Definition of the domain for summative evaluation

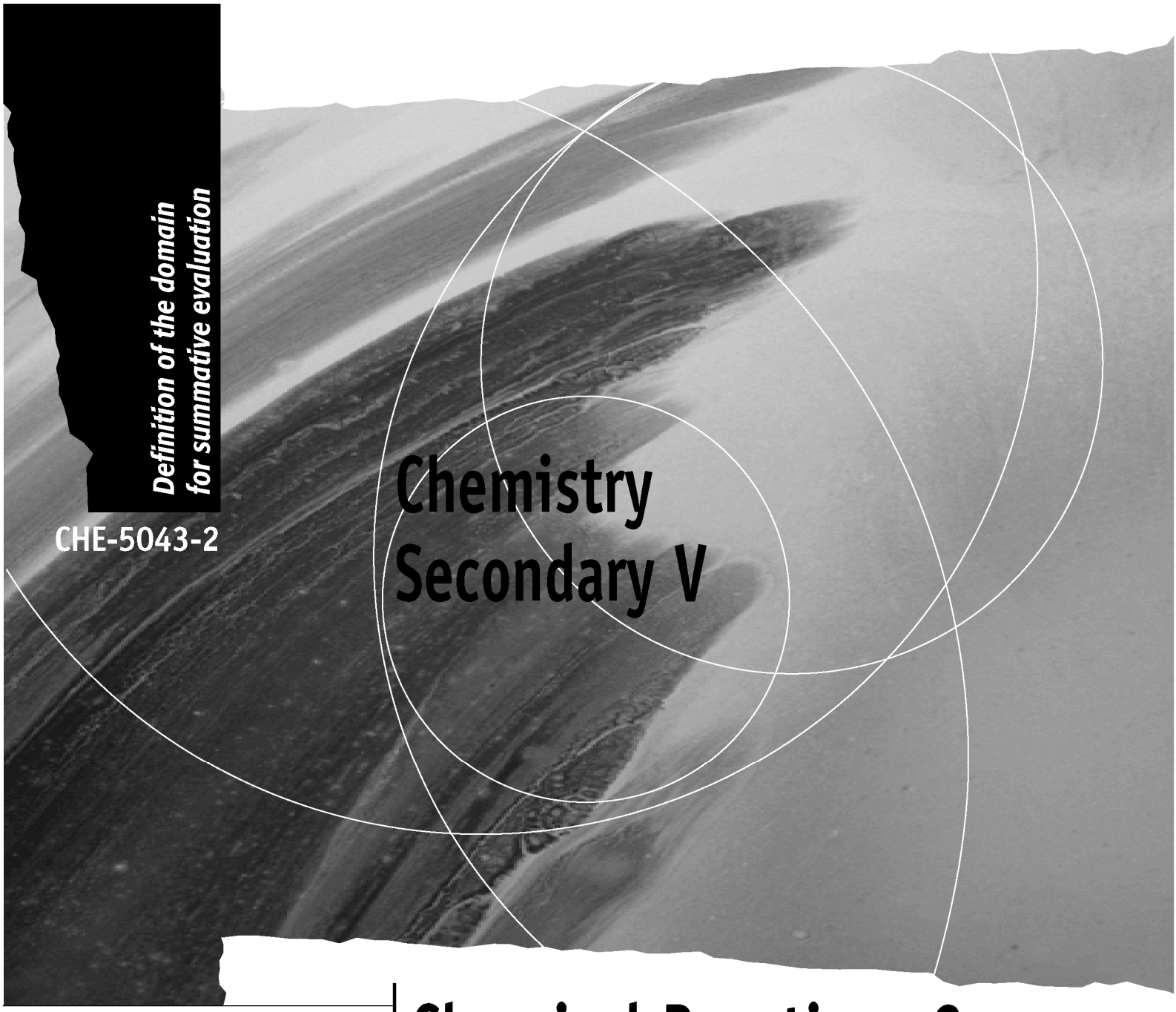
CHE-5043-2

Chemistry Secondary V

Chemical Reactions 2 : Equilibrium and Oxidation-Reduction

Reach for your Dreams

Québec



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Chemistry Secondary V

Chemical Reactions 2 : Equilibrium and Oxidation-Réduction

Formation professionnelle et technique
et formation continue

Direction de la formation générale
des adultes

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1. Introduction

This definition of the domain for summative evaluation describes and classifies the essential and representative elements of the *Chemistry* program – specifically, for the course entitled *Chemical Reactions 2: Equilibrium and Oxidation-Reduction*. 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 definition of the domain for summative evaluation is used to prepare 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
The purpose of this program is to provide students with rigorous training in the use of the scientific method. Students become familiar with the basic concepts of chemistry and either acquire or improve the skills related to the experimental method.	Evaluation items should test the students' knowledge and understanding of the basic concepts of chemistry and of the experimental method.
Students acquire an understanding of various phenomena that goes beyond the mere ability to apply formulas in solving mathematical problems.	Evaluation should involve problem situations that test the students'understanding of various phenomena. Evaluation should not focus solely on calculations and their results.
The program presents scientific knowledge from a historical, technological and social perspective.	Evaluation should also reflect the relationship between the related content and the history-technology-society perspective (HTS).
In this program, considerable time is devoted to the experimental approach and students are required to perform experiments.	A major part of the evaluation process should focus on the experimental method. In addition to items pertaining to objectives that relate to the experimental method, items that test the students' understanding of the related content may refer to laboratory work.
To help students acquire or improve the skills related to the experimental method, the course entitled *Chemical Reactions 2: Equilibrium and Oxidation-Reduction* focuses on having students integrate the different aspects of the experimental method.	In the course entitled *Chemical Reactions 2: Equilibrium and Oxidation-Reduction*, evaluation relating to the experimental method should involve having students write an experimental procedure and a laboratory report.

