PHYSICAL SCIENCE
secondary IV

Ionic Phenomena :
A Study of an Environmental Problem

PSC-4012-2

DEFINITION OF THE DOMAIN FOR SUMMATIVE EVALUATION

NOVEMBER 1998

Québec

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Direction de la formation générale des adultes
Service de l'évaluation des apprentissages

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1. Introduction

This definition of the domain for summative evaluation describes and classifies the essential and representative elements of the *Physical Sciences* program—specifically, for the course PSC–4012–2: Ionic Phenomena: A Study of an Environmental Problem. It presents an overview of the program, but should by no means replace the program itself. The purpose of defining the domain is to ensure that all summative evaluation instruments are consistent with the overall program.

The organization of this definition of the domain is the same as that of those of other courses. The content of each section is, however, specific to this course.

The goal of the definition of the domain for summative evaluation is to permit the preparation of examinations that are valid from one version to another, from year to year and from one school board to another, taking into account the responsibilities shared by the ministère de l'Éducation and the school boards.

2. Program Orientations and Consequences for Summative Evaluation

Orientations	Consequences
One aim of the program is to help students acquire scientific knowledge, especially in chemistry.	The evaluation should verify the students' acquisition of scientific knowledge in chemistry.
The program also aims to help students become citizens with an understanding of science and technology.	The evaluation should verify the students' understanding of the social, economic and political issues related to scientific and technological development.
It is designed to help students acquire an understanding of chemical phenomena rather than have them merely apply formulas.	The evaluation should verify the students' ability to understand chemical phenomena and analyze results.
It is also designed to acquaint students with the historical evolution of scientific and technological knowledge.	The evaluation should verify the students' knowledge of the events that led to the modification of certain scientific theories.
The program is intended to help students acquire technological knowledge related to scientific discovery.	The evaluation should verify the students' acquisition of certain technological knowledge.
In the program, the students are asked to analyze the social consequences of certain scientific discoveries and technological changes.	The evaluation should verify the students' understanding of the social consequences of certain scientific discoveries and technological changes.
They are also asked to analyze the relationships between science, technology and society.	The students will be asked to analyze one or more social, economic or political issues related to scientific and technological development.

3. Content of the Program for Purposes of Summative Evaluation

Themes

- **Basic concepts**

  – Simplified atomic model currently in use
    - Concept of model
    - Characteristics of the simplified model currently in use
    - Chemical symbols

  – Periodic table
    - Relationship between chemical family, period and electron distribution
    - Characteristics of metals, non-metals, hydrogen and chemical families (alkali metals, alkaline earth metals, halogens and noble gases)

  – Atoms, ions and isotopes
    - Distinction between atom, ion and isotope
    - Determination of the charge of ions (anions and cations)
    - Number of protons, neutrons and electrons

  – Nomenclature of binary and polyatomic compounds
    - Rules for naming binary compounds (new nomenclature)
    - Rules for naming polyatomic compounds (traditional nomenclature)

  – Distinction between acids, bases and salts
    - Formulas and equations for dissociation
    - Definition of pH and pH scale
    - Characteristics

  – Classification of matter
    - Distinction between pure substance and mixture
    - Distinction between the different types of mixtures (homogeneous mixture, heterogeneous mixture, suspension)
    - Distinction between element and compound

  – Concentration and dilution of solutions
    - Definition of concentration
    - Units of concentration (g/L, mol/L, M)
    - Mole and Avogadro's number
    - Equation for a dilution ($V_1C_1 = V_2C_2$)

- **Matter in action**

  – Chemical bonds
    - Criteria associated with different types of chemical bonds (ionic, polar covalent and non-polar covalent)
    - Determination of the type of chemical bond: octet rule and electronegativity table
    - Representation of chemical bonds: Lewis diagram and structural formula

  – Formation of binary compounds
    - Neutrality of a molecule
    - Molecular formula
    - Representation of binary compound molecules: Lewis diagram and structural formula

