CHEMISTRY INTRODUCTION

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Contents

Overview

This introductory topic presents a broad overview of chemistry and a summary of this curriculum. Knowledge of chemistry is helpful to everyone. Even if we are unaware of it, chemistry always occurs around us. An understanding and appreciation for chemistry is helpful for various jobs and industries – from healthcare to business roles and even artists. Certainly, chemistry is at the forefront and center of many essential aspects of our daily lives. Chemistry involves materials, energy sources we consume, control of diseases, food supply processes, medicines, and other elements. Chemistry bridges across the other natural sciences.

Chemistry's relationship with life science, physics, and Earth and planetary sciences is evident to science students as they become familiar with the discipline of chemistry. In this set of topics, students will acquaint themselves with a new, microscopic world of wonder – they will identify ways to solve real-world problems – and, most importantly, prepare themselves for their future.

Nature of Matter

In its simplest terms, matter has mass and occupies space. It would be reasonable to call matter "the stuff" that the universe is made up of. Chemistry students become progressively familiar with the atomic nature of matter and the variety of elements and compounds made from them. The states of matter, along with physical and chemical properties – as well as the changing from one state to another – these concepts are among the central themes chemistry students learn regarding matter.

Properties of Matter

Matter has both physical and chemical properties. Examples of physical properties include color, volume, melting and boiling point, odor, and hardness. A pure substance can be described in terms of its chemical properties. Some examples of chemical processes we see and experience around us are the rusting of various metals, the digestion of food, and the release of energy during the chemical conversion (combustion) of gasoline in our cars.

Earth science students review the physical properties of minerals in Minerals of the Earth (Earth Science topic 17). Biology students investigate chemical change through how the digestive system converts food into energy for the human body in Physiology (Biology topic 42). Chemistry students learn to recognize types of change (physical and chemical), such as these examples, along with the properties of matter and its potential.

The Elements

An element is a substance whose atoms all have the same number of protons. All of a particular element's atoms have the same atomic number. Elements are chemically the most straightforward substances and cannot be broken down using chemical reactions. One hundred and eighteen (118) elements are displayed on the periodic table – representing all the elements in the known universe. Of these, the first 92 are naturally occurring on Earth. The remaining have been "manufactured" in a lab.

There are several interesting facts about each of the known elements. For example, oxygen makes up almost half of Earth's atmosphere, oceans, and crust combined – but nitrogen is 78% of the air we breathe. Carbon is by far the most crucial element to living things, but hydrogen, oxygen, and nitrogen are also vital to cells of living things. Each element has an interesting story – and purpose. Chemistry students become familiar with groups of like-kind elements and their patterns. All this helps shape our views and deepen our knowledge and understanding of our world.

Using the Periodic Table

Most chemistry classrooms have a periodic table hanging on the wall. The chart shows all the known elements and provides a surprising lot of information about each. The chart – despite its quizzical shape – guides chemists around the world. The rationale behind its quizzical shape and arrangement of elements becomes increasingly apparent to chemistry students as they progress through further topics.

The first column of elements (beginning with H – hydrogen – at the top left) has a similar set of chemical properties. All of them in the first column (except for hydrogen) are called Alkali metals. The second column is called the Alkaline earth metals. Columns 3 through 12 are called Transition metals. The column on the far right represents the Noble gases.

The periodic table is laid out very intentionally in columns and rows. A one-, two- or three-letter identifier provides a convenient way for chemists to communicate about an element or combinations of elements without using the entire, formal name(s). The numbers (written in sequence from 1 through 118) represent the number of protons in one atom of that element. The number is called the atomic number. These and other essential aspects of the period table are covered here.

Naming Binary Compounds

While there are 118 chemical elements, many combinations of the elements make a compound. For our purposes here, a compound comprises two or more components. A binary compound is made up of exactly two different elements. This topic introduces the rules for naming a binary compound – naming a compound with exactly two elements.

Early scientists used common names to describe specific elements and compounds. An easy example of this is salt. The expression "salt" in everyday language refers to table salt used to preserve and flavor food. The word salt was used for centuries before chemistry became a sophisticated science. To chemists, the expression "salt" means something entirely different than the singular meaning of table salt. Many different salts are not table salt.

