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PHYSICAL SCIENCE PROGRAM

SECONDARY IV

OCTOBER 1997

Québec

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Direction de la formation générale des adultes

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Gouvernement
du Québec

La ministre de l'Éducation

In accordance with Section 461 of the Education Act (R.S.Q., c. I-13.3), I hereby approve the new Secondary IV Physical Sciences program for adult education. Application of this program will become obligatory in all adult education centres as of July 1, 1997.

PAULINE MAROIS

1035, De La Chevrotière
Québec (Québec) G1R 5A5

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Coordinator	Pauline Pelletier	Commission scolaire des Patriotes
Production Team	André Dumas	Commission scolaire catholique de Sherbrooke
	René Lord	Commission scolaire de la Jeune-Lorette
	Harold Lavoie	Commission scolaire St-Hyacinthe – Val-Monts
	Serge Marcil	Commission des écoles catholiques de Montréal
	Céline Tremblay	Consultant, Commission scolaire des Patriotes
	René Vézina	Consultant, Commission scolaire des Patriotes
	Jacky Tremblay	Commission scolaire des Découvreurs
	Louise Bourque	Consultant, Commission scolaire des Patriotes
Consultants	Pierrette Marcotte	Direction de la formation générale des adultes
	Mireille Moisan	Direction de la formation à distance
	Yves Gingras	UQAM
	Science teachers at the following school boards participated in the development process by experimenting the new program with their students: CECM, commissions scolaires de Chicoutimi, des Découvreurs, des Draveurs, Le Gardeur, La Neigette, de Matane, Memphrémagog, Rouyn-Noranda, de Sherbrooke, de Trois-Rivières, Saint-Jean sur Richelieu and du Sault-Saint-Louis.	
Coordinators, Physical Science Program	Serge Leloup	Direction de la formation générale des adultes (until 1996)
	Pierrette Marcotte	Direction de la formation générale des adultes (as of 1996)
Program Coordinator	Marc Leduc	Direction de la formation générale des adultes
Director	Alain Mercier	Direction de la formation générale des adultes
Translation		Services à la communauté anglophone, Direction de la production en langue anglaise

TABLE OF CONTENTS

pages

pages

INTRODUCTION

1. Presentation

The Secondary IV *Physical Science* program is designed for Québec adult education students. It is intended both for students taking courses for their Secondary School Diploma (SSD) and for those who already have their diploma and are preparing to enter CEGEP.

1.1 Program Development Context

In 1986, during a phase of general revision of secondary-level natural science programs, the Direction générale de l'éducation des adultes (DGEA) set up an advisory committee in charge of analyzing the content of the new Secondary IV *Physical Science* program of study, for the youth sector, produced by the Direction générale des programmes (DGP). The advisory committee's mandate was to make recommendations concerning the possibility of using this program in adult education.

An orientation document published in 1988 described the concerns of people working in adult education as regards content, learning objectives and andragogical approach. These considerations, in addition to recent developments in the fields of science teaching and cognitive psychology, guided the development of this program. The present version is the result of revisions undertaken by several committees as well as of field tests in a dozen school boards.

This program replaces the preceding Secondary IV Physics, Chemistry and Physical Science programs. It prepares students for the Secondary V Physics and Chemistry programs. It is also a prerequisite for admission to CEGEP.

This new program is designed to heighten the awareness of students, in general education for adults, regarding the interaction between science, technology and society and to help them understand the implications of this interaction for their lives. The new program allows students to approach the subject through examples an applications, to seek an understanding of the phenomena in question and to form personal opinions that deepen their involvement, as citizens, in the major debates affecting our society today, or at least help them understand the issues at stake.

1.2 Relationship with Other Programs

The thematic content of the *Physical Science* program for adults has been harmonized with that of *Physical Sciences 416-436*, the program used in the youth sector. Together these programs ensure that secondary-level students, whether they study in the youth or the adult sector, receive an education in the sciences that is similar and that conforms to the conditions required for obtaining an SSD.

The *Physical Science* program also favours the development of skills and the acquistion of knowledge traditionally associated with technology or the social sciences and humanities (geography, political science, sociology, psychology, etc.), rather than the natural sciences. The object is to make students fully aware of the connections between the different aspects of a society that both produces and uses techno-scientific knowledge.

The news media provide an inexhaustible supply of information that can stimulate research and analysis or even contribute to the development of the other skills and attitudes specified in the *Physical Science* program objectives. The new information technologies (computers, information highways, Internet, CD-ROM, interactive television, etc.) can facilitate access to this information. These documentary research activities are well adapted to the learning objectives targeted in the *English Language Arts* and *Micro-computing* programs.

1.3 Science-Technology-Society Approach (STS)

The *Physical Science* program has an STS (science, technology, society) approach, which means it has a dual objective: to permit students to acquire the knowledge they need to understand scientific phenomena, and to enable citizens to participate actively in the social and political life of their community.

The STS orientation offers a promising approach to the challenge of teaching science on the cusp of the twenty-first century. By focusing on the numerous relationships between science and human activity, and notably by tying these relationships both to the private lives of the students — youth or adult — and to their role as members of the community, the STS approach offers an interesting alternative to traditional programs. This approach aims to make learning more significant to the students and at the same time to enable them to perceive scientific knowledge from a historical perspective. By doing so, the approach invalidates the myth of the absolute nature of scientific knowledge. Students come to realize that scientific concepts are not static and that their evolution is linked to the development of theoretical and technical knowledge.

The STS approach give an analytic perspective on scientific and technological phenomena, which influence, or are influenced, by the evolution of society. A program based on this orientation should enable students to:

- understand that technology is an application of science;
- understand that science, technology and society constantly interact and influence each other;
- increase their ability to examine techno-scientific problems and to express opinions about them.

1.4 Goals

The *Physical Science* program is intended to develop the students' knowledge, skills and attitudes in the following domains: techno-scientific, political and social, personal and intellectual.

a) In the techno-scientific domain:

- assimilate basic concepts in physics and chemistry;
- begin acquiring the scientific and technological culture required to fulfill one's role as citizens;
- realize that scientific and technological development results from the application of concepts and principles originating in scientific discoveries;
- observe the historical evolution of scientific and technological knowledge;
- understand certain applications in the techno-scientific domain;
- understand that aspects of science and technology are in constant interaction.

b) In the social and political domain:

- realize that science and technology carry positive or negative effects on society;
- understand that scientific and technological developments necessitate social choices;
- realize that the decisions of members of a democratic society influence scientific and technological developments;
- realize that scientific and technological developments require specific skills and knowledge, and that in consequence they need a specialized work force;
- understand that scientific and technological developments express the social, political and economic choices of a society.

c) In the personal and intellectual domain:

- analyze different points of view concerning the development, introduction and use of techniques;
- make a list of possible alternative solutions to certain technological problems;
- develop a desire to learn more about science and technology and stimulate curiosity with regard to these domains.

1.5 Skills

Given that, for most students, this Secondary IV program is their first contact with the world of science and technology, the program's first goal is to develop a set of cognitive skills that will serve essential strategies in the students' daylives.

