Content and Language Integrated Learning (CLIL) Materials in Chemistry and English: Iodometric Titrations. Teacher's Instructions

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INTRODUCCIÓ

El material[1]

El material es presenta en forma de mòduls i cada mòdul pot estar format per Input Sources, Worksheets i Fact Files.

El conjunt de Input Sources i Worksheets que formen el material tenen com a objectiu la realització de la quantificació del coure present en un cable elèctric realitzat amb coure electrolític d'elevada puresa. El mètode analític seleccionat és la Valoració Iodomètrica del Coure.

Per què s'ha escollit aquesta quantificació?

Les raons per a l'elecció són les següents:

1. És una tècnica que s'utilitza als laboratoris de Control de Qualitat.
2. Permet l'elaboració de presentacions de conceptes teòrics.
3. El material en llengua anglesa que es va trobar era interessant i de qualitat.
4. La mostra és coneguda pels alumnes.
5. La mostra és de fàcil adquisició i baix cost.
6. La quantitat de coure que és present als cables elèctrics es coneix amb anterioritat. Això permet que al final l'alumnat pugui comparar els seus resultats amb el teòric.
7. El material i els reactius necessaris es troben fàcilment als laboratoris docents.

Elaboració del material

L'esquelet que vertebra el material són les Input Sources (fonts d'informació), a partir de les quals es van elaborar les Worksheets (fulls de tasques).

Què són les Input Sources?

Són la informació que es dona a l'alumnat. En el material hi ha diverses Input Sources, que s'analitzaran amb detall al apartat següent.

- Textos originals.
- Textos elaborats.
- Presentacions en format Power Point (Fact File).
- Class notes: Apunts de classe.

S'ha fet una distinció en la nomenclatura de les presentacions: en aquest cas s'ha utilitzat la paraula Fact File. S'ha escollit aquest nom perquè s'inclouen activitats, és a dir, no és només una font d'informació sinó que també hi ha

[1] Tot el material es pot descarregar en la següent pàgina web: http://diposit.ub.edu/dspace/handle/2445/2.

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participació directa de l'alumnat. S'ha dissenyat el material de forma que l'alumnat sigui el centre, és a dir, que l'alumnat tingui un paper actiu.

El material s'agrupa en mòduls. El material que es presenta a cada mòdul té uns objectius comuns, aquests s'assoleixen amb les Input Sources i els Worksheets.

Els mòduls amb els seus objectius es recullen a la taula 1. A la taula 2 es recull un detall del contingut del material per a l'alumnat i, per últim, a la taula 3, el material disponible per al professorat.

Module	**Aims**
Module 0. Introduction	To introduce the key terms To introduce the topic
Module1. Getting ready for the titrations	To check students' previous knowledge about volumetric analyses To review previous titrations carried out in the laboratory by the students
Module 2. Iodometric and Iodimetric Titrations	To introduce Iodometric and Iodimetric Titrations To check: previous knowledge about Titrations and oxidizing and reduced agents; and comprehension of the topic of the Lecture
Module 3. Iodometric Titration of Copper	To introduce the main features of the Iodometric Titration of Copper
Module 4. The sample: Copper wire	To introduce the sample To justify the necessity for the quantification of copper in a copper wire
Module 5. The Procedure for the Iodometric Titration of Copper	To introduce the Iodometric Titration of Copper procedure To understand the steps of the procedure To understand a text about a procedure To check the reactions involving in the Iodometric Titration of Copper To review some concepts about redox reactions
Module 6. The Experiment	To prepare the procedure: to check Laboratory Equipment and Reagents To prepare the procedure: calculations in order to prepare the dissolutions needed in the performing of the procedure To keep a record of: the weigh samples and volumes of the titrant To perform the calculations in order to obtain the % of copper in the sample

