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

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Input Source 0:
Introduction: The Iodometric Determination of Copper

KEY CONCEPTS

- **Type of chemical analytical analysis**: Titration
- **Type of titration**: Redox
- **Analyte**: Copper
- **Standard solution:** Sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) 0.1M
- **Indicator**: Starch

AIMS

1. To conduct an iodometric determination of copper, i.e., to measure how much copper there is in a wire.
2. To distinguish between an iodometric and an iodimetric process.

OUTLINE

1. Titration review.
2. Titration Introduction: Iodometric procedures.
3. Reactions in an idometric titration.
4. The sample.
5. Dissolving copper wire
6. The pre-treatment of the sample before doing the titration.
7. The role of Indicators
8. Titration steps.
9. Calculations.

KEYTERMS

Read, Listen to and Practice the Keyterms:

quantify
copper - electrolytic copper
wire - electric wire - an electric wire
purity
99.99%
titrations – types of titrations / redox titration
quantitative – quantitative analysis – quantitative analysis methods
acid-base
complexometric - complexometric titration
precipitation
method – complexometric method – redox method
idometric method – iodometric method

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INPUT SOURCE 0:
INTRODUCTION: THE IODOMETRIC DETERMINATION OF COPPER

Copper wire surrounds our daily lives. It has a lot of uses; the most important use of **copper wire** is to conduct electricity.

Copper is a good electricity conductor, but its conductivity deceases with the presence or impurities (other metals different form copper). Consequently, it is very important to produce **copper wire** with a high **purity** (only **copper**).

The purest **cooper** is **electrolytic copper**, which is obtained by electrolytic deposition. The **electrolytic copper** has a **purity of 99.99%.**

The industry that produces **electrolytic copper** and also the industry that buys this product need to control its **purity**. To control the **purity**, there are several analytical **methods**; one of them is an **Iodometric Titration**.

In this lesson we are going to **quantify** the percentage of **copper** wire by an iodometric **titration**.

As you know, **titrations** are **quantitative analysis methods**. There are four types of **titrations**: **acid-base, complexometric, precipitation** and **redox**.

The **method** used to **quantify** the percentage of **copper** contained in a **wire** is a **redox titration**, the fourth titration type.

A **complexometric titration** can be used for the determination of **copper**, but the **redox method** presents less interference than the **complexometric method**.

The **redox method** used is an **iodometric** one. In an **iodimetric method** a solution of iodide (I^-) is oxidizing to iodine (I_2) by the analyte (copper in this case), then the generated iodine is reduced by thiosulfate ($S_2O_3^{2-}$), the standard solution. Iodine forms an intensely blue complex with starch. When all the iodine is spent the blue colour disappears. This **titration** can be performed in a moderate acid medium pH 3-5.

Below a scheme of the iodometric **titration** of **copper**.

$$\mathbf{2\,Cu^{2+} + 4I^- \rightarrow 2CuI + I_2}$$

Analyte of unknown concentration

Titrant
-standrard solutions: sodium thisolfate
-known concentration

$$\mathbf{I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}}$$

This **method** is useful for the determination of **copper** in ores, salts, solutions, **wire**, alloys.

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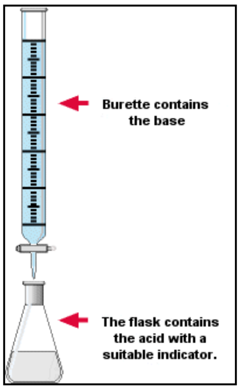
Worksheet 1a: Initial Evaluation Quiz on Volumetric Analyses

INSTRUCTIONS

1. These exercises will check what you know about volumetric analyses.
2. In pairs or small groups complete the 15 items.
4. You have just 5′.
5. Self-correct your answers with the key.
6. Compare your score with another group.

Task 1. MAIN CHEMICAL ANALYSIS TERMS

Four chemical analyses terms (analyte, standard solution, indicator and quantitative analysis) are reviewed. Match the concept with its definition:



Source: http://www.teachmetuition.co.uk

(1) Analyte	
(2) Standard solution	
(3) Indicator	
(4) Quantitative analysis	

A. This involves measuring the proportions of known components in a mixture.

B. This is a chemical term which describes a solution of known concentration.

C. A substance used to show the presence of a chemical substance or ion by its colour.

D. This is a substance or chemical constituent that is determined in an analytical procedure.

Task 2. TITRATION DEFINITION

The text below reviews what titration method is about. Some key words have been removed. Complete the text with the most appropriate word from the box.

volume	end point	equivalence point
titrant	volumetric	burette reagent

A titration is a method of ____________(5) analysis in which a volume of one reagent (the __________) (6) is added to a known volume of another________(7) slowly form a ________(8) until an end point is reached. The added (9) before the end point is reached is noted.

In titration, the point at which the reaction is complete is the ________________(10). The _____________(11) is the point at which the indicator just changes colour.

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Task 3. TYPES OF TITRATION

Titration is a method of volumetric analysis. We can classify the titrations methods depending on the type of standard solution and analyte. How many types of titration can you think of? How are they called? List the four types of titrations.

THE FOUR MAIN TYPES OF TITRATION
1. ____________________ (12)
2. ____________________ (13)
3. ____________________ (14)
4. ____________________ (15)

Compare your score group with the other group.

1. Which group has the highest score?
2. Say to your partner in which ones you got wrong.
3. Do you need help?

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	**Average**
My score																
Other group																

0- 10	**LOW**	**YOU NEED TO GO OVER ALL THE CONCEPTS BEFORE YOU PROCEED**
11-12	**GOOD**	**CHECK THE CONCEPTS YOU GOT WRONG BEFORE YOU PROCEED**
13-14	**VERY GOOD**	**CHECK THE CONCEPT/S YOU GOT WRONG**
15-	**EXCELLENT**	**HELP YOUR CLASSMATES WHO GOT A LOWER MARK**

Key:
Task 1: 1d, 2b, 3c, 4a
Task 2: (5) volumetric, (6) titrant, (7) reagent, (8) burette, (9) volume, (10) end point, (11) equivalence point.
Task 3: Acid-base, complexometric, precipitation and redox.

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Worksheet 1b: Checking Previous Knowledge on Titrations

INSTRUCTIONS

1. Review previous titrations that you may perform in the laboratory.
2. Work in small groups of three students.
3. Do the tasks on your own.
4. Compare your answer with the other students.
5. Check your class notes if there is some disagreement.
6. Plan the tips about Titrations that you need to review.

Task 1: TYPES OF TITRATIONS

There are four main types of titrations. Are you familiar with the all of them? If so, complete the grid with the help of your classmates if necessary.

	Types of Titration
1	
2	
3	
4	

Task 2: MOST COMMON TITRATIONS CARRIED OUT IN CHEMISTRY COURSES

Have you already performed any of the following acid-base, complexometric and precipitation titrations in the laboratory? Tick as many as you have done.

Type	**Procedure**	**Performed**
I.Acid-base	1. Standardization of hydrochloric acid	
	2. Standardization of sodium hydroxide	
	3. Determination of acetic acid in vinegar	
	4. Determination of ammonia	
	5. Standardization of sulphuric acid	
	6. Standardization of ammonia	
II.Complexometric	7. Determination of hardness in water	
	8. Standardization of EDTA	
III.Precipitation	9. Determination of chloride	
	10. Standardization of silver nitrate	
IV.Redox	11. Standardization of potassium permanganate	
	12. Determination of hydrogen peroxide	

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Can you remember any titrations that you or your classmates may have carried out in the laboratory and which are not listed above?

Me	Std. 1	Std. 2

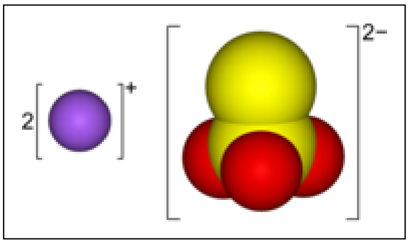
In the Iodometric Titration of Copper the titrant is sodium thiosulphate. Sodium thiosulphate is not a primary standard and it is necessary to standardise it before performing the Iodometric Titration of Copper.

If you have no information about the standardization (*) of sodium thiosulphate you should search for information and then do this task.

Barreiro's class notes 07

(*) standardization or standardisation

Some information about Sodium thiosulfate



General Systematic name: Sodium thiosulfate (Sodium thiosulphate)
Other names: Sodium hyposulfite Hyposulphite of soda
Molecular formula $Na_2S_2O_3$
Appearance White crystals

Source : http://en.wikipedia.org

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Task 3: CHECKING THIOSULFATE STANDARDISED PROCEDURE

Decide if these statements are true or false. Write down your answer in the table below.

Standardisation of Sodium Thiosulfate

Titrations performed	Me	Std. 1	Std. 2	Key
1. The sodium thiosulfate is a standard solution, because it isn't hygroscopic.	F			F
2. The sodium thiosulfate isn't a standard solution, we need to boil the water in order to destroy micro-organisms which metabolize the thisolufate ion.				
3. A small amount of sodium carbonate is added to the thiosulfate solution.				
4. The thioslufate solution was standardized with potassium iodide.				
5. The thiosulfate solution was standardized with potassium iodate.				
6. No indicator is needed because of the colour of the iodine.				
7. An indicator is needed; in that case we used starch that forms a blue colour with iodine.				
8. It's necessary to do the titration slowly; it should take an hour to generate iodine.				
9. The value of the molecular weight of the thiosulfate is twice its equivalent weight.				
10. The value of the molecular weight of the thiosulfate is the same of its equivalent weight.				

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Task 4. PLAN YOUR STUDY

After having performed task 1, 2 and 3 and compare your answers with your partners, now it is time to plan the tips that you need to revise.

Keep a record of:

What have I learned? 1) Types of titration 2) Examples of each type of titration 3) Needed for standardization of sodium thiosulfate 4) Characteristics of standardization of sodium thiosulfate

What do I need to revise? You may want to read or consult your course book or class notes. You could also consult the bibliography.

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Plan your study.

In **task 1** we reviewed the four types of titration: a) acid-base, b) complexometirc, c) precipitation and d) redox.

In **task 2** for each type of titration we reviewed the most commonly titrations conducted in laboratories.

Some of the commonest acid-base titrations are Standardization of hydrochloric acid, Standardization of sodium hydroxide, Standardization of ammonia, Standardization of sulphuric acid Determination of acetic acid in vinegar, Determination of ammonia

Some of the commonest complexometric titrations are Standardization of EDTA and Determination of hardness in water.

Some of the commonest precipitation titrations are Standardization of silver nitrate and Determination of chloride.

Some of the commonest redox titrations are Standardization of potassium permanganate and Determination of hydrogen peroxide

In task 3 we revised the needed and some characteristics of Standardization of sodium thiosulfate.