  – Behaviour of acids, bases and salts in an aqueous solution
    - Electrical conductivity of solutions
    - Reaction of litmus paper
    - Distinction between molecular dissolution and ionic dissolution
    - Distinction between strong electrolytes, weak electrolytes, and non-electrolytes
    - Distinction between strong acids, weak acids, strong bases, weak bases, and salts

  – pH of a solution
    - Acid-base indicators, turning point and pH range

  – Chemical reactions
    - Reactants and products
    - Balancing chemical equations
    - Stoichiometric calculations
    - Acid-Base neutralization

- **Use of chemicals**

  – Analysis of a problem related to the use of chemicals
    - Definition of the problem
      - Causes of the problem
      - Sources of the causes
      - Chemical reactions
      - Technical objects involve

    - List of consequences
      - Effects on terrestrial and aquatic ecosystems
      - Effects on human health
      - Effects on materials
      - Effects on the economy

    - Analysis of potential solutions
      - Scientific and technical solutions
      - Political solutions
      - Personal solutions

Skills

- **Knowing**: Stating the manifestations or components of a scientific or technical phenomenon.

- **Understanding**: Applying acquired knowledge to deduce information.

- **Analyzing**: Examining the components of a phenomenon in order to determine relationships.

4. Table of Dimensions

In the preceding sections, the content was specified. The following table of dimensions illustrates the specific relationships between the themes and skills.

THEMES / SKILLS	BASIC CONCEPTS 40%	MATTER IN ACTION 36%	USE OF CHEMICALS 24%
KNOWING 6%	• Simplified atomic model currently in use • Characteristics of metals, non-metals, hydrogen and chemical families (1) 6%		
UNDERSTANDING 40%	• Electron distribution according to family or period • New and traditional nomenclature • Distinction between acids, bases, and salts • Classification of matter: (pure substances and mixtures) • Problems involving dilution (2) 20%	• Types of chemical bond • Formation of binary compounds • Determination of the chemical formula of a binary compound • Phenomenon of molecular and ionic dissolution • Balancing chemical equations (4) 20%	
ANALYZING 54%	• Distinction between atoms, ions, and isotopes (4%) • Concentrations expressed in different units (6%) • Acidity expressed in different units (4%) (3) 14%	• Classification of electrolytes, acids, bases, and salts • Determination of the pH range • Stoichiometric calculations • Acid-Base neutralization (5) 16%	• Sources of the problem • Effects of chemicals • Solutions to problems related to the use of chemicals (6) 24%

5. Observable Behaviours

Dimension 1

Select statements that correctly describe the concept of model and the simplified atomic model.

Associate metals, non-metals, hydrogen, alkali metals, alkaline earth metals, halogens and noble gases with statements describing their characteristics.

Dimension 2

Given the electron distribution of different elements, state to which period or family they belong or give the electron distribution of elements whose family and period are known.

Given the chemical formula of a compound, state its name or, given the name of a compound, state its chemical formula. Use the rules for naming a binary compound according to the new nomenclature and the rules for naming a polyatomic compound according to the traditional nomenclature. A list of the names and formulas of the main polyatomic atoms is provided (see appendix).

Given the chemical formulas of different compounds, classify these compounds as acids, bases or salts (according to Arrhenius' definition).

Classify different substances as pure substances or mixtures and, if pure substances, as elements or compounds and, if mixtures, as homogeneous, heterogeneous or suspensions.

Solve problems involving dilution by applying the formula $V_1C_1 = V_2C_2$ (e.g. pesticides, fertilizers, cleaning products).

Dimension 3

Given the number of protons, neutrons and electrons in several atoms or ions, group the isotopes of a single element and classify them as neutral atoms, anions or cations.

Rank solutions whose concentration is expressed in different units (e.g. mol/L, g/L, kg/L).

Rank solutions whose acidity is expressed in different units (pH, $[H^+]$).

