A [colorimeter](https://en.wikipedia.org/wiki/Colorimeter_%28chemistry%29) is a device used to test the concentration of a solution by measuring its absorbance of a specific wavelength of light. To use this device, different [solutions](https://en.wikipedia.org/wiki/Solutions) must be made, and a control (usually a mixture of [distilled water](https://en.wikipedia.org/wiki/Distilled_water) and another solution) is first filled into a [cuvette](https://en.wikipedia.org/wiki/Cuvette) and placed inside a colorimeter to calibrate the machine. Only after the device has been calibrated can you use it to find the densities and/or concentrations of the other solutions. You do this by repeating the calibration, except with cuvettes filled with the other solutions. The filter on a colorimeter must be set to red if the liquid is blue. The size of the filter initially chosen for the colorimeter is extremely important, as the wavelength of light that is transmitted by the colorimeter has to be same as that absorbed by the substance.

**Spectronic 21**

 The Spectronic 21 Colorimeter (spectrophotometer) is an update of the Spectronic 20 Colorimeter (spectrophotometer). The operation is very simple and similar to that of the Spec 20. At the top of the instrument is a meter that displays both absorbance and percent transmittance of the sample being measured. On the left side is the compartment for holding the sample to be measured. On the top right are the wavelength selector and indicator. On the lower front left is the knob that controls the 100% position on the %T scale. On the lower front right is the switch that turns on the power.

Here are the steps to follow when using a Spec 21.

* Turn the instrument on using the switch at the lower right front of the instrument. Allow about 5 minutes for warm up when first turned on.
* Select the appropriate wavelength for the sample to be measured.
* With the Spec 21 no adjustment is necessary to set 0%T, this is done automatically.
* Fill a tube half full with water. This is called a blank. Place it in the sample holder and close the cover.
* With the blank in the sample holder and the cover closed, adjust the meter needle all the way to 100%T using the light control knob on the lower left front of the instrument.
* Remove the blank and place the sample to be measured in the sample holder and close the cover.
* Read absorbance value (or %T) from meter. In this case the readings are 20%T and 0.70 absorbance units.
* Repeat this step with additional known samples if making a calibration curve or verifying proportionality (Beer's Law).
* Repeat this step with a solution of unknown concentration, so that its absorbance can be compared to the absorbance of a known solution.

Additional details on operation of the spectronic 21

* SET WAVELENGTH
The wavelength selector is on the top right side of the instrument. To set the wavelength correctly, you must view the dial from directly above. Otherwise, you may read the dial wrong. Such 'parallax' errors occur if your line of sight is NOT PERPENDICULAR to the face of the dial.
* CUVETTES
All readings are done in cuvettes, which resemble small glass test tubes, but are made from higher quality glass.
Usually you will need two cuvettes to take the readings -- one to hold the water blank and one to hold blue sample solutions.
* RINSE CUVETTES
In case your cuvettes are not clean and dry before using, you should rinse them thoroughly with the solution, which you will be reading in them. Several small rinses are preferred to using one big rinse in order to coat the inside of the cuvette.
* FILLING VOLUME
When pouring a liquid into the cuvette, the solution must fill the cuvette to a sufficient height so that the internal light beam passes through the solution in the cuvette, and not through air.
The Spec 21 cuvettes have a horizontal index mark to show the minimum required filling volume.
* KIMWIPES
It is important to clean the outside, lower portion of a cuvette before taking any readings. Fingerprints, liquid droplets, and smudges on the cuvette surface can give false light absorbance readings.
The proper procedure for cleaning the surface of a cuvette is to use laboratory tissues, called Kimwipes.
* CLEAN WITH KIMWIPES
Wipe the cuvette first with a damp Kimwipe and then with a dry tissue.
After cleaning the cuvettes, you should handle them by their tops. Don't touch the lower portion of the glass.
* AIR BUBBLES
Even after cleaning the cuvette errors may still occur in a reading if air bubbles are present in the solution.
Before reading a sample of even a blank, you must REMOVING AIR BUBBLES
Removing air bubbles can be done by tapping the bottom of the cuvette to dislodge the bubbles.
Remove all air bubbles.
* REMOVING AIR BUBBLES
If tapping does not work, then cover the top of the cuvette with Parafilm (a stretchy plastic covering) and slowly invert the cuvette several times until all the bubbles are removed.
* SAMPLE HOLDER
Once the sample or blank is free from bubbles and in a clean cuvette, it can be inserted into the sample holder.
The sample holder is located on the left, top surface of the Spec 21. It is fitted with a cover, which must be closed before taking readings.
* INSERTING A CUVETTE
When inserting a cuvette into the sample chamber, GENTLY push the cuvette into its position. Hard pushing could damage the instrument.
* VERTICAL INDEX MARK
To assure reproducible positioning in the sample chamber, the cuvette has a vertical index mark near its top.
When inserted properly, the vertical index mark on the cuvette must be exactly aligned with the small nub on the top of the sample holder as seen here.
* FINAL STEP
Close the cover to the sample chamber. Stray light can enter and give false readings

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