Key:
Task 1. Acid-base, complexometric, precipitation and redox
Task 3. 1 F, 2T, 3T, 4 F, 5T, 6 F, 7 T,8 F, 9 F, 10 T

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Fact File 1: Introduction to Iodometric and Iodimetric Titrations

Fact File 1:
INTRODUCTION TO IODOMETRIC AND IODIMETRIC TITRATIONS

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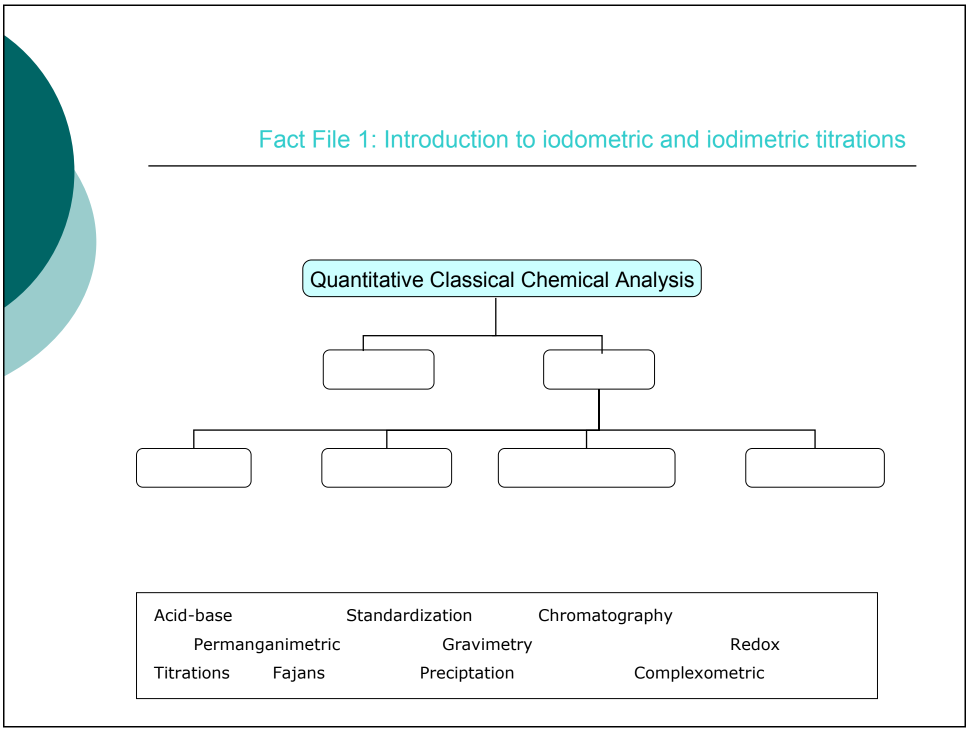
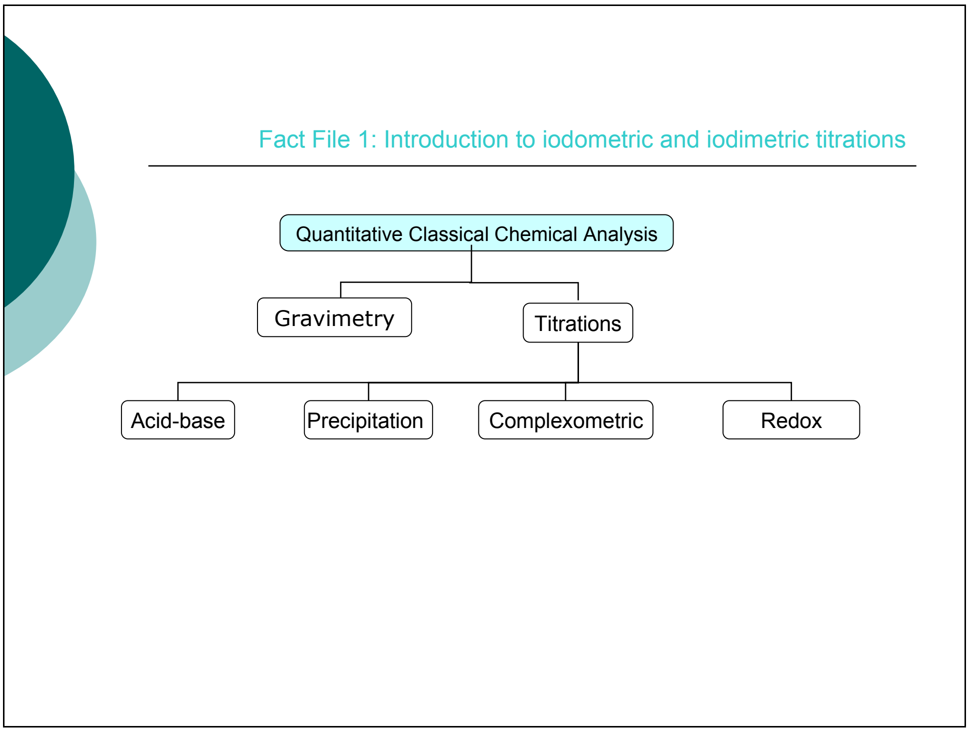
Activity 1
1. Work in pairs.
2. What is the aim of this presentation?



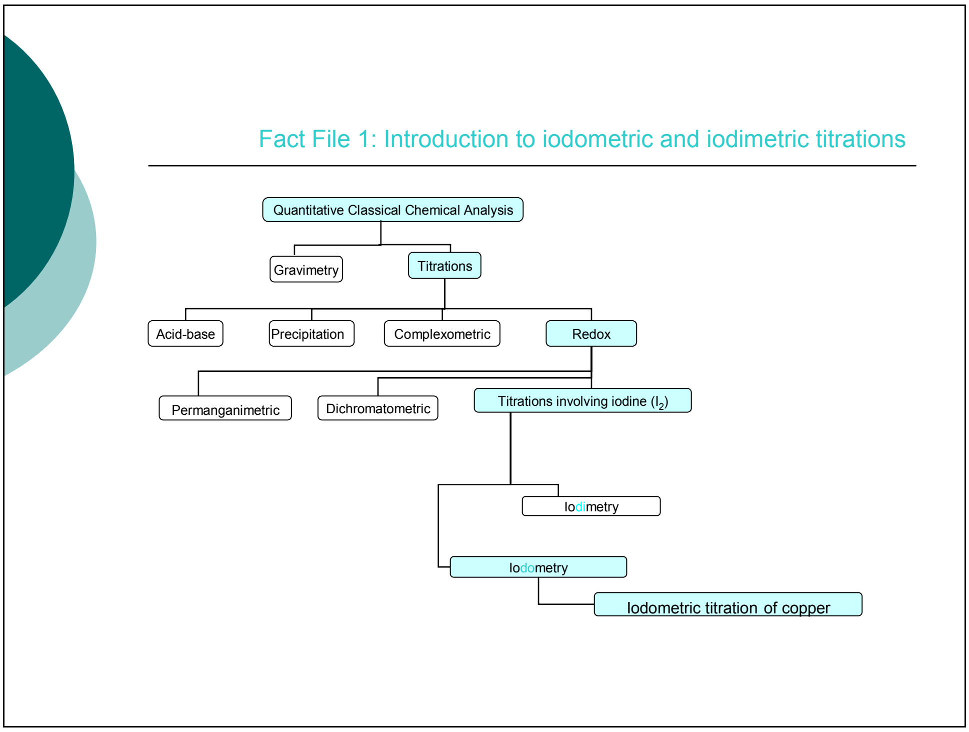
Activity 2

1. Work in pairs.
2. On the slide you can see an incomplete flow-chart.
3. Complete this flow chart with the most appropriate key term from the box. Pay attention, you only need 6 and there are 10!
4. Now, compare your answer with another pair. Do you have any differences?
5. What does this flow chart represent? Discuss it with your partner.



Activity 3

1. Work in pairs.
2. What are parmanganimetric and dichromatometric methods?
3. Keep a record of your answer.
4. You have just 2 minutes.



Activity 4

1. Work in pairs.
2. What are the advantages of titrations in front of gravimetries?
3. Keep a record of your answer.
4. You have just 2 minutes.

Fact File 1: Introduction to iodometric and iodimetric titrations

Titrations	Examples
Acid-base	*Quantification of acetic acid in vinegar*
Complexometric	
Precipitation	
Redox	

Activity 5

1. Work in groups of three.
2. Complete the table with an example for each type of titration.
3. You have 1 minute.
4. Now, check your answer with another group. If there are new examples complete the table.

Fact File 1: Introduction to iodometric and iodimetric titrations

Titrations	Examples
Acid-base	Quantification of acetic acid in vinegar
Complexometric	Quantification of chloride (Cl^-) in water
Precipitation	Water Hardness (Calcium and magnesium)
Redox	Quantification of hydrogen peroxide (H_2O_2)

Activity 6

1. Work in the same group of three.
2. Have you the same examples?
3. Tell the class the different ones.

Fact File 1: Introduction to iodometric and iodimetric titrations

	Titration example	Analyte	Titrant	Indicator
Acid-base	Quantification of acetic acid in vinegar	Acetic acid (CH_3COOH)	Sodium hydroxide ($NaOH$)	Phenolphthalein
Complexometric	Quantification of chloride (Cl^-) in water			
Precipitation	Water Hardness (Calcium and magnesium)			
Redox	Quantification of hydrogen peroxide (H_2O_2)			

Activity 7

1. Work in the same group of three.
2. Indicate for each example the Analyte, the Titrant and the indicator.
3. You have 2 minutes.
4. Check the answer with the class.

Fact File 1: Introduction to iodometric and iodimetric titrations

	Titration example	Analyte	Titrant	Indicator
Acid-base	Quantification of acetic acid in avinegar	Acetic acid (CH_3COOH)	NaOH (sodium hydroxide)	Phenolphthalein
Complexometric	Water Hardness (Calcium and magnesium)	Calcium and magnesium (Ca^{2+}, Mg^{2+})	EDTA	Eriochrome black T Murexide
Precipitation	Quantification of chloride (Cl^-) in water	Chlordie	$AgNO_3$ (silver nitrate)	Mohr, Volhard, Fajans
Redox	Quantification of hydrogen peroxide (H_2O_2)	Hydrogen peroxide (H_2O_2)	$KMnO_4$ (potassium permanganate)	No indicator

Activity 8

1. Work in pairs.
2. How could be the reaction between the analyte and the titrant?
3. Keep a record of your answer.

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Fact File 1: Introduction to iodometric and iodimetric titrations

Titrations:

- Direct Titrations
- Indirect Titrations
- Back Titrations
- Iodometry

Activity 9

1. Work in pairs.
2. Do you remember what direct titrations are?
3. Do you remember what indirect titrations are?
4. Do you remember what back titrations are?

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Fact File 1: Introduction to iodometric and iodimetric titrations

Titrations	Example		Type of reaction
Acid-base	Quantification of acetic acid in vinegar		□ Direct Titration □ Indirect Titration □ Back Titration
Complexometric	Water Hardness (Calcium and magnesium)		□ Direct Titration □ Indirect Titration □ Back Titration
Precipitation	Quantification of Cl in Water	Mohr Method	□ Direct Titration □ Indirect Titration □ Back Titration
		Fajans Method	□ Direct Titration □ Indirect Titration □ Back Titration
		Volhard Method	□ Direct Titration □ Indirect Titration □ Back Titration
Redox	Quantification of hydrogen peroxide (H_2O_2)		□ Direct Titration □ Indirect Titration □ Back Titration

Activity 10

1. Work in the same group of three.
2. For each example tick the type of titration. If there are some examples that you don’t know, guess the type of reaction: Direct Titration, Indirect Titration, Back Titration.
3. You have just 2 minutes.

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Fact File 1: Introduction to iodometric and iodimetric titrations

Titrations	Example		Type of reaction
Acid-base	Quantification of acetic acid in vinegar		■ Direct Titration □ Indirect Titration □ Back Titration
Complexometric	Water Hardness (Calcium and magnesium)		■ Direct Titration □ Indirect Titration □ Back Titration
Precipitation	Quantification of Cl in Water	Mohr Method	■ Direct Titration □ Indirect Titration □ Back Titration
		Fajans Method	■ Direct Titration □ Indirect Titration □ Back Titration
		Volhard Method	□ Direct Titration □ Indirect Titration ■ Back Titration
Redox	Quantification of hydrogen peroxide (H_2O_2)		■ Direct Titration □ Indirect Titration □ Back Titration

Activity 11

1. Work in the same group of three.
2. Give an example of back titration that you have performed in the laboratory?

____

____

____

____

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Fact File 1: Introduction to iodometric and iodimetric titrations

Direct titration

analyte	+	**titrant**	→	**product**
unknown		known		

Example: Quantification of acetic acid in vinegar

$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

Activity 12

1. Work in pairs.
2. For the example: Quantification of acetic acid in vinegar, identify: analyte, sample, titrant and product.
3. Keep a record of your answer.

Fact File 1: Introduction to iodometric and iodimetric titrations

There are a lot of **redox titrations** classified according to the **titrant** used.