Dimension 4

State whether a chemical bond is ionic, polar covalent or non-polar covalent and explain the answer using the octet rule and electronegativity values.

Given two elements and using a Lewis diagram or structural formula representation, explain the formation of the compound made up of the two elements.

Given the conductivity of an aqueous solution, determine the type of dissolution (ionic or molecular) and illustrate the molecular aspect.

Determine the chemical formula of a binary compound, given the electron configuration of the constituent elements or their position in the periodic table.

Given a description of a chemical reaction, write and balance the equation of the reaction (maximum: five terms).

Dimension 5

Given the results of experiments on the conductivity of a solution, the reaction of litmus paper or its pH, state whether the solute is a strong electrolyte, a weak electrolyte or a non-electrolyte and whether it is an acid, a base or a salt.

Given the results obtained from acid-base indicators whose turning points are known, determine the pH range of a solution.

Determine, using stoichiometric calculations, the quantities of a substance involved in a reaction, given the equation for the reaction.

Explain, using equations, how neutralization can offer a solution to an acid-base imbalance.

Dimension 6

Given newspaper or magazine articles dealing with problems related to the use of chemicals, assess the value of the case analysis with regard to the definition of the problem, the list of consequences and the value of proposed solutions. For each step of the case analysis:

- identify the factors involved;
- assess the relevance of the facts or information cited in support of the argument;
- make a list of elements to be verified before accepting the author's conclusion.

6. Explanation of Content and Weighting

On the basis of the objective of helping students become citizens with an understanding of science and technology, the themes have been weighted as follows: 40% for basic concepts in chemistry, 44% for matter in action and 26% for the use of chemicals.

The program aims to help students gain an understanding of chemical phenomena and the relationships between science, technology and society. This explains the weighting given to the skill of understanding (40%).

Finally, the case analysis should lead the students to consider the social, economic and political issues related to scientific and technological development. This area counts for 24% of the final mark.

On the basis of the tasks prescribed in the terminal objectives, the weighting of the themes and skills has been established as follows:

- Knowing 6%
- Understanding 40%
- Analyzing 54%

- Basic concepts in chemistry 40%
- Matter in action 36%
- Use of chemicals 24%

7. Description of the Examination

7.1 Type of Examination

The summative evaluation consists of an examination in two parts. Both parts should be given at the end of the course.

The first part is a written examination; it covers dimensions 1 through 5 and counts for 76% of the final mark. It includes objective and short-answer test items. All the observable behaviours for each dimension should be measured. Except for Dimension 3, the points allotted to a dimension are divided equally between the observable behaviours for that dimension.

The second part is a written examination; it covers Dimension 6 and counts for 24% of the final mark. It includes one or more essay questions.

