Worksheet 3: Reading on the Iodometric Titration of Copper

INTRODUCTION

In the Input Source 2: The Iodometric Titration of Copper, you will find the following information:

a. Differences between iodometric and iodimetric titrations.
b. The Standard solution used in an Iodometric titration.
c. The basic reaction in Iodometric Titrations.
d. Reactions involved in the Iodometric Titration of Copper.
e. The necessity of an indicator during the process.
f. Problems observed and how to solve them.

Before reading the theoretical discussion of the iodometric titration of copper, some key terms are given. A pre-reading task is also proposed in order to elicit previous knowledge.

INSTRUCTIONS

1. In pairs do the three pre-reading tasks.
2. Read the Input Source 2.
3. After reading the Input Source 2 self-correct pre-reading tasks.
4. Then, think about what you have learned.

PRE-READING TASKS

Task 1. PRE-READING COMPREHENSION I

In a scale of 1-5 (1 not important at all to 5 extremely important) examine the following statements) and give your score for each one.

You will self-correct your answers after reading the Input Source 2.

1. Before carrying out an experiment in the laboratory it’s very important to know what the reactions involved in the experiment are.
   1 □  2 □  3 □  4 □  5 □

2. The reactions give us information about the evolution of the experiment.
   1 □  2 □  3 □  4 □  5 □

3. Each experiment has its own particular features, and it’s very important to know all of them and the problems that we can observe in the process.
   1 □  2 □  3 □  4 □  5 □

4. Also, it’s necessary to recognize all the safety precautions we must observe in the handling of the procedure.
   1 □  2 □  3 □  4 □  5 □
Task 2. PRE-READING COMPREHENSION II

Test yourself before reading.
Read the questions before reading the Input Source 2. Probably you already know some of the answers.
After reading Input Source 2 self-correct your answers.

Tick the correct answer:

1. Which titrate is used in the iodimetric process?
   a. □ sodium thiosulphate
   b. □ iodine

2. Which titrate is used in the iodometric process?
   a. □ sodium thiosulphate
   b. □ iodine

3. Is it necessary to use an indicator in an iodometric titration?
   a. □ Yes, because the brown colour of iodine disappearing as iodine is consumed.
   b. □ No, because the brown colour of iodine in an aqueous solution is sufficiently intense to serve as an indicator.

4. When should the starch be added?
   a. □ Starch should be added at the beginning of the titration.
   b. □ Starch should be added after most of the iodine has been consumed.

5. Why is it necessary to add any tyiocianate ion?
   a. □ There is a problem, the Cul forms a complex with the I₂, and therefore the I₂ shouldn’t be titrated by the thiosulfate. That means that we have reached the end point before the equivalent point, and consequently there is a determinate error.
   b. □ The addition of an tyiocianate ion allows the formation of the complex Cul-I₂, and so the standard solutions reacts directly with the generated iodine.
Task 3. KEY TERMS THAT YOU KNOW

Work in pairs. You have 2 minutes to complete the grid below. Translate each word into your own language. One example has been given. Compare your answer with other pairs and complete the grid. If there are some key terms that you have not translated, you should read the Key Terms Glossary in the last page and complete the grid.

<table>
<thead>
<tr>
<th>English word</th>
<th>Translation</th>
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<tbody>
<tr>
<td></td>
<td>Me and my partner</td>
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<tr>
<td>1. bumping</td>
<td></td>
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<tr>
<td>2. dropwise</td>
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<tr>
<td>3. sluggish</td>
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<td>4. starch</td>
<td>midó</td>
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<td>5. swirl</td>
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<td>6. tap water</td>
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<td>7. to expel</td>
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<td>8. to label</td>
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<td>9. to release</td>
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<tr>
<td>10. to slow down</td>
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<td>11. wire</td>
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THE IODOMETRIC TITRATION OF COPPER

The titration of iodine against sodium thiosulfate, using starch as the indicator of colour change, is one of the most accurate volumetric redox processes. The descriptive term for the titration procedure depends on which reagent is used as the titrant. If iodine, I₂, is used as the titrant, then the process is termed an iodimetric process. If on the other hand thiosulfate, S₂O₃²⁻, is used as the titrant, then this type of titration is termed an iodometric process, and the iodometric titration of copper is the procedure used in this analysis described here. In either iodimetric and iodometric process, the principal reaction is the oxidation of thiosulfate by iodine to produce iodide ion, I⁻, and the tetrathionate ion, S₄O₆²⁻. This process is showed in the following reaction:

\[ \text{I}_2(\text{aq}) + 2 \text{S}_2\text{O}_3^{2-}(\text{aq}) \rightarrow 2 \text{I}^- (\text{aq}) + \text{S}_4\text{O}_6^{2-} (\text{aq}) \]