3. Course Content for Purposes of Summative Evaluation

Themes

- **Related Content**

  – A system in equilibrium:
    - macroscopic and submicroscopic equilibrium
    - interpretation of the experimental results
    - interpretation of graphs

  – Factors affecting the equilibrium of a system:
    - predicting the effects of changes made to a system in equilibrium
    - interpretation of the results using Le Châtelier's principle

  – Concentration and pH value of a solution:
    - mathematical definition
    - measurements obtained by titration
    - conversions

  – Equilibrium constant:
    - generalization of the expression
    - influence of temperature on its value
    - interpretation of a change in the value of the constant using Le Châtelier's principle

  – Relative strength of different acids:
    - ionization constant (K_a)
    - interpretation of the results of experiments
    - classification of different acids

  – Description of an oxidation-reduction reaction:
    - oxidation, reduction, oxidizing agent, reducing agent

  – Equations for an oxidation-reduction reaction:
    - writing an equation
    - balancing an equation

  – Standard reduction or oxidation potentials:
    - potential difference of a pair of metals

  – Electrochemical cell:
    - description
    - eventual weakening or "death" of a cell

– Problem solving:
  - factors affecting the equilibrium of a system
  - dynamic aspect of chemical equilibrium
  . equilibrium constant
  . concentrations at equilibrium
  - oxidation-reduction
  - spontaneity of oxidation-reduction reactions
  - electrochemical cells

- **History-Technology-Society perspective (HTS)**

  – Relationships between the study of chemical equilibrium and oxidation-reduction, and the evolution of chemistry:
    - discoveries resulting from the study of chemical equilibrium
    - discoveries resulting from the study of oxidation-reduction

  – Technical applications of chemical equilibrium or electrochemistry:
    - everyday acids and bases
    - use of chemical equilibrium in industrial applications
    - operation of an electrochemical cell
    - operation of an electrolytic cell
    - applications of electrochemistry

  – Social changes and environmental consequences related to the use of chemical equilibrium and oxidation-reduction:
    - disturbance of the equilibrium of a natural cycle
    - importance of pH in certain environments
    - use of chemical equilibrium in industry
    - development of electrochemistry

- **Experimental method**

  – Writing an experimental procedure:
    - choice of necessary equipment
    - instructions
    - applicable safety rules

