

Inorganic Chemistry 1



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I. Inorganic Chemistry 1

by Chrispin Kowenje

II. Prerequisite Courses or Knowledge

Introduction to Chemistry 1: Matter and measurements, Structure and periodicity of the atom, Molecules and compounds, and Chemical reactions.

- Computer literacy (microsoft word processor and excel).

III. Time

120 hours

- Unit 1. Periodic Table of elements (14 hours)
- Unit 2. Atomic Structures and trends in s and p Block elements (30 hours)
- Unit 3. General Properties of s and p Block elements (40 hours)
- Unit 4. Occurrence, abundance and Extraction of the s and p block elements (16 hours)
- Unit 5. Economic uses of s and p Block Elements (20 hours)

IV. Material

In general, the learner needs to have;

- Course recommended text books
- Computer with internet connection
- CD-ROMs
- Access to e-Library
- Scientific calculator

V. Module Rationale

Introductory Chemistry 1 undepinned the concepts of matter, measurements, structure and periodicity of the atom, Molecules and compounds, and their chemical reactions. This study builds on the aforementioned concepts by being the foundation stone for better understanding of chemicals and the various ways of classifying the elements in Chemistry. With the ever expanding chemistry knowledge, here we show how best to predict and understand the simple applications of both chemical principles and chemical compounds and the use of the elements of the periodic table.



VI. Content

6.1 Overview

The course commences with a critical look at the Periodic table of elements and why they are classified as such. The table makes it easier to comprehend, early enough, the concepts and facts of chemistry of elements. The chemistry of the s- and p-block (or main block) elements and their compounds which then follows provides a systematic treatment of these elements and their compounds based on their common properties.

In unit 1, which utilises the concept of electronic configuration of the elements, you will review the classification of elements into metals, non-metals and metalloids as well as into s, p, d, and f blocks of the periodic table. This will be followed by a study of the atomic structures and general trends across a period and down a group in unit 2. Unit 3 examines general properties of s- and p- block elements. Unit 4 examines the abundance, occurrence and the extractions of the elements.

In recent years industrial research in the chemistry of main block elements has flourished; many new technological developments, such as Si-Ge transistors in computers and VCRs, have been achieved using these elements or their compounds. Examples of the economic uses are given in unit 5 and we hope that this module will stimulate your interest in inorganic chemistry, a field in which trained personnel are still scarce in both academic institutions and industrial laboratories.

6.2 Outline

120 hours

Unit 1. Periodic Table of elements (14 hours)

- Introduction and history to Periodicity in chemical elements
- Terminologies used in the periodic table of elements
- Classification of periodic table elements
- Electronic configuration of s-Block elements
- Electronic configuration of p-Block elements
- Electronic quantum numbers and electronic orbitals
- s-, p-, d-, and f-block elements
- Metals, non-metals and metalloids

**Unit 2. Atomic Structures and trends in s and p Block elements (30 hours)**

- Atomic size across and down the table
- Melting and boiling points of s and p block elements
- Electronegativities
- Ionization Energy trends
- Electron affinities
- Nuclear binding energies
- Effective nuclear charge

Unit 3. General Properties of s and p Block Elements (40 hours)

- Valency and formula of s-, and p-block elements and their compounds
- Naming of simple s-, and p-block compounds
- General characteristics of metals, non-metals and metalloids
- Physical Properties of S block elements
- Physical and chemical Properties of s-Block elements
- Physical and chemical Properties of p-Block elements

Unit 4. Occurrence, abundance and Extraction of s and p block elements (16 hours)

