Balances and Glassware for Solution Preparation

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Open Beam Balances

- Least expensive option
- Typical accuracy: 0.01 gram
- Open beam balances
  - Can have 1, 2, or 3 beams
  - Can have 1 or 2 pans
  - Two pan balance is most versatile
- Hanging pan balances are similar to single pan open beam balances.

Harvard Trip Balance
(double beam)

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Open Beam Balances

We frequently use balances to measure quantities of solid substances. Sometimes, we use them to measure quantities of liquids. For simplicity of discussion, the terms "mass" and "weight" will be used interchangeably, although they are not equivalent terms.

The choice of a balance depends on the quantity to be weighed and the accuracy needed. The design may trade capacity for accuracy, or *vice versa*, because we don't need the same accuracy when weighing a large quantity as we need with a small quantity. For example, the error introduced by an inaccuracy of 0.1 gram is 10% when weighing 1 gram, while it is only 0.01% when weighing one kilogram.

With any balance, the weight of the container must be subtracted from the total weight so that a desired mass (net weight) is correctly determined. To get a balance to display only net weight, one first “tares” the instrument by placing weighing paper or a weigh boat or other container on the pan and setting the display to read zero.

A typical open beam or hanging pan balance is accurate to the nearest 0.1 gram. Such a balance is quite suitable for quantities above 100 grams. In fact, the error introduced when weighing 10 grams is only 1%, which is well within reasonable limits for biological buffers.

The pointer of a calibrated trip balance is straight up when there is nothing on either pan, indicating that the pans are in balance. Sliders on one or more beams are used to add weight to one side of the balance (usually the left side), causing one pan to drop. When an equal weight is placed on the opposite pan, the two pans are again balanced.

One way to use a trip balance is to weigh a container, pre-set the beams to read the weight of the container plus a desired net weight, and then add material to the container until the pointer indicates balance. A second procedure is to place identical containers on each pan so that the desired net weight can be pre-set using the beams and material added to the balance point.

The mass of an unknown can be determined by placing it on the pan and moving the weights until a balance point is reached (the weight of the container must be subtracted, of course).

A two pan open beam balance is especially convenient for balancing centrifuge tubes. In a centrifuge, the rotor must be balanced by placing tubes of equal weight opposite each other. An unbalanced rotor can fly off its mount, shatter, or both, thus damaging the centrifuge and possibly causing serious injuries to personnel.

References:

Gerstein, A. (Ed.). (2001). *Molecular Biology Problem Solver*. John Wiley & Sons, Inc.

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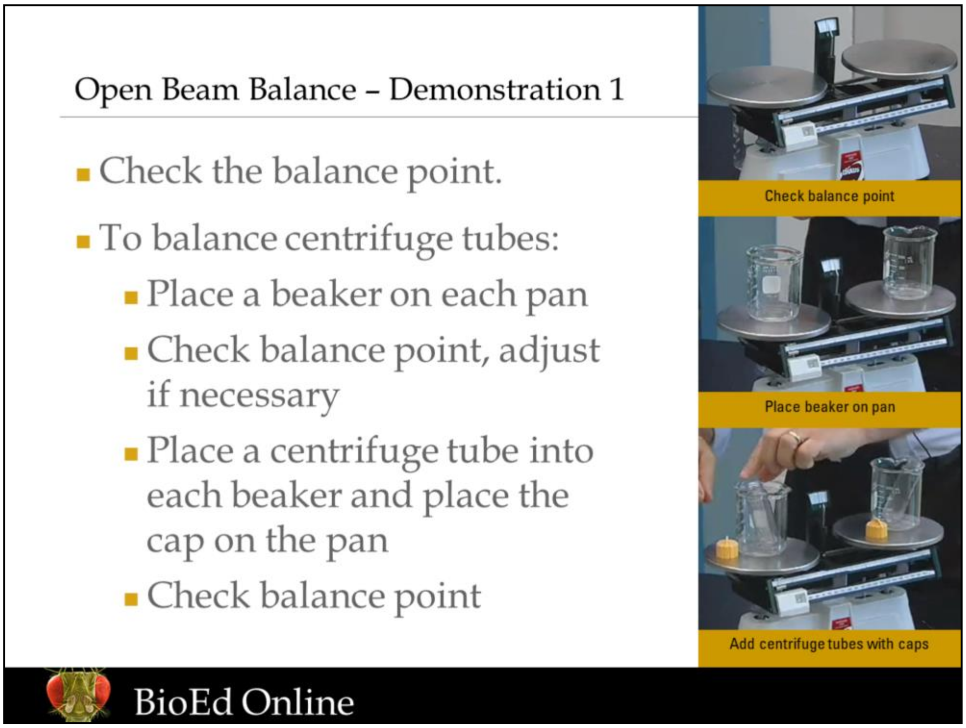
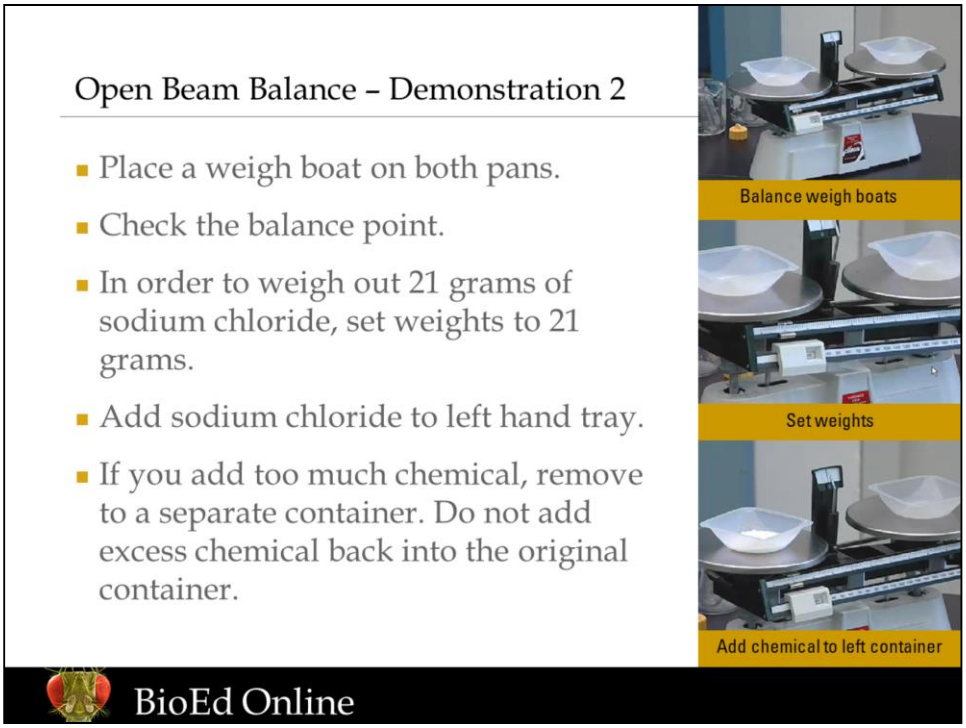