  – Writing a laboratory report:
    - clear and organized presentation of all the parts of the laboratory report
    - description of the experiment conducted
    - presentation of the results
    - rigorous analysis of the results
    - discussion of the results
    - conclusion to be drawn from the results, given the problem to be solved

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

Themes / Skills	Related Content 55%	HTS Perspective 15%	Experimental Method 30%
Knowing 4%	Description of an oxidation-reduction reaction **(1) 4%**		
Understanding 31%	Factors affecting the equilibrium of a system (4%) pH value of a solution (4%) Equilibrium constant (4%) Equations for oxidation-reduction reactions (4%) **(2) 16%**	Relationships between the study of chemical equilibrium and oxidation-reduction, and the evolution of chemistry (5%) - discoveries resulting from the study of chemical equilibrium and oxidation-reduction Technical applications of chemical equilibrium or electrochemistry (5%) - everyday acids and bases - chemical equilibrium in industrial applications - operation of electrochemical and electrolytic cells - applications of electrochemistry Social changes and environmental consequences related to the use of chemical equilibrium and oxidation-reduction (5%) - disturbance of the equilibrium of a natural cycle - importance of pH in certain environments - use of chemical equilibrium in industry - development of electrochemistry **(4) 15%**	
Analyzing 65%	A system in equilibrium (4%) Relative strength of different acids (4%) Standard reduction or oxidation potentials (4%) Electrochemical cells (4%) Problem solving (19%) **(3) 35%**		Writing an experimental procedure (10%) - necessary equipment - instructions - safety rules Laboratory report (20%) - clear and organized presentation - description of the experiment - presentation of the results - analysis of the results - discussion of the results - conclusion **(5) 30%**

5. Observable Behaviours

Dimension 1

– Given a series of statements describing oxidation-reduction reactions, choose those that are true. Justify one's choice or correct false statements to make them valid. (4%)

Dimension 2

– Predict how a system in equilibrium is affected by the addition of a catalyst or by a change in concentration, pressure or temperature. Justify this prediction using Le Châtelier's principle. (4%)

– Determine the pH of two solutions used in an acid-base titration. Use the solution with a known concentration and the titration measurements for the solution whose concentration is unknown. (2%)

Determine the H_3O^+ and OH^- concentrations of a solution whose pH is known. (2%)

– Write the equilibrium constant for a chemical reaction whose equation is given and predict how the value of this constant will be affected by a change in temperature. Justify one's prediction using Le Châtelier's principle. (4%)

– Balance an oxidation-reduction equation using oxidation numbers. (4%)

Dimension 3

– Given different systems, choose those that are in equilibrium and explain why the others are not. The systems will be presented in any of the following forms: diagrams illustrating a system in which a chemical reaction is taking place, written descriptions of this type of system, graphs illustrating forward or reverse reactions as a function of time, or results of laboratory experiments on the equilibrium of a system. (4%)

– Given the results of an experiment aimed at determining the relative strength of at least three acids, write the ionization equations for these acids, determine the value of the ionization constant for each acid and rank them in order of strength. (4%)

– Given three oxidizing or reducing agents whose standard oxidation or reduction potentials are known, rank the possible oxidation-reduction couples in order of the potential difference produced. Steps of the work are to be shown. (4%)

– Given a series of statements explaining the operation or the eventual weakening of electrochemical cells, as well as diagrams of these cells, choose those statements that are true. Justify one's choice or correct false statements to make them valid. (4%)

– Problem solving:

  Suggest at least two changes that should be made to a system in equilibrium in order to increase or decrease the amount of any of the products or reactants. Explain these changes using Le Châtelier's principle. (4%)

  Use the equilibrium constant to analyze chemical equilibrium. Determine the equilibrium concentrations or the initial concentrations of one or more reactants or products. (4%)

  Using stoichiometric calculations, determine the quantities of substances involved in an oxidation-reduction reaction whose equation is known. (4%)

  Given a series of oxidation-reduction couples, choose those that will give rise to spontaneous reactions and those that will not. Justify one's choice. (3%)

  Given the diagram of an electrochemical cell, write the net reaction equation for this cell and determine its potential difference. (4%)