The skills targeted are the following:

COMPARING	Developing the ability to discern the differences and similarities between two things (concrete, abstract, real, mental, etc.).
SUMMARIZING	Developing the ability to distinguish between the essential and the accessory.
CRITICISING A SCIENTIFIC TEXT	Improving the ability to read a scientific text, to distinguish the facts in it from the hypothesis and conjecture, and to assess the value of the information in the text.
EXTRAPOLATING	Developing the ability to evaluate possible consequences or to project into the future the implications of present-day decisions and events.
ARGUING AND TAKING A STAND	Developing the ability to analyze facts, compare points of view, evaluate data, events or arguments, establish links between facts or events and develop one's own opinions on the basis of their analysis.

In order to help the students develop these skills, the learning materials accompanying this program must include a wide range of activities, such as the reading of articles, research, discussion and observation. These activities should be adapted to the practical realities of the current events and the students' everyday life.

Finally, this program introduces students to the scientific method; they will formally develop their familiarity with the scientific method in Secondary V. In Secondary V programs, a systematic effort is made to develop skills for laboratory work and to develop the ability to use experimental procedure.

1.6 Learning Focuses and Integrating Themes

The *Physical Science* program has three integrating themes, which correspond to the three courses in the program: *Nuclear Energy: Energy in Matter, Electricity: What's the connection*? and *Ionic Phenomena: A Study of an Environnemental Problem*. These themes serve to integrate into the adult education program the physics and chemistry content of the Physical Sciences programs 416 and 436 used in the youth sector. In fact, the parallel between the titles of the courses that make up the adult program and the titles of the modules in the youth sector program is obvious: *Properties and Structure of Matter*, *Electrical Phenomena* and *Ionic Phenomena*.

The use of integrating themes also makes it possible to enrich the program with relevant content from domains such as the social sciences, the history of the sciences and technology.

2. Structure of the Program and of the Learning Content

2.1 Relationship among the Courses

The *Physical Science* program contains three courses, each similar in structure and outlook. The courses are complementary, but are not arranged in a hierarchy: any one of them may be taken first, second or third. Independent courses such as these allow for easier course and class organisation.

2.2 Course 1: Nuclear Energy: Energy in Matter

The course on nuclear energy deals with the major scientific principles associated with the fundamental relationship between matter and energy. It focuses on the atomic structure and the classification of elements. Students learn about the evolution of knowledge that enabled human beings to channel nuclear energy. The course also familiarizes students with the various applications of nuclear energy in the energy, medical and military fields. In the social sphere, the course raises the issue of the use of nuclear energy, notably to produce electricity.

2.3 Course 2: Electricity: What's the connection?

The course on electricity presents the principles underlying electrical phenomena. It treats the concepts of static electricity, dynamic electricity, magnetism and electromagnetism. It covers electric circuits and the steps involved in the production and use of electricity. In the social sphere, it aims to make students think about the consequences of the use of electricity as well as the implications of the choice of a particular method of producing it. It enables the students to evaluate issues brought about by political choices made to satisfy the growing demand for electricity.

2.4 Course 3: Ionic Phenomena: A Study of an Environnemental Problem

The course on ionic phenomena focuses on the principal concepts and phenomena related to chemistry, which students must know about, for example, to understand the problem of acid rain or that of water pollution caused by fertilizers and pesticides. It presents the atomic model and the periodic table of the elements. It considers the chemical bonds leading to the formation of compounds such as acids, bases and salts. In the social sphere, it enables students to analyze the major factors behind acidification or pollution of bodies of water. After presenting a detailed case study, it calls on the students to assess the value of articles discussing problems arising from the use of chemicals.

2.5 Relationship among the Objectives

Each course is described in terms of general objectives, terminal objectives, intermediate objectives and related content.

The general objectives give an overall indication of the nature of the knowledge, the skills and attitudes to be acquired in a given course. They specify which of the program goals correspond to that particular course.

The terminal objectives present the knowledge, the skills and attitudes that the students should have acquired or developed by the end of the course. They are formulated to permit measurement and observation of the extent to which they have been attained.

The numbering of the general and terminal objectives is designed to facilitate their location, and is in no way intended to indicate sequence or relative importance.

The intermediate objectives and the related content provide an indication of the scope of the terminal objectives. They specify or elaborate on the content of the terminal objectives. The list is neither exhaustive nor prescriptive nor sequential. Theses objectives are not numbered.

3. Evaluation

The purpose of evaluation is in part to help students learn and in part to provide data necessary for the certification of studies. In general, information concerning the evaluation of learning and the certification of studies is located in other official documents such as the *Definition of the Domain for Summative Evaluation* and the *Administrative Manual for the Certification of Studies in General Education for Adults* rather than in the program.

Formative evaluation is part of the teaching and learning process. Its role is to support and guide decisions concerning the choice of learning situations, materials and teaching strategies. It is undertaken by teachers and is governed by policies established by school boards and other teaching establishments. The Ministère can, if need be, propose conceptual frameworks or examples of formative evaluation instruments.

For purposes of summative evaluation, the Ministère provides a definition of the domain for each of the courses in a program and, if necessary, official or supplementary examinations. On the basis of the summative evaluation, a decision is made as whether or not a student has attained the objectives of the course and can receive the certification for that course.

PROGRAM CONTENT FOR EACH COURSE

COURSE 1

NUCLEAR ENERGY: ENERGY IN MATTER

GENERAL OBJECTIVES

1. To know the characteristics of the simplified atomic model currently in use and the steps in its evolution.

2. To understand the principles underlying the construction and interpretation of the periodic table of the elements.

3. To know the principal characteristics of radioactive elements, the nature and characteristics of the rays they emit and the related units of measure.

4. To understand the nature and source of nuclear energy.

5. To know the different military and non-military uses of nuclear energy as well as the related technology.

6. To analyze the social, political, economic, technical and environmental issues raised by the use of radioactivity and nuclear energy.

7. To defend their stand on the use of nuclear energy, using appropriate arguments.

8. To situate, in a historical and social perspective, the evolution of knowledge and techniques related to the use of nuclear energy.

9. To realize that a basic knowledge of matter and energy is required to understand the current debate around the sources of energy and their exploitation.