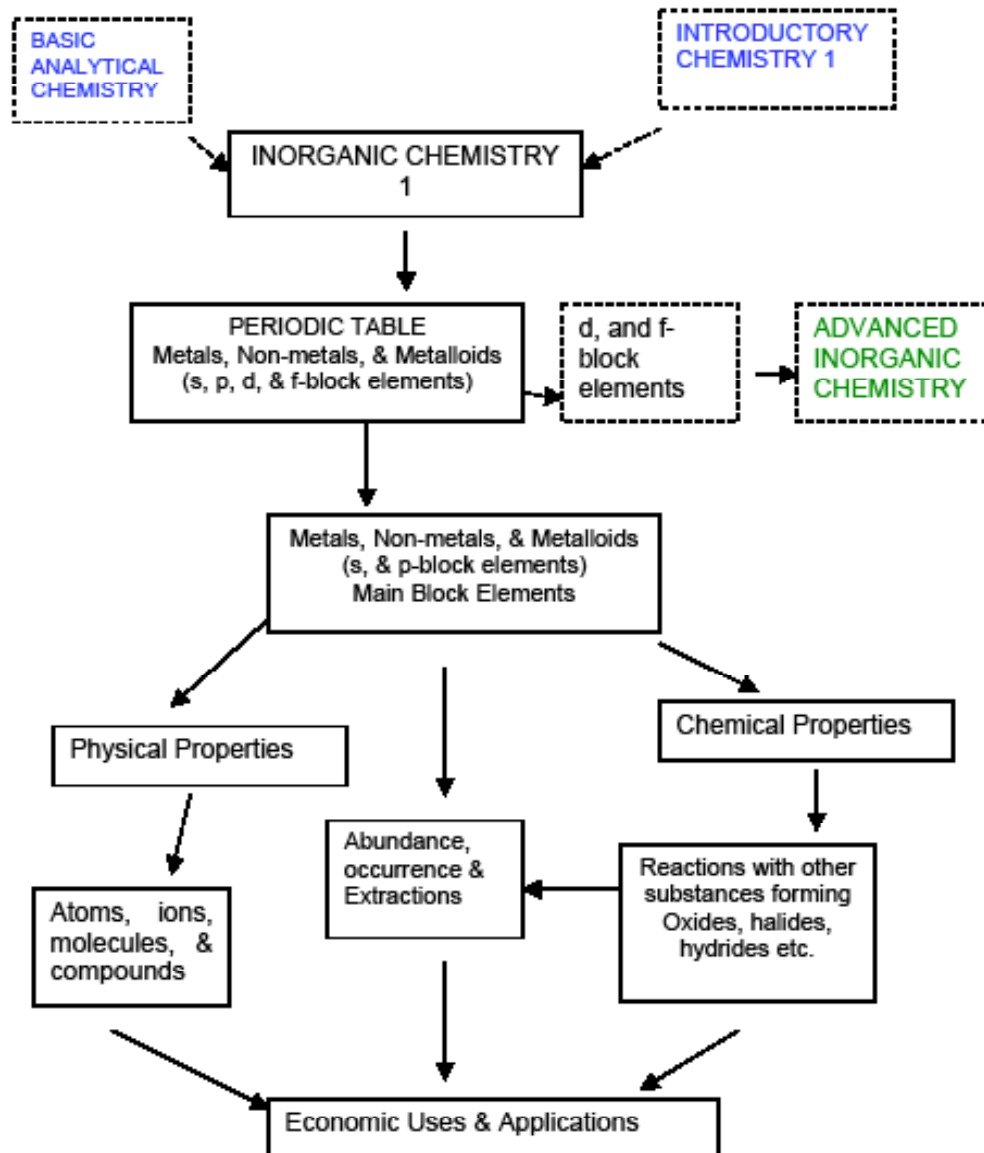
- Occurrence, abundance and extraction of group 1 elements
- Occurrence, abundance and extraction of group 2 elements
- Occurrence, abundance and extraction of group 13 - 16 elements
- Occurrence, abundance and extraction of group 17 elements
- Occurrence, abundance and extraction of group 18 elements

Unit 5. Economic uses of s and p Block Elements (20 hours)

- Economic use of selected group 1 elements
- Economic use of selected group 2 elements
- Economic uses of selected group 13 – 16 elements
- Economic uses of selected group 17 elements
- Economic uses of selected group 18 elements



The Flow of the Module: A Learner's Progression through the units.





VII. General Objective(s)

By the end of this module you are expected to be able to:

- Understand the placements of elements in the periodic table
- Classify elements into s, p, d and f blocks of the periodic table
- Describe and explain the periodicity in the physical properties of the s- and p-block elements
- Describe and explain the general features in the chemical properties of the s- and p-block elements
- Describe, explain and predict the physical and chemical properties of the compounds of s- and p-block elements
- Describe and even predict the methods used for extraction of the s- and p-block elements
- State and predict the economic uses of the s- and p-block elements

VIII. Specific Learning Objectives (Instructional Objectives)

Unit	Learning objective(s) At the end of this unit the learner should be able to:
1. Periodic Table of elements	<ul style="list-style-type: none"> - Describe and predic the position of an element in the periodic table by use of the atomic numbers. - Use different labelling sytems for the periodic table - Use the periodic table to classify the elements according to IUPAC system. - Identify and locate s-block elements in the periodic table according to their electron configuration - Identify and locate p-block elements in the periodic table according to their electron configuration - Classify the elements into s-, p-, d-, and f-block elements also as metals, non-metals and metalloids according to loca-tion in the periodic table



2. Atomic Structures of s and p Block elements

- Describe and explain the periodicity in atomic and ionic radii of elements of the periodic table.
 - Explain and describe how the trends in melting and boiling points are related to the electronic structures of the s and p block elements.
 - Describe, explain and predict the periodicity in electronegativity of the elements across the table.
 - Describe, explain and predict the periodicity in ionization energy of the elements across the table
 - Describe, explain and predict the periodicity in electron affinity of the elements across the table.
 - Describe, explain and predict the periodicity in nuclear binding energies of the elements across the table.
 - Calculate the nuclear binding energy of any element in the periodic table.
 - Calculate the effective nuclear charge of any element in the periodic table.
-