Dimension 4

– Explain the relationships between the study of chemical equilibrium or oxidation-reduction, and the evolution of chemistry. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

– Explain the use of chemical equilibrium or electrochemistry in a technical application. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

– Briefly describe the situation that prevailed before the advent of a technical application involving the use of chemical equilibrium or electrochemistry and the new possibilities resulting from its implementation. This involves using the information provided with the exam and knowledge acquired during the course. (5%)

Dimension 5

– Write an experimental procedure that could be used to solve a problem related to chemical equilibrium or oxidation-reduction. The suggested procedure must include the list of necessary equipment, the appropriate safety rules and a set of clearly written instructions. The necessary equipment will be chosen from a list of materials generally used in chemistry and provided with the exam. (10%)

– Performe a laboratory experiment according to a given experimental procedure and write a laboratory report. The experiment can be on any subject studied in any of the three modules in the program. All the parts of the laboratory report must be presented in a clear and organized manner; the report must include an accurate description of the experiment performed and of the results (presentation, analysis and discussion), as well as a clear conclusion related to the problem stated. (20%)

6. Explanation of the Content and Weighting

In accordance with the objectives of the Secondary V *Chemistry* program, students should acquire a theoretical knowledge of chemistry, while examining the historical, technological and social aspects of this discipline. Students should also acquire or improve the skills related to the experimental method. Summative evaluation instruments will reflect this principle.

Two factors were considered in determining the relative importance of the dimensions pertaining to the experimental method: the progress made in acquiring or improving the skills related to the experimental method and the relative importance of the experimental method in the evaluation scheme used in the youth sector. As in the youth sector, the experimental method accounts for 25% of the overall mark for the three courses in the program. However the relative importance of this theme varies from one course to another. It accounts for 30% of the mark obtained in the present course.

The dimensions related to the history-technology-society perspective account for 15% of the mark in each of the three courses.

Given the relative importance of the previously mentioned dimensions, evaluation pertaining to the related content accounts for 55% of this course mark.

The relative importance of any skill to be developed in this course is determined by adding up the weightings given to the observable behaviours pertaining to that skill. In the present course, the relative importance of each skill is as follows:

KNOWING	4%
UNDERSTANDING	31%
ANALYZING	65%

7. Description of the Examination

A. Type of Examination

The examination for purposes of summative evaluation will be administered at the end of the course. It consists of two parts:

– One part is a written examination covering dimensions 1 to 4, inclusive, and is worth 70% of the course mark. It consists of restricted-response, short-answer or extended-response items.

– The other part is a laboratory examination covering dimension 5 and is worth 30% of the course mark.

Both parts of the examination are compulsory. All the observable behaviours for each dimension must be taken into account.

