

Video « Conductivity – How to perform a conductometry measurement? »

Time	Text
00:09	Hello, This video will show how to determine the conductivity of a solution and at the same time how to use an electrical conductivity meter. To carry out this experiment, we will need an electrical conductivity meter with its instruction manual, a conductivity cell connected to the electrical conductivity meter, a magnetic stirrer with a magnetic bar (if we want to homogenize the solution), a potassium chloride solution at 0.1 mol/L that will be our calibrating solution, and of a solution to analyse (here we will choose tap water), distilled water and a thermometer to check the room temperature.
00 :56	The conductivity cell is made of two plates of platinized platinum between which the solution will be placed. In this case, we will study the mobility of ions between the two plates. In order to know how to carry out a conductometry measurement, we will first try to understand the principle behind the measurement. For conductometry, the conductivity cell will determine the inverse of the resistivity of the solution between the two plates. The inverse of this resistance is called conductance, written G and expressed in Siemens, which correspond to Ohms^{-1} . This conductance is related to the conductivity (written sigma) that we wish to determine, by the correlation factor k expressed in cm^{-1} . The conductivity is expressed in Siemens per centimetre, therefore the relation between sigma and G is: Sigma equals k times G.
2:16	The objective is first to determine the cell constant k and therefore to carry out a calibration of the electrical conductivity meter. To calibrate the electrical conductivity meter, we have to use a solution whose conductivity is known at several temperatures. We generally use a solution of potassium chloride at 0.1mol/L, and a thermometer to record the temperature because this one can have an important influence on the conductivity value.
03:00	If we look at the room temperature, we are at 21°C. In order to know the conductivity value of the KCl solution at 0.1 mol/L at 21°C, we generally use the conductometer manual, but one can also look in the scientific literature. In this manual, the conductivity value of the KCl solution at 0.1 mol/L at 21°C is fixed at 11.97 milliSiemens per centimetre. We will therefore try and find this value of 11.97 mS/cm on the screen of the electrical conductivity meter for our calibration solution of KCl.
3 :51	To carry out this first step of calibration, we will activate the calibration mode of the conductometer by pressing the CELL button. It indicates the initial value for the cell constant, which is 0.930 cm^{-1} . After pressing a second time on the CELL button, the electrical conductivity meter indicates to dip the cell in the calibrating solution, which we are going to do.
04:23	We take the cell, and remove the cap filled with distilled water. We will first cautiously dry the cell, take the calibrating KCl solution at 0.1 mol/L, and then dip the cell in the KCl solution. Once this is done, the cell gives a conductivity value, here of 11.40 mS/cm. Our goal will be now to change the cell constant k in order to find the value of 11.97 mS/cm: The conductivity value of a KCl solution at 0.1 mol/L at 21°C. This is what we will do here.
05 :20	We change the value of the constant k; and when doing a conductometry measurement, we must thoroughly wait for the value to be stable. Once the value is stabilized, here at 11.97 mS/cm, we can read the value for the constant k, here it is 0.937 cm^{-1} .
05 :50	I can confirm this value for the cell constant. And before measuring with the solution to analyse, I will take the cell out of the calibration solution, dry it, and rinse it with distilled water.
06:15	This calibration step will allow us to measure absolute values for the conductivity. It is not always necessary to calibrate, in particular when monitoring conductivity over time for a kinetic experiment, or when monitoring conductivity against a volume of base or acid added during an acid-base titration. However, this calibration step is interesting in order to determine the cell constant, which will inform us on the potential degradation of the cell. Indeed, the cell constant values are usually situated around the unit. If the value we get after a calibration is below 0.8 or over 1.2, it means the cell has been damaged and must be changed.
07:19	We will now do the measurements on the solution to analyse: tap water. First we will put some of the tap water in another beaker and rinse the conductivity cell with it, in order to remove impurities that may be present on the cell, and also any residual distilled water that could false the measurement. Then the solution to analyse is placed under the conductivity cell, the cell is dipped in the solution and we can read the value: here we have 0.41 mS/cm. The last step is to remove the cell from the solution, to rinse it with distilled water, and place the cap with distilled water back on. It is important for the cell to be kept in aqueous environment, this is why distilled water is poured in the cap.
08:43	The tap water we analyse here is not pure, considering that there are ionic species beside the water molecules. This has been demonstrated though the conductivity measurement we carried out. The value of

	0.41 mS/cm is largely superior to the value we would expect for pure water. Indeed for pure water, containing only very small amounts of H_3O^+ or HO^- ions (10^{-7} mol/L), we would expect a conductivity of 0.055 microSiemens/cm. We are far from this value, which proves there are ionic species in solution.
09:32	As we saw before, temperature influences a lot the value of conductivity. For chemical reactions where there can be a change in temperature, it is necessary to use a thermostatically-controlled beaker like this one. A solution is flowing in the wall of the beaker to control temperature.
10:02	In certain cases, it is necessary to homogenize the solution. The solution to analyse is placed on a magnetic stirrer, a magnetic bar is added and the solution is stirred. Once the solution is homogenized, the conductivity cell is dipped in it. The important point is not to carry any conductometry measurement while the solution is stirred, in order not to disturb the solution between the two platinized platinum plates.
10:38	For an acid-base titration for example, it is necessary to leave the cell in the solution and to homogenize each time we add a little volume of acid or base. This is how we proceed: we homogenize after each volume added and then the magnetic agitator is turned off for the same reasons as before, to not disturb the solution between the platinized platinum plates. We read the conductivity value once it is stabilized.
11:18	For a kinetic monitoring, we often cannot turn the agitation off. In this case we must proceed with a moderate agitation and place the cell as far away as possible from the magnetic bar in order to disturb the solution as less as possible.