle. Also you can try weighing two objects separately that are exactly half of the total weighing capacity. Then the difference between the two readings should be less than the actual tolerance for accuracy.
- If numerical readings turn blank or become frozen, it is safe to assume that your equipment has a contaminate, is damaged, or mishandled and thus is not producing the desired results.
- Cornerload is term that indicates the ability of an instrument to generate the same readings for an object, regardless of where it is placed on the weighing pan. At all the positions on the weighing pan, the readings should be the same. And if there are errors, they can be fixed during a field service.
- Linearity testing is done to ensure that the weighing instrument is delivering the same sensitivity throughout its functional range.