B. Characteristics of the Examination

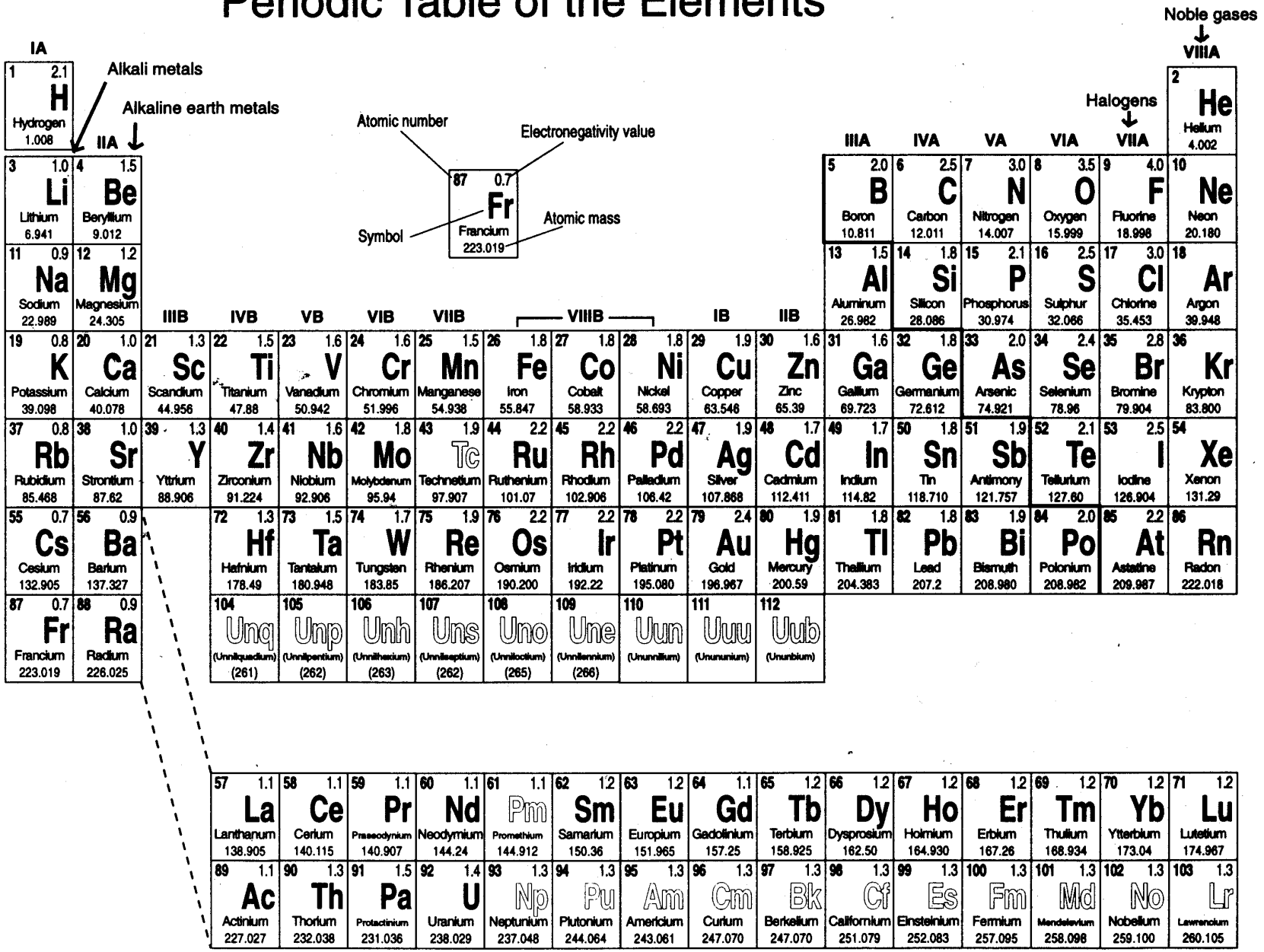
The part covering dimensions 1 to 4 is written in a single session lasting no more than 180 minutes. Students are permitted to use a calculator and must be provided with a periodic table, a table of standard reduction potentials and appropriate information required by dimension 4. Examples of this material are included in Appendix 1 and 2.

The part covering dimension 5 is administered in the laboratory in a single session lasting no more than 120 minutes. The appropriate information must be incorporated into each related item or group of items.

C. Pass Mark

The pass mark for the entire examination is 60%.