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.1 Compare the current simplified atomic model with the atomic theories developed by the Ancient Greeks and by Dalton, Thomson, Rutherford and Bohr.	- State the atomic theory of the following Ancient Greek philosophers: Leucippus, Democritus, Aristotle and Empedocles. - State the basic principles behind Dalton's atomic theory. - Describe Thomson's atomic model. - Describe Rutherford's atomic model. - Describe Bohr's atomic model. - Describe the simplified atomic model currently in use.	- Atomism of the Greek philosophers (400 B.C.) - Dalton's atomic theory . Atomic mass . Atoms . Molecules - Thomson's atomic theory . Electrons and positive charges - Rutherford's atomic theory . Existence of an atomic nucleus - Bohr's atomic theory . Existence of orbits or energy levels - Simplified atomic model currently in use . Electrons and electronic configuration . Protons . Neutrons . Orbits or energy levels . Relative mass of atomic particles: nucleus, proton, neutron and electron . Mass number . Dimension of the atom and the nucleus
1.2 Put the different atomic theories in a historical and technical context.	- Identify the historic discovery or event that marked the passage from one atomic model to another.	- Historical events or discoveries . Deviation of the cathode ray by a magnetic field: existence of electrons . Rutherford's gold foil experiment: existence of the nucleus . Failure of the nucleus to break up due to repulsion between protons: existence of neutrons . Other

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.3 In the modern periodic table, locate the metals, the nonmetals, hydrogen and the actinides as well as the following chemical families: the alkali metals, the alkaline earth metals, the halogens and the noble gases.	- Define the expression "chemical family" or "group" as it pertains to the periodic table. - Define the term "period" as it pertains to the periodic table. - Determine the position of the metals and the nonmetals in the periodic table. - Give the characteristics and the position in the periodic table of the following elements: hydrogen, the alkali metals, the alkaline earth metals, the halogens, the noble gases, the transition metals and the actinides.	- Classification of the elements according to Mendeleev - Modern periodic table - Position of chemical families in the periodic table . Alkali metals . Alkaline earth metals . Halogens . Noble gases - Position of hydrogen - Position of the metals and the nonmetals - Position of the transitional metals and the actinides - Radioactive elements - Natural and synthetic (artificial) elements
1.4 Given the name of one of the first twenty elements, provide information about that element which can be found in or deduced from the modern periodic table.	- Match each of the first twenty elements in the periodic table with its chemical symbol. - State the relationship between the atomic number of an element and the number of protons and electrons in its atoms. - State the relationship between the atomic number of an element and its mass number. - Apply the relationship between the number of protons, neutrons and electrons in an atom and the atomic number and mass number of that element. - Sate the relationship between the group number and the number of electrons in the outermost energy level. - Sate the relationship between the period number and the number of energy levels.	- Chemical symbol - Atomic number - Mass number . Atomic mass unit - Link between the atomic number and the number of protons and electrons - Link between the atomic number and mass number and the number of neutrons - Link between the number of each chemical family and the number of electrons in the outermost energy level - Link between the period number and the number of energy levels

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.5 Compare the atomic structure of the isotopes of an element.	- Define the term "isotope". - State the number of protons, neutrons and electrons in the isotopes of an element.	- Isotope
1.6 Calculate the atomic mass of an element, given the relative abundance of its isotopes.	- Distinguish between the mass number and the atomic mass of an element. - Define the term "relative abundance".	- Relative abundance of isotopes
1.7 Classify examples of changes in matter as physical, chemical or nuclear changes.	- Give examples of changes in matter. - Identify the characteristics of a physical change. - Identify the characteristics of a chemical change. - Identify the characteristics of a nuclear change.	- Physical changes . Examples: tear in a sheet of paper, changes in phases, etc. . Characteristics - Chemical changes . Examples: acidification of milk or wine, rust, etc. . Characteristics - Nuclear changes . Examples: radioactivity of radium, fission of uranium, etc. . Characteristics
1.8 Distinguish among the following types of nuclear reactions: radioactivity, fission, fusion.	- Briefly describe radioactivity. - Distinguish between natural radioactivity and artificial radioactivity. - Briefly describe nuclear fission. - Briefly describe a chain reaction. - Briefly describe nuclear fusion.	- Natural radioactivity . Site of the reaction . Products of the reaction - Artificial radioactivity - Nuclear fission - Fission of uranium 235 - Fission of uranium 238 - Chain reaction - Nuclear fusion - Atomic structure of H (hydrogen), D (denterium) and T (tritium)

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.9 Compare the nature, speed, electric charge and penetrating power of alpha, beta and gamma radiation and of X-rays and describe how these different types of radiation affect matter.	- Distinguish between the electron configuration of a neutral atom and that of its corresponding ion. - Distinguish between a positive ion and negative ion. - Indicate the part of the atom where radioactive decay occurs. - Describe the different types of radiation emitted when radioactive elements decay. - Distinguish between X-rays and gamma rays. - Distinguish between wave radiation and particle radiation. - Discribe how alpha, beta, gamma and X-rays affect an atom. - Recognize the different types of ionizing radiation.	- Difference between neutral atom and ion - Radioactive elements - Properties and characteristics of alpha, beta and gamma radiation and X-rays - Ionization radiation . Diagram of an alpha particle - Electromagnetic wave radiation . Electromagnetic spectrum . Energy associated with different regions of the spectrum - Ionizing rays
1.10 Given the half-life of a radioactive element, calculate how much of a given sample of that element will remain after a certain period of time or the time required for a certain amount of that element to decay.	- Define the expression "half-life". - State the relationship between the half-life of a radioactive element and the amount of a given sample of that element which remains after a certain period of time.	- Half-life - Graph showing the mass remaining and the half-life of a radioactive element
1.11 For a given decay process, identify the radioactive element, the type of radiation emitted or the new element obtained.	- Give the atomic notation for the alpha or beta radiation emitted during a decay process. - Write the nuclear equation for the decay of a radioactive element that emits alpha or beta radiation. - Verify that the law of conservation of matter applies for a given alpha or beta decay process.	- Nuclear change - Structure of the atomic nucleus during a nuclear reaction - Atomic notation of the elements and of radiation - Radioactive family of uranium 238 - Law of the conservation of matter

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.12 Match each unit of measure for radiation with the phenomenon it measures.	- Define the following units of measure: the curie and the becquerel. - Define the following units of measure: the rad and the gray. - Define the following units of measure: the rem and the sievert.	- Units and sub-units of measure of radiation . Curie and becquerel: number of decays per second . Rad and gray: energy of one radiation beam . Rem and sievert: harmful potential of a radiation beam
1.13 State the relationships between the energy released during a nuclear reaction, the mass defect and the stability of the resulting isotope.	- Define "mass defect". - Explain how the stability of an atom relates to the number of neutrons in its nucleus. - Sate the relationship between the mass of a given quantity of matter and the energy it can release.	- Mass defect. - $E = mc^2$ - Mass defect liberated energy - Isotope stability and mass defect
1.14 Compare the atomic bomb and the hydrogen bomb in terms of their components, their power, the type of nuclear reaction involved and their destructive effects.	- Briefly describe the structure and operation of an atomic bomb (A-bomb). - State the nuclear reactions involved in detonating an atomic bomb (A-bomb). - Briefly describe the structure and operation of a hydrogen bomb (H-bomb). - State the nuclear reactions involved in detonating a hydrogen bomb (H-bomb).	- Nuclear fission - Controlled and uncontrolled chain reactions - Critical mass - Constituent elements of the atom bomb - Atomic structure of H, D and T - Nuclear fusion - Constituent elements of the hydrogen bomb - Military advantages of the H-bomb
1.15 Compare the operation of a hydroelectric power station, a conventional thermal power station and a nuclear power station.	- Describe how a power station works in general. - Briefly describe how a hydroelectric power station works. - Briefly describe how a conventional thermal power station works. - Briefly describe how a nuclear power station works.	- Operation of a hydroelectric power plant - Operation of a fossil fuel electric plant - Operation of a nuclear energy power plant - Points of comparison . Motive power . Components of the power plant . Other