1) Permanganimetric: Titrant $KMnO_4$

2) Dichromatometric: Titrant $K_2Cr_2O_7$

3) Titrations involving **iodine (I_2)**
- **Iodimetry**
- **Iodometry**

Titrations that create or consume I_2 are widely used in **quantitative analysis**.

Activity 13

1. Work in pairs.
2. Which is the characteristic of Iodimetric and Iodometric Titrations?
3. Keep a record of your answer.

Fact File 1: Introduction to iodometric and iodimetric titrations

A **reducing agent** is the element or compound in a redox reaction that reduces another species. In doing so, it becomes *oxidized*, and is therefore the electron donor in the redox.

Examples of reducing agents:

The active metals sodium, magnesium, aluminum, and zinc,

NaH, CaH_2, and $LiAlH_4$, which formally contain the H^- ion.

Activity 14

1. Work in pairs.
2. Do you remember what a reducing agent is?
3. Give two examples of reducing agents.
4. Keep a record of your answer.

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Fact File 1: Introduction to iodometric and iodimetric titrations

An **oxidaizing agent** is the element or compound in a redox reaction that oxidaizes another species. In doing so, it becomes *reduced*, and is therefore the element or compund that gain electrons.

Examples:

permanganate (MnO_4^-), chromate (CrO_4^{2-}), and dichromate ($Cr_2O_7^{2-}$) ions, sodium hypochlorite (bleach) as well as nitric acid (HNO_3), perchloric acid ($HClO_4$), and sulfuric acid (H_2SO_4)

Activity 15

1. Work in pairs.
2. Do you remember what an oxidizing agent is?
3. Give four examples of oxidizing agents.

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Fact File 1: Introduction to iodometric and iodimetric titrations

When a reducing **analyte** is titrated with iodine (the titrant), the method is called **iodimetry**.

Iodimetry: A direct titration with only 1 reaction:

analyte *unknown*	**+**	**titrant (iodine I_2)** *known*	$\rightarrow$	**product (iodide I^-)**

Activity 16

1. Work in pairs.
2. What is the main characteristic of the analyte in Iodimetric Titrations?
3. Keep a record of your answer?

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Lecture 1: Introduction to iodometric and iodimetric titrations

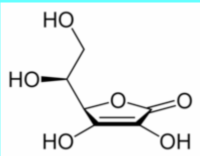
When a reducing **analyte** is titrated with iodine (the titrant), the method is called **iodimetry**.

Example: Quantification of Ascorbic Acid (Vitamin C)

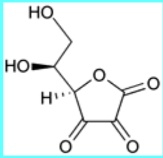
$C_6H_8O_6 + I_2 \rightarrow C_6H_6O_6 + 2I^- + 2H^+$

Iodine rapidly oxidizes ascorbic acid, $C_6H_8O_6$, to produce dehydroascorbic acid, $C_6H_6O_6$.

Ascorbic acid



Dehydroascorbic acid



Pictures taken from: http://en.wikipedia.org

Activity 17

1. Work in pairs.
2. Identify the analyte, the titrant and the product of the example of an iodimetric titration: Quantification of Ascorbic Acid?
3. Keep a record of your answer.

Lecture 1: Introduction to iodometric and iodimetric titrations

Iodometry is the titration of iodine (I_2) produced when an oxidizing analyte is added to excess I^-(iodide).

Then the iodine (I_2) is usually titrated with standard **thiosulfate** solution.

Iodometry: Not a direct titration because there are 2 reactions:

analyte + $\mathbf{I^-}$ → $\mathbf{I_2}$
unknown

$\mathbf{I_2}$ + **titrant (standard thiosulfate)** → **product**
Known

Activity 18

1. Work in pairs.
2. What is the main characteristic of the analyte in Iodometric Titrations?
3. Keep a record of your answer?

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Fact File 1: Introduction to iodometric and iodimetric titrations

Example: Quantification of Copper

$$2\,Cu^{2+} + 4I^- \rightarrow 2CuI + I_2$$

$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

Activity 19

1. Work In pairs.
2. Identify the analyte and the titrant of this procedure.
3. Keep a record of your answer.

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Fact File 1: Introduction to iodometric and iodimetric titrations

Iodimetric titrations:

a)
b)
c)

Iodometric titrations:

a)
b)
c)

Activity 20

1. Work in groups of three.
2. List the three main characteristics of Iodimetric and Iodometric Titrations: a) type of anlyte, b) number of reactions, c) standard solution.
3. Keep a record of your answer.

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Fact File 1: Introduction to iodometric and iodimetric titrations

Analytical applications:

Iodimetric titrations:

Species analyzed (reducing analytes)

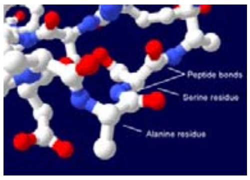
SO_2

H_2S

Zn^{2+} , Cd^{2+} , Hg^{2+} , Pb^{2+}

Cysteine, glutathione, mercaptoethanol

Glucose (and other reducing sugars)



Section of a protein structure

Source: http://en.wikipedia.org

Activity 21

1. Work in pairs.
2. In which type of samples should you quantify glucose?
3. Keep a record of your answer.

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Fact File 1: Introduction to iodometric and iodimetric titrations

Analytical applications:

Iodometric titrations:

Species analyzed (oxidizing analytes)

- HOCl
- Br_2
- IO_3^- , IO_4^-
- O_2, H_2O_2, O_3
- NO_2^-
- Cu^{2+}
- MnO_4^-, MnO_2

Activity 22

1. Work in pairs.
2. In which type of samples should you quantify copper?
3. Keep a record of your answer.

Fact File 1: Introduction to iodometric and iodimetric titrations

In this lesson: **Iodometric titration of copper**

Sample: Copper wire (solid)

First: Dissolve the sample

copper wire **Cu^0** → dissolution → **Cu^{2+}**

Copper ion: oxidizing agent

Second: Pre-treatment of the sample

Activity 23

1. Work in pairs.
2. Why is it necessary to dissolve the copper wire?
3. Keep a record of your answer.

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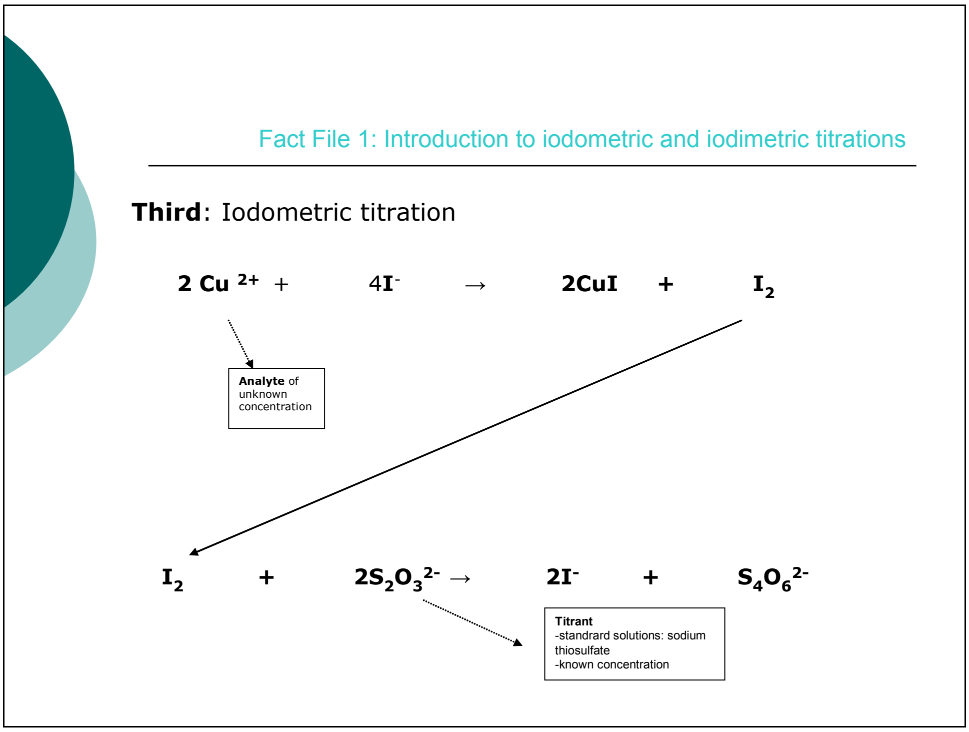


Activity 24

1. Work in pairs.
2. Write the formula of iodine and iodide.

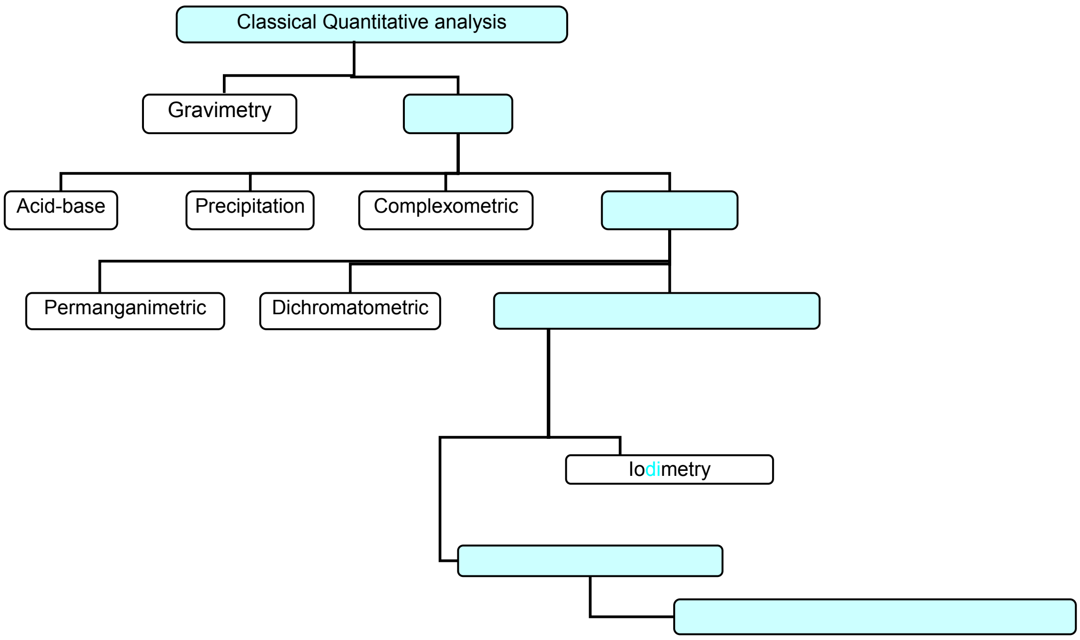
Worksheet 2a: Recalling the Basic Information from the Fact File 1

INSTRUCTIONS

1. Now that you have listened to the lecture, check what you have learned.
2. In pairs, do the 5 activities below.
3. You have just 5'
4. When you finish check your answer with the class.

Task 1. CLASSIFICATION OF IODOMETRIC TITRATION OF COPPER

Complete the flow chart.



Task 2. TYPES OF REDOX TITRATIONS

There are a lot of **redox titrations** classified according to the **titrant** used. Complete with the correct information.

- Permanganimetric: Titrant ________________
- Dichromatometric: Titrant _________________
- Titrations involving ___________ (I_2)

  ____

  ____

Titrations that create or consume ______ are widely used in quantitative analysis.

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Task 3. IODIMETRY

Complete the information missing in the box.

Iodimetry (It is a direct titration: ____ reaction)

analyte + **titrant (________)** → **product**
unknown *known*

Task 4. IODOMETRY

Complete the information missing in the box.

Iodometry (It is not a direct titration: ___reactions)

analyte + ____ → ____
unknown

____ + **titrant (________________)** → **product**
Known

Task 5. IODOMETRIC TITRATION OF COPPER

Complete the information about the Iodometric titration of copper; the procedure that we are going to perform in the laboratory.

