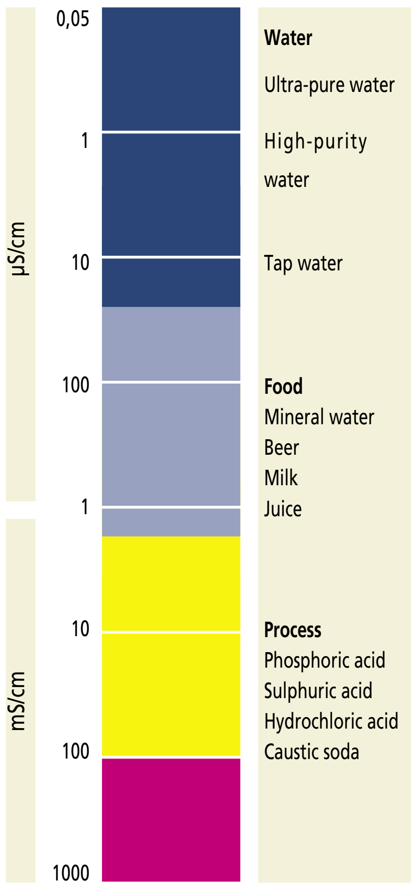
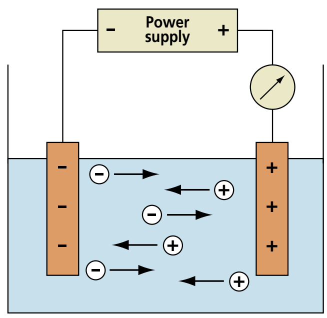
Measuring conductivity. A little theory

What is conductivity and why is it measured?
Conductivity is the capacity a solution has for conducting an electrical current.
Conductivity is a measurement of the total concentration of ions in a solution.
It is used in a wide variety of industries. In some cases the nature of the ions is a known factor and it is used to determine their concentration. For example in the food industry a conductivity meter is used to measure the salinity of the samples and it is applied in quality control. However, measuring conductivity in waste water, industrial effluents, etc. helps provide readings on their total ionic strength. Generally speaking, measuring conductivity is a quick and easy way of determining the ionic strength of a solution. The main disadvantage is that it is a non-specific technique.



How is conductivity measured?
A complete system for measuring conductivity includes these basic components:
- A conductivity cell.
- A temperature probe.
- An instrument for measuring.

The conductivity meter measures the electrical conductivity of the ions in a solution. To do this, it applies an electrical field between two electrodes and measures the electrical resistance of the solution. To prevent changes occurring in the substances, or the deposit of a layer on the electrodes, etc., alternating current is used.



The units of measurements which are normally used are S/cm. Other alternative forms of expressing the conductivity are Salinity and Total Dissolved Solids (TDS).

Salinity
This refers to the NaCl concentration of a hypothetical solution with the same conductivity as the study sample. It is expressed in ppm or g/l of NaCl.

TDS *(Total Dissolved Solids)*
Conductivity can be used as an indicator of the quantity of materials dissolved in a solution.
It is expressed in ppm or g/l of $CaCO_3$.

The effect of temperature
The conductivity of a solution is very dependent on temperature. This has a dual effect on electrolytes: it affects how far they dissolve and ion mobility.
The conductivity of a solution increases with temperature. This increase is normally expressed as %/ °C, and is called the Temperature Coefficient (TC). As a rule, aqueous solutions have a TC of almost 2%/ °C.

Substance @ 25ºC	Concentration %	Temperature Coefficient, TC
HCl	10	1.56
KCl	10	1.88
NaCl	10	2.14
HF	1.5	7.20

Temperature compensation consists of calculating, applying the TC, the conductivity value of a sample at a temperature known as the Reference, normally 25 °C (EN 27888).
To apply this compensation, some CRISON conductivity cells hold an internal temperature sensor, in other cases it needs to be acquired separately.

Calibrating with standards

This involves adjusting the values read by the instrument and the cell, according to the values of certain standard solutions, see page 84.
Calibration is very important for obtaining highly accurate readings.
CRISON instruments allow calibration to be performed on one, two or three points, depending on the model.

One-point calibration

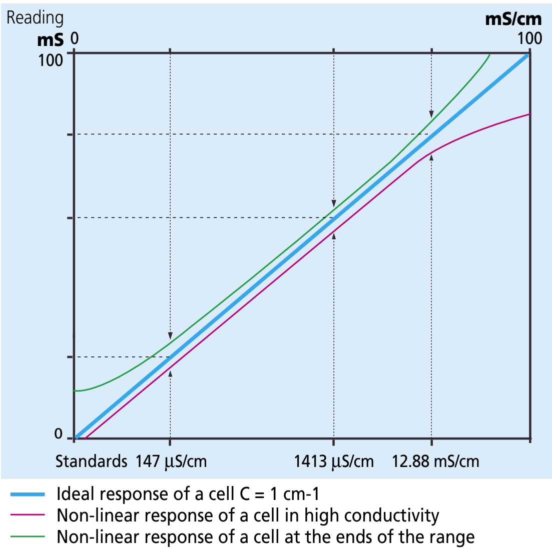
This form of calibration is acceptable when measuring conductivity values around that of the standard used. This is the most common type of calibration. In this type, 1413 µS/cm is the most commonly-used standard.

Two-point calibration

Two-point calibration is recommended for work in low or medium conductivity regions where accuracy is required. The 147 S/cm and 1413 µS/cm standards should be used for low conductivity regions, and 1413 µS/cm and 12.88 mS/cm for medium conductivity.
If you are calibrating with more than one standard, we recommend that you start with the one with the lowest conductivity to avoid contamination problems.

Three-point calibration

Three-point calibration is recommended when conductivities of the samples to be measured cover a wide range of conductivities.



Frequency of calibration

This depends on the accuracy required by the user and the effect of the samples on the cell.
Calibration lasts for a long time if the measuring plates are not subjected to any kind of alteration.

Stirring and conductivity

Stirring improves the quality of measurements by increasing the speed and reproducibility of the measurements.
Stirring should always be done at average speed.

GLP (Good Laboratory Practice)
Good laboratory practices in the measurement of χ

GLP recommendations attempt to guarantee the quality and validity of analyses performed in laboratories.

The requirements are as follows:
- The instrument must perform a auto-test.
- The instrument must compensate automatically for analogue drift
- There should be a password to protect the measurement programmes.
- The value of the measurement should only appear when the point of stability is reached. It should be impossible to get an incorrect reading.
- Possibility of printing out reports, with the date and time of the measurement or calibration in the header.
- Easy access to the instrument's programs.
- Details of calibration.
- "Calibration expired" message.
- Fixed and compulsory calibration protocol with 1 or 2 certified standards which the instrument can recognise.
- Calibration and measurement under identical conditions.
- Time control for the duration of the measurement and stirring speed.
- It should be impossible to obtain a measurement if the calibration is wrong.

The GLP 31 and 32 conductivity meters have been especially designed to comply with the precise specifications given in the GLP.

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