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.16 Describe the operation of a CANDU nuclear reactor.	- Describe the function of the main components of a CANDU nuclear reactor.	- Nuclear fuel cluster - Role of cadmium - Role of heavy water - Role of the condenser - Operation of the CANDU reactor - Role of pressure tubes
1.17 Compare the technology used in CANDU nuclear reactors with the technology used in other countries (former USSR, England, United States).	- Identify the characteristics of Russian, English and American nuclear power stations. - Briefly describe what a Slowpoke reactor is.	- Nuclear technology of other countries (American, English and Russian) . Presence of a wall . Nature of the fuel used . Cooling medium - The Slowpoke
1.18 Describe the use of radioactive elements in medicine, food irradiation and carbon-14 dating.	- Determine the function of the radioactive isotopes used in medicine. - Identify the advantages of irradiating food and surgical instruments. - Distinguish between radioactivity and irradiation. - State the significance of the relationship between the amount of carbon-14 and the amount of carbon-12 found in a sample to be dated.	- Radio-isotopes used in the field of medicine . Role of radio-isotopes . Role of cobalt 60 . Role of iodine 131 . Role of gamma rays in radiotherapy - Radio-isotopes used in irradiation . Irradiation of foods . Sterilization of surgical instruments - Distinction between radioactivity and irradiation - Isotopes of carbon-12 and carbon-14
1.19 Compare the advantages, disadvantages and difficulties involved in using nuclear fission and nuclear fusion to produce electricity.	- List the advantages and disadvantages of using nuclear fission to produce electricity. - State the characteristics of plasma. - List the advantages and difficulties involved in using nuclear fusion to produce electricity.	- Plasma - Fission energy and fusion energy - Advantages of using fusion to produce electricity - Difficulties involved in using fusion to produce electricity - Tokamak reactor

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
1.20 Describe the risks, consequences and advantages of using nuclear energy.	- Compare the extent to which we are exposed to the main sources of natural and artificial radiation. - List the risks involved in mining, processing and using uranium ore. - Identify the risks associated with the normal or faulty operation of a nuclear power station and with the disposal of its waste. - Identify the risks associated with the military use of nuclear energy. - Describe how the use of nuclear technology affects public health, the environment and democracy. - Describe how nuclear technology benefits the economy and the environment, as well as scientific and technological research and development in Canada.	- Natural and artificial sources of radiation - Acceptable levels of radiation (present norm) - Concept of risk - Risks associated with the extraction, transformation and use of uranium ore - Risks associated with the operation of a nuclear power plant . Presence of radionuclides in the gas and liquid waste produced by nuclear power plants . Thermal pollution . Examples of incidents that have occurred in nuclear power plants (Three Mile Island, Tchernobyl, Tchebiabinsk) - Risks associated with waste management . Handling of used fuels . Methods used to deactivate a reactor - Risks associated with the military use of nuclear energy - Consequences . Paths by which radiation reaches humans and animals . Effects of ionizing radiation on human tissues . Impact of irradiation on health . Nuclear winter . Greenhouse effect . Maccarthyism . Freedom of information - Non-military advantages (irradiation of foods, medical uses, etc.) . Impact of nuclear energy on the Canadian economy . Impact of nuclear energy on scientific and technological research and development
1.21 Express one's point of view regarding a specific use of nuclear technology, ensuring that the reasoning used to support this opinion is based on facts.	- Distinguish between such things as facts, opinions, and value judgements, - In newspaper and magazine articles, identify facts, opinions and value judgements relating to the risks, consequences and advantages involved in using nuclear technology.	- Use of nuclear energy . Electricity production . Medical uses . Dating . Other

COURSE 2

ELECTRICITY: WHAT'S THE CONNECTION?

GENERAL OBJECTIVES

1. To know the basic characteristics of static and dynamic electricity, magnetism and electromagnetism.

2. To place, in historical and social context, the evolution of knowledge and techniques related to the use of electricity, magnetism and electromagnetism.

3. To understand the laws that govern the operation and use of electric circuits.

4. To understand the distribution of electricity in residential circuits and its domestic use.

5. To understand the operation of manufactured objects related to the use of energy or magnetism.

6. To become aware of the risks and dangers associated with electricity and the rules to follow in order to use it safely.

7. To become aware of the importance of the energy produced and consumed in our society.

8. To understand the current debate about issues related to the production and consumption of electrical energy in our society.

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.1 Explain the characteristics and role of the components of a simple electric circuit.	- Describe the components of a simple electric circuit. - Draw a diagram of an electric circuit. - Define the characteristics of an electric circuit. - Indicate the role of the components of a simple electric circuit. - Indicate the influence of resistance and the electromotive force of a cell on current intensity. - Associate the characteristics and role of the components of an electric circuit with the characteristics and roles of the components of a hydraulic circuit.	- Components of a simple electric circuit . Source (cell) . Wiring . Resistor (lamp, heating element, etc.) . Switch - Symbols of the components on the diagram of an electric circuit - Characteristics of an electric circuit . Current intensity (*I*) . Electromotive force (*E*), potential difference or pressure or voltage (*V*) . Resistance of a conductor (*R*) - Components of a simple hydraulic circuit . Pump . Pipes . Filter - Characteristics of a hydraulic circuit . Flow of water . Force of the pump . Characteristics of the filter

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.2 Compare the characteristics of different kinds of cells, batteries and power supplies and the ways in which they are used.	- Describe how a cell works. - Describe the characteristics of different types of cells. - Define the terms "voltage" and "electromotive force" (emf). - Compare the energy capacity of different types of cells. - Distinguish between cells, batteries and power supply (or power pack). - Indicate the advantages and disadvantages of cells, batteries and power supply for simple use.	- Components of a cell . Anode . Cathode . Electrolyte - Symbols and units of measure . Potential difference in volts (V) . Emf (*E*) in volts (V) - Rechargeable cells - Batteries - Power pack - Cells - Alkaline cells - High performance cells - Advantages or disadvantages . Durability . Price . Environmental costs . Energy output . Maintenance
2.3 Distinguish between the ammeter, the voltmeter and the ohmmeter in terms of their use and the way they are connected.	- Indicate how an ammeter, a voltmeter and an ohmmeter are used. - Indicate how an ammeter, a voltmeter and an ohmmeter are connected. - On the diagram of an electric circuit, show where the ammeter, the voltmeter and the ohmmeter are connected. - Measure the parameters of an electric circuit using an ammeter, a voltmeter and an ohmmeter.	- Ammeter . Use . Symbol . How it is connected - Voltmeter . Use . Symbol . How it is connected - Ohmmeter . Use . Symbol . How it is connected