Iodometric titration of copper:

Titration type: ______________________

Sample: ______________________

Analyte: ______________________

Titrant: ______________________

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Worksheet 2b: Evaluation Quiz on Iodometric and Iodimetric titrations

INSTRUCTIONS

1. This quiz will check what you know about Iodometric and Iodimetric titrations.
2. Do the Quiz individually, in pairs or in small groups.
3. For each statement say whether you think it is true or false.
4. You have just 5'.
5. Self-correct your answers and compare your score with your partner/other group.
6. Help your partner in the statements that he/she has wrong.

QUIZ

1. Iodometric titration of copper is a redox titration.
☐ True ☐ False

2. In iodimetry, the titrant solution is iodine (I_2).
☐ True ☐ False

3. Iodometric titration is a direct titration.
☐ True ☐ False

4. In iodometry, the titrant solution is sodium thiosulfate.
☐ True ☐ False

5. Two main reactions are involved in iodometry process.
☐ True ☐ False

6. The redox titrations involving iodine are widely used.
☐ True ☐ False

7. The sample: copper wire is not solid.
☐ True ☐ False

8. The indicator used is phenolphthalein.
☐ True ☐ False

9. Iodometric titrations are a type of complexometric titrations.
☐ True ☐ False

10. In iodometric titrations the analyte is an oxidizing agent.
☐ True ☐ False

	1	2	3	4	5	6	7	8	9	10	Average
Your score											
Your partner/group											
Statements that both disagree											

Are you happy with your score?____________

Key: 1T, 2T,3F,4T,5T,6T,7F,8 F,9 F, 10 T

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Worksheet 3a: Lead-in tasks.
The Iodometric Titration of Copper

INTRODUCTION

In the Input Source 1: **The Iodometric Titration of Copper**, you will find the following information:

a. Differences between Iodometic 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.

Barreiro's class notes'07

INSTRUCTIONS

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

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 1.

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 ☐

Worksheet 3a. Task 1	1	2	3	4
Your answer before reading				

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Task 2. PRE-READING COMPREHENSION II

Test yourself before reading.
Read the questions before reading the Input Source 1. Probably you already know some of the answers.
After reading Input Source 1 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 thiocyante ion?

a. ☐ There is a problem, the CuI forms a complex with the I_2, and therefore the I_2 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 thiocyanate ion allows the formation of the complex $CuI-I_2$, and so the standard solutions reacts directly with the generated iodine.

Worksheet 3a. Task 2	1	2	3	4	5
Your answer before reading					

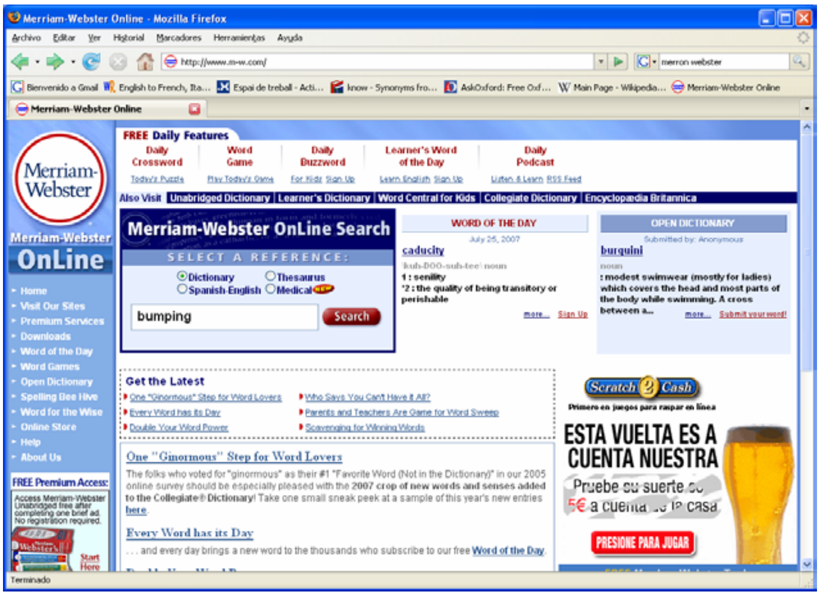
Task 3. KEY TERMS THAT YOU KNOW

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 look up the definition in the Merriam-Webster on-line: http://www.m-w.com and then, complete the grid.

English word	Translation		
	Me and my partner	Other group	After reading the key
1. starch	**midó**		
2. accurate			
3. to serve			
4. to interfere			
5. traces			
6. sluggish			
7. minor			
8. weak			
9.to slow down			
10. to replace			
11. to release			

Worksheet 3a: key Terms

Results of the search on Merrian-Webster: http://www.m-w.com/



1. starch

3 entries found for starch.
To select an entry, click on it.

starch[1,transitive verb]
starch[2,noun]
animal starch
Go

Main Entry: [2]starch
Function: *noun*
1 : a white odorless tasteless granular or powdery complex carbohydrate $(C_6H_{10}O_5)_x$ that is the chief storage form of carbohydrate in plants, is an important foodstuff, and is used also in adhesives and sizes, in laundering, and in pharmacy and medicine
2 : a stiff formal manner : FORMALITY
3 : resolute vigor

2. accurate

One entry found for accurate.
Main Entry: ac·cu·rate
Pronunciation: 'a-ky&-r&t, 'a-k(&-)r&t
Function: *adjective*
Etymology: Latin *accuratus,* from past participle of *accurare* to take care of, from *ad-* + *cura* care
1 : free from error especially as the result of care <an *accurate* diagnosis>
2 : conforming exactly to truth or to a standard : EXACT <providing *accurate* color>

3 : able to give an accurate result <an *accurate* gauge>
synonym see CORRECT
- ac·cu·rate·ly /'a-ky&-r&t-lE, 'a-k(&-)r&t-, 'a-k(y)&rt-/ *adverb*
- ac·cu·rate·ness /-ky&-r&t-n&s, -k(&-)r&t-n&s/ *noun*

3. to serve

Main Entry: [1]serve
Pronunciation: 's&rv
Function: *verb*
Inflected Form(s): served; serv·ing
Etymology: Middle English, from Anglo-French *servir,* from Latin *servire* to be a slave, serve, from *servus* slave, servant
intransitive verb
1 a : to be a servant b : to do military or naval service
2 : to assist a celebrant as server at mass
3 a : to be of use <in a day when few people could write, seals *served* as signatures -- Elizabeth W. King> b : to be favorable, opportune, or convenient c : to be worthy of reliance or trust <if memory *serves*> d : to hold an office : discharge a duty or function <*serve* on a jury>
4 : to prove adequate or satisfactory : SUFFICE <it will *serve* for this task>
5 : to help persons to food: as a : to wait at table b : to set out portions of food or drink
6 : to wait on customers
7 : to put the ball or shuttlecock in play in various games (as tennis, volleyball, or badminton)
transitive verb
1 a : to be a servant to : ATTEND b : to give the service and respect due to (a superior) c : to comply with the commands or demands of : GRATIFY d : to give military or naval service to e : to perform the duties of (an office or post)
2 : to act as server at (mass)
3 *archaic* : to pay a lover's or suitor's court to (a lady) <that gentle lady, whom I love and *serve* -- Edmund Spenser>
4 a : to work through (a term of service) b : to put in (a term of imprisonment)
5 a : to wait on at table b : to bring (food) to a diner c : PRESENT, PROVIDE -- usually used with *up* <the novel *served* up many laughs>
6 a : to furnish or supply with something needed or desired b : to wait on (a customer) in a store c : to furnish professional service to
7 a : to answer the needs of b : to be enough for : SUFFICE c : to contribute or conduce to : PROMOTE
8 : to treat or act toward in a specified way <he *served* me ill>
9 a : to bring to notice, deliver, or execute as required by law b : to make legal service upon (a person named in a process)
10 *of a male animal* : to copulate with
11 : to wind yarn or wire tightly around (a rope or stay) for protection
12 : to provide services that benefit or help
13 : to put (the ball or shuttlecock) in play (as in tennis or badminton)
- serve one right : to be deserved

4. to interfere

Main Entry: in·ter·fere
Pronunciation: "in-t&(r)-'fir

Function: *intransitive verb*
Inflected Form(s): -fered; -fer·ing
Etymology: Middle English *enterferen,* from Anglo-French (*s'*)*entreferir* to strike one another, from *entre-* inter- + *ferir* to strike, from Latin *ferire* -- more at BORE
1 : to interpose in a way that hinders or impedes : come into collision or be in opposition
2 : to strike one foot against the opposite foot or ankle in walking or running -- used especially of horses
3 : to enter into or take a part in the concerns of others
4 : to act reciprocally so as to augment, diminish, or otherwise affect one another -- used of waves
synonym see INTERPOSE
- in·ter·fer·er *noun*

5. traces

Main Entry: [1]trace
Pronunciation: 'trAs
Function: *noun*
Etymology: Middle English, from Anglo-French, from *tracer* to trace
1 *archaic* : a course or path that one follows
2 a : a mark or line left by something that has passed; *also* : FOOTPRINT b : a path, trail, or road made by the passage of animals, people, or vehicles
3 a : a sign or evidence of some past thing : VESTIGE b : ENGRAM
4 : something (as a line) traced or drawn: as a : the marking made by a recording instrument (as a seismograph or kymograph) b : the ground plan of a military installation or position either on a map or on the ground
5 a : the intersection of a line or plane with a plane b : the usually bright line or spot that moves across the screen of a cathode-ray tube; *also* : the path taken by such a line or spot
6 a : a minute and often barely detectable amount or indication <a *trace* of a smile> b : an amount of a chemical constituent not always quantitatively determinable because of minuteness
- trace·less /-l&s/ *adjective*
synonyms TRACE, VESTIGE, TRACK mean a perceptible sign made by something that has passed. TRACE may suggest any line, mark, or discernible effect <a snowfield pockmarked with the *traces* of caribou>. VESTIGE applies to a tangible reminder such as a fragment or remnant of what is past and gone <boulders that are *vestiges* of the last ice age>. TRACK implies a continuous line that can be followed <the fossilized *tracks* of dinosaurs>

6. sluggish

Main Entry: slug·gish
Pronunciation: 'sl&-gish
Function: *adjective*
1 : averse to activity or exertion : INDOLENT; *also* : TORPID
2 : slow to respond (as to stimulation or treatment)
3 a : markedly slow in movement, flow, or growth b : economically inactive or slow

- slug·gish·ly *adverb*
- slug·gish·ness *noun*

7. minor

Main Entry: [1]mi·nor
Pronunciation: 'mI-n&r
Function: *adjective*
Etymology: Latin, smaller, inferior; akin to Old High German *minniro* smaller, Latin *minuere* to lessen
1 : inferior in importance, size, or degree : comparatively unimportant
2 : not having reached majority
3 a : having half steps between the second and third, the fifth and sixth, and sometimes the seventh and eighth degrees <*minor* scale> b : based on a minor scale <*minor* key> c : less by a semitone than the corresponding major interval <*minor* third> d : having a minor third above the root <*minor* triad>
4 : not serious or involving risk to life <*minor* illness>
5 : of or relating to an academic subject requiring fewer courses than a major