Taula 1.- Els mòduls i els seus objectius

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Module	Student's material
Module 0. Introduction	**Input Source 0**: Introduction: The Iodometric Determination of Copper
Module 1. Getting ready for titrations	**Worksheet 1a**: Initial Evaluation Quiz on Volumetric Analyses
	Worksheet 1b:Checking Previous Knowledge on Titrations
Module 2. Iodometric and Iodimetric Titrations	**Fact File 1**: Introduction to Iodometric and Iodimetric Titration
	Worksheet 2a: Recalling the Basic Information from Fact File 1
	Worksheet 2b: Evaluation Quiz on Iodometric and Iodimetric Titrations
Module 3. Iodometric Titration of Copper	**Worksheet 3a:** Lead-in tasks. The Iodometric Titration of Copper
	Worksheet 3a: Key Terms Key
	Input Source 1: The Iodometric Titration of Copper
	Worksheet 3b: Checking Comprehension Tasks. The Iodometric Titration of Copper
Module 4. The Sample: Copper wire	**Worksheet 4a:** Lead-in Tasks. Copper in our daily live
	Input Source 2: Copper in our daily live
	Worksheet 4b: Checking Comprehension about Copper in our daily live
Module 5. The Procedure for the Iodometric Titration of Copper	**Fact File 2:** The Procedure for the Iodometric Titration of Copper
	Input Source 3: Flow-chart of the Procedure
	Worksheet 5a: Recalling the Basic Information from Fact File 2
	Input Source 4: Experimental Procedure of Determination of Copper in a Copper wire
	Worksheet 5b: The Procedure: Searching for chemical information
	Worksheet 5c: The Procedure: Reactions
	Input Source 5: Reminder of Redox Reactions
	Worksheet 5d: Reminder of Redox reactions
Module 6. The Experiment	**Worksheet 6a:** The Experiment: Laboratory Equipment and Reagents
	Worksheet 6 b: The Experiment: Previous Calculations
	Worksheet 6 c: The Experiment. A Quiz of the Procedure
	Report Sheet: Iodometric Determination of Copper

Taula 2.- Table of Contents: Student's material

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Module	Teacher's material
Module 0. Introduction	**MP3 Introduction Aims** (CD)(*) **MP3 Input Source 0** (CD)(*) **MP3 Key Terms** (CD)(*)
Module 1. Getting ready for titrations	
Module 2. Iodometric and Iodimetric Titrations	**Power Point Fact File 1** (CD)(*) **Fact File 1:** Introduction to Iodometric and Iodimetric Titrations
Module 3. Iodometric Titration of Copper	
Module 4. The Sample: Copper wire	
Module 5. The Procedure for the Iodometric Titration of Copper	**Power Point Fact File 2** (CD)(*) **Fact File 2**: The Procedure for the Iodometric Titration of Copper
Module 6. The Experiment	

Taula 3.- Table of Contents: Teacher's material

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Input Sources – Fact File

A l'hora d'elaborar material per a una classe, s'utilitzen vàries fonts d'informació. Com s'ha comentat anteriorment, aquestes poden provenir de llibres, Internet, material audiovisual, textos d'elaboració pròpia, diaris...

El material que es presenta recull algunes d'elles. A continuació es detallen, una per una, les Input Sources i els Fact Files.

Input Source 0: Introduction. The Iodometric Determination of Copper.

Aquesta Input Source està catalogada com a Class Notes, és a dir, com a apunts de classe.

Fact File 1: Introduction to Iodometric and Iodimetric Titration

Aquesta és la primera presentació. Com s'ha comentat anteriorment, les presentacions per part del professor/a s'han anomenat Fact Files.

Associat a cada Fact File es troba, per al professorat, el guió de la Fact File i la presentació en Power Point[2] i, per a l'alumnat, el Fact File que conté les diapositives i les activitats.

En aquesta presentació s'introdueixen les diferències entre els processos Iodomètrics i Iodimètrics.

Per a l'elaboració del Fact File 1, s'ha utilitzat la bibliografia sobre Anàlisi Químic detallada al final.

Input Source 1: The Iodometric Titration of Copper

Aquest és un text original. El text pertany a la pàgina web personal d'un professor d'Anàlisi Químic de la University of Kentucky (Source: http://www.wku.edu/~charles.henrickson/chem330.htm).

De tota la informació trobada es va escollir la que fos més clara en l'exposició d'idees.

Si bé hi ha autors que aconsellen simplificar els textos originals, s'ha considerat que per l'edat i maduresa de l'alumnat no era interessant presentar els textos originals simplificats. El que si que s'ha fet és un "enriquiment" del text. En els primers paràgrafs, s'han substituït alguns pronoms relatius i s'han afegit articles, adverbis i conjuncions, per a fer el text més comprensible.

[2] Fact File 1 Power Point es troba en el CD dels Teacher's materials i també es pot descarregar en la següent pàgina web: http://diposit.ub.edu/dspace/handle/2445/2

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Per veure com s'ha realitzat aquest "enriquiment", primer es presenta el text original i després el text *enriched*. A la segona versió, la que es troba al material dels alumnes, les paraules afegides es troben en un color diferent.