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.4 Use the definition of current to explain simple concrete situations.	- Associate electric current with the displacement of electrons in a conductor. - Associate current intensity with the flow of electrons in a conductor. - Determine the conventional direction of current in a simple circuit. - Correctly use the units of measure of current (ampere) and charge (ampere-hour and Coulomb). - Apply the formula $I = Q/t$ in simple concrete cases.	- Structure of the atom - Characteristics of the electron . Charge . Symbol - Direction of current . Conventional . Electronic - Electric charge (Q) . Elementary charge (e) . Units of electric charge . Coulomb (C) $1\ C = 6.25 \times 10^{18}\ e$. Ampere-hour (Ah) $1\ Ah = 3\ 600\ C$ - Current (I) . Definition: $I = Q/t$. Unit of measure: ampere (A) - Examples of concrete situations . Charge and discharge of cells and power supplies . Duration of use of battery-run electric appliances . Other
2.5 Explain how conductive, semi-conductive and insulating materials are used.	- Describe the electric properties of conductors, insulators and semi-conductors. - Describe the movement of electrons in a conductor, an insulator and a semi-conductor. - Give examples of insulating, conductive and semi-conductive materials and of their uses.	- Conductors . Properties . Examples - Insulators . Properties . Examples - Semi-conductors . Properties . Examples - Internal structure of a conductor - Internal structure of an insulator - Internal structure of a semi-conductor

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.6 Use Ohm's law to determine how the variation in one or two parameters will affect a simple electric circuit.	- Define resistance. - Determine resistance using a graph of V as a function of I. - State Ohm's law. - Apply Ohm's law in simple concrete cases.	- Resistance (R) . Definition: $R = \frac{\text{voltage}}{\text{current}}$. Unit of measure: ohm (Ω) - Graph of V in relation to I - Ohm's law ($V = RI$)
2.7 Use the formula $R = \rho L/A$ to determine how the variation in one or two parameters will effect the resistance of a conducting wire.	- Determine the relationship between the length of a wire and its resistance. - Determine the relationship between the cross section of a wire and its resistance. - Define resistivity as the electric characteristic of a material. - State the relationship between the characteristics of a conductor and its resistance. - Associate R, L, A and ρ with their respective units of measure. - Interpret the colour code of resistors. - Associate different uses with the gauge of wires.	- Factors influencing the resistance of a conducting wire . Length of the wire (L) . Cross section of the wire (A) . Resistivity (ρ) . Temperature - Proportionality between R, ρ, L and A - Units of measure of ρ, L, A and R - $R = \frac{\rho L}{A}$ - Colour code of resistors - Size of conductors . Wire gauge (American Wire Gage) . Use

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.8 Determine the value of one or more variables in a series circuit, including total current, current in the resistor, equivalent resistance, resistance of a resistor, electromotive force and voltage across the terminals of resistors.	- Determine by experimentation the relationship between equivalent resistance and the resistance of the resistors in a series circuit. - Describe the relationship between total current and the current intensity of a resistor in a series circuit. - Describe the relationship between the electromotive force and the voltage across the terminals of the resistors in a series circuit. - Calculate the equivalent resistance of a series circuit. - Draw the equivalent circuit of a series circuit. - Determine the voltage across the terminals of each resistor in a series circuit. - Determine the current intensity of each resistor in a series circuit.	- Series circuit - Resistors in series - Equivalent circuit - Equivalent resistance . $R_{eq} = R_1 + R_2 + R_3 \ldots$ - Current in a series circuit - Voltage in a series circuit

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.9 Determine the value of one or more variables in a parallel circuit, including total current intensity, current intensity in the resistor, equivalent resistance, the resistance of a resistor, electromotive force and voltage across the terminals of the resistors.	- Determine the relationship between the equivalent resistance and the resistance of the resistors in a parallel circuit. - Demonstrate mathematically the relationship between equivalent resistance and the individual resistances in a parallel circuit. - Describe the relationship between total current intensity and the current intensity of a resistor in a parallel circuit. - Describe the relationship between the electromotive force and the voltage across the terminals of the resistors in a parallel circuit. - Calculate the equivalent resistance in a parallel circuit. - Draw the equivalent circuit of a parallel circuit. - Determine the voltage across the terminals of each resistor in a parallel circuit. - Determine the current intensity in each resistor in a parallel circuit.	- Resistors in parallel - Equivalent resistance . $1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$ - Current intensity in a parallel circuit - Voltage in a parallel circuit
2.10 Explain the distribution of voltages and current intensities in a series-parallel circuit.	- Distinguish, in a series-parallel circuit, between resistors connected in series and those connected in parallel.	- Definition of a series-parallel circuit - Decomposition of a series-parallel circuit

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.11 Explain why some components of an electric circuit are connected in series and others are connected in parallel.	- Give examples of the use of series connections. - Indicate the advantages of a series connection. - Give examples of the use of parallel connections. - Indicate the advantages of a parallel conection.	- Series connections . Fuses and circuit breakers . Switches . Cells . Ammeter . Control of current . Advantages - Parallel connections . Independant components (automobile headlights, outlets in residential circuits, etc.) . Cells . Voltmeter . Advantages
2.12 Solve problems concerning the power and energy consumption of various electric appliances.	- Define power as energy produced or consumed per unit of time. - Calculate the power provided by a source. - Apply the principle of the conservation of energy to an electric circuit. - Calculate the power dissipated by one or more elements in a circuit or by one or more electric appliances. - Calculate the energy consumed by one or more elements in a circuit or by one or more electric appliances. - Correctly use the units of power and of energy, the watt and its multiples, the joule and the kilowatt-hour.	- Definition of power $P = \frac{E}{t}$ - Unit of power (watt, W) - Definition of energy (E) - Units of energy (joule, J, and kilowatt-hour, kWh) - Transformation of kilowatt-hours into joules - Transformation of joules into kilowatt-hours - Output ($P = EI$) - Power consumed ($P = VI$) - Rating plate on electric appliances - Power of common electric appliances

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.13 Explain the Joule effect by referring to concrete situations, in which the aim is to utilise the effect or to minimize it.	- State the principle of the conservation of energy and of power. - Define the Joule effect. - Calculate the power produced by the Joule effect in a resistor. - Calculate the percentage of power lost through the Joule effect in the transportation of electricity. - Define yield. - Give examples of the utilisation of the Joule effect. - Give examples of situations requiring minimization of the Joule effect.	- Principle of the conservation of energy and power . $E_{supplied} = E_{consumed}$. $P_{supplied} = P_{dissipated}$ - Definition of the Joule effect - Joule effect ($P = RI^2$) - Joule effect and high-voltage lines - Joule effect and heating elements - Joule effect and operation of fuses - Yield
2.14 Distinguish between alternating and direct current on the basis of their characteristics, sources and uses.	- Describe the characteristics of direct current. - Describe the characteristics of alternating current. - Calculate the average power produced or generated by an alternating current circuit. - Distinguish between effective current and full-load amperes. - Distinguish between effective (or rms) voltage and peak voltage. - List the sources of alternating current and of direct current. - Give examples of the uses of alternating current and of direct current.	- Direct current . Definition . Graph of V in relation to t . Graph of I in relation to t - Use of direct current . Sources . Examples of appliances - Alternating current . Definition . Graph of V in relation to t . Graph of I in relation to t . Different forms . Definition and unit of frequency . Effective (or rms) current ($I_{rms} = 0.707\ I_0$) . Effective (or rms) voltage ($V_{rms} = 0.707\ V_0$) . Average power: $P_0 = V_{rms}\ I_{rms}$ - Use of alternating current . Sources . Examples of appliances