8. weak

Main Entry: weak
Pronunciation: 'wEk
Function: *adjective*
Etymology: Middle English *weike,* from Old Norse *veikr;* akin to Old English *wIcan* to yield, Greek *eikein* to give way, Sanskrit *vijate* he speeds, flees
1 : lacking strength: as a : deficient in physical vigor : FEEBLE, DEBILITATED b : not able to sustain or exert much weight, pressure, or strain c : not able to resist external force or withstand attack d : easily upset or nauseated <a *weak* stomach>
2 a : mentally or intellectually deficient b : not firmly decided : VACILLATING c : resulting from or indicating lack of judgment or discernment d : not able to withstand temptation or persuasion <the spirit is willing but the flesh is *weak*>
3 : not factually grounded or logically presented <a *weak* argument>
4 a : not able to function properly <*weak* eyes> b (1) : lacking skill or proficiency <tutoring for *weaker* students> (2) : indicative of a lack of skill or aptitude <history was my *weakest* subject> c : wanting in vigor of expression or effect <a *weak* translation of the poem>
5 a : deficient in the usual or required ingredients : DILUTE <*weak* coffee> b : lacking normal intensity or potency <a *weak* radio signal> <a *weak* strain of virus>
6 a : not having or exerting authority or political power <*weak* government> b : INEFFECTIVE, IMPOTENT
7 : of, relating to, or constituting a verb or verb conjugation that in English forms the past tense and past participle by adding the suffix *-ed* or *-d* or *-t*
8 a : bearing the minimal degree of stress occurring in the language <a *weak* syllable> b : having little or no stress and obscured vowel sound <*'d* in *he'd* is the *weak* form of *would*>
9 : tending toward a lower price or value <a *weak* market> <a *weak* dollar>
10 : ionizing only slightly in solution <*weak* acids and bases>
- weak·ly *adverb*
synonyms WEAK, FEEBLE, FRAIL, FRAGILE, INFIRM, DECREPIT mean not strong enough to endure strain, pressure, or strenuous effort. WEAK applies to deficiency or inferiority in strength or power of any sort <felt *weak* after the surgery>. FEEBLE suggests extreme weakness inviting pity or contempt <a *feeble* attempt to walk>. FRAIL implies delicacy and slightness of constitution or structure <a *frail* teenager

unable to enjoy sports>. FRAGILE suggests frailty and brittleness unable to resist rough usage <a reclusive poet too *fragile* for the rigors of this world>. INFIRM suggests instability, unsoundness, and insecurity due to old age or crippling illness <*infirm* residents requiring constant care>. DECREPIT implies being worn-out or broken-down from long use or old age <the dowager's *decrepit* retainers>.

9. to slow down

Main Entry: ^{3}slow
Function: *verb*
transitive verb : to make slow or slower : slacken the speed of <*slow* a car> -- often used with *down* or *up*
intransitive verb : to go or become slower <production of new cars *slowed* sharply>
synonym see DELAY

10. to replace

Main Entry: re·place
Pronunciation: ri-'plAs
Function: *transitive verb*
1 : to restore to a former place or position <*replace* cards in a file>
2 : to take the place of especially as a substitute or successor
3 : to put something new in the place of <*replace* a worn carpet>
- re·place·able /-'plA-s&-b&l/ *adjective*
- re·plac·er *noun*

11. to release

Main Entry: ^{1}re·lease
Pronunciation: ri-'lEs
Function: *verb*
Inflected Form(s): re·leased; re·leas·ing
Etymology: Middle English *relesen,* from Anglo-French *relesser,* from Latin *relaxare* to relax
transitive verb
1 : to set free from restraint, confinement, or servitude <*release* hostages> <*release* pent-up emotions> <*release* the brakes>; *also* : to let go : DISMISS <*released* from her job>
2 : to relieve from something that confines, burdens, or oppresses <was *released* from her promise>
3 : to give up in favor of another : RELINQUISH <*release* a claim to property>
4 : to give permission for publication, performance, exhibition, or sale of; *also* : to make available to the public <the commission *released* its findings> <*release* a new movie>
intransitive verb : to move from one's normal position (as in football or basketball) in order to assume another position or to perform a second assignment
synonym see FREE
- re·leas·able /-'lE-s&-b&l/ *adjective*

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Input Source 1: The Iodometric Titration of Copper

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**, 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 **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, $S_4O_6^{2-}$. 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 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 I_2 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**, 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.

$$2\ S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_62^-(aq) + 2I^-(aq)$$

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-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 I_2 from $CuI\text{-}I_2$, 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

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Worksheet 3b: Checking comprehension tasks. The Iodometric Titration of Copper

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 **iodometric** 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 I_2**, and therefore the I_2 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 I_2 in the complex CuI-I_2**, and a new complex is formed **CuI-SCN**.

Barreiro's Class notes'07

Task. CORRECTION OF THE PRE-READING TASKS

1. Check with your partner your answers to the tasks 1 and 2, Worksheet 3a.
2. Do you want to change any answer in task 1 and 2 Worksheet 3a?
3. Then, check your answers with the key.

Worksheet 3a. Task 1	1	2	3	4
Your answer before reading				
Your answer after reading				
Disagreement (check your answer with the key)				

Worksheet 3a. Task 2	1	2	3	4	5
Your answer before reading					
Your answer after reading					
Disagreement (check your answer with the key)					

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After checking your answers with the key, now complete this grid:

What have I learnt in task 1?
1) About the importance of knowing the reactions involved in an experiment. 2) The information that the reactions give us of an experiment. 3) The importance of knowing the features and problems of an experiment. 4) The importance of knowing the safety precautions of an experiment.
What have I learnt in task 2?
1) Titrants used in Iodometric and Iodimetric processes. 2) Indicator used in Iodometric and Iodimetric processes. 3) When the indicator should be added. 4) The necessity of adding thiocyanate ion.

Key Worksheet 3a: Task 1: 1.5; 2.5; 3.5; 4.5 Task 2: 1.b; 2.a; 3.a; 4.b; 5.a

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Worksheet 4a: Lead-in Tasks. Copper in our daily live

INTRODUCTION

In the Input Source 2 ***Copper in our daily lives*** you will find some information about the sample, copper wire, that we are going to analyze in the Laboratory.

The information that you are going to read about is:
a. Copper in our lives
b. Copper's properties
c. The effect of the impurities in the electrical conductivity
d. Quality control of electrolytic copper
e. Analytical methods in order to quantify copper

Barreiro's class notes'07

INSTRUCTIONS

1. In pairs, do pre-reading tasks.
2. Read the Input Source 2 Copper *in our daily lives.*
3. In pairs, do the comprehension tasks.

Task 1: PRICE OF METALS

Rank the list of these metals according to their price from the cheapest to the most expensive.

Copper, nickel, aluminium, zinc, lead and uranium.

	Me	My partner
The cheapest ↓		
The most expensive		

Answer key: You will find the answer in the Input Source 3.

Task 2. GENERAL KNOWLEDGE ABOUT METALS

What do you think about these statements? Are they true or false?

	True	False
1. The purer the metal the better the electrical conductivity.		
2. The metal with the highest electrical conductivity is copper.		
3. It's very difficult to obtain copper of a high purity.		
4. The major use of copper is as an electrical conductor.		
5. It's easy to obtain wires from copper.		

Answer key: You will find the answer in the Input Source 2

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Input Source 2: Copper in our daily live

Copper in our lives

The wires that deliver electricity for power and most that carry telephone messages are made of copper. So are the wires in electric motors and generators, and the circuits in radios, television sets, computers, and other electronic devices.

The major use of copper is as an electrical conductor. About 50% of the current demand is for electrical uses. Copper has a very high electrical conductivity per unit volume.

Ag vs Cu

Silver has more electrical conductivity than copper (see Figure 1), but copper is cheaper than silver.

Copper's properties

Copper has a high electrical conductivity; a high thermal conductivity; is easy to draw into wires (ductility); a low corrosion; a low toxicity to humans and a low price. These characteristics support the broad use of copper.

Metal	**Relative electrical conductivity (20 ºC) 100% IACS***
Silver	106
COPPER	100
Gold	72
Aluminum	62
Magnesium	39
Zinc	29
Nickel	25
Cadmium	23
Cobalt	18
Iron	17
Platinum	16
Tin	15
Lead	8

Figure 1.- Conductivities of some metals
Source: http://www.coppercanada.ca

(*) Referred to as 100 %IACS, or International Annealed Copper Standard. The unit for expressing the conductivity of nonmagnetic materials by testing, using the eddy-current method.

The effect of the impurities in the electrical conductivity

We have said that copper has a high electrical conductivity; this is while copper is pure (100%). But when copper has impurities (other metals such as: Ni, As, Ag, Fe, Bi, Pb) the **electrical conductivity** decreases. So it is very important to produce copper with a high purity. This copper with high purity is electrolytic copper. Electrolytic copper has 99.9% purity; meaning that it only has 0.1 % of impurities.

Quality control

The process for obtaining electrolyte copper is called electrolytic deposition. It is necessary to control the purity of the electrolytic copper obtained in the process. The Quality Control Department of the industry performs the necessary analysis in the electrolytic copper. Only electrolytic copper with at least 99.9% purity is accepted.

Analytical methods in order to quantify Cu

There are several analytical methods to determine the purity of copper. One of them is the **iodometric titration of copper**. Titrations are classical quantitative analysis. Titrations are a well-known process which has been performed since 1800. Titrations are inexpensive and fast. For these reasons titrations are widely used in industry.

Iodometric Cu titrations uses

Industry, which produces electrolytic copper, uses **iodometric copper titrations** in order to control the process and the final product. Atomic absorption (spectrometric method) is also used.

In this lesson we are going to check the **purity of a copper wire**, which should be at least 99.9%. At the end of the procedure you should decide, if the copper wire would be suitable for electrical uses.

Other **iodometic titrations** are used to determine: Br_2; H_2O_2; O_2; O_3; NO_2^-; MnO_4^- … in different samples such as: medicjnes, foods, detergents, water, wine …

Metal	**Price** (22 May 07) / **US$/lb** (1 lb=0.454 Kg)
Copper	3.5138
Nickel	24.3231
Aluminum	1.2850
Zinc	1.6996
Lead	0.9888
Uranium	120

Figure 2.- Native copper
Here you have some metal prices. Source: http://www.kitcometals.com/

Figure 3.- Native copper.

Written by Lidia Barreiro 2007

Worksheet 4b: Checking Comprehension about Copper in our daily live

INSTRUCTIONS

1. Work in pairs.
2. Do the 3 tasks.
3. You need to check your answers on Worksheet 4a.

Task 1. CHECKING ANSWERS OF PRICE OF METALS

Worksheet 4a. Task 1.	1	2	3	4	5
Your answer before reading					
Your answer after reading					
Disagreement (check your answer with the key)					

With your partner answer these questions:

1. How many have you guessed? Me:______ and my partner: ______

2. What information about the prices of metals surprised you and your partner most?

Me:____
____
____

My partner: ____
____
____

Task 2. CHECKING ANSWERS ON GENERAL KNOWLEDGE ABOUT METALS

Worksheet 4a. Task 2.	1	2	3	4	5
Your answer before reading					
Your answer after reading					
Disagreement (check your answer with the key)					

Rewrite the statements that are false.

1. The purer the metal the better the electrical conductivity.
2. The metal with the highest electrical conductivity is copper.

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3. It's very difficult to obtain copper of a high purity.

4. The major use of copper is as an electrical conductor.

5. It's easy to obtain wires from copper.

Discuss with your partner. What information about copper surprised you most? Write it down in the box below.

Task 3. TIPS ABOUT COPPER ANALYSIS

Discuss with a partner or in small group the following questions:

1. Is there more than one method to quantify copper? If so, which one?

2. Why do you need to quantify copper in a copper wire? Give two reasons:

Cooper wire

Copper alembic

Source: http://www.tuthilltown.com

Source: http://www.tuthilltown.com

Key : **Task 1**: Pb, Al, Zn, Cu, Ni and U. **Task 2:** 1. T; 2.F; 3.F; 4.T; 5.T **Task 3**: 2.The metal with the highest electrical conductivity is silver; 3. It is not very difficult to obtain copper of a high purity. **Task 5**: 1. Yes, For instance atomic absorption. 2. As a quality control during the process of obtaining electrolytic copper and as final product.