Text original:

IODOMETRIC DETERMINATION OF COPPER

DISCUSSION: The titration of iodine against sodium thiosulfate, using starch as the indicator, is one of the most accurate volumetric processes. The descriptive term for the procedure depends on which reagent is used as the titrant. If iodine, I_2, is used as the titrant, the process is termed an **iod*i*metric process**. If thiosulfate, $S_2O_3^{2-}$, is used as the titrant, it is termed an **iod*o*metric process**, which is the procedure used in this analysis. In
either process, the principal reaction is the oxidation of thiosulfate by iodine to produce iodide ion, I^-, and the tetrathionate ion, $S_4O_6^{2-}$:

$$I_{2(aq)} + 2\ S_2O_3^{2-}{}_{(aq)} \rightarrow 2\ I^-_{(aq)} + S_4O_6^{2-}{}_{(aq)}$$

The brown color of molecular iodine in an aqueous solution is sufficiently intense to serve as an indicator, the brown color disappearing as I_2 is consumed, but this is possible only if there are no other colored substances present to interfere. Usually though, an indicator is preferred, and starch is commonly used for this purpose. "Soluble" starch forms an intensely blue-colored complex with molecular iodine. Even traces of iodine produce a visible color, making an indicator blank unnecessary. The blue color of the complex disappears if the solution is heated, but returns again with cooling. When iodine is titrated with thiosulfate (an iod*o*metric titration), starch should be added only after most of the iodine has been consumed; otherwise, the disappearance of the blue color at the end point is sluggish. Sodium thiosulfate solutions are standardized using pure copper wire as a primary standard. The metallic copper is first oxidized with nitric acid to copper(II) ion, Cu^{2+} , 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, I_2.

$$2\ Cu^{2+}_{(aq)} + 4\ I^-_{(aq)} \rightarrow 2\ CuI_{(s)} + I_{2(aq)}$$

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

$$2\ S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$$

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 I_2 is slowly released into the solution by the CuI-CI_2 complex. This "after-bluing" can be avoided by adding some potassium thiocyanate, KSCN, just before the end point is reached. The thiocyanate ion,

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SCN^-, replaces the complexed I_2 from $CuI\text{-}CI_2$, releasing the I_2 to solution where its reaction with thiosulfate is rapid.

$$CuI\text{-}CI_{2(s)} + SCN^-_{(aq)} \rightarrow CuI\text{-}SCN^-_{(aq)} + I_{2(aq)}$$

Source: http://www.wku.edu/~charles.henrickson/chem330.htm

Text *enriched* (modificacions en un color diferent):

THE IODOMETRIC TITRATION OF COPPER

The titration of iodine against sodium thiosulfate, using starch as the indicator of color 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, I_2, is used as the titrant, then the process is termed an **iodimetric process**. If on the other hand thiosulfate, $S_2O_3^{2-}$, is used as the titrant, then this type of titration is termed an **iod*o*metric 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, $S_4O_6^{2-}$. This process is showed in the following reaction:

$$I_{2(aq)} + 2\ S_2O_3^{2-}{}_{(aq)} \rightarrow 2\ I^-_{(aq)} + S_4O_6^{2-}{}_{(aq)}$$

The brown color of molecular iodine in an aqueous solution is sufficiently intense to serve as an indicator of color change, because the brown color will begin disappearing at the same time as I_2 is consumed, but this color change is possible only if there are no other colored substances present to interfere. Usually though, an indicator is preferred, and starch is commonly used for this purpose. "Soluble" starch forms an intensely blue-colored complex with molecular iodine. Even traces of iodine produce a visible color, making an indicator blank unnecessary. The blue color of the complex disappears if the solution is heated, but returns again with cooling. When iodine is titrated with thiosulfate (an iod*o*metric titration), starch should be added only after most of the iodine has been consumed; otherwise, the disappearance of the blue color 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, Cu^{2+} , 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, I_2.

$$2\ Cu^{2+}_{(aq)} + 4\ I^-_{(aq)} \rightarrow 2\ CuI_{(s)} + I_{2(aq)}$$

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

$$2\ S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$$

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 I_2 is slowly released into the

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solution by the CuI-I_2 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 I_2 from CuI-I_2, releasing the I_2 to solution where its reaction with thiosulfate is rapid.

$$CuI\text{-}I_{2(s)} + SCN^-_{(aq)} \rightarrow CuI\text{-}SCN^-_{(aq)} + I_{2(aq)}$$

Adapted from: http://www.wku.edu/~charles.henrickson/chem330.htm

Input source 2: Copper in our daily live

Aquest és un text elaborat especialment per a aquest material. Les fonts per a l'elaboració del text es detallen a la bibliografia.

Per què elaborar un text sobre la mostra? L'objectiu és donar informació sobre la mostra i posar de manifest la necessitat i utilitat de l'anàlisi.

