

Chemistry

Secondary Education
Second year
Sciences Section

PART 2



ORBITALS Collection

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Center for Educational Research and Development



National
Textbook

مقرس
New Curriculum

Republic of Lebanon

Ministry of Education and Higher Education

■
CHEMISTRY
■

Secondary Education

Second Year

Sciences Section

Center for Educational Research and Development





National
Textbook

New Curricula



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CHEMISTRY



Secondary Education

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Sciences Section

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The National Textbook Project

This is the second installment of textbooks completed by the Center as part of a three-stage effort to produce the books called for by the New Curricula. We are placing these books in the hands of students with the great hope that we are moving, step by step, toward the goal of acquiring sound and modern learning, using sophisticated educational means and up-to-date methodology that encourage and reinforce individual thinking and research, the acquisition of skills, the development of ethical and national attitudes, the feeling of national belonging as well as the feeling of belonging to humanity at large.

The on-going revolution in information, communication and educational technology has undoubtedly limited the role of the textbook and lowered the rank it used so recently to occupy. However, in our society and in many other societies, the textbook remains the basic means of education, and it is our duty to exert our utmost effort and care to come up with the best product as to form and content. Yet we should not lose sight of the fact that the textbook is not sufficient by itself but should rather be used as a stepping stone to access other sources of information. What is important is to keep a clear vision and maintain the right course toward our objective. The means should not turn into the end and the student should always remain the focus of the learning/teaching process.

No one ignores or denies the fact that textbook writing requires very high academic and educational qualifications and very wide field experience. The authors committees undeniably possess such qualifications and qualities, yet last year's textbooks did contain some faults and gaps which were duly pointed out by researchers in many articles, and, indeed, we have benefited from some of them. Such is the nature of human work, no matter how good the intentions or how great the effort exerted.

Constructive criticism is a real contribution to raising the standard of authorship, minimizing errors and filling gaps. We only hope that criticism will always be objective and motivated by a desire to enhance educational reform in order to achieve better products.

A favorite adage handed down from our old scholars: "He who criticizes you is as helpful as a co-author". Let all criticism directed at the Center be of this caliber.

In closing, we hope that we all will have benefited from our experience and that the textbooks of the third and final stage be closer to realizing our hopes and more beneficial to our students. We are now preparing ourselves to assess the parts so far achieved of the new curricula and to assure that our educational movement is proceeding on the right track for achieving the best results.

June 2, 1999

**President, National Center for Educational
Research and Development**

Nemer FRAYHA

Note to teachers and students:

This is part two of the text book which constitutes ten chapters.

General Coordinator

Foreword

The chemistry curriculum of the second year of the secondary education – scientific series is fundamentally composed of two main parts. The first deals with conceptual chemistry: thermochemistry, electrochemistry, atomic orbitals and organic chemistry. The second deals with industrial chemistry and pollution: industrial inorganic chemistry, petroleum and natural gas, metallurgy, and pollution, with a major goal: to show that chemistry is a concrete science, and to emphasize its importance in the economy of a country as well as its applications in everyday life.

The curriculum takes into account that the student is acquainted with basic chemistry, in the first secondary year and in previous years, and that, according to the scientific series, he can be motivated to a diversified content.

However, in order to attain the planned pedagogical objectives which are: To help the student to understand scientific concepts and the acquisition of experimental work, as well as a scientific culture and considering the industrial part of the curriculum; our concern was to adopt a simple language, to ensure sufficient illustration (photos, schemes ...) and to follow the organization of the book.

Organization of the book

The book is divided into sixteen chapters all having similar pattern.

Each chapter is introduced by an illustration and a commentary related to the topic to be discussed. In this introduction page the objectives, the prerequisites, and the chapter contents are given.

The illustration given in each chapter is conceived as an essential pedagogic support especially in the chapters of industrial chemistry and pollution where laboratory investigations generally are not considered. In the chapters concerning the conceptual parts of the curriculum, these investigations, illustrated in the text, play the role of pedagogical support. They are an experimental and concrete introduction to the studied concepts. The interpretation of their results leads to the understanding of the concepts.

The solved exercise is a direct application of scientific notions, which precedes it. The chapter review is its summary. It includes the principle notions discussed. The method sheets are a supplement, sometimes necessary to complete the treated topics. The laboratory work sheets, which are more elaborated than the laboratory investigations, are complete experimental applications related to the subject of the chapter.

The documentary activities are numerous and diversified, written in a simple style constitute a supplementary information to the student. This diversity and the easy style will provoke his interest.