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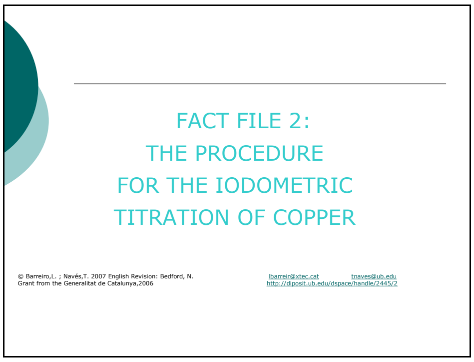
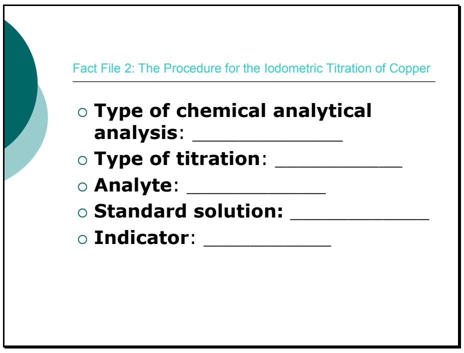
Fact File 2: The Procedure for the Iodometric Titration of Copper



Decide if these statements are true or false:

Statements	Me	My partner	Key
1. The titration that we are going to carry out in the laboratory is a Iodimetric one.			
2. Copper is the analyte.			
3. In this presentation we are going to see the main steps of the procedure.			



Complete the missing information on the slide.

____

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____

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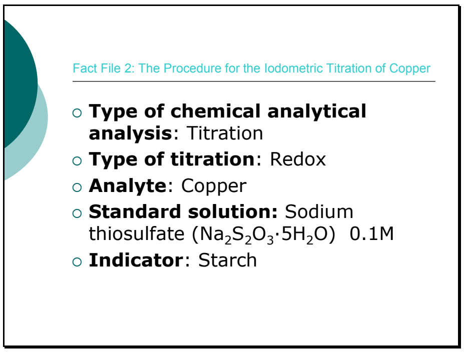

1. Did you get all the answers right?
2. Do you need extra help?

____

____

____

____

____

____

____

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

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

Steps of the procedure:

Step 1. Weigh the samples

Step 2. Dissolve of the samples

Step 3. Pre-treat of the samples (addition of reactives in order to prepare the sample for the titration)

Step 4. Titrate

(see Input Source 3: Flow-chart of the Procedure)

Keep a record of the main actions.

____

____

____

____

____

____

____

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

STEP 1

Weigh 3 samples

≈ 0.500 –0.6000 g

sample 1 sample 2 sample 3

Make a list of the main actions of the Step 1.

____

____

____

____

____

____

____

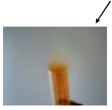
Fact File 2: The Procedure for the Iodometric Titration of Copper

STEP 2

- **Add** 10 ml concentrated HNO_3 and heat.
- Nitric acid is an oxidizing agent.
- The reaction:

$$3Cu + 8\ HNO_3 \rightarrow 3Cu^{2+} + 6NO_3^- + 2NO + 4H_2O$$

blue



Nitrogen dioxide
http://en.wikipedia.org

Answer these questions:

a) Which species has blue colour in this step?

b) Which species has brown colour?

c) Make a list of the main actions of Step 2.

____

____

____

____

____

____

____

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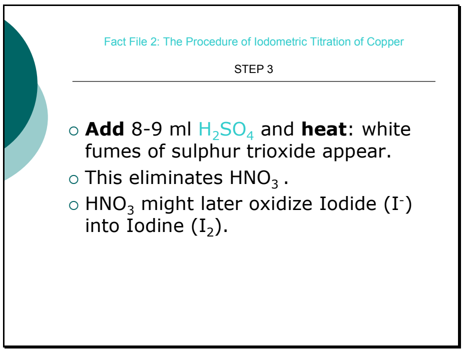
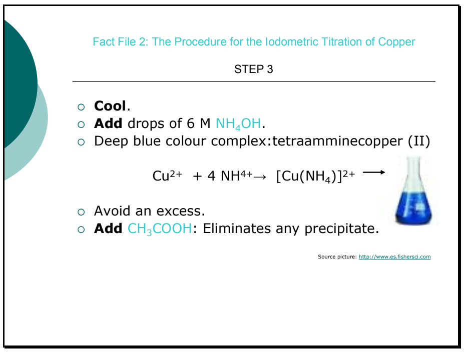
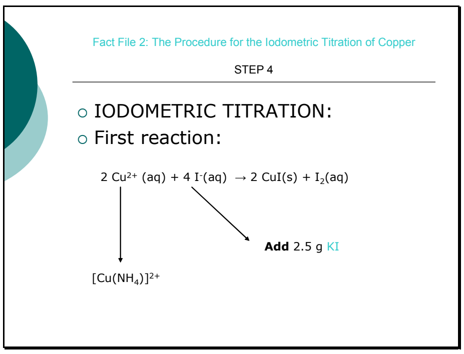
Fact File 2: The Procedure for the Iodometric Titration of Copper



Answer this question: Why is it necessary to add sulphuric acid?

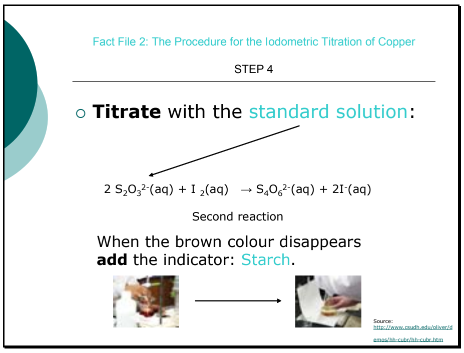


Answer these questions:
a) Which species has deep blue colour in this step?
b) Why is it necessary to add acetic acid?
c) Make a list of the main actions of Step 3.

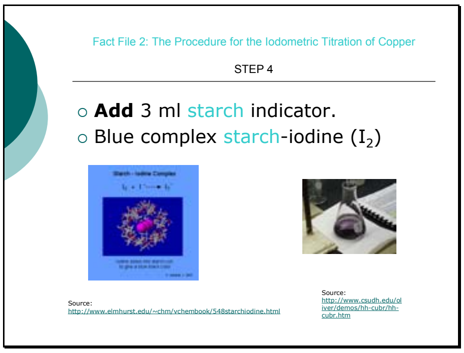


Why is it necessary to add potassium iodide?

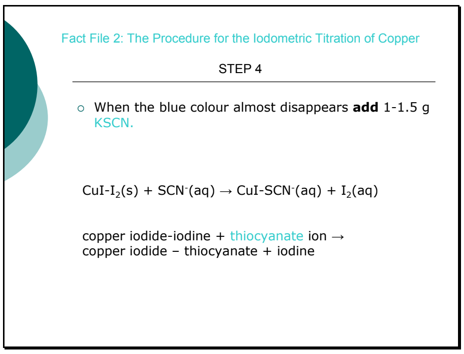
Fact File 2: The Procedure for the Iodometric Titration of Copper



When will you add the indicator? At the beginning? Why?



Which complex forms the blue colour?



Do you remember why it is necessary to add potassium thiocyanate?

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

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

STEP 4

- **Titrate** drop by drop until the blue colour disappears, turns colourless and holds for 20-30 seconds.

Source: http://www.csudh.edu/oliver/demos/hh-cubr/hh-cubr.htm

- **Calculate** the percentage of copper.

Why do you need to wait 20-30 seconds after reaching the end point?

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Worksheet 5a: Flow-chart of the Procedure

Dissolution of the sample

Copper wire

Weigh 3 samples
≈ 0.500 –0.6000 g

sample 1 sample 2 sample 3

To each flash
add 10 ml
concentrated HNO_3

Heat the hot plate. Until the solution of the copper wire into a blue solution

Pre-treatment of the sample

To each flash
add 8-9 ml
concentrated H_2SO_4

Evaporate the hot plate until white fumes of sulphur trioxide appear

Cool

Add drops 6M NH_4OH until the solution turns a deep blue.
Avoid an excess of NH_4OH

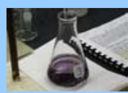
Add 3-4 ml concentrated CH_3COOH to dissolve any precipitate

Iodometric Titration of Copper

Add 2.5 g KI

Titrate immediately with $Na_2S_2O_3 \cdot 5H_2O$. Stop when the dissolution turns into a light yellow colour.

Add 3 ml of starch indicator. A blue deep colour appears.



Continue titrating until the blue colour almost disappears.
Add 1-1.5 g KSCN.

Add titrant drop by drop until the blue colour disappears, turns into colourless and holds 20-30 seconds.

Calculate the percentage of copper

Flow chart designed by Lidia Barreiro

Source of photos:
www.es.fishersci.com
www.crscientific.com
http://www.csudh.edu/oliver/demos/hh-cubr/hh-cubr.htm

Worksheet 5a: Recalling the Basic Information from the Fact File 2

INSTRUCTIONS

1. Now that you have listened to the lecture, check what you have learned.
2. In pairs, do the 5 activities below.
3. You have just 5'
4. When you finish check your answers with the class.

Task 1. THE REAGENTS OF THE PROCEDURE

Complete the grid.

Reagent	Name of the compound
a. HNO_3	*Nitric acid*
b. H_2SO_4	
c. NH_4OH	
d. CH_3COOH	
e. KI	
f. $Na_2S_2O_3$	
g. KSCN	

Task 2. REAGENT AND ITS UTILITY IN THE PROCEDURE

Match each reagent with the reason of its use during the procedure.

Reagent	Reason
a. HNO_3	
b. H_2SO_4	
c. NH_4OH	
d. CH_3COOH	
e. KI	
f. $Na_2S_2O_3$	
g. Starch	
h. KSCN	

Reasons:

1. To avoid the formation of the complex $CuI-I_2$
2. To dissolve any precipitate
3. To eliminate nitric acid
4. To act as an indicator
5. To react with the copper and to form I_2
6. To form a complex with the copper
7. To dissolve the sample
8. To react with the I_2

Key: Task 1: a. nitric acid; b. sulphuric or sulfuric acid;c. ammonium hydroxide; d. acetic acid; e. potassium iodide;f. sodium thiosulphate or thiosulfate; g. Potassium thiocyanate.
Task 2: a.7; b.3; c.6; d.2; e.5; f.8; g.4; h.1

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

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 HNO3 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 NO2 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 H2SO4 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, and 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 percent of copper in the copper wire.

Adapted from: http://www.wku.edu/~charles.henrickson/chem330.htm
(Material form the Western Kentucky University)

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http://diposit.ub.edu/dspace/handle/2445/2

Worksheet 5b: The Procedure.
Searching for Chemical Information

INSTRUCTIONS

1. Read the Input Source 4 ***Experimental Procedure of the Determination of Copper in a Copper wire***.
2. If necessary, look up in the dictionary the words that you do not understand. You may work in the table attached to the text.
3. There is a Flow Chart of this experimental procedure in Worksheet 5a.
4. Attached to the text there are 5 columns. In pairs or small groups fill in each column the following information: (1) **Reagents**, (2) **Laboratory equipment**, (3) **Operations**, (4) **Colours** and (5) **Safety tips**.

(1) **Reagents**: Write down the formula of the reagent and their required concentration in the procedure *e.g.: concentrated nitric acid*
(2) **Laboratory equipment**: Write down the name of the pieces of laboratory equipment *e.g.: flasks*
(3) **Operations**: Write down all the operations –actions- that you need to perform in the laboratory according to the procedure *e.g.: to weigh*
(4) **Colours**: Substances, solutions and their colours *e.g.: blue (copper (II) ion solution)*
(5) **Safety tips**: Safety equipment required *e.g.: goggles*

Note: Remember that you should consult the safety sheets of the reagents

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Experimental Procedure of Determination of Copper in a Copper wire	Reagents (1)	Laboratory equipment (2)	Operations (3)	Colours (4)	Safety Tips (5)
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.	HNO_3 concentrated	Flasks Analytical balance Hot plate	To weigh To label To heat	Brown gases (NO_2) Blue (copper solution)	Gloves Work under hood Rubber bulb Goggles
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, and 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 percent of copper in the copper wire.					
Adapted from: http://www.wku.edu/~charles.henrickson/chem330.htm (Material form the Western Kentucky University)					

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Worksheet 5c: The Procedure: Reactions

INTRODUCTION

In this worksheet we are going to review all the reactions involved in the Iodometric Titration of Copper.