Per elaborar el text s'ha seguit la següent pauta:

1. La rellevància de la mostra, les seves característiques i utilitat.
2. La necessitat de l'anàlisi: informació que s'obté.
3. Altres mètodes analítics per quantificar coure.
4. Altres utilitats del mètode seleccionat.

La idea bàsica del text és presentar la mostra i l'anàlisi, i fer rellevant per a l'alumnat la necessitat de l'anàlisi.

Fact File 2: The Procedure for the Iodometric Titration of Copper

A l'igual que en el cas del Fact File 1 hi ha, per al professorat, el guió de la Fact File i la presentació en Power Point[3] i, per a l'alumnat, el Fact File que conté les diapositives i les activitats.

En aquesta presentació s'introdueix el procediment etapa per etapa. S'explica el que passa en cada etapa (reactivitat), els reactius necessaris i quin objectiu tenen.

Input Source 3: Flow-Chart of the Procedure

Es presenta de forma visual i esquemàtica el procediment. A l'hora de preparar material AICLE/CLIL, és molt important utilitzar gràfics i fotografies, donat que aquests elements ajuden a organitzar la informació i a presentar-la de forma més clara.

[3] Fact File 2 Power Point es troba en el CD dels Teacher's materials i també es pot descarregar en la següent pàgina web: http://diposit.ub.edu/dspace/handle/2445/2

Input Source 4: Experimental Procedure of Determination of Copper in a Copper Wire

El procediment que més tard es durà a terme al laboratori es presenta ara en forma de text.

S'ha considerat interessant abordar el procediment abans de presentar el text. D'aquesta forma l'alumnat ja en té una idea i, per tant, el text resulta més assequible.

S'ha mantingut el text original, modificant-ne només els dos primers passos, ja que el procediment original era per a un mineral de coure i s'ha adaptat per a un cable elèctric de coure. El canvi correspon a la major facilitat de trobar cable de coure en front a minerals de coure.

A continuació es presenta el text original i la modificació realitzada.

Text original:

Determination of Copper in Copper Ore

1. Weigh accurately three 0.5 to 0.6 g samples of copper ore into separate, labeled, 250 mL flasks. To each flask add 10 mL of concentrated HCl (12 M HCl) and evaporate the solution on a hot plate **under the hood** until the volume is about 5 mL. Swirl each flask during heating to avoid bumping.

2. Cool each flask under tap water until it can be comfortably handled, then add 10 mL of concentrated HNO_3 to each. Heat below the boiling point until the dark, dense copper ore on the bottom of each flask has dissolved.

3. Remove from the heat, cool, and carefully deliver about 8 mL of 9 M H_2SO_4 down the side of each flask. Evaporate each solution until white fumes of sulphur trioxide appear. This expels any nitric acid which might later oxidize iodide to iodine.

4. Cool, then *carefully* add 6 M aqueous ammonia *dropwise* to each flask until the deep blue color of the copper-ammonia complex forms. Avoid an excess of aqueous ammonia. Now, add 3 to 4 mL of glacial acetic acid. Any precipitate that might be present should dissolve with addition of the acid.

5. From this point on, treat each sample individually. Add 2.5 g of potassium iodide to one flask and titrate immediately with 0.1M sodium thiosulfate (previously standarizated), until the browncolor of molecular iodine is almost gone. Observe the color by interrupting the titration and allowing the precipitate of copper (I) iodide to settle partially.

7. Add 3 mL of starch indicator, and continue titrating dropwise until the blue color of the starch-iodine complex just disappears with the addition of *one* drop of one titrant. Then add 1 to 1.5 g of potassium thiocyanate, and titrate *dropwise* until the blue color disappears and holds for 20 to 30 seconds.

8. Calculate the percent of copper in the copper ore.

Source: http://www.wku.edu/~charles.henrickson/chem330.htm

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Text modificat (modificacions en un color diferent):

Experimental procedure of Determination of Copper in a Copper wire

1. Weigh accurately three 0.5 to 0.6 g samples of copper wire into separate, labelled, 250 ml flasks. To each flask add 10 ml of concentrated HNO_3 to each. Heat on a hot plate below the boiling point until the wire copper on the bottom of each flask has dissolved. Work under the hood because brown gases of NO_2 are generated during the process. You will observe that the solution turns blue due to the copper (II) ion in solution.

2. Remove from the heat, cool, and carefully deliver about 8 ml of 9 M H_2SO_4 down the side of each flask. Evaporate each solution until white fumes of sulphur trioxide appear. This expels any nitric acid which might later oxidize iodide to iodine.

3. Cool, then carefully add 6 M aqueous ammonia dropwise to each flask until the deep blue colour of the copper-ammonia complex forms. Avoid an excess of aqueous ammonia. Now, add 3 to 4 ml of glacial acetic acid. Any precipitate that might be present should dissolve with addition of the acid.

