Video « Titration – How to perform a colorimetric titration? »

Time	Text
00 :10	Hello, in this video we will see how to perform a colorimetric titration and how to use a calibrated burette. To carry out a colorimetric titration we need the following material: A graduated burette, a beaker, a magnetic bar, a magnetic stirrer, the solution to titrate, the solution to analyze and coloured indicators. Let's first try to understand the principle of a colorimetric titration. The solution to titrate is placed in a beaker and the titrating solution is placed in the graduated burette. To be a relevant titration reaction, this one have to be quantitative, unique and proceed rapidly. At the equivalence point it is necessary for the titrating species (titrant) to react in a stoichiometric way with the titrated species (analyte). The equivalence point, i.e. the volume of the titrating species added, is then determined in order to deduce the amount of substance and the concentration of the analyte.
01 :15	How should we proceed experimentally to carry out a colorimetric titration? An important point is the choice of the graduated burette. Here for example, you can see three burettes made of glass, but one can also use plastic burette. The size of the burette is important. We can find burettes of 50 ml, 15 mL, 25 mL. Here you have three burettes of 25 ml. What may differ between each two burettes is also the type of tap. At the top of the burette there is a funnel which can be of different sizes and will facilitate the filling of the burette. Another important point between these two burettes: in one case you do not have a visualization help to read the volume, while an aid is present here (you can see it on the back). It will give us more precision to determine the equivalence point.
02 :25	Then how do we choose the burette? Generally the equivalent point is located intentionally at the middle of the burette. Typically for a 25 ml burette, an equivalent point in the range of 12 to 15 ml is searched.
02 :43	How do we experimentally carry out a colorimetric titration? The first step is to rinse the graduated burette with distilled water. To do so, we will close the tap, place a beaker underneath as a waste beaker, and fill the burette with distilled water up to the top. Distilled water is passed through the tap and we can check that there is no leakage.
03 :28	After this rinsing step with distilled water, we must rinse the graduated burette with the titrating solution, in order to remove the remaining distilled water that could lead to a wrong value of equivalence point. As before we first check that the tap is closed, we place a waste beaker below, and we fill the burette to the top with the titrating solution. The solution is then run through the burette.
04 :10	After this second rinsing step of the burette with the titrating species, we will now fill the burette with the titrating species. As before, we check that the tap is closed, then we place a waste beaker, and we add the titrating solution up to the top. We go a little bit higher than the zero in order to use the tap and check that there is no air bubble above or below the tap. If so, the procedure is to open and close the tap several times as quickly as possible. So we're going to open the tap and move to zero. Here we check that there are no air bubbles above or below the tap. Then we make sure that the meniscus is at the zero level and we will have properly filled this burette with the titrating solution.
05 :27	When filling the burette and coming to the zero, attention must be paid to the meniscus. The eyes must be well in front of it. The look must not be too low or too high to avoid parallax errors.
05 :45	The next step is to place the solution to analyze in the beaker. Usually, the beaker will be rinsed with the solution to analyze. In the same way as for the burette, traces of water are removed in the beaker to avoid disturbing the titration. The beaker is rinsed and the solution to analyze is dispensed in it using a volumetric pipette. We take the sample. We use a volumetric pipette to be as accurate as possible in order to precisely determine the amount of substance of the analyzed species, and its concentration thereafter.
07 :31	A magnetic bar is then placed in the beaker. We check that the agitation is homogeneous and is not too strong, then we add a coloured indicator in the beaker. We add a few drops of coloured indicators to make sure that there is a colouration. Here the solution has a blue colour and the equivalence point will be determined when there is a change of colour in the beaker.
08 :17	We will now carry out the titration and determine the equivalence point. That is the purpose of the coloured indicator. The solution now shows a pale blue colour difficult to distinguish. Usually, to better distinguish the colour, and in particular the change of colour that will occur during this titration, we place a white cloth or white paper under the beaker. This allows us to better see the colour. Then we will perform the titration. Generally three titrations are carried out to determine the equivalence point as precisely as

	possible.
08 :57	First titration: We will titrate quickly and roughly evaluate the equivalence point, to know where it is located. Then we will carry out two more precise titrations, where we will each time add the titrating solution more carefully: we will add millilitre per millilitre (or every 2 ml) around the equivalence point. So a second titration, more precise, will be carried out, where equivalence point will be determined. And then a third titration where we will determine again an equivalence point in order to check that the two equivalence points obtained in the second and third titrations are identical.
09 :40	At first, we carry out a fast titration, to try to roughly evaluate the equivalence point.
10 :11	After this, we have observed a change of colour at an equivalence point of 13 ml. We will now carry out a second titration, more accurate. We know that our equivalence point is located around 13 ml, and we will therefore do a quick drip up to 10-11 ml. A quick drip or a fast trickle (you see here that it is quite fast) with the titrating solution.
10 :55	So now we're around 8 ml. We're going to start making a much slower drip. The goal is to be as accurate as possible in determining the equivalent volume, and the colour change, trying to be precise down to the drop.
11 :19	Now we are getting at 11 ml, and we're going to slow down the flow a little more. The important point is to have a significant colour change, and we can see that through a good persistence of colour. Here we can see when adding the drops that a yellow colour appears but quickly vanishes since the solution is homogenized. We are really close to 13 ml, at exactly 12.4 ml. You can see here that the colour is almost permanent; there is a blue remanence, so we'll add one more drop to really be as accurate as possible. Now we have a good persistence of the yellow colour. To be really sure we can add another drop. Now we really have a deep colour change. We are at an equivalence point of 12.5 ml. To read the equivalence point, I make sure as before that my eye is well at the level of the meniscus, and I read at the bottom of the meniscus.
12 :58	Once the titration is done, we must empty the burette and then rinse this burette with distilled water for future use, so that it is not soiled with the titrating solution. We add distilled water at the top of the burette and rinse it thoroughly.
13 :54	There are several types of coloured indicators depending on the nature of the titration reaction. There may be acid-base, redox, complexation or adsorption indicators. In our case we performed an acid-base colorimetric titration with an acid-base indicator. The soda was titrated with hydrochloric acid and the bromothymol blue (BBT) was used as a coloured indicator. The BBT is blue in basic environments and yellow in acidic environments. For this titration of the soda by hydrochloric acid, one could have used another coloured indicator such as the phenolphthalein. Some reactions do not necessarily require the addition of a coloured indicator, especially when the reagents or products are coloured. This is for example the case of manganometry with $KMnO_4$ (potassium permanganate), where $KMnO_4$ is purple in solution. $KMnO_4$ reacts with Fe^{2+} for example. A reaction occurs between $KMnO_4$ and Fe^{2+} leading to Mn^{2+} and Fe^{3+}. The equivalence point is determined by the colour change when $KMnO_4$ is in excess. The solution turns to purple.