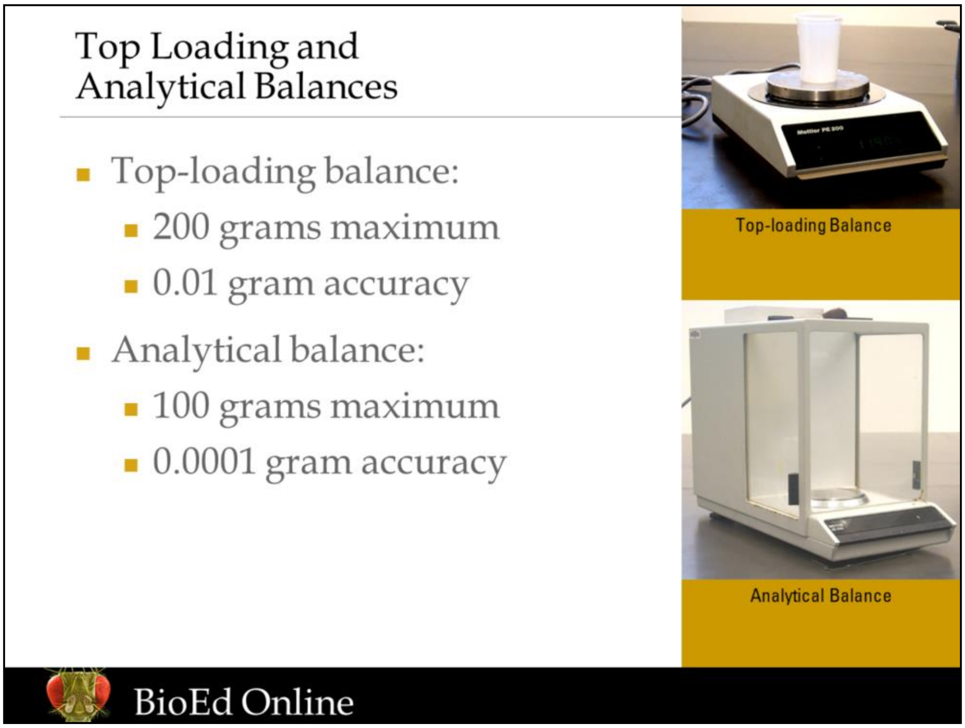
Open Beam Balance – Demonstration 1

A two pan open beam balance is especially convenient for balancing centrifuge tubes. In a centrifuge, the rotor must be balanced by placing tubes of equal weight opposite each other. An unbalanced rotor can fly off its mount, shatter, or both, thus damaging the centrifuge and possibly causing serious injuries to personnel.



Open Beam Balance – Demonstration 2

One way to use a balance is to place identical containers on each pan so that the desired net weight can be pre-set using the beams and material added to the balance point.