4. From this point on, treat each sample individually. Add 2.5 g of potassium iodide to one flask and titrate immediately with 0.1M sodium thiosulfate (previously standardized), until the brown colour of molecular iodine is almost gone. Observe the colour by interrupting the titration and allowing the precipitate of copper (I) iodide to settle partially.

5. Add 3 ml of starch indicator, and continue titrating dropwise until the blue colour of the starch-iodine complex just disappears with the addition of one drop of one titrant. Then add 1 to 1.5 g of potassium thiocyanate, and titrate dropwise until the blue colour disappears and holds for 20 to 30 seconds.

6. Calculate the percentage of copper in the copper wire.

Adapted from: http://www.wku.edu/~charles.henrickson/chem330.htm

Input Source 5: Reminder of redox reactions

Es tracta de'uns apunts de classe que recullen conceptes sobre reaccions redox, que solen resultar difícils per a l'alumnat. Aquestes notes volen ser una revisió dels conceptes redox més importants.

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Worksheets

Les Worksheets recullen les tasques que els alumnes han de realitzar. Estan associades a Input Sources o Fact Files, excepte les Worksheets que componen el mòdul 1 i el mòdul 6.

Les Worksheets tenen com a objectius preparar (per les Input Sources, Fact File) i avaluar l'alumnat, així com fer-lo reflexionar sobre el seu propi aprenentatge.

Les dues Worksheets que componen el Mòdul 1 han estat dissenyades per a valorar els coneixements previs de l'alumnat sobre mètodes volumètrics.

El Mòdul 6 conté una preparació abans de realitzar l'experiment al laboratori. Consta de tres Worksheets en què es repassa el material, els reactius i els conceptes bàsics sobre el procediment, i es realitzen els càlculs previs.

Al Mòdul 6 també trobem el Report Sheet, en què es recolliran les dades de l'experiment i s'anotaran els resultats finals.

Tasks

Les Worksheets contenen diferents tipus de tasques. Algunes d'aquestes estan agrupades en forma de Quiz (Test) que permet fer una avaluació ràpida (inicial o final) i fer reflexionar a l'alumnat sobre el seu aprenentatge.

Tipus de tasques:

- Completar taules: per exemple, escriure la fórmula al costat del nom del reactiu
- Vertader o fals
- Classificar: per exemple, donada una valoració, indicar si és àcid-base, complexomètrica, redox o de precipitació.
- Aparellar informacions: per exemple, fotos d'aparells amb el nom en anglès.
- Fer llistes: per exemple, reactius, operacions...
- Cercar una informació específica d'un text (escrit, diapositiva)

En tot el material existeix repetició, es repeteixen els Key Terms i també es treballen els mateixos conceptes amb tasques diferents. La repetició és una part molt important en el material AICLE/CLIL.

A continuació es presenta una proposta de com introduir el material a la classe.

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TEACHER'S INSTRUCTIONS

Lesson:

The Iodometric Titration of Copper.

Grade Level:

Higher education

Studies[4]:

Vocational Training Courses
Vocational Family: Chemistry
Educational Level: Advanced
Course: Analysis and control
CFGS d'Anàlisi i Control / CFGS de Análisis y Control

Name of the subject:

Crèdit 4: Tècniques bàsiques de laboratori: volumètriques i gravimètriques /Técnicas básicas de laboratorio: volumétricas y gravimétricas / Laboratory Basic Techniques: Titrations and gravimetries

Other Studies:

This material can be used in vocational courses and university courses which work on classical quantitative analysis.

It could be also used in Chemistry courses in High School (USA) or A-levels (UK).

[4] Originally designed for Vocational Training Courses: CFGS Analysis and Control

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Presenting the material

In developing the materials different type faces and colours have been used to indicate what kind of information or task needs to be developed.

Instructions
Instructions as to how the tasks on each of the worksheets need to be done.

Input Source: Class notes
Information which is added to clarify concepts or as an introduction.

Input source:
Texts

Tasks
Exercises for the students

Power Point Presentations and Recordings

The Power Point presentations and the recordings can be downloading in http://diposit.ub.edu/dspace/handle/2445/2.

There is also a CD with the Teacher's Material that contains all the files: Power Point presentations, audio files and pdf files.

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Instructions

The contents of the materials are in table 2 and 3.

Here are the instructions for using them.

The structure of the instructions is:

Aims	Didactic objectives
Aids	Electronic material needed as computer, MP3 player and projector
Material	Power Point, audio file, worksheets (copies for students), dictionaries
Procedure	How to introduce the material during the class
Questions for students	Suggested question for students. These can be used during the presentation or as an assignment
Comments	Suggestions

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Module 0. INTRODUCTION

 16 min.