Table salt is sodium chloride (NaCl), a binary compound. Magnesium chloride (MgC_{l2}) is also a binary compound and a type of salt. While Epsom salt ($MgSO_4$-$7H_2O$) is not a binary compound, it, too, is a type of salt. There are so many combinations of the elements that it is impractical to memorize a simplistic and unique name for every one of the millions of combinations. So, instead, there is an agreed-upon naming method. You can think of it as a set of rules for naming compounds. In this topic, students become familiar with the rules for naming compounds with precisely two different elements.

Naming and Writing Formulas

Students become further acquainted with rules and conventions associated with saying the names and printing the names of various compounds. Naming conventions are introduced for several of the most frequently encountered polyatomic ions. In this instance, the names of common polyatomic ions must be memorized. Common names for polyatomic ions are used in much the same way as a single element. As an example, sodium sulfate (Na_2SO_4) combines the names of sodium (Na, an element) with sulfate (SO_4, an ion). Polyatomic ions are charged entities composed of several atoms bound together. Common polyatomic ions (such as sulfate) have unique names which students must memorize.

Scientific Notation and Units

Measurements include a numeric value and a unit of measure. Most chemistry students have encountered measurement principles many times before reaching this point. Even so, this topic emphasizes several essential aspects of measurement—necessary for applying math skills to chemistry concepts.

A solid mastery of scientific notation and powers of ten provide the basis for many chemistry calculations. Using SI units of measure and the meaning of various prefixes such as "kilo" and "milli" is crucial to a chemistry student. However, applying significant digits, appropriate rounding, and concepts of uncertainty in measurements become essential. Students practice conversions, calculations, units of measure, and critical thinking in this topic.

Atoms and Moles

Compared to other subjects, the periodic table, and its display of the elements (atoms) serve as a chemistry student's visual representation of their subject. Similarly, the mole (abbreviated mol) is the most essential mathematical distinction of chemistry compared to other subjects. Avogadro's number is a mol or 6.022×10^{23}. This topic introduces the mole, such as how "dozen" conveys 12. Reasons behind the usage of the mole, ways to apply it to chemistry calculations, and better grasping the atom's smallness are practiced and discussed.

Combining patterns and other information conveyed by the periodic table and concepts of Avogadro's number became the foundation of many more advanced topics in chemistry.

Formulas of Compounds

This topic distinguishes between an empirical formula and a molecular formula. Both are used to describe compounds. They are similar in several respects but different from each other. They serve various purposes. This topic emphasizes empirical formulas. Even so, it is instructive to understand what a molecular formula is – partially for contrast. A molecular formula provides the composition of the present molecules, whereas an empirical formula expresses the smallest whole-number ratio of atoms present. An example may provide the most apparent difference between the two types of formulas.

Empirical formula: Three molecules have identical empirical formulas. The three molecules in this example are formaldehyde, erythrose, and glucose. Each of these has the same empirical formula, which is CH_2O. This example is the smallest whole-number ratio of atoms in each of these three compounds. All three molecules have the same carbon, hydrogen, and oxygen atoms ratio. For every carbon atom, there are two hydrogen atoms and one oxygen atom.

Molecular formula: In contrast, the molecular formulas of these three molecules are formaldehyde (CH_2O), erythrose ($C_4H_8O_4$), and glucose ($C_6H_{12}O_6$). Notice that the molecular formula describes the total number of atoms present (the composition) within their respective molecules.

Evidence for Chemical Reaction: Not all chemical reactions are visible. Many chemical reactions signal their change through the production of heat (exothermic reaction) – or absorption of heat (endothermic reaction). That said, visible changes often take place too. Examples of visible changes that may (not always) indicate a chemical reaction has taken place are color change, solid formation, bubbles production, or a flame. This topic gives students a grasp of how to identify a chemical reaction's characteristics and learn the information provided by a chemical equation. A chemistry student's essential skill is balancing the chemical equation for a reaction.

Reactions in Aqueous Solutions

While this is not intended as a bio-chemistry topic, students should note that most chemical reactions that make life occur in aqueous solutions. Chemists use a handful of driving forces to predict whether such a reaction will occur. Students explore these: formation of a solid, transfer of electrons, formation of water, and formation of a gas. There are notably a variety of ways to classify reactions.