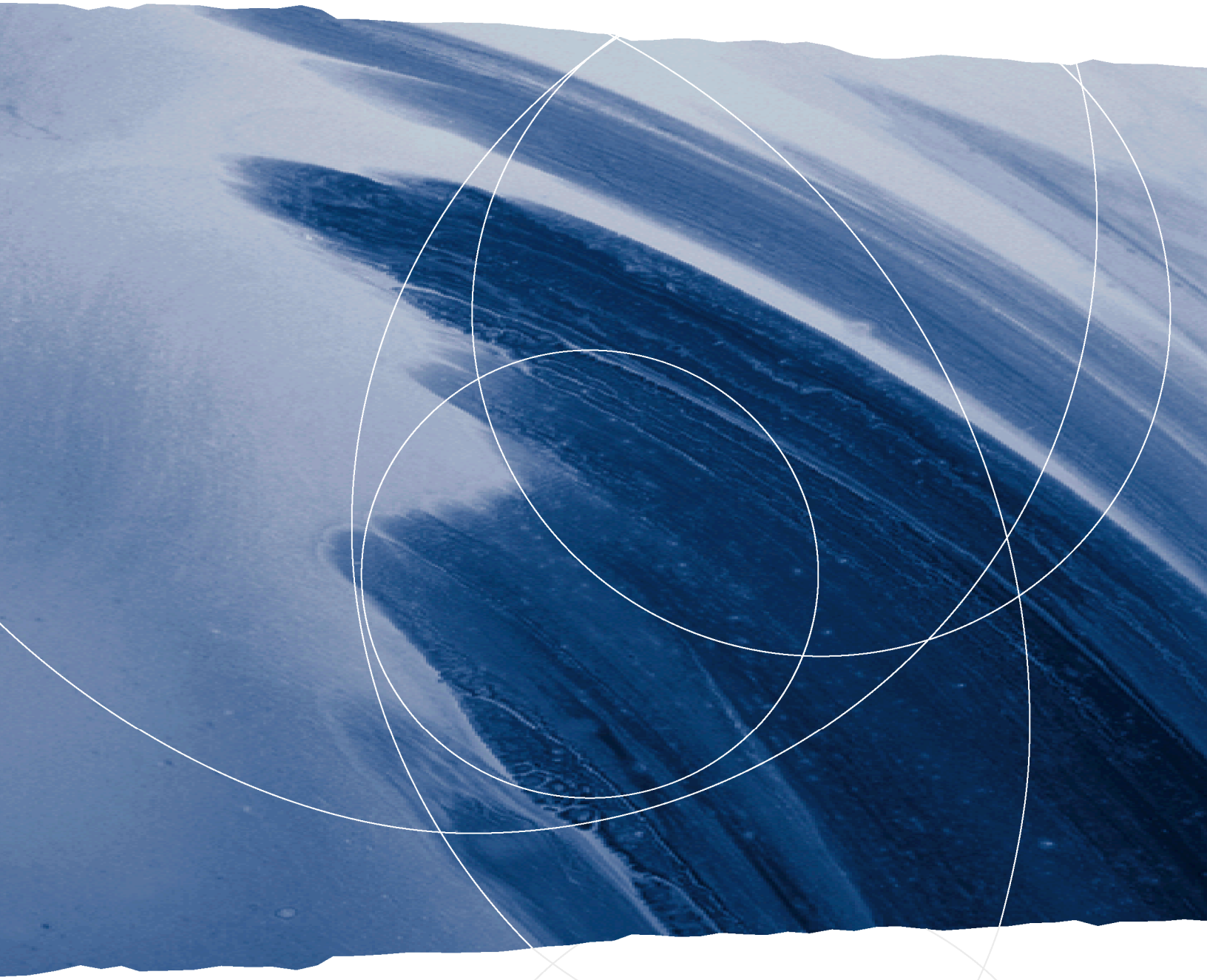
Periodic Table of the Elements



Standard Reduction Potentials

	E^o (volts)
$F_2 + 2\ e^- \rightarrow 2\ F^-$	2.87
$Ag^{2+} + e^- \rightarrow Ag^+$	1.99
$Co^{3+} + e^- \rightarrow Co^{2+}$	1.95
$H_2O_2 + 2\ H^+ + 2\ e^- \rightarrow 2\ H_2O$	1.78
$Ce^{4+} + e^- \rightarrow Ce^{3+}$	1.70
$PbO_2 + 4\ H^+ + SO_4^{2-} + 2\ e^- \rightarrow PbSO_4 + 2\ H_2O$	1.69
$MnO_4^- + 4\ H^+ + 3\ e^- \rightarrow MnO_2 + 2\ H_2O$	1.68
$2\ e^- + 2\ H^+ + IO_4^- \rightarrow IO_3^- + H_2O$	1.60
$MnO_4^- + 8\ H^+ + 5\ e^- \rightarrow Mn^{2+} + 4\ H_2O$	1.51
$Au^{3+} + 3\ e^- \rightarrow Au$	1.50
$PbO_2 + 4\ H^+ + 2\ e^- \rightarrow Pb^2 + 2\ H_2O$	1.46
$Cl_2 + 2\ e^- \rightarrow 2\ Cl^-$	1.36
$Cr_2O_7^{2-} + 14\ H^+ + 6\ e^- \rightarrow 2\ Cr^{3+} + 7\ H_2O$	1.33
$O_2 + 4\ H^+ + 4\ e^- \rightarrow 2\ H_2O$	1.23
$MnO_2 + 4\ H^+ + 2\ e^- \rightarrow Mn^{2+} + 2\ H_2O$	1.21
$IO_3^- + 6\ H^+ + 5\ e^- \rightarrow ½\ I_2 + 3\ H_2O$	1.20
$Br_2 + 2\ e^- \rightarrow 2\ Br^-$	1.09
$VO_2^+ + 2\ H^+ + e^- \rightarrow VO^{2+} + H_2O$	1.00
$AuCl_4^- + 3\ e^- \rightarrow Au + 4\ Cl^-$	0.99
$NO_3^- + 4\ H^+ + 3\ e^- \rightarrow NO + 2\ H_2O$	0.96
$ClO_2 + e^- \rightarrow ClO_2^-$	0.954
$2\ Hg^{2+} + 2\ e^- \rightarrow Hg_2^{2+}$	0.91
$Ag^+ + e^- \rightarrow Ag$	0.80
$Hg_2^{2+} + 2\ e^- \rightarrow 2\ Hg$	0.80
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	0.77