The brown colour of molecular iodine in an aqueous solution is sufficiently intense to serve as an indicator of colour change, because the brown colour will begin disappearing at the same time as I₂ is consumed, but this colour change is possible only if there are no other coloured substances present to interfere. Usually though, an indicator is preferred, and starch is commonly used for this purpose. "Soluble" starch forms an intensely blue-coloured complex with molecular iodine. Even traces of iodine produce a visible colour, making an indicator blank unnecessary. The blue colour of the complex disappears if the solution is heated, but returns again with cooling. When iodine is titrated with thiosulfate (an iodometric titration), starch should be added only after most of the iodine has been consumed; otherwise, the disappearance of the blue colour at the end point is sluggish. Sodium thiosulfate solutions are standardized using pure copper as a primary standard. The metallic copper is first oxidized with nitric acid to copper(II) ion, Cu²⁺, which is reduced by reaction with iodide ion to copper(I), Cu⁺, which precipitates as white or cream-colored copper(I) iodide, CuI. The reduction of copper (II) to copper(I) oxidizes iodide ion to molecular iodine, I₂.

\[ 2 \text{Cu}^{2+}(\text{aq}) + 4 \text{I}^- (\text{aq}) \rightarrow 2 \text{CuI} (s) + \text{I}_2 (\text{aq}) \]

The molecular iodine which forms is then titrated with sodium thiosulfate in the presence of the CuI precipitate.

\[ 2 \text{S}_2\text{O}_3^{2-}(\text{aq}) + \text{I}_2(\text{aq}) \rightarrow \text{S}_4\text{O}_6^{2-} (\text{aq}) + 2\text{I}^- (\text{aq}) \]

One minor problem with this particular iodometric titration is that copper(I) iodide forms a weak complex with molecular iodine which slows down its reaction with thiosulfate. As a consequence of this, once the starch indicator has turned from blue to colorless, the blue color returns after a few seconds as I₂ is slowly released into the solution by the CuI-I₂ complex. This "after-bluing" can be avoided by adding some potassium thiocyanate, KSCN, just before the end point is reached. The thiocyanate ion, SCN⁻, replaces the complexed I₂ from CuI-I₂, releasing the I₂ to solution where its reaction with thiosulfate is rapid.

\[ \text{CuI-I}_2(s) + \text{SCN}^- (\text{aq}) \rightarrow \text{CuI-SCN}^- (\text{aq}) + \text{I}_2(\text{aq}) \]

Source: http://www.wku.edu/~charles.henrickson/chem330.htm
POST- READING TASKS

Task 4. CORRECTION OF THE PRE-READING TASKS

KEY STUDY HELP OF THE IODOMETRIC TITRATION OF COPPER PROCEDURE

1) **Iodine** is the titrate (standard solution) used in iodimetric titration.

2) **Sodium thiosulfate** is the titrate (standard solution) used in iodimetric titration.

3) **It is necessary to use an indicator** in iodometric titrations because the brown colour of iodine disappearing as iodine is consumed.

4) **Starch should be added after most of the iodine has been consumed.** Otherwise, the disappearance of the blue colour at the end point is sluggish.

5) There is a problem, the **CuI forms a complex with the I₂**, and therefore the I₂ shouldn’t be titrated by the thiosulfate. That means that we have reached the end point before the equivalent point, and consequently there is a determinate error. **The addition of the thiocyanate liberate the I₂ in the complex CuI-I₂**, and a new complex is formed **CuI-SCN**.

Check with your partner your answers of the pre-reading tasks 1 and 2.

Do you want to change any answer in task 1 and 2?

Then, check your answers with the key.

### Task 1

<table>
<thead>
<tr>
<th>Your answer before reading</th>
<th>1</th>
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<th>Your answer after reading</th>
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<tr>
<th>Disagreement (check your answer with the key)</th>
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### Task 2

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<th>Your answer before reading</th>
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<tr>
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After checking your answers with the key, now complete this grid:

<table>
<thead>
<tr>
<th>What have I learnt in task 1?</th>
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<tr>
<th>What have I learnt in task 2?</th>
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Task 5. STUDY HELP

Now it is time to think about you have learnt. Answer these questions.

1. Which is the Titrant in an Iodometric process?

2. Which is the Titrant in an Iodimetric process?

3. In redox titrations involving iodine, what is the indicator used?

4. When do you add the indicator?

5. Why is necessary to add thiocyanate?
### KEY TERMS

1. **bumping**: something that bulges out or is protuberant or projects from a form  
2. **dropwise**: in the form of drops  
3. **sluggish**: inactive, slow  
4. **Starch**: A polysaccharide consisting of various properties of two glucose polymers, amylase and amylopectin. It occurs widely in plants, especially in roots, tubers, seeds, and fruits, as a carbohydrate storage product and energy source.  
5. **swirl**: vortex  
6. **tap water**: water directly from the tap  
7. **to expel**: eliminate, eject  
8. **to label**: an identifying or descriptive marker that is attached to an object  
9. **to release**: allow to go, set free  
10. **to slow down**: decelerate  
11. **wire**: piece or length of metal