Further, at least three crucial ways (equation type) describe reactions in solution: molecular formula equations, a complete ionic equation, and a net ionic equation. Because of the importance of reactions in aqueous solutions to life, concepts and techniques presented in this topic apply to a breadth of other scientific principles.

Classifying Reactions

Many chemical reactions involving oxygen produce energy (heat). Such a combustion reaction typically results in a visible flame. Combustion reactions are oxidation-reduction reactions (but not all oxidation-reduction reactions result in combustion). Synthesis (or combination) reactions are another subclass of the oxidation-reduction class of reactions.

Decomposition reactions are yet another subclass of oxidation-reduction reactions. Precipitation and acid-base reactions are essential reactions that differ from oxidation-reduction reactions. Here, familiarity with types, classes, and subclasses of reaction types is emphasized, along with practice in identifying these from a written formula.

Using Chemical Equations

Chemistry is really about reactions. A chemical change is a rearrangement of atoms – as one or more substances change to new substances. Mole-to-mole relationships and mass calculations provide information to practicing chemists and chemistry students. Applying mathematical ratios, making practical use of scientific notation, and thoughtfully comparing both sides of an equation are essential skills for chemistry students to master.

Limiting Reactants and Percent Yield

The limiting reactant (or limiting reagent) is a reactant in a chemical reaction that determines the amount of product that is formed. Identification of the limiting reactant makes it possible to calculate the theoretical yield of a reaction. Of the reactants involved, the reactant that runs out first – and limits the number of products formed – is called the limiting reactant. Using concepts from this topic, students become familiar with essential chemistry skills – calculating percent yield and the theoretical yield of a reaction's products.

Energy Temperature and Heat

Energy is power derived from the use of physical or chemical resources. Energy is mainly used to provide light and heat or to work machines. Heat (or thermal energy) is related to temperature. While we cannot see individual atoms vibrating, we can feel their kinetic energies as temperature. When there's a difference between the temperature of the environment and a system within it, thermal energy is transferred between them as heat. For example, energy flow is called heat if energy transfers from hot water to cold water.

Heat can be defined as a flow of energy due to a temperature difference. Using these concepts, students recognize and categorize chemical reactions where heat flows out of a system (exothermic reaction) and where heat moves into a system (endothermic reaction).

Using Energy in the Real World

Chemistry is connected to other natural sciences. This topic explores a vital intersection between chemistry and physics. When we use energy to do work, we degrade its usefulness.

Two driving forces of nature include energy spread and matter spread. These driving forces are explained through a tendency in nature scientists call entropy. Entropy is a measure of disorder. As energy spread increases, entropy increases. So, too, as matter spread increases, entropy increases.

Further, from the second law of thermodynamics (an important scientific law in physics), we know that the universe's entropy constantly increases. This topic connects chemistry and physics by reviewing the relationship between chemical reactions and entropy.

Atoms and Energy

Atoms are the tiny building blocks of all existing substances. They are so small that we can't even observe with our naked eye. An atom is made up of a nucleus, which has protons and neutrons. And electrons are circling the nucleus in orbitals. Atoms can emit and receive energy. When atoms receive energy, they become excited. Atoms can also release energy by emitting light. A photon carries away the emitted energy.

Atomic Orbitals

Electrons occupy shells around the nucleus of an atom. Electrons move in every direction, but they are limited to their area or the orbit that the electron follows, which is what we call shells. Within each shell, there are subshells. Orbitals are regions within an atom that the electron will most likely occupy.

Orbitals within a shell are divided into subshells with the same value as the angular quantum number. Chemists describe the shell and subshell in which an orbital belongs with a two-character code such as 2p or 4f. The orbital names s, p, d, and f stand for names given to groups of lines initially noted in the spectra of the alkali metals. These line groups are called sharp, principal, diffuse, and fundamental.

Characteristics of Chemical Bonds

Strong chemical bonding generally involves sharing or transferring electrons between the participating atoms. Chemical bonds hold together the atoms in molecules, crystals, metals, and diatomic gases. There are two types of bonds: covalent and ionic. Covalent bonds form when atoms share electrons.