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.15 Explain the use of certain wiring and distribution methods in residential electric circuits.	- Describe the service lines from the transformer to the distribution board in a house. - Describe the service lines from the distribution board to the outlets. - Describe the service lines from the outlets of a universal shunt. - Describe the service lines from the outlet of a branch circuit. - Distinguish between the usual rating of fuses for 120 V circuits and the rating of fuses for 240 V circuits. - Describe how a double plug outlet works. - Describe the characteristics of an outlet located in a bathroom. - Describe the uses of grounding as a safety measure. - Plan the installation of a simple residential electric circuit.	- Overview of the electric installation of a house . Service lines to the network . Distribution within the house - Service lines to the network . Peak current: 60 A, 100 A and 200 A entrances . Composition of service lines: live wires (black and red), neutral wire (white) . Ufer . Meter . Distribution board . Ground connections - Distribution within the house . Distribution board . Bus work . Circuit breakers . Branch circuits . Universal shunts and branch circuits . Service lines for 120 V outlets . Outlets . Different types . Different service lines . Service lines for 240 V outlets . Simple diagram of a residential 60 A circuit

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.16 Describe the characteristics of transformers and their role in the transportation and use of electricity.	- Distinguish between the role of the transformer and the role of the rectifier and inverter. - Define the terms "primary" and "secondary" as applied to transformers. - Compare power at the primary and secondary coils in a transformer. - Associate the role of voltage reducer or booster of a transformer with the relationship between the number of turns in the secondary and primary coils. - Give examples of how voltage reducers (step-down transformers) and boosters (step-up transformers) are used. - Solve problems using the equations $\frac{V_1}{V_2} = \frac{I_2}{I_1} = \frac{N_1}{N_2}$	- Inverter - Rectifier - Primary coil - Secondary coil - Conservation of power $V_1 I_1 = V_2 I_2$ - Voltage reducer (step-down) transformer - Booster (step-up) transformer - $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$ - Examples of how transformers are used
2.17 Explain the risks and dangers associated with the use of electricity.	- Define the terms "electric shock" and "electrocution". - Explain the security role of certain parts of an electric appliance. - Identify situations associated with electricity use that represent a risk or danger.	- Electric shocks - Electrocution - High-voltage lines - Danger posed by contact of water with electricity - Ground connection - Fuses and circuit breakers

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.18 Illustrate the relationship between science, technology and society using examples from the history of electricity, magnetism or electromagnetism.	- Identify and place in their historical context the principal steps leading to the present state of knowledge about electricity. - Identify and place in their historical context the principal steps leading to the present state of knowledge about magnetism. - Identify and place in their historical context the principal steps leading to the present state of knowledge about electromagnetism.	- Electrostatics . Property of yellow amber (Thalès) . Electrifiable materials (Gilbert, Du Fay) . Electric machines (von Guericke) . Leyden jar (Van Musschenbroek) . Electric forces . Lightning = electricity (Franklin) . Unit of electric charge (Coulomb) - Dynamic electricity . First cell (Galvani, Volta) . Electrolysis - Magnetism . Magnetite and iron . Compass (China) - Electromagnetism . Discovery (Oersted and Ampère) . Induction (Faraday) . Theory (Maxwell) . Technical applications . Telephone (Bell) . Electric power plants . Phonograph (Edison) . Radio (Hertz and Marconi) . Other

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.19 Explain examples of the electrification of matter by rubbing, by contact or by induction.	- State the law of the conservation of electric charge, which applies whenever two electrically charged objects enter into contact. - Describe the phenomenon of electrification by the contact of a neutral object with an electrically charged object. - Describe the phenomenon of electrification by rubbing together two insulators. - Describe the phenomenon of electrification by rubbing or contact with a conductor. - Describe the effect of a ground connection on an electrically charged conductor. - Describe the phenomenon of electrification by induction. - Describe examples of electric discharge.	- Charge and matter . two types of behaviour: attraction and repulsion . two types of charges: positive and negative . three states of matter: positive, negative, neutral - Law of the conservation of electric charge . Total constant charge . Transfer of charges from one body to another (electrification) - Electrification . By rubbing . By contact . By induction . Comparison between insulators and conductors
2.20 Use Coulomb's law to determine how the variation in one parameter will affect electric force.	- State Coulomb's law. - Predict the variation in electric force resulting from a change in the value of one charge. - Predict the variation in electric force resulting from a change in the distance between the two charges.	- Coulomb's law $F = k \frac{Q_1 Q_2}{d^2}$ - Interpretation of Coulomb's law - Proportionality between force and charges - Variation of force: the inverse of the square of the distance

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.21 Illustrate the magnetic field lines between two poles of a magnet or electromagnet.	- Draw the magnetic field lines around a magnet or between the identical or different poles of two magnets. - Recognize the poles of a magnet on the basis of the direction of the magnetic field lines. - Draw the magnetic field lines around an electromagnet or between the identical or different poles of two electromagnets.	- Properties of magnets . North and South poles . Compass . Indissociability of the poles . Magnetic domains - Magnetic force . Attraction between different poles . Repulsion between identical poles - Earth's magnetism - Electromagnet . Circular loop . Solenoid . Left-hand rule - Magnetic field lines . Bar magnet . Horseshoe magnet . Earth . Electromagnets
2.22 Describe some applications of electromagnetism and state the operating principle of a motor and a generator.	- Describe electromagnetic induction. - Briefly describe some uses of electromagnetic induction. - Briefly explain how an electric motor works. - Briefly explain how a generator works. - Describe the energy conversions involved in the operation of a motor and a generator.	- Applications of electromagnetism . Images produced by magnetic resonance . Information storage (magnetic tapes) . Loud speakers . Electric motors . Generators . Transformers - Magnetic field and current . Effect of a magnetic field on a conductor when a current flows through it . Electromagnetic lifts - Electromagnetic induction . Production of an induced electromotive force - Motors and generators . Operation . Energy conversion . Comparison between a motor and a generator - Operation of transformers

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.23 Describe different uses of static electricity and the dangers associated with it.	- List different uses of static electricity. - Explain why static electricity may be dangerous in certain situations.	- Uses . Plastic film . Electrostatic spray gun paint . Insecticide . Electrostatic precipitators . Xerography - Safety measures . Means of transportation (trucks, airplanes, tank cars, etc.) . Construction of certain buildings (refineries, operating rooms, flour silos, computer centres) . Use of belts
2.24 Explain how each type of electric power plant transforms one source of energy into another.	- Describe how an electric power plant operates in general. - Briefly describe how a hydroelectric power plant operates. - Briefly describe how a fossil fuel electric plant operates. - Briefly describe how a nuclear power plant operates. - Briefly describe how a diesel power plant operates. - Briefly describe how a wind turbine operates.	- Operation of an electric power plant - Types of electric power plant - Hydroelectric power plant - Thermal power plant . Fossil fuel . Nuclear . Gas turbine - Diesel power plant - Wind turbine - Energy conversion in each type of electric power plant