The different forms of exercises (fill in the blanks, multiple choice, classical exercises and exercises taken from daily life), help the student to understand and assimilate the scientific subjects studied.

Finally, all suggestions that our colleagues will kindly communicate to us will be received with our great attention and interest.

The authors

Features of the book

Unit Opener

- Picture introducing the chapter

- Commentary introducing the chapter

The Unit Opener page features a large photograph of an industrial facility. A yellow circle highlights the title 'Study of the Principles of manufacturing' and the chapter number '7'. A text box at the bottom left contains a commentary paragraph. On the right side, there are sections for 'Objectives', 'Prerequisites', and 'Chapter content', each with a list of items.

- Title
- Objectives
- Prerequisites
- chapter Contents

Course

- Remarks and supplementary information

- Presents definitions, results and conclusions

- Illustration

The Course page is titled '5.1 Dry cells and storage batteries'. It includes a photograph of a Toshiba battery, a diagram of a dry cell, and a diagram of an electrochemical cell. Text boxes provide definitions and supplementary information. A red arrow points from the 'Remarks and supplementary information' label to a text box on the left.

- Introduction to the chapter

- To widen the students knowledge concerning all fields of applications

Documentary activities

The Documentary activities page is titled 'Observation and analysis of lead storage battery'. It contains two numbered activity boxes, each with a photograph of a battery and a list of questions. A red arrow points from the 'To widen the students knowledge concerning all fields of applications' label to the activity boxes.

Experimental activity

Laboratory investigation

3.1 Oxidation-reduction potential

3.1.1 The Daniell cell

Activity 1 Construction of electrochemical cell.

Objective
Investigate the electrochemical cell producing electric current.

Equipment
Zinc strip, Beakers, Voltmeter, Resistance, Electronic digital multimeter, Connecting wires.

Reagents
1 mg of zinc strip of copper. ZnSO₄ (1 mol/L), ZnSO₄ solution (1 mol/L), Copper (II) sulfate CuSO₄ solution (1 mol/L), Salt bridge (potassium nitrate).

Procedure
Cut the zinc strip in the beaker which contains zinc sulfate solution. Dip the copper strip in the beaker which contains copper (II) sulfate solution. Connect the two solutions by the salt bridge (Fig. 3.1.1). Connect the multimeter in series with the voltmeter in an electric circuit joining the zinc strip (Fig. 3.1.2). Observe what happens.

Observation
The voltmeter indicates a current flow of low intensity from the copper strip to the zinc strip. The voltmeter indicates a value equal to 1.1 volts. After some time the color of the copper (II) sulfate solution changes from blue to light green. The current flow decreases. Careful measuring shows that the rate of the zinc strip has increased and the mass of the copper strip has increased.

Interpretation
The system constituted in activity 1 is called an electrochemical cell. In this case, it is a Daniell cell.

An electrochemical cell is constructed by using two different metals, each being dipped in its electrolyte solution, which contains its M^{n+} . The two electrolyte solutions are connected by a salt bridge.

The cell has produced an electric current in the external circuit, which represents the two different zinc and copper. Therefore, it operates as a current generator.

Electrochemical cell generates electric current by chemical reaction.

LABORATORY INVESTIGATION

Identification test of some metallic cations in solution

Objective
Recognize the presence of some metallic cations in aqueous solution.

Procedure

- Identification test of Ag^+ ions**
In a test tube, add few mg of silver (I) nitrate solution, $AgNO_3$, into the water of the solution. Add few drops of the 5 mg/L solution of hydrochloric acid. Observe what happens. Write the ionic equation of the corresponding reaction. Let it settle for few minutes. Observe what happens.
- Identification test of Cu^{2+} ions**
In a test tube, add few mg of copper (II) sulfate solution, $CuSO_4$, into the water of the solution.

Figure 3.20
(a) White precipitate of $AgCl$. (b) The precipitate turns brown when exposed to light.

Figure 3.21
Blue precipitate of $Cu(OH)_2$.

Figure 3.22
Blue precipitate of $Cu(OH)_2$.

Figure 3.23
Add few drops of the 1 mol/L solution of sodium hydroxide, $NaOH$. Observe what happens. Write the ionic equation of the corresponding reaction. Let it settle for few minutes. Observe what happens.

Figure 3.24
Add few drops of the 1 mol/L solution of sodium hydroxide, $NaOH$. Observe what happens. Write the ionic equation of the corresponding reaction.