3. General Properties of s and p Block Elements

- Examine the valencies of the s-, and p-block elements.
 - Predict and state the common oxidation states for s-, and p-block elements.
 - Predict the formula and the name of simple compounds of s- and p-block elements.
 - Explain the stability of common oxidation state for s and p block elements.
 - Predict and explain the trend in the chemical and physical properties of s-block elements.
 - Predict and explain the trend in the chemical and physical properties of p-block elements.
 - Explain, give examples of the anomalous behaviour of the first (period 2) elements.
 - Describe what Inert pair effect is.
 - State and give example of diagonal relationships in the periodic table.
-



4. Occurrence, abundance and Extraction of Elements

- Appreciate the natural abundances of the s and p block elements.
 - Define terminologies associate with extraction of elements.
 - Observe the natural abundances table of the s and p-block elements.
 - Describe and explain the general methods used for extracting s block (metals) elements.
 - Describe and explain the general methods used for extracting groups 13, 14, 15, and 16 elements.
 - Describe and explain the general methods used for extracting groups 17 elements.
 - Describe and explain the general methods used for extracting group 18 elements.
 - Carry out a research project based on the extraction of one s-block element and two p-block elements and write a report.
-

5. Economic uses of s and p Block elements

- Appreciate the economic uses of some selected s block elements.
 - Appreciate the economic use of some selected p block elements.
 - Predict economic use(s) of some hypothetical element(s) of the s or p sections of the periodic table.
-



IX. Teaching and Learning Activities

9.1 Pre-assessment

Title of Pre-assessment : Pre-assessment test for Inorganic Chemistry 1.

Rationale : The test below evaluates your preparedness level for the Inorganic Chemistry 1 course. It is in no way intended to find your mistakes, but to bring out the bests you can recall, as per now.

Questions

1. An anion is,
 - a) an atom that has gained electrons
 - b) an atom that has lost electrons
 - c) a charged molecule
 - d) a charged element
2. Define an element
 - a) an atom that takes part in chemical reaction
 - b) a pure substance that consists of only one type of atom
 - c) different kinds of atoms of similar chemicals
 - d) an atom that can never be divided into simpler particles
3. What is an atomic number of an atom?
 - a) Number of protons
 - b) Number of electrons
 - c) Number of protons and neutrons
 - d) Number of electrons and protons
4. ${}_1\text{H}^1$, ${}_1\text{H}^2$, and ${}_1\text{H}^3$ are all
 - a) isotopes
 - b) allotrops
 - c) group members
 - d) anisotropes



5. chemical changes are those that
 - a) take place very fast
 - b) produce a new substance
 - c) where electrons are involved
 - d) where heat is applied

6. What is an atomic orbital
 - a) spot where electron is in an atom
 - b) a wave for an allowed energy state for an electron in atom
 - c) A wave for an allowed energy state for an electron in an atom or molecule
 - d) Sub-shell of an atom.

7. What are allotropes?
 - a) members of the same atom but different neutrons
 - b) Different forms of the same element
 - c) Different forms of the same atom
 - d) Different structures of the same element

8. what is octet rule?.
 - a) When electrons are 8 in an orbital
 - b) During bond formation, when atoms attain 8 electrons in valence shell electronic configuration.
 - c) when elements of group 8 (noble gases) are stable
 - d) having 8 valence electrons

9. Define a chemical bond
 - a) Shortest distance connecting two atoms in a molecule
 - b) attractive forces that hold two or more atoms together in a molecule
 - c) the two electrons that attract each other and hold atoms together
 - d) Shortest distance of approach between two atoms

10. Melting point of a substance is?
 - a) The temperature at which the solid and liquid phases are in equilibrium
 - b) the temperature where all solid has turned to liquid
 - c) the temperature when water is ice
 - d) is 0°C for Ice.



11. Electronic configuration

- a) the arrangement of electrons in atomic orbitals
- b) the presence of electrons in orbitals
- c) the shape of electronic orbitals such as s, p, and d-orbitals
- d) the act of studying electrons in an atom

12. Isoelectronic species are

- a) Atoms having the same amount of current in them
- b) Atoms or ions that have the same electronic arrangements
- c) Atoms that have the same number of electrons
- d) Atoms that have lost all their electrons

13. What is an electrochemical series?

- a) series for atoms of same group,
- b) The list of elements/compounds when arranged in order of their standard reduction potentials, from most oxidizing to most reducing.
- c) The list of atoms when arranged in order of their standard reduction potentials, from most oxidizing to most reducing.
- d) members of same period in periodic table.