$O_2 + 2\ H^+ + 2\ e^- \rightarrow H_2O_2$	0.68
$MnO_4^- + e^- \rightarrow MnO_4^{2-}$	0.56
$I_2 + 2\ e^- \rightarrow 2\ I^-$	0.54
$Cu^+ + e^- \rightarrow Cu$	0.52

	E^o (volts)
$O_2 + 2\ H_2O + 4\ e^- \rightarrow 4\ OH^-$	0.40
$Cu^{2+} + 2\ e^- \rightarrow Cu$	0.34
$Hg_2Cl_2 + 2\ e^- \rightarrow 2\ Hg + 2\ Cl^-$	0.34
$AgCl + e^- \rightarrow Ag + Cl^-$	0.22
$SO_4^{2-} + 4\ H^+ + 2\ e^- \rightarrow H_2SO_3 + H_2O$	0.20
$Cu^{2+} + e^- \rightarrow Cu^+$	0.16
$2\ H^+ + 2\ e^- \rightarrow H_2$	0.00
$Fe^{3+} + 3\ e^- \rightarrow Fe$	-0.036
$Pb^{2+} + 2\ e^- \rightarrow Pb$	-0.13
$Sn^{2+} + 2\ e^- \rightarrow Sn$	-0.14
$Ni^{2+} + 2\ e^- \rightarrow Ni$	-0.23
$PbSO_4 + 2\ e^- \rightarrow Pb + SO_4^{2-}$	-0.35
$Cd^{2+} + 2\ e^- \rightarrow Cd$	-0.40
$Fe^{2+} + 2\ e^- \rightarrow Fe$	-0.44
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	-0.50
$Cr^{3+} + 3\ e^- \rightarrow Cr$	-0.73
$Zn^{2+} + 2\ e^- \rightarrow Zn$	-0.76
$2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$	-0.83
$Mn^{2+} + 2\ e^- \rightarrow Mn$	-1.18
$Al^{3+} + 3\ e^- \rightarrow Al$	-1.66
$H_2 + 2\ e^- \rightarrow 2\ H^-$	-2.23
$Mg^{2+} + 2\ e^- \rightarrow Mg$	-2.37
$La^{3+} + 3\ e^- \rightarrow La$	-2.37
$Na^+ + e^- \rightarrow Na$	-2.71
$Ca^{2+} + 2\ e^- \rightarrow Ca$	-2.76
$Ba^{2+} + 2\ e^- \rightarrow Ba$	-2.90
$K^+ + e^- \rightarrow K$	-2.92
$Li^+ + e^- \rightarrow Li$	-3.05



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