Remember that there are five reactions involved in the Iodometric Titration of Copper.

Reaction 1: Dissolution of copper wire
Reaction 2: Formation of the complex $[Cu(NH_3)_4]^{2+}$
Reaction 3: Reaction between the analyte and the iodine.
Reaction 4: The second reaction of the titration.
Reaction 5: Addition of thiocyanate ion.

The first reaction is the dissolution of the sample. Remember that titrations must be performed in solution, and in our case the sample is solid, so it is necessary to dissolve the sample of copper wire.

In Reaction 2, we form the blue complex tetraamminecopper (II).

Reaction 3 and reaction 4 are the common reactions in all Iodometric titrations.

Iodometric processes are not direct titrations. Iodometric titrations involve two reactions:

analyte + I^- → I_2 (Reaction 3)
unknown

I_2 + titrant (standard thiosulfate) → product (Reaction 4)
Known

The last reaction, number 5, is specific for the iodometric titration of copper.

We are going to work deeply each of these five reactions.

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INSTRUCTIONS

1. Work in pairs or small groups of three.
2. First read the information about the reactions and then do the tasks for each reaction. Read carefully the instructions for each task.
3. You have just 15 minutes for all the tasks.

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Reaction 1: DISSOLUTION OF COOPER WIRE

The sample is solid, it is a copper wire. As we know, all the titrations must be performed in solution; therefore the first step is to dissolve the sample.
Nitric acid is a common dissolvent of copper; other options are sulphuric acid and also aqua regia (the mixture is formed by freshly mixing concentrated nitric acid and concentrated hydrochloric acid, usually in a volumetric ratio of one to three respectively).

Nitric acid is a powerful oxidation agent. The reaction between the copper and the nitric acid is:

$$3Cu + 8\ HNO_3 \rightarrow 3Cu^{2+} + 6NO_3^{-} + 2NO + 4H_2O \text{ (Reaction 1)}$$

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Task 1: CHECKING REDOX CONCEPTS

1. Work on your own.
2. Tick the correct statement.
3. Check your answer with the key and compare your score with your partners.

1. What is losing electrons in reaction 1?
   a. ☐ The copper
   b. ☐ The nitrate

2. What is gaining electrons in reaction 1?
   a. ☐ The copper
   b. ☐ The nitrate

3. Complete the definition: An oxidant or oxidising agent…

a. ☐ … takes electrons from another species (atom, ion or molecule) and are themselves reduced.

b. ☐ … gives electrons from another species (atom, ion or molecule) and are themselves reduced.

4. Competes the definition: A reductant or reducing agent…

a. ☐ … takes electrons from another species (atom, ion or molecule) and are themselves oxidised.

b. ☐ … gives electrons from another species (atom, ion or molecule) and are themselves oxidised.

Check your answer with the key and compare your score with your partners.

	1	2	3	4	Average
My score					
Std. 1's score					
Std. 2's score					

If your score is less than 4, you must do Worksheet 5d.

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Task 2: PREDICTING THE DISSOLUTION OF COPPER WIRE

Here you have some pictures of the procedure of the copper wire dissolution with nitric acid. Below each photo write the number of the correct sequence.

☐

☐

☐

☐

☐

☐

`Check your answer after carrying out the dissolution of copper in the laboratory.`

Reaction 2: FORMATION OF THE COMPLEX $[Cu(NH_3)_4]^{2+}$

The addition of aqueous ammonia forms the complex tetraamminecopper (II).

$$Cu^{2+} + 4\ NH_4OH \rightarrow [Cu(NH_3)_4]^{2+} + 4\ H_2O \quad \text{(Reaction 2)}$$

The complex tetraamminecopper (II) has a deep blue colour.

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Reaction 3: REACTION BETWEEN THE ANALYTE AND THE IODINE

Some copper is as ion form copper (II) ion, Cu^{2+}, and other as $[Cu(NH_3)_4]^{2+}$. In the next reaction we consider that all the copper is as copper (II) ion.
In fact, copper (II) ion in aqueous dissolution forms this complex $[Cu(H_2O)_6]^{2+}$, but we simply write Cu^{2+}.

So, the copper (II) ion reacts with the iodine (provided by the KI added). The reaction that takes place is:

analyte $+ \quad I^- \quad \rightarrow \quad I_2$

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unknown

$2\ Cu^{2+}_{(aq)} + 4\ I^-_{(aq)} \rightarrow 2\ CuI_{(s)} + I_{2(aq)}$ (Reaction 3)

This is also a redox reaction. The reduction of copper (II) to copper (I) oxidizes iodide ion to molecular iodine, I_2. The iodine is titrated with sodium thiosulfate (standard solution), reaction 4.

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Task 3: FIRST REACTION OF THE IODOMETRIC TITRATION

The sentences below help to understand the reaction between the copper and the iodine. Some key words have been removed.

With your partner complete the sentences with the most appropriate word from the box.

reduced	*Iodine*	copper(I) iodide	*iodide*	Oxidized
Copper(II)	*one*	Copper (I)		*two*

1. The reduction of _____________(1) to ______________(2) oxidizes ___________(3) to molecular _________________(4).

2. The copper (II) gains ___________ (5) electron. So the copper (II) is _____________(6).

3. The iodide loses ____________ (7) electron. So the iodide is ________________ (8).

4. Copper (I) precipitates as white or cream-colored______________ (9).

Check your answer with the key.

Number of correct answers: __________

Reaction 4: THE REACTION OF THE TITRATION

In the reaction 3 iodine (I_2) has been generated. This iodine is titrated with the standard solution sodium thiosulfate.

This is the second reaction that all iodometric titrations have in common. In all iodometric titrations, first the analyte oxidizes the iodide to iodine (reaction 3), and then, the iodine is titrated with sodium thiosulfate (standard solution).

I_2 + titrant (standard thiosulfate) → product
Known

$2\ S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$ (Reaction 4)

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Task 4: SECOND REACTION OF THE IODOMETRIC TITRATION OF COPPER

With your partners write down the half-equations of the reaction 4.

$$2\ S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-{}_{(aq)} \quad \text{(Reaction 4)}$$

If you don't remember how to do it, do Worksheet 5d first.

Reaction 5: THE ADDITION OF THIOCYANATE ION

There is a problem in this procedure, the CuI forms a complex with the iodine generated in reaction 2. This complex means that some iodine will not be titrated with sodium thiosulfate.
To avoid the formation of this complex some thyiocianate ion is added.
The thyiocianate ion replaces the iodine in the complex $CuI\text{-}I_{2(s)}$ and forms a new complex $CuI\text{-}SCN^-{}_{(aq)}$, and therefore the iodine complex is liberated.

$$CuI\text{-}I_{2(s)} + SCN^-{}_{(aq)} \rightarrow CuI\text{-}SCN^-{}_{(aq)} + I_{2(aq)} \quad \text{(Reaction 5)}$$

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Task 5: ADDITION OF KSCN

Work on your own and after checking your answer compare your score with your partners.
After reading each statement decides if it is true or false.

1. During the procedure a complex between CuI and I_2 is formed.
   ☐ True ☐ False

2. The complex $CuI\text{-}I_2$ does **not** interfere with the titration of I_2 with thiosulphate.
   ☐ True ☐ False

3. The tyiocianate replaces the I_2 in the complex $CuI\text{-}I_2$ and forms a new complex.
   ☐ True ☐ False

4. The newly-formed complex is $CuI_2\text{-}SCN$.
   ☐ True ☐ False

5. We can perform the procedure without the addition of the tiocyanate ion.
   ☐ True ☐ False

Check with the key and compare your score with your partners' score.

	1	2	3	4	5	**Average**
My score						
Std. 1's score						
Std. 2's score						

Key: Task 1: 1.a; 2.b; 3.a; 4.b **Task 2**: 5, 1, 3, 2, 6, 4 **Task 3**: (1) copper (II); (2) copper (I); (3) iodide; (4) iodine; (5) one; (6) reduced; (7) two; (8) oxidized; (9) copper (I) iodide
Task 4: $2e^- + I_2 \leftrightarrow 2I^-$; $2S_2O_3^{2-} \leftrightarrow S_4O_6^{2-} + 2e^-$. **Task 5**: 1.T; 2.F; 3.T; 4. F; 5.F.

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Input Source 5: Reminder of Redox Reactions

OXIDATION STATES (OR ORXIDATION NUMBERS)

In reactions which give rise to ionic compounds it is easy to see where electrons have been lost or gained. But what happens when there are covalent bonds in the reaction? For example:
$H_{2(g)} + ½ O_{2(g)} \rightarrow H_2O_{(l)}$

It is not possible to write half-equations for this reaction, so, using our current definition of oxidation as a process of electron loss, how do we know hydrogen has been oxidised? This is where the concept of **oxidation states** comes in. No electrons are *transferred* in the formation of a covalent bond, we can *pretend* that they are.

In the covalent bond between hydrogen and oxygen is the more electronegative element. This means that it has more power than hydrogen to attract electron density in the covalent bond.

We can know define oxidation and reduction in terms of changes in oxidation states:

Oxidation occurs when the oxidation state of an element in a reaction increases. Reduction occurs when the oxidation state of an element in a reaction decreases.

If there is not change in the oxidations states of species involve in a reaction, this reaction is not a redox one.

Simple rules for assigning oxidation states

The guidelines for assigning oxidation states (numbers) are given below:

1. The oxidation state of any element such as Fe, H_2, O_2, P_4, S_8 is zero (**0**).
2. The oxidation state of oxygen in its compounds is **-2**, except for peroxides like H_2O_2, and Na_2O_2, in which the oxidation state for O is -1.
3. The oxidation state of hydrogen is **+1** in its compounds, **except** for metal hydrides, such as NaH, LiH, etc., in which the oxidation state for H is **-1**.
4. The oxidation states of other elements are then assigned to make the algebraic sum of the oxidation states equal to the net charge on the molecule or ion.
5. The following elements usually have the same oxidation states in their compounds: **+1** for alkali metals - Li, Na, K, Rb, Cs; **+2** for alkaline earth metals - Be, Mg, Ca, Sr, Ba; **-1** for halogens except when they form compounds with oxygen or one another.
6. The sum of the oxidations states of all the atoms and ions in a compound is always zero.
7. The sum of the oxidation states in a polyatomic ion is always the charge on the ion.

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Adadpted from : http://www.science.uwaterloo.ca
; http://www.chemguide.co.uk/inorganic/redox/oxidnstates.html

REDUCTION AND OXIDATION REACTIONS

Redox (shorthand for **reduction**/**oxidation** reaction) describes all chemical reactions in which atoms have their **oxidation number** (oxidation state) changed.

One important fact to remember in studying **oxidation-reduction** reactions is that the process of **oxidation** cannot occur without a corresponding **reduction** reaction.

Oxidation must always be *"coupled"* with **reduction**, and the electrons that are "lost" by one substance must always be *"gained"* by another as matter (such as electrons) cannot be destroyed or created. Hence, the terms *"lost or gained"*, simply mean that the electrons are being transferred from one particle to another.

The term **redox** comes from the two concepts of **reduction** and **oxidation**. It can be explained in simple terms:

- **Oxidation** describes the *loss* of electrons by a molecule, atom or ion
- **Reduction** describes the *gain* of electrons by a molecule, atom or ion

Substances that have the ability **to oxidize** other substances are said to be **oxidative** and are known as **oxidizing agents**, **oxidants** or **oxidizers**. Put in another way, the **oxidant** *removes electrons* from another substance, and is thus **reduced itself**.