Aims:

1. Students will be able to identify the necessity of the Iodometric Titration of Copper.
2. Students will learn the key terms.
3. Students will practice the pronunciation of key terms.

Aids:

- Mp 3 player.

Materials:

- Copies of Introduction for each student. (Student's material)

Procedure:

Warm-up	2 min.	1. Ask the students what are the terms related to Titrations that they know. 2. Write the answers on the board.
Present objective	2 min.	3. Aims and outline.
Practice or main activity	10 min.	4. Hand out a copy of the Introduction to each of the students. 5. Read, listen and practice the key terms. 6. Listen to the introduction.
Reflect Anticipatory Set	2 min.	7. Ask questions to students. In pairs, students keep a record of the questions and answer them in their notebook.

Questions for students

1. What is the purpose of this lesson?
2. What is the sample?
3. What is the name of the analysis?
4. Utilities of the analysis method.
5. Why is it necessary to quantify the amount of copper in a copper wire?

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Module 1. Getting ready for Titrations

 17 min.

Aims:

1. Students will be able to check their previous knowledge about titrations.
2. Students will review terms and concepts about titrations.
3. Students will review previous titrations carried out in the laboratory.
4. Students will review some tips about the standardization of the standard solution sodium thiosulphate.

Materials:

- Copies of Worksheets 1a and 1b for each student. (Student's material)

Procedure:

Warm-up	4 min.	1. Divide the class into pairs. 2. Write on the board some terms related to Chemical analysis and Titrations. 3. Students should write in a piece of paper only the terms that are related to Titrations. 4. Students compare their answer with other pairs.
Present objective	1 min.	6. Aims
Practice	10 min.	7. Hand out a copy of Worksheet 1a to the students. 8. Read the instructions. 9. Do the quiz. 10. The students self-correct the quiz. 11. In pairs students comment on the quiz.
Reflect Anticipatory Set	2 min.	12. Comment the results of the quiz. 13. Students review the answer of the warm-up activity.
Assignment	15 min.	13. Hand out a copy of Worksheet 1b.

(*) Warm-up activity: e.g.: burette, analyte, bunsen, primary standard, column, indicator, reaction, chromatograph, spectrum, acid-base …
Underlined terms related to titration.

Questions for students

1. What is your score?
2. Do you need help from your classmate?
3. Have you forgotten any of the titrations performed in the laboratory?
4. Do you remember the standardised of sodium thiosulphate? What have you forgotten about this procedure?

Comment

It will be interesting to check the answers of worksheet 1b. It will give information about the problems that students have with Titrations.

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Module 2. Iodometric and Iodimetric Titrations

 55 min.

Aims:

1. Students will be review the different type of titrations: acid-base, precipitation, complexometric and other redox titrations.
2. Students will be able to distinguish between Iodometric and Iodometric titrations.
3. Students will be able to identify the standard solution, indicator and reactions involved in Iodometric titrations.
4. Students will be able to identify the standard solution, indicator and reactions involved in Iodimetric titrations.
5. Students will be able to identify the samples that could be quantified by Iodometric and Iodimetric titrations.
6. Students will practice taking notes during a lecture.

Aids:

- Computer and projector.

Materials:

- Power Point and Script Fact File 1. (Teacher's material)
- Fact File 1 (Student's material)
- Copies of worksheets 2a and 2b for each student. (Student's material)

Procedure:

Warm-up	6 min.	1. Hand out a copy of Fact File 1 (Student's material) 2. In the first part of the Lecture there are some activities designed to elicit information about the four types of titrations. (*) These activities are the warm-up. (From slide 1 to slide 3)
Present objective	2 min.	3. The objective of the lecture is given in slide 4.
Practice	40 min.	4. Finish the presentation. 5. At the end of Fact File 1 hand out a copy of Worksheet 2a. 6. Read the instructions. 7. Do Worksheet 2a. 8. Students self-correct Worksheet 2a. 9. Check comprehension.
Reflect Anticipatory Set	7 min.	12. Hand out a copy of Worksheet 2b. 13. Read the instructions. 14. In pairs do Worksheet 2b. 15. Students self-correct Worksheet 2b. 16. Ask students about their score.
Assignment	15 min.	18. Students will answer in their notebook the Questions for students.

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Questions for students

1. Enumerate the different types of redox titrations.
2. What points in common do Iodometric and Iodimetric titrations have?
3. What differences are there between these two types of titrations?
4. What is a Permanganimetric Titration?
5. What is a Dichrometric titration?
6. What is the difference between an Iodometric titration and an Iodimetric titration?
7. Are you happy with your score?