7.2 Characteristics of the Examination

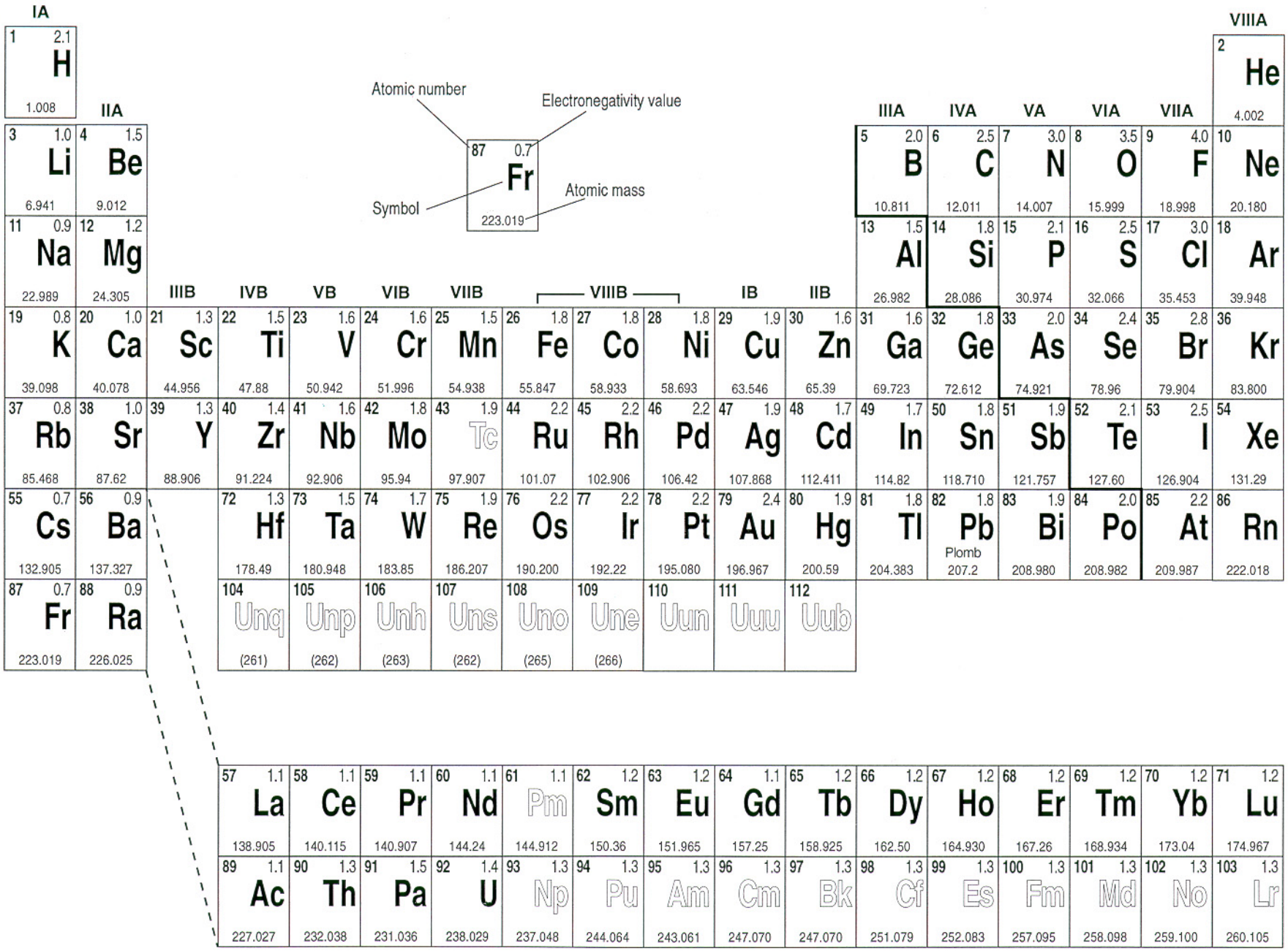
The first part of the examination should be taken in a single sitting of no more than 120 minutes. A periodic table of the elements including electronegativity indicators and a list of the names and formulas of the main polyatomic ions will be provided. The students may use a calculator.

The second part of the examination should be taken in a single sitting of no more than 90 minutes. The relevant information (e.g. numerical data, tables, documentation) should accompany each question.

7.3 Pass Mark

To pass the course, students must obtain a combined total of 60 out of 100 on the examination.

Periodic Table of the Elements



Names, formulas and charges of some polyatomic ions

Ammonium	NH_4^+
Acetate	CH_3COO^-
Dihydrogen phosphate	$H_2PO_4^-$
Bicarbonate	HCO_3^-
Hydroxide	OH^-
Nitrate	NO_3^-
Permanganate	MnO_4^-
Carbonate	CO_3^{-2}
Chromate	CrO_4^{-2}
Dichromate	$Cr_2O_7^{-2}$
Sulphate	SO_4^{-2}
Sulphite	SO_3^{-2}
Borate	BO_3^{-3}
Phosphate	PO_4^{3}

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