Lewis Structures

Lewis structures, also known as Lewis dot diagrams, Lewis dot formulas, Lewis dot structures, electron dot structures, or Lewis electron dot structures (LEDS), show the bonding between atoms of a molecule and the lone pairs of electrons that may exist in the molecule.

The Lewis structure represents the covalent bonding of a molecule or ion. Covalent bonds are chemical bonds formed by the sharing of electrons in the valence shells of the atoms. The atoms in a Lewis structure tend to share electrons, so each atom has eight electrons (the octet rule).

Describing the Properties of Gases

Gases have three characteristic properties: (1) they are easy to compress, (2) they expand to fill their containers, and (3) they occupy far more space than the liquids or solids from which they form.

The fundamental properties of gases differentiate gases from liquids and solids: (1) A gas has no definite shape or volume; it will expand to fill its container. (2) A gas is easily compressible. (3) Gases form homogeneous mixtures with each other (without exception).

Using Gas Laws to Solve Problems

Gas laws are the physical laws that describe the properties of gases, including Boyle's and Charles' laws.

One of the gas laws chemistry students learn is the ideal gas law. It has four variables. The four gas variables are pressure (P), volume (V), number of moles of gas (n), and temperature (T). Lastly, the constant in the equation shown below is R, known as the gas constant, which will be discussed in depth further later:

$$\underline{\mathbf{PV = nRT}}$$

ideal gas law

Using a Model to Describe Gases

While the most useful of the gas laws is the ideal gas equation, under certain conditions, gases do not obey the ideal gas equation. At high pressures and low temperatures, the properties of gases can deviate significantly from the predictions of the perfect gas equation. This topic addresses the characteristics of the individual gas particles that influence a gas's behavior.

Intermolecular Forces and Phase Changes

Intermolecular forces (IMF) are the forces that that mediate interaction between molecules, including forces of attraction or repulsion, which act between molecules and other types of neighboring particles – such as atoms or ions. While most substances consisting of small molecules are gases at average temperatures and pressures, water is a liquid. Why? The answer has to do with intermolecular forces – those forces which exist between the molecules.

NOTE: Intramolecular forces are forces inside the molecules, holding them together, whereas intermolecular forces are between molecules.

Vapor Pressure and Boiling Point

The pressure of vapor present at equilibrium with its liquid is called the equilibrium vapor pressure – or, more commonly – the vapor pressure of the liquid. The vapor pressures of liquids vary widely. Liquids with high vapor pressures are called volatile – that is, they evaporate rapidly. The vapor pressure of a liquid at a given temperature is determined by the intermolecular forces acting among the molecules. There is a relationship between vapor pressure and the boiling point of a liquid. This topic explores vapor pressure and its relationship to boiling point.

Properties of Solids

Most solids contain mixtures of various components. Some naturally occurring solids are almost pure substances. Crystalline solids are explored in this topic. There are three categories of crystalline solids: ionic, molecular, and atomic. Table salt (NaCl) is an example of an ionic solid. Frozen water (frozen H2O) is an excellent example of a molecular solid. A pure diamond is an example of a solid made from only one type of atom – carbon (C). Several careers-types require a deep understanding of the properties of solids. Some examples of these include material scientists, metallurgical engineers, and crystallographers.

Solution Composition and Properties

There are several ways in chemistry to describe the composition of a solution. One way is through a solution's mass percentage.

Another similar way is to tell a solution's concentration – often expressed as molarity (M or mol).

There are some essential conventions chemistry students should become familiar with, such as solute concentration, which is always written in terms of the form of the solute before it dissolves.

Because math becomes crucial in chemical formulation, conventions like this one become increasingly important as the need for precision increases.

New terms such as "standard solution" and "dilution" have specific meanings in chemistry. Some of the latest expressions also convey new concepts – such as "colligative property" (a solution property that depends on the number of solute particles present).

This topic may initially seem overly concerned with precise meaning and exactness of measurement. And it is.

Especially for students with an eye toward college-level chemistry, this topic introduces ideas that set them up for future success in upper-level chemistry pursuits.

Plasma Gas Liquid Solid (Not)

So far, students have been shown that matter exists as plasma, gas, liquid, or solid. This topic introduces some "not-so-cut-and-dry" categories of matter, including non-classical states of matter, low-temperature states of matter, and high-energy states of matter. Students research, explore and discuss a matter that could be more easily categorized: glass, crystals with some degree of disorder, liquid crystal states, microphase-separated matter, magnetically ordered matter, degenerate matter, and superfluid.