Top Loading and Analytical Balances

Most modern balances are electronic, with digital displays. A top loading electronic balance is probably the most frequently used weighing device in a typical laboratory. The capacity of such a balance is similar to that of an open beam balance, namely 200 grams or more, and a typical accuracy is plus or minus 0.01 grams. Electronic balances are convenient because it is necessary only to place a container on the pan, tare it to zero, and then add material to the container until the desired mass is displayed. There is no "balancing act" involved. Unfortunately, a typical electronic balance costs well over $1,000.

Electronic balances should be placed on stable surfaces and away from strong drafts, since air currents and vibrations affect the stability and accuracy of the readings. They also are designed with adjustable feet so they can be leveled.

When accuracy of better than 0.01 grams is desired and/or when quantities of less than a gram are measured, an analytical balance is preferred. The pan, which is placed upon or suspended from a sensitive weighing apparatus, is protected from drafts by a housing with doors through which materials can be introduced or removed. The sequence of operations is to tare the instrument with a piece of weighing paper on the pan with doors closed, introduce material through an open door, close the door to get a final precise weight, and then turn off the balance to remove the material.

Analytical balances cost perhaps twice as much as top loading electronic balances, depending on the level of accuracy and on the capacity of the balance. Because these devices are so expensive they should be kept scrupulously clean. Use a brush to remove any trace amounts of chemicals that may remain on a pan or the floor of an analytical balance, for example. Stainless steel pans should be washed frequently and rinsed with high quality water. Many chemicals are corrosive, and even non-corrosive materials tend to absorb water, promoting corrosion.

References:

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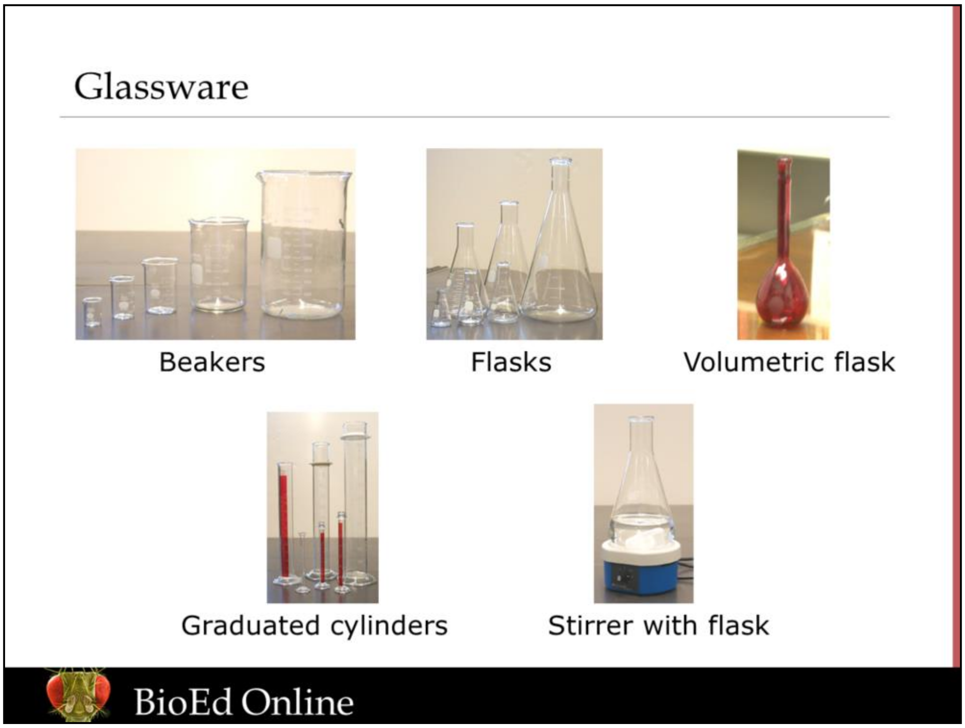

Glassware

Beakers are suitable for mixing solutions because they have large open tops into which one can pour solvent or large amounts of dry chemicals. Flasks are a bit easier to handle than beakers are, and the solution is less likely to splash out of a flask. The narrow opening discourages evaporative loss and contamination from the outside. A powder funnel can be used to add dry chemicals to a flask, while a glass funnel can be used to add liquid. To measure liquid volumes of 10 milliters or more, graduated cylinders usually are the practical choice. Cylinders are accurate to perhaps 1% of total volume, which is more than sufficient for most solutions. We seldom need volumetric flasks in biology, since we don't need such a high level of precision.

It is good practice to choose graduated cylinders and containers that are as close as possible to the intended volume of the contents. For example, it is not very accurate to use a 2 liter cylinder to measure out 100 ml of water. The same principle holds for weighing materials. It does not make sense to weigh out one hundredth of a gram of substance in a container that weighs 100 grams.

A magnetic stirring rod is useful when it takes some time for a solute to go into solution, although it is possible to add additional contamination into the solution. Use heat only if a formula calls for it.

References:

Reed,R., Holmes,D., Weyers, J., & Jones,A. (2003).*Practical Skills in Biomolecular Sciences* (2nd ed.). Pearson/Prentice Hall.]

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