Comments

(*) You should adapt the answer of the activities according to the titrations performed. The examples given are the most common titrations performed in all chemical analysis laboratories.

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Module 3. Iodometric Titration of Copper

 34 min.

Aims:

1. Students will be able to read and listen about the procedure for the Iodometric Titration of Copper.
2. Students will be able to identify the differences between Iodometric and Iodimetric Titrations.
3. Students will be able to learn about the main features about the Iodometric Titration of Copper.

Aids:

- Monolingual English dictionaries as *Oxford Advanced Learner's Dictionary of Current English* or similar.
- Computers with Internet.

Materials:

- Copies of Worksheet 3a, Input Source 1 and Worksheet 3b. (Student's material)

Procedure:

Warm-up	3 min.	1. In groups of three or four, students write in their notebook the information that they expect to find in the Input Source 1: The Iodometric Titration of copper. 2. Each group read it to the class.
Present objective	1 min.	3. Hand out a copy of Worksheet 3a. 4. Read the introduction.
Practice	20 min.	5. Read the instructions. 6. Students do tasks in Worksheet 3a. 7. Students read Input Source 2, and look up words that they don't understand. 8. Students finish the tasks. 9. Students self-correct their answers.
Reflect Anticipatory Set	10 min.	12. Hand out a copy of Worksheet 3b. 13. Read the instructions. 14. Students do Worksheet 3b. 15. Students self-correct worksheet 3b.

Questions for students

1. Which titrant is used in Iodimetric titrations?
2. Which titrant is used in Iodometric titrations?
3. Which indicator is used in Iodometric titrations?
4. Why is the addition of thiocyanate necessary?

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Module 4. The sample: Copper Wire

 25 min.

Aims:

1. Students will learn about the price and electrical characteristics about some metals.
2. Students will learn the influence of impurities in the conductivity of metals.
3. Students will learn the main characteristics about copper.
4. Students will learn the composition and utility of copper wires.
5. Students will learn the utility of quantification of copper in a copper wire.
6. Students will learn the utility of the Iodometric Titration of Copper in a copper wire.

Materials:

- Copies of Worksheet 4a, Input Source 2 and Worksheet 4b for each student. (Student's material)

Procedure:

Warm-up	2 min.	1. In groups of three or four students, they will discuss the following question: What metal do you think is the most important in our daily live and why? 2. Write on the board the answer of the groups of students.
Present objective	1 min.	3. Hand out a copy of the Worksheet 4a. 4. Read the introduction.
Practice	19 min.	5. Read the instructions. 6. Students do Worksheet 4a. 7. Students read Input Source 2. 8. Hand out a copy of Worksheet 4b. 9. Students do checking comprehension tasks. 10. Students self-correct their answers.
Reflect Anticipatory Set	3 min.	10. In the same work groups as in the warm-up activity, students discuss again the same question.

Questions for students

1. What is the most expensive metal in the world?
2. What other types of cable do you usually use?
3. Do any of you collect minerals?
4. What surprised you most in the text?

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Module 5. Part I. The Procedure for the Iodometric Titration of Copper.

28 min.

Aims:

1. Students will be able to identify the steps involving in the procedure of the Iodometric Titration of Copper.
2. Students will be able to identify the reactions which take place throughout the procedure.
3. Students will be able to identify the necessary reagents to develop the procedure in the laboratory.
4. Students will be able to select the laboratory equipment necessary for the developing the laboratory procedure.
5. Students will be able to identify the safety measures and the necessary precautions to take to perform the procedure in the laboratory.

Aids:

- Computer and projector.

Materials:

- Power Point Fact File 2, Fact File 2. (Teacher's material)
- Copies of Fact File2. (Student's material)
- Copies of Input Source 3 and Worksheets 5a. (Student's material)

Procedure:

Warm-up	2 min.	1. Hand out a copy of Fact File 2 and Input Source 3. 2. There is a warm-up activity on slide 2. A summary of the main information about the titration.
Present objective	2 min.	3. Aims
Practice	20 min.	4. Continue giving the Lecture. 5. At the end of the Lecture hand out a copy of Worksheet 5a. 6. Students do the tasks.
Reflect Anticipatory Set	3 min.	7. Students self-correct the answers. 8. Comment the answers with the class.

Questions for students

1. What balance do we weigh the samples in?
2. What state are the samples in?
3. How are the samples dissolved?
4. What is the titrant solution?
5. What is the indicator?

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6. When must the indicator be added?