Substances that have the ability **to reduce** other substances are said to be **reductive** and are known as **reducing agents**, **reductants**, or **reducers**. Put in another way, the **reductant** *transfers electrons* to another substance, and is thus **oxidized itself**.

Memo help:

Reduction

Oxidant + e^- → Product

(Gain of Electrons) (Oxidation Number Decreases)

Oxidation

Reductant → Product + e^-

(Loss of Electrons) (Oxidation Number Increases)

Picture taken from: http://en.wikipedia.org/wiki/Oxidation

In this web site there is a mind map about redox reactions. It’s very interesting.
Give a look! http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/redoxcon.html#c1

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Adapted from http://en.wikipedia.org and http://library.kcc.hawaii.edu/external/chemistry/basic_model.html

Worksheet 5d: Reminder of Redox Reactions

INSTRUCTIONS

1. These tasks will help you to remind redox concepts. Input Source 5 will help you to remind how to determine Oxidation States and some concepts about Redox Reactions.
2. Work in small groups of three, do the tasks below.
3. Self-correct your answers.

Task 1. WRITE DOWN THE OXIDATION STATES OF EACH ELEMENT IN THE FOLLOWING

1. NaCl	Na:	Cl:	
2. HNO_3	H:	N:	O:
3. MnO_4^-	Mn:	O:	
4. K_2SO_4	K:	S:	O:
5. H_3PO_4	H:	P:	O:
6. $Cr_2O_7^{2-}$	Cr:	O:	

Your score: number of correct answers:______ over 15

Task 2. TASK ON REDOX CONCEPTS

Tick the correct statement:

1. Complete the sentence: Oxidation is ….
   a. ☐ … loss of electrons.
   b. ☐ … gain of electrons.

2. Compete the sentence: Reduction is …
   a. ☐ … loss of electrons.
   b. ☐ … gain of electrons.

3. Complete the definition: An oxidant or oxidising agent…

a. ☐ … take electrons from another species (atom, ion or molecule) and are themselves reduced.

b. ☐ … give electrons from another species (atom, ion or molecule) and are themselves reduced.

4. Compete the definition: A reductant or reducing agent…

a. ☐ … take electrons from another species (atom, ion or molecule) and are themselves oxidised.

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b. ☐ … give electrons from another species (atom, ion or molecule) and are themselves oxidised.

5. When magnesium burns in chlorine, the following reaction occurs:

$$Mg_{(s)} + Cl_{2(g)} \rightarrow MgCl_{2\,(s)} \quad (1)$$

a. ☐ In this reaction, magnesium is the oxidant because it oxidises chlorine.
b. ☐ In this reaction, chlorine is the oxidant because it oxidises magnesium.

6. For the reaction below *(1)*, the half-equation for chlorine is:

a. ☐ $Cl_2 + 2e^- \rightarrow 2Cl^-$

b. ☐ $Cl_2 \rightarrow 2Cl^- + 2e^-$

7. For the reaction (1), the half-equation for magnesium is:

a. ☐ $Mg + 2e^- \rightarrow Mg^{2+}$
b. ☐ $Mg \rightarrow Mg^{2+} + 2e^-$

	1	2	3	4	5	6	7	**Average**
My score								
Std. 1's score								
Std. 2's score								

Task 3. WRITING REDOX REACTIONS

For the following reactions:

1. Write down the full equation
2. Write down the half-equations
3. State which species is being oxidised and which is being reduced
4. State which species is the oxidant and which is the reductant.

Reaction 1: Lithium reacts with water, hydrogen is given off and lithium hydroxide is formed.

1.

2.

3. The specie is being oxidised is ______________________ and the specie is being reduced is ___________________________ .

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4. The oxidant is ____________________________ and the reductant is _________________ .

Reaction 2: Magnesium reacting with nitrogen to form magnesium nitride (Mg_3N_2).

1.

2.

3. The specie is being oxidised is _____________________ and the specie is being reduced is ___________________________ .

4. The oxidant is ____________________________ and the reductant is _________________ .

5. When Mg_3N_2 is added to water, ammonia is evolved; is this a redox reaction?

Mg_3N_2 (aq) + $6H_2O$(l) → $3Mg(OH)_2$ (aq) + $2NH_3$ (g)

Score: One point for each question.

Reaction 1: _______ over 4
Reaction 2: _______ over 4

Average: ______

Key:
Task 1: (1) +1, -1; (2) +1, +5, -2; (3) +7, -2; (4) +1, +6, -2; (5) +1, +5, -2; (6) +5, -2
Task 2: 1.a; 2.b; 3.a; 4. b.; 5.b; 6.a; 7. b.
Task 3:
Reaction 1: 1) $2Li + 2H_2O \rightarrow 2LiOH + H_2$ (g) 2) $2Li \rightarrow 2Li^{2+}$ + 2e-;
$2H_2O + 2e^- \rightarrow 2OH^- + H_2$ g); 3)lithium; water; 4) water; lithium
Reaction 2: 1) $2Mg+N_2 \rightarrow Mg_3N_2$; 2) $3Mg \rightarrow 3Mg^{2+} + 6e^-$; $N_2 + 6e^- \rightarrow 2N^{3-}$ 3) magnesium; nitrogen; 4) nitrogen; magnesium; 5)No, there is not a loss and gain of electrons, there is no change in oxidation numbers.

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Worksheet 6a: The Experiment.
Laboratory Equipment and Reagents

INSTRUCCIONS

1. These tasks will check what you know about technical vocabulary in the laboratory.
2. In pairs or small groups, do the two tasks below.
3. You have just 5 minutes.
4. Self-correct your answers.

Task 1: THE EQUIPMENT

Here you have a box with names of some pieces of laboratory equipment and pictures of pieces of equipment. Match each photo with its word.

lab tongs	beaker	buret clamp
erlenmeyer or conical flask	hot plate	buret or burette
markers	ring stand	dropper pipet
goggles	analytical balance	pipet bulb

Analytical balance   ____________   ____________

____________   ________________________   ________________________

(3 pieces of equipment)

____

____

____

__________________   ______________________   ___________________

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Task 2: THE SOLUTIONS / REAGENTS

It's very important to know the formulae and the systematic nomenclature of the chemical products.

Below you will find the list of reagents that you will need in this experiment. Complete the table, writing the formulae in the second column and indicating the type of chemical product (acid, base or salt) in the third column.

REAGENTS FOR THE IODOMETRIC TITRATION OF COPPER		
Sytematic name	**Formula**	**Type of chemical product (acid, base or salt)**
1.Hydrochloric acid	HCl	acid
2.Aqueous ammonia		
3.Glacial acetic acid		
4.Nitric acid		
5.Sodium thiosulphate pentahidrate		
6.Potassium thiocyanate		
7.Sulphuric acid		
8.Potassium iodide		

In order to keep a record complete the following summary grid. Write the formula of all the reagents needed. If you think you will forget the systematic name in English, write the name next to the formula

SUMMARY GRID OF REAGENTS FOR THE IODOMETRIC TITRATION OF COPPER	
I. ACIDS	1. HCl
	2.
	3.
	4.
II. SALTS	5. $Na_2S_2O_3 \cdot 5H_2O$ Sodium thiosulphate pentahidrate
	6.
	7.
III. BASE	8.

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Key:

Task 1: analytical balance; hot plate; beakers; dropper pipete; markers; Erlenmeyer Flask; Burette; buret clamp and ring stand; pipet bulb; goggles; lab tongues

Task 2: HCl, acid; NH_4OH, base; CH_3COOH, acid; HNO_3, acid; $Na_2S_2O_3 \cdot 5H_2O$, salt; KSCN, salt; H_2SO_4, acid; KI, salt.

Task 3: I. Acids: HCl, CH_3COOH, HNO_3, H_2SO_4. ; II. Salts: $Na_2S_2O_3 \cdot 5H_2O$, KSCN, KI; III. Base: NH_4OH

Worksheet 6b: The Experiment. Previous calculations

INTRODUCTION

Before carrying out the experiment in the laboratory, it is necessary to perform some calculations. In this experiment the two calculations are: the volume of the reagents in order to prepare the dissolutions and the theoretical volume of standard dissolution to reach the equivalent point.

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INSTRUCTIONS

1. In pairs, do the two calculations below.
2. You have just 10 minutes.
3. The teacher will check your results.

Calculation 1: DISSOLUTIONS

We need to prepare sulphuric acid 9M and aqueous ammonia 6 M.
The teacher will give you the dissolution volume that you need to prepare for each reagent.

Calculation 1: ______ ml of 9M sulphuric acid

Calculation 2: ______ ml of 6M aqueous ammonia

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Calculation 2: VOLUME OF STANDARD SOLUTION

In order to choose the most appropriate burette, we need to know the volume of the standard solution that is going to be needed to reach the equivalent point.

For this calculation we are going to suppose that the copper wire has a 99.9% percentage of copper.

Calculate the volume of sodium thiosulfate (use the molarity determinate in the standardisation) you will consume if your sample weight 0.5 g of wire copper with a 99.9% purity.

Volume of the burette: ___________

The teacher will check your results!

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Worksheet 6c: The Experiment. A Quiz of the Procedure

INSTRUCTIONS

1. This quiz will check if you are ready to perform the procedure of Iodometric Titration of Copper.
2. In pairs, or small groups of three, do the two tasks below.
3. You have just 10 minutes.

Task 1. STEPS IN THE PROCEDURE

Decide which of these two actions is performed first and tick it.

What do we perform in the first place? Decide which of these two actions is performed first.

1. a. ☐ The standardization of the sodium thiosulfate.
   b. ☐ The idodometric titration of copper.

2. a. ☐ Add nitric acid.
   b. ☐ Weigh the sample.

3. a. ☐ Add sulphuric acid and evaporate it.
   b. ☐ Add nitric acid and heat on a hot place.

4. a. ☐ Add aqueous ammonia.
   b. ☐ Add glacial acetic acid.

5. a. ☐ Add the indicator starch.
   b. ☐ Begin the titration, adding the standard solution.

Task 2. REAGENTS INVOLVED

The task consists of completing the table below (page 2).
In the first column there is a list of seven reagents. Write the formula of each reagent in the second column.
Write in the third column the reason for adding each reagent.
You have all the reasons in the box below, but **pay attention**, there are more reasons than reagents.

Reasons:
a. This reacts with the copper. The copper oxidizes iodide to iodine.
b. This expels any nitric acid which might later oxidize iodide to iodine.
c. This acts as an indicator.
d. This oxidizes copper (I) to copper.
e. This avoids the formation of the complex $CuI-I_2$.
f. This forms a blue-intense complex with copper.
g. This forms a brown complex with the starch.
h. This dissolves any precipitate.
i. This dissolves the copper wire.

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Reagent	Formula	Reason
1.Nitric acid	HNO_3	i
2. Sulphuric acid		
3. Aqueous ammonia		
4. Acetic acid		
5. Potassium iodide		
6. Starch	**Not necessary in this case**	
7. Potassium thiocyanate		

Task 1

Your score	1	2	3	4	5
Key					

Task 2

Your score	Formula	1	2	3	4	5	6	7
	Formula Key							
	Proposal	1	2	3	4	5	6	7
	Proposal Key							

1 point for each correct answer

Your final score:______

Are you ready?_______

Do you need help? ______

Key: Task 1: 1.a; 2.b; 3.b; 4.a; 5.b
Task 2: 1) HNO_3, i ; 2) H_2SO_4, b; 3)NH_4OH, f; 4) CH_3COOH, h; 5) KI, a; 6)-, c; 7)KSCN, e

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REPORT SHEET: IODOMETRIC DETERMINATION OF COPPER

Name: ______________________________ Date: ______________

Determination of Copper in Copper wire

	Sample 1	**Sample 2**	**Sample 3**
mass of copper wire (g)			
ml of $Na_2S_2O_3$ to reach end point $M_{(Na_2S_2O_3)}$=			
% Copper in Sample			
Average %-Copper ± s.d.:			

Show calculations for one of the samples below:

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