Acids and Bases

Beyond the general notions of acids and bases introduced in physical science (for example), this advanced review examines two relevant models: the Arrhenius and the Brønsted-Lowry Model. Students discuss similarities and differences between weak vs. strong acids – and the determination of the acidity of a solution. Concepts of titration, the titration curve (also called the pH curve), and discussions of buffered solutions are reviewed.

Equilibrium

In everyday language, synonyms of "equilibrium" include balance, symmetry, parity, equality, and stability. These everyday words may suggest that "things have stopped – and activity is static." While it is true the expression equilibrium in chemistry applies to the absence of changes in concentrations of reactants or products – at the molecular level, things are dynamic, not static. Here, students are introduced to the law of chemical equilibrium (once called "the law of mass action"). Volume and pressure changes are examined for their respective impact on equilibrium. Students further familiarize themselves with concepts dealing with solubility and usages of the equilibrium constant (denoted as "K").

Oxidation-Reduction Reactions

Oxidation is an increase in the oxidation state (a loss of electrons). In contrast, the reduction is a decrease in the oxidation state (or a gain of electrons). Students examine how balancing oxidation-reduction reactions can be accomplished by multiple methods. In particular, the trial and error method is commonly used as a first try (this may be called the "inspection method" elsewhere). Another method is "half-reactions."

A half-reaction is either a redox reaction's oxidation or reduction reaction component. A half reaction is achieved/calculated by considering the change in oxidation states of individual substances involved in the response). Students briefly review concepts of electrochemistry in the context of lead storage and dry cell batteries. Students examine the relationship and dependency of these battery types on chemistry's redox reactions.

Organic Chemistry

This last and final topic lightly introduces generalized concepts associated with the advanced organic chemistry topic. Often, college-level chemistry begins with an entire semester of inorganic chemistry (Chem I) – preceding a semester of organic chemistry (Chem II). Students become acquainted with the importance of carbon (C).

Various formulas related to Alkanes and their naming conventions are touched upon. Contrasts and comparisons of Alkenes and Alkynes are briefly examined.

Last, a few conventions for naming Aromatic compounds are introduced. This topic does not aim for application or higher-level considerations of the subject matter. Instead, students should strive to become initially familiar with basic ideas and concepts, preparing them for more advanced pursuits at a collegiate level.

End Year Capstone

Knowledge of chemistry is helpful to everyone. Throughout this course, we have examined that chemistry occurs all around us – all the time. This understanding and appreciation for chemistry is useful for various jobs and industries. Chemistry is at the forefront and center of many vital aspects of our daily lives. During this course, students encountered fundamentals of matter and the periodic table, formulas of compounds and solutions, calculation techniques, atoms and bonds, basics of gas, examinations of solids and solutions, and a handful of more advanced topics.

Because chemistry is involved with materials we use, energy sources we consume, control of diseases, food supply processes, medicines, and other aspects, chemistry bridges other natural sciences. Over this class year, students have acquainted themselves with a new perspective of the universe's microscopic world of wonder. Most importantly, they have better prepared themselves for their future.

Questions

True/False

1. Chemistry is not relevant to various jobs and industries.

Answer: False

2. All elements displayed on the periodic table naturally occur on Earth.

Answer: False

3. The periodic table is laid out intentionally in columns and rows.

Answer: True

4. The first column of elements in the periodic table is called Alkaline earth metals.

Answer: False

5. All matter has both physical and chemical properties.

Answer: True

6. An element is a substance that can be broken down using chemical reactions.

Answer: False

7. There are 100 elements displayed on the periodic table.

Answer: False

8. Chemistry students learn to recognize types of change, such as physical and chemical changes.

Answer: True

9. The periodic table provides much information about each known element.

Answer: True

10. Binary compounds are compounds made of only one element.

Answer: False

Multiple Choice

1. What is the primary purpose of the chemistry introduction?

a) To explore the periodic table

b) To understand the physical properties of matter

c) To provide a broad overview of chemistry and its relevance to aspects of daily life

d) To study the atomic nature of matter

Correct answer: c)