- Title
- Objective
- Procedure
- Observation
- Questions to be answered
- Interpretation

Elaborated experimental work applied to subject presented

Chapter review

Method sheet

Chapter review

An oxidation-reduction reaction involves an electron transfer between two reactants. The oxidizing agent gains electrons and the reducing agent loses electrons. Oxidation is a loss of electrons. Reduction is a gain of electrons.

The reducing agent of a redox reaction is the species that is oxidized. The oxidizing agent of a redox reaction is the species that is reduced. $M^{n+} + e^- \rightarrow M$

The electrochemical cell changes the oxidizing agents of M^{n+} in a solution according to an increasing order of oxidizing power and the reducing agents of these couples according to an increasing reducing power.

Method sheet

A- Safety recommendations for the preparation of acid solution

- Concentrated acid solutions are dangerous to the body. Their effects are serious: skin burning, harm to eyes, ... etc. They should be handled with care by following the safety rules.
- Use proper tools when withdrawing concentrated acids.
- Don't pour water into concentrated acid, but always pour acid into water (in continuously). Cool if needed.
- Work under a hood.

B- Calculation for the preparation of an acid solution from a stock (commercial) solution

Preparation of one liter of a 1 mol/L solution of hydrochloric acid from a 37% (mass percentage) commercial solution. Molar mass of hydrochloric acid $M(HCl) = 36.5 \text{ g/mol}$. Density of the solution $\rho = 1.19 \text{ g/mL}$.

Mass of acid in one liter of 1 mol/L solution $m_1 = 36.5 \text{ g}$

Mass of the commercial solution containing this mass of acid $m_2 = \frac{36.5 \text{ g}}{0.37} = 98.65 \text{ g}$

Volume of the solution containing the mass m_2 of acid $V_2 = \frac{m_2}{\rho} = \frac{98.65 \text{ g}}{1.19 \text{ g/mL}} = 82.90 \text{ mL}$

So, 82.90 mL of the commercial solution must be taken to prepare one liter of a 1 mol/L solution of hydrochloric acid.

Solved exercise direct application to the proceeded notion

Exercises

Exercises

1. Complete the following sentences:

a) In an oxidation-reduction reaction, the oxidizing agent is reduced and the reducing agent is oxidized. The quantity of matter of the oxidizing agent is reduced and the quantity of matter of the reducing agent is increased.

b) In an oxidation-reduction reaction, the oxidizing agent is reduced and the reducing agent is oxidized.

2. Answer True or False:

a) A reaction system is identified by its reactants.

b) An oxidation-reduction reaction is identified by its reactants.

c) Thermodynamics is the study of the first law effect that affects a chemical reaction.

d) During an exothermic reaction, the system releases heat.

e) An exothermic reaction is one reaction, in which heat is released.

3. Indicate the bond's nature:

a) Consider the reaction $Ca + Cl_2 \rightarrow CaCl_2$ (in 100% yield). The heat of formation of $CaCl_2$ is -795 kJ/mol . Calculate the heat of formation of $CaCl_2$ (in 100% yield).

b) The heat of formation of liquid water is -285.8 kJ/mol . Calculate the heat of formation of water in M_2O .

4. Calculate the heat of reaction for the following reaction: $2H_2 + O_2 \rightarrow 2H_2O$

5. Calculate the heat of reaction for the following reaction: $2H_2 + O_2 \rightarrow 2H_2O$

6. Calculate the heat of reaction for the following reaction: $2H_2 + O_2 \rightarrow 2H_2O$

MCQ classical questions and applications to everyday life

Solved exercise

The heat of combustion of a compound, expressed in kJ/mol , refers to one mole of compound. Heat of combustion are generally given in tables.

Write the stoichiometric equation of the reaction.

Verify if the reactants are in their stoichiometric proportions.

Calculate the quantity of heat (in kJ) exchanged during combustion.

Mass of oxygen is 114 g.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ $\Delta H = -891 \text{ kJ/mol}$

To verify if the reactants are in their stoichiometric proportions, one can follow the following method:

Volume of oxygen is 31 L of O_2 :

$n = \frac{V}{V_m} = \frac{31 \text{ L}}{24 \text{ L/mol}} = 1.29 \text{ mol}$

Amount of moles of oxygen:

$n = \frac{m}{M} = \frac{114 \text{ g}}{32 \text{ g/mol}} = 3.56 \text{ mol}$

Accept n_{O_2} in the stoichiometric proportions, if the reactants are in stoichiometric proportions, the heat flow:

$Q = n \cdot \Delta H = 1.29 \text{ mol} \cdot (-891 \text{ kJ/mol}) = -1149 \text{ kJ}$

$\Delta H = -891 \text{ kJ/mol}$ (in 100% yield)

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