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
2.25 Describe the advantages and disadvantages of locating, building and using different types of electric power plants and the problems associated with the transportation of electricity.	- Describe the advantages and disadvantages associated with the construction of each type of electric power plant. - Describe the advantages and disadvantages associated with the use of each type of electric power plant. - Describe the problems associated with the transportation of electricity.	- Advantages and disadvantages of different types of electric power plants in terms of the environment, the economy and society . Job creation . Pollution (mercury, noise, emissions, etc.) . Costs . Transportation . Other - Problems associated with the transportation of electricity . Cost . Loss of energy through the Joule effect . Effect of electromagnetic fields on health
2.26 By analyzing a specific case, illustrate how complex it is to choose a mode of electricity production.		- Grande-Baleine Project - Sainte-Marguerite Project - Ashuapmushuan River Dam - Other

COURSE 3

IONIC PHENOMENA: A STUDY OF AN ENVIRONNEMENTAL PROBLEM

GENERAL OBJECTIVES

1. To know the characteristics of the current simplified atomic model.

2. To grasp the importance of the periodic table for an understanding of the electron configuration of the elements, chemical combinations and stoichiometric calculations.

3. To know both the new and the traditional nomenclature of the chemical components.

4. To know the characteristics of the acids, bases and salts.

5. To solve problems related to concentration, dilution and stoichiometry.

6. To place, in a historical and social perspective, the evolution of knowledge and techniques related to the use of chemicals.

7. To know a method for analyzing problems and to apply this method in solving problems related to the use of chemicals.

8. To understand the sources and effects of problems related to the use chemicals and to analyze potential solutions to these problems.

9. To realize that a basic knowledge of chemistry is required to understand some debates on environmental issues.

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.1 Describe the current simplified atomic model.	- Define a scientific model. - Give the characteristics of the current simplified atomic model. - Draw a diagram of the atoms of the twenty lightest elements.	- Concept of model in the sciences - Characteristics of the current simplified atomic model . Small size of the atom . Elementary particles: protons, neutrons and electrons . Mass and charge of the elementary particles . Existence of the nucleus . Organization of the elementary particles within the atom . Mass number . Electron distribution in the energy levels of the first twenty elements in the periodic table . Relationship between the mass of the nucleus and that of the atom . Relationship between the dimensions of the nucleus and those of the atom
3.2 Using the electron configuration of at least two elements, explain the relationship between the number of electrons in the outermost energy level and the element's chemical group number, and also the relationship between the number of energy levels and the element's period number.	- Define the expression "chemical family" or "group" as it pertains to the periodic table. - Define the term "period" in the periodic table. - Give the electron configuration of the first twenty elements in the periodic table, using a short hand notation. - State the relationship between the group number and the number of electrons in the outermost energy level. - State the relationship between the period number and the number of energy levels.	- Mendeleev's classification of the elements - Modern periodic table . Chemical family . Period

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.3 Describe the metals, the nonmetals and the elements of the following chemical families: the alkali metals, alkaline earth metals, halogens and noble gases.	- Indicate where the following elements are located in the periodic table: hydrogen, the metals, the nonmetals and the chemical families (alkali metals, alkaline earth metals, halogens and noble gases). - Indicate the properties and uses of the metals and nonmetals. - Indicate the properties and uses of the alkali metals, alkaline earth metals, halogens and noble gases. - Distinguish between hydrogen and the alkali metals.	- Position of chemical families in the periodic table . Alkali metals . Alkaline earth metals . Halogens . Noble gases - Position of the metals and nonmetals in the periodic table - Special case of hydrogen - Properties . Metals and nonmetals . Hydrogen . Alkali metals . Alkaline earth metals . Halogens . Noble gases
3.4 Using the octet rule, explain the type of chemical bond between two particular elements.	- Indicate the characteristics of the electron configuration of the noble gases (helium, neon and argon). - State the octet rule. - Determine the ionization levels of the first twenty elements in the periodic table. - Distinguish between ionic bonds, covalent polar bonds and covalent non-polar bonds. - Define the term "electronegativity". - Indicate the electronegativity associated with ionic, covalent polar and covalent non-polar bonds. - Using the electronegativity table, determine the type of bond (ionic, covalent polar or covalent non-polar) between two given elements.	- Electron configuration and chemical stability of the noble gases - Octet rule - Ionization - Element - Compound - Electronegativity table - Criteria associated with an ionic bond - Criteria associated with a covalent non-polar bond - Criteria associated with a covalent polar bond - Determination of the type of bond

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.5 Distinguish between neutral atoms, ions and isotopes as regards the number of protons, neutrons and electrons they have.	- Determine the number of protons, neutrons and electrons of an element whose atomic number and atomic mass are known. - Determine the charge of an ion whose atomic number or chemical family is known. - Compare the electron configuration of an ion with that of the corresponding neutral atom. - Describe the isotopes of a given element. - Distinguish between atomic mass and mass number.	- Atomic number - Chemical symbol - Relationship between atomic number and number of protons and electrons - Relationship between atomic number, mass number and number of neutrons - Relation between the number of the family and the number of electrons in an atom's outermost energy level - Octet rule - Electron configuration of an ion - Anion - Cation - Distinction between an atom and an ion - Mass number . Atomic mass unit - Isotope - Atomic mass
3.6 Explain the formation of binary compounds using a Lewis diagram and, if appropriate, structural formula representation.	- Identify anions and cations. - Determine the charge of each ion. - Represent the ions using a Lewis diagram. - Represent the compound formed by ionic or covalent bonds, using a Lewis diagram. - Represent the compound formed by ionic or covalent bonds, using structural formula representation. - Draw a diagram representing the chemical reaction between an element from group I or II and an element from group VI or VII, using the current simplified atomic model. - Distinguish between an element and a compound.	- Valence electron - Ion - Lewis diagram - Unpaired electrons - Structural formula representation

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.7 Determine the molecular formula of a binary compound.	- Identify anions and cations. - Determine the charge of the anion and cation on the basis of the octet rule or the chemical family. - Determine the number of anions and cations necessary for the formation of a binary compound.	- Octet rule - Charge of an ion - Neutrality of a molecule - Sign - Cross-over rule - Molecular formula
3.8 According to the new nomenclature, give the name of a binary compound whose chemical formula is known or the chemical formula of a binary compound whose name is known.	- Know the principal suffixes used to designate binary compounds in the new nomenclature. - Know the significance of the prefixes used to designate the number of a type of atom. - Know the method for naming a binary compound according to the new nomenclature. - Know how to write the formula of a binary compound according to the new nomenclature.	- Traditional nomenclature - New nomenclature - Naming a binary compound according to the new nomenclature - Suffix "-ide" . Oxide . Hydride . Carbide . Nitride . Sulphide - Rule for writing a binary compound
3.9 According to the traditional nomenclature, give the name of a polyatomic compound whose chemical formula is known or the chemical formula of a polyatomic compound whose name is known.	- Know the principal suffixes used to designate polyatomic compounds in the traditional nomenclature. - Know the significance of the prefixes used to designate the number of a type of atom or polyatomic ions. - Know the method for naming a polyatomic compound according to the traditional nomenclature. - Know how to write the formula of a polyatomic compound according to the traditional nomenclature.	- Traditional nomenclature - New nomenclature - The most commonly used suffixes for polyatomic compounds - Naming a polyatomic compound according to the new nomenclature and the traditional nomenclature - Polyatomic ions - Rule for writing a polyatomic compound