14. The correct ranking of bonds in order of greatest to least bond strength is;

- a) covalent, Van der waals, hydrogen,
- b) Van der waals, hydrogen, covalent,
- c) covalent, hydrogen, Van der waals,
- d) hydrogen, Van der waals, covalent

15. Covalent bonds are formed by,

- a) metals and non-metals,
- b) sharing of electrons,
- c) transfer of electrons,
- d) non-metals alone

16. A chemical compound is always,

- a) chemically neutral,
- b) electrically neutral,
- c) both positively and negatively charged,
- d) either positively or negatively charged.



17. Define a catalyst

- a) a substance that increases the rate of a reaction
- b) a substance that increases the rate of a reaction but is itself not consumed
- c) a substance that produces the desired product faster in a chemical reaction
- d) a substance that changes a rate of a reaction.

18. Excited state of an atom is when?,

- a) one or more electrons are not in the lowest possible energy level
- b) when an electron leaves the atom
- c) when an atom acquires more energy
- d) when an atom has more electrons than it needs

19. Define an atomic mass unit (AMU) according to the IUPAC.

- a) 1 amu = 1/12 the mass of Carbon 12
- b) 1 amu = 1/16 the mass of Oxygen 16
- c) 1 amu = 1/1 the mass of hydrogen
- d) 1 amu = the maximum number of protons in an atom.

20. Anode

- a) tip of a bulb element
- b) electrode of an electrochemical cell where reduction occurs
- c) terminal of a dry cell
- d) electrode of an electrochemical cell where oxidation occurs



Answer Key

- 1.A
- 2.B
- 3.A
- 4.A
- 5.B
- 6.C
- 7.B
- 8.B
- 9.B
- 10.A
- 11.A
- 12.B
- 13.B
- 14.C
- 15.B
- 16.B
- 17.B
- 18.A
- 19.A
- 20. D



Pedagogical Comment For Learners

As a learner, the pre-assessment test evaluates your present level of chemistry knowledge as a link to that knowledge you are to acquire in this Inorganic chemistry 1. Your test score should help in identifying your competence and indicate areas where you need special emphasis on. The basics of understanding Inorganic chemistry 1 lies in appreciating the effects of electronic configurations and their concomitant interactions in atoms, ions, molecules, compounds etc as they direct the periodicity of the elemental properties. A learner who scores 40 percent or less in the pre-assessment test is likely to encounter difficulties comprehending the contents of this module and is, therefore, advised to review Introductory Chemistry 1, which is a prerequisite to this course. However, your performance index is not in anyway intended to make you be discouraged or be complacent; it is for you to appreciate how much effort you need to put in this work, be ready to make that extra mile.

Key Concepts

Atomic number. Is the number of protons in the nucleus or the number of electrons in an atom.

An ion. A charged atom or molecule. An **ion** is positive (cation) if it has lost electrons or negative (anion) if it has gained electrons

Isotopes. One member of a (chemical-element) family of atomic species which has two or more nuclides with the same number of protons (Z) but a different number of neutrons (N). Because the atomic mass is determined by the sum of the number of protons and neutrons contained in the nucleus, isotopes differ in mass. Since they contain the same number of protons (and hence electrons), isotopes have the same chemical properties.

Allotropes. One or more forms of an elementary substance. Examples are Graphite and diamond are both allotropes of carbon. O_2 and ozone, O_3 , are allotropes of oxygen.

Electronic ground state. This is electronic configuration of an atom with the lowest energy orbitals all occupied according to Hund's rule.

Isoelectronic series. A series for atoms or ions that have the same electronic arrangements/configuration.

Electroneutrality. The principle expresses the fact that all pure substances carry a net charge of zero. That is the overall charge in a molecule like $[Na^+Cl^-]^0$ is zero.

Chemical change. A change that results in the formation of a new substance, such as the burning of wood.

Catalyst. Anything/substance which creates a situation in which change can occur at a faster rate.



Atomic mass unit. An atomic mass unit (symbolized AMU or amu) is defined as precisely $1/12$ the mass of an atom of carbon-12. The carbon-12 (C-12) atom has six protons and six neutrons.

Chemical bond. An attractive force that holds atoms together to form molecules or Electrical interaction between electrons of one atom and the positive nucleus of another atom that result in the binding of atoms together in a stable unit.

Alloy. Is a homogeneous mixture of two or more elements, at least one of which is a metal, and where the resulting material has metallic properties. The resulting substance usually has different properties (sometimes substantially different) from those of its components.

Base. A substance that ionises in water to form hydroxide ions and a cation (there are more fundamental definitions of the term).

Bond polarity. The extent to which the bonding electron pairs between the two atoms is displaced towards one of the atoms.

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