Comments

The Fact File 2 itself has Warm-up activities, practice and the Reflect Anticipatory Set is in Worksheet 5a. The Flow-chart (Input Source 3) should help the student to understand this lecture.

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Module 5. Part II. The Procedure for the Iodometric Titration of Copper.

 38 min.

Aims:

1. Students will be able to extract the main information from a text of the description of the procedure.
2. Students will be able to identify the reagents needed to develop the procedure in the laboratory.
3. Students will be able to identify the Laboratory Equipment needed to develop the procedure in the laboratory.
4. Students will be able to identify the operations needed to develop the procedure in the laboratory.
5. Students will be able to identify the species and compounds formed during the procedure.
6. Students will be able to identify the safety rules needed to develop the procedure in the laboratory.
7. Students will be able to identify reactions and in which stages of the procedure they take place.
8. Students will be able to remind redox concepts.

Materials:

- Copies of Worksheets 5b, 5c, 5d and Input Sources 4 and 5 for each student. (Students' material)
- Monolingual English dictionaries as *Oxford Advanced Learner's Dictionary of Current English* or similar. Or Internet Connexion in order to consult an On-line Dictionary.

Procedure:

Warm-up	3 min.	1. Divide the class in small groups of three or four. 2. Brainstorming about Iodometric Titration of Copper. They have 3 minutes to write on a piece of paper what they know about the procedure.
Present objective	2 min.	3. Aims
Practice	30 min.	4. Hand out a copy of Input Source 4. 5. Students read Input source and look-up the words that they don't know. 6. Hand out a copy of Worksheet 5 b and 5c. 7. Read the instructions. 8. Students do and self-correct Worksheet 5b and 5c. 9. Some students should do Worksheet 5d.
Reflect Anticipatory Set	3 min.	11. In the same groups as in the Warm-up activity. Students read and complete what they know about Iodmetric Titration of Copper.
Assignment	15 min.	12. Worksheet 5d could be done and self-corrected as an assignment.

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Questions for students

1. What new information on the procedure have you learned from the text that you have read?
2. Did you find the text difficult?
3. What other reactive can be used to dissolve the copper sample?
4. What coordinated compound is formed?
5. Which is reduced the copper (II) ion or the iodide?
6. Why must we add potassium thiocyanate?

Comments

Students need to look up safety information in the safety sheets of the Products, or the label of the reactive.
Safety sheets are available in Internet (i.e: http://www.panreac.com) or in the Catalogues of Reagents offered by Commercial Brands.

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Module 6: The Experiment

 3 h

Aims:

1. Students will be able to use the technical vocabulary related to Laboratory Equipment necessary for developing the laboratory procedure.
2. Students will be able to practice the names and formulae of the necessary reactives.
3. Students will be able to perform the calculations necessary for developing the laboratory procedure: preparation of dissolutions and volume of titrant solution at the equivalent point.
4. Students will be able to keep a record of the data generated during the procedure of the laboratory.
5. Students will be able to perform the calculations in order to give a final result.
6. Students will be able to revise the key points of the procedure before performing it in the laboratory.

Materials:

- Copies of Worksheets 6a, 6b and 6c for each student. (Student's material)
- Copies of Report Sheet for each student. (Student's material)

Procedure:

Warm-up	4 min.	1. Divide the class in small groups of three. 2. Students write down the information and calculations that they need to do before carried out the experiment in the laboratory
Present objective	1 min.	4. Aims
Practice	3 h.	5. Hand out a copy of Worksheet 6a to the students. 6. Read the instructions. 7. Students do the tasks in pairs. 8. Students check their answers. 9. Comment on answers in class. 10. Hand out a copy of Worksheet 6b to the students. 11. Read the instructions. 12. Students do the tasks in the work laboratory pairs. 13. The teacher should check the calculations. 14. Hand out a copy of the Worksheet 6c to each work laboratory pairs. 15. Students do Worksheet 6c. 16. The teacher should check the quiz and decide if the students are ready to perform the experiment in the laboratory. 17. Students do the experiment.

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		18. Students do the calculations. 19. Students show and explain the final result to the teacher.
Reflect Anticipatory Set	5 min.	20. Comment and compare the results with the class.
Assignment	30 min.	21. A report of the experiment.

Questions for students

1. Are you ready to perform the procedure?
2. Do you understand what happens at each stage of the procedure?
3. What is the percentage of copper present in the sample?
4. Does the result obtained correspond with the theoretical value?
5. Do you consider that your result is good?

Comments

If all the students have analyzed the same sample the results can be recorded on a sheet and compared. The results could be discussing in class.

As a final task students should write a report.

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Oxford Dictionaris: http://www.askoxford.com/

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