

## REDOX TITRATION – HOW TO DETERMINE HYDROGEN PEROXIDE CONTENT

### Were you cheated by your supplier?

Mr. Black is owner of a small pharmacy shop. He sells a lot of pharmacy products. In his portfolio, there is also a hydrogen peroxide solution sold as a disinfection. Sold solution should be of 3 % w/w. Nevertheless, Mr. Black is not sure, whether his supplier does not cheat and to earn more, he sells him hydrogen peroxide solution with much smaller concentration.

Can you help to Mr. Black and find the concentration of hydrogen peroxide solution from his pharmacy shop? Is the solution sold in his shop OK?

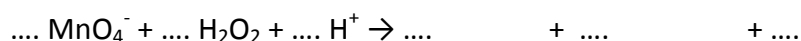


**What is the concentration of hydrogen peroxide solution sold in Mr. Black's pharmacy shop?**

### What you need to know

To determine the concentration of hydrogen peroxide in solution, the method called manganometry can be used. In this method, the sample is titrated by volumetric solution of potassium permanganate at acidic conditions. This method can be used in the case of Mr. Black problem as well. Titration is made up to pink color.

The reaction which occurs in the solution is written bellow. Please, balance the equation!



Cite this work as:

Šmejkal, Petr and Stratilová Urválková, Eva (2014). Redox titration – how to determine hydrogen peroxide content. pp. 1-6. Available at <http://comblab.uab.cat>

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**Before you start, you should know:**

It was told, that the titration is made up to pink color. Unfortunately, if you are newbie, you do not know, what is the right pink color. You do not know the exact point, when the titration is finished and we reached the equivalence point. One solution can be to find an “unbiased” method which is not influenced by our color perception and eliminates our inexperience. You can use MBL and measurement of some suitable property by sensors, which response is not influenced by subjective perceptions. But which sensor (and measured property) should be selected? Try to select suitable sensor for your task, if you have pH sensor, ORP (Oxidation-Reduction Potential) sensor and conductivity sensor and give reasons for your selection. After the selection is done, perform the titration using the procedure below.

1. Why have you selected ..... sensor? Give reasons! Give reasons why you have not selected ..... sensor.

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2. What property do you plan to measure with selected sensor and dependence of which property on which property do you plan to measure?

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3. Suggest an experimental setup for your measurement and draw a scheme. Discuss your suggestion with your teacher.

## Procedure

### Chemicals:

- volumetric solution of  $\text{KMnO}_4$  of  $c=0.02 \text{ mol/dm}^3$
- $\text{H}_2\text{SO}_4$  solution of  $c=2 \text{ mol/dm}^3$
- sample solution of  $\text{H}_2\text{O}_2$  from pharmacy shop of Mr. Black

### Equipment:

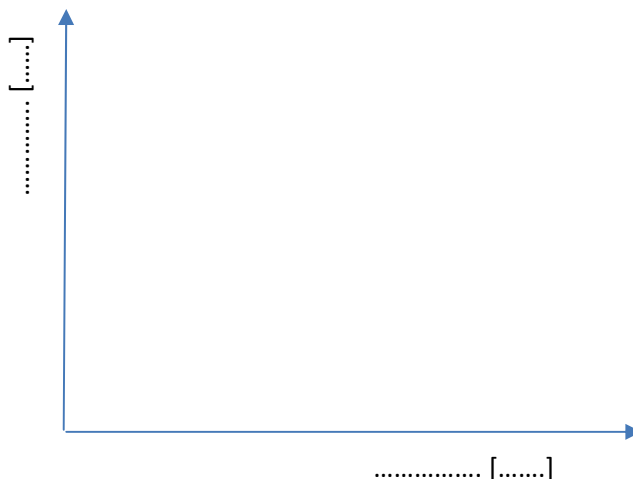
- Volumetric glass (volumetric cylinder, pipette, burette)
- 2 beakers, beaker of volume of 250 ml
- sensor .....
- PC with suitable control software installed

### Procedure:

1. Pour 2.00 mL of sample (taken using pipette) into 250 mL beaker and dilute it approximately to 150 mL with distilled water.
2. Add 5 mL of sulfuric acid with volumetric cylinder.
3. Built the experimental setup which you suggested previously. Do not forget to insert the selected sensor.
4. Run control software and select manual data collection (in correspondence with your MBL system. Set-up measurement and quantities displayed on  $x$  and  $y$  axes in accordance with your suggestions. (If you use the PASCO system, select *Setup – Sampling Options* – tick „Manual Sampling Control“, „Keep samples on button or menu item command“ and „Keep data on command“ – fill field „Name“ with property you want to display on  $x$  axis, and fill in the field „Units“ with units of this property. Select „OK“. In left window double click on Graph item, graph will be displayed in the main field of program window. Click on the name of  $x$  axis. Usually, this axis display time. Select measured property instead of “Time”. Using the same procedure, select the measured property on  $y$  axis. Click on „Start“ button in main program window. After pressing the “Start” button, the button “Stop” appears instead of the “Start” button and another “Green tick” button on the right side of the “Stop” button. Click on the “Green tick” button at zero volume. New window with field to be filled appears for entering the axis  $x$  value. Write zero and click „OK“, the point is displayed in graph window. Then add 0.3 mL, click “Green tick” button and write the total added volume. The point is displayed in graph after click on “OK” button. Repeat the procedure and follow the curve displayed. You should add about 10 mL more of titration agent than it is needed to reach equivalence point (you can simply estimate, which point on titration curve corresponds to equivalence point). Stop the measurement by click on “Stop” button.
5. Follow the titration curve. Add enough of titration agent – about than 10 mL after the solution becomes colorless

## Evaluate your data

Draw below your curve and estimate the equivalence point. Read the corresponding value of volume which corresponds to equivalence point and write it down below. Which color of solution corresponded to equivalence point? Do you think that color change at equivalence point is well distinguishable?

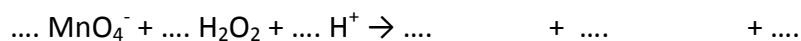


1. What is the volume of added titration agent in equivalence point? .....mL
2. What is the color of solution in equivalence point? .....
3. What is the volume of added titration agent exactly when titrated solution become colorless?

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### Calculation:

Calculate percent composition (by mass) of the sample. What is the content of hydrogen peroxide? Use the equation below (balance it):



Molar weight of hydrogen peroxide is 34 g/mol. Density of sample is 1,01 g/cm<sup>3</sup>.

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### Conclusion:

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## Communicate your results

Write for Mr. Black an official protocol about the results of your determination and recommendations how to solve the situation with his supplier.

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In previous experiments, you got enough of experience and information to answer the following questions:

1. Why the solution is titrated to pink color and not to colorless solution?

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2. What point at titration curve is the equivalence point and why? Give the reasons. What is the color of the solution at this point?

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## Specific questions

1. Would it be possible to use such titration for determination of concentration of iron (III) ions? Give the reasons for your answer.

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2. What property is in fact indicated using this method and explain the titration curve with regard to your answer.

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