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.10 Using characteristics and equations for dissociation, explain why a substance is an acid, a base or a salt.	- Distinguish among the characteristics of acids, bases and salts. - Describe Arrenhuis' ionization theory concerning acids and bases. - Distinguish among equations for the dissociation of acids, bases and salts.	- Acids according to Lavoisier, Leibig and Arrhenius - Arrhenius' definition of an acid - Arrhenius' definition of a base - Definition of a salt - Equation for the dissociation of an acid - Equation for the dissociation of a base - Equation for the dissociation of a salt
3.11 On the basis of experimental results, classify a substance as a non-electrolyte, a strong electrolyte, a weak electrolyte, a strong acid, a weak acid, a strong base, a weak base or a salt.	- By conducting an experiment, distinguish between a molecular dissolution and an ionic dissolution. - By conducting an experiment, distinguish between an electrolyte and a non-electrolyte. - By conducting an experiment, distinguish between a strong electrolyte and a weak electrolyte. - By conducting an experiment, distinguish between a strong acid and a weak acid. - By conducting an experiment, distinguish between a strong base and a weak base.	- Litmus paper - Electrical conductivity - Molecular dissolution - Ionic dissolution - Strong electrolyte - Weak electrolyte - Non-electrolyte - Strong acid - Weak acid - Strong base - Weak base
3.12 In molecular terms, explain the dissolution in an aqueous solution of the following substances: non-electrolytes, strong electrolytes, weak electrolytes, strong acids, weak acids, strong bases, weak bases and salts.	- Distinguish between molecular dissolution and ionic dissolution. - Distinguish between electrolytes and non-electrolytes. - Distinguish between strong electrolytes and weak electrolytes. - Distinguish between strong acids and weak acids. - Distinguish between strong bases and weak bases.	- Molecular dissolution - Ionic dissolution - Strong electrolyte - Weak electrolyte - Non-electrolyte - Strong acid - Weak acid - Strong base - Weak base

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.13 Classify a substance according to whether it is a mixture or a pure substance and, if a mixture, whether it is homogenous, heterogenous or a suspension and, if a pure substance, whether it is an element or a compound.	- Indicate the two categories into which matter is classified. - Describe the three categories of mixtures. - Indicate the two categories of pure substances. - Distinguish between solvent and solute. - Distinguish between homogeneous mixture and heterogeneous mixture.	- Classification of matter - Mixture - Pure substance - Homogeneous mixture - Heterogeneous mixture - Solution - Solvent - Solute - Aqueous solution - Element - Compound - Suspension - Mechanical mixture
3.14 Compare solutions whose concentrations are expressed in different units.	- Give the definition and the equation for a concentration. - Given a mass in kilograms, express it in grams. - Given a volume in millilitres, express it in litres. - Solve problems about the concentration of solutions expressed in terms of mass of solute per volume of solution. - Define the term "mole". - Calculate the molar mass of a compound on the basis of the atomic mass of its constituent elements. - Given a quantity of matter expressed in grams, convert it into moles and vice-versa. - Solve problems about the concentration of solutions expressed in moles per litre.	- Concentration: the quantity of solute per volume of solution - $c = m/V$ - Transformation of kilograms into grams - Transformation of millilitres into litres - Concentration in grams per litre - Avogadro's number - Mole - Molar mass - Transformation of grams into moles - Transformation of moles into grams - Concentration in moles per litre or molarity

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.15 Solve problems about dilution.	- Given a volume of solution in millilitres express it in litres. - Define the term "dilution". - State the mathematical relationship between the characteristics (volume and concentration) of the stock solution and those of the diluted solution.	- Dilution - $V_1 c_1 = V_2 c_2$
3.16 Rank solutions whose acidity is expressed in different units.	- Define the term "pH". - Given the pH of a solution, determine whether it is acidic or basic. - Express in pH a concentration of H^+ given in moles per litre (mol/L) and vice versa.	- Definition of pH - pH scale - pH of an acid solution - pH of a neutral solution - pH of a basic solution - pH of pure water
3.17 Determine the pH range of a solution on the basis of data or results obtained from acid-base indicators whose turning point are known.	- Define the term "turning point". - Indicate the turning point of the acid-base indicators. - By conducting an experiment determine the turning point of acid-base indicators.	- Acid-base indicator - Universal indicator - Turning point
3.18 Express various chemical reactions as balanced equations.	- Distinguish between the reactants and the products in a chemical reaction. - Write the equation for a chemical reaction on the basis of a descriptive statement. - Balance chemical equations. - Verify the law of the conservation of matter on the basis of a balanced equation.	- Chemical reaction - Reactant - Product - Chemical equation - Balancing an equation - Law of the conservation of matter . Conservation of the number of atoms . Conservation of mass

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.19 Using stoichiometric calculations, determine the quantity of the substances involved in a chemical reaction.	- Balance the reaction equation. - Express in moles the proportions of the reactants and the products. - Express in grams the proportions of the reactants and the products.	- Balanced equation - Coefficient - Calculation of molar mass - Conversion of moles into grams - Conversion of grams into moles
3.20 Using equations, explain how neutralization can offer a solution to an acid-base imbalance.	- Write the equations used for the dissociation constant of acids and bases. - Define the term "neutralization". - Write the balanced equation for the neutralization of a simple acid by a simple base. - Recognize the equations for neutralization.	- Neutralization - Neutralization equation
3.21 Describe a problem related to the use of chemicals.	- Describe the historical evolution of the problem. - Identify the chemicals that cause the problem. - Explain the scientific and technical factors involved.	- Causes of the problem - Sources of the causes . Natural sources . Industrial sources - Chemical reactions - Technical objects involved
3.22 Make a complete list of the consequences of a problem related to the use of chemicals.	- Indicate the environmental effects of the problem. - Indicate the social, political and economic consequences of the problem.	- Effects on terrestrial ecosystems - Effects on aquatic ecosystems - Effects on human health - Effects on materials - Effects on the economy

TERMINAL OBJECTIVES	INTERMEDIATE OBJECTIVES	RELATED CONTENT
3.23 Analyse potential solutions to a problem related to the use of chemicals.	- List the potential solutions. - Indicate the feasibility and limitations of each of the solutions proposed. - Assess the scientific, technical, social, political and economic value of the solutions proposed.	- Scientific and technical solutions - Political solutions - Personal solutions
3.24 Evaluate articles about problems related to the use of chemicals by focussing on the description of the problem, its consequences and the proposed solutions.		

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