2. What is the simplest definition of matter?

a) Something that takes up space

b) Something that has mass and occupies space

c) Something visible

d) Something tangible

Correct answer: b)

3. What are examples of physical properties of matter?

a) Density and reactivity

b) Volume and boiling point

c) Flammability and color

d) Acidity and odor

Correct answer: b)

4. How many naturally occurring elements are there on Earth?

a) 92

b) 100

c) 118

d) 50

Correct answer: 92

5. What is the purpose of the periodic table?

a) To arrange elements in alphabetical order

b) To provide information about each known element

c) To categorize compounds

d) To list the elements in order of their atomic mass

Correct answer: b)

6. Which column of elements in the periodic table is called the Alkaline earth metals?

a) First column

b) Second column

c) Third column

d) Fourth column

Correct answer: b)

7. What is the number of protons in one atom of an element called?

a) Atomic mass

b) Atomic weight

c) Atomic number

d) Proton number

Correct answer: c)

8. What are binary compounds?

a) Compounds made of two elements

b) Compounds made of one element

c) Compounds made of three elements

d) Compounds made of multiple elements

Correct answer: a)

9. According to the text, What is the primary goal of chemistry students?

a) To explore the microscopic world

b) To identify ways to solve real-world problems

c) To prepare for their future

d) All of the above

Correct answer: d)

10. What is the total number of elements displayed on the periodic table?

a) 92

b) 100

c) 118

d) 50

Correct answer: c)

Basic Thinking Prompts

1. Name three ways chemical processes happen in our daily lives.

2. What ways can chemistry help us understand how something works?

   In our body?

   In a car?

   In a recipe?

   In a pond or lake?

3. Why do scientists like to have chemistry symbols organized on a wall chart?

4. Give examples of how chemistry is used in different jobs.

   At a doctor’s office?

   In the cleaning business?

   When protecting the environment?

5. How does chemistry overlap with other sciences?

   With biology?

   With Earth science?

   With rocket science?

Simplified Critical Thinking

1. Why is it important to learn about chemistry, and how does it affect our daily lives?

2. How do the properties of things around us help us understand how they work?

3. Why is the periodic table important for scientists, and how does it help them study elements?

4. Can you give examples of how chemistry is used in healthcare, business, and environmental protection?

5. How does studying chemistry help us understand how different areas of science are connected?

Critical Thinking

1. How does understanding chemistry impact various aspects of our daily lives, and why must students recognize its relevance?

2. In what ways do the physical and chemical properties of matter manifest in the world around us, and how do these properties contribute to our understanding of natural phenomena?

3. Why is the periodic table considered a fundamental tool for chemists, and how does its structure and organization assist in studying and communicating chemical elements?

4. What are some real-world examples of applying chemistry principles in different fields such as healthcare, business, and environmental science?

5. How does the study of chemistry contribute to our understanding of the natural world and the interconnectedness of various scientific disciplines?

Advanced Critical Thinking Prompts

1. How does understanding chemistry impact various aspects of our daily lives, and why must students recognize its relevance?

2. In what ways do the physical and chemical properties of matter manifest in the world around us, and how do these properties contribute to our understanding of natural phenomena?

3. Why is the periodic table considered a fundamental tool for chemists, and how does its structure and organization assist in studying and communicating chemical elements?

4. What are some real-world examples of applying chemistry principles in different fields such as healthcare, business, and environmental science?

5. How does the study of chemistry contribute to our understanding of the natural world and the interconnectedness of various scientific disciplines?

Vocabulary

Alkali metals: Alkali metals are a group of chemical elements in the periodic table that are highly reactive, have one electron in their outer shell, and are found in Group 1 of the periodic table.

Alkaline earth metals: Alkaline earth metals are a group of chemical elements in the periodic table that are reactive but less so than the alkali metals, have two electrons in their outer shell, and are found in Group 2 of the periodic table.

Atomic - relating to an atom or atoms

Chemical - relating to chemistry or the interactions of substances as studied in chemistry

Chemistry - the study of the composition, structure, properties, and reactions of matter

Combustion - the process of burning something

Compounds - a thing that is composed of two or more separate elements

Digestion - the process of breaking down food by mechanical and enzymatic action in the alimentary canal into substances that can be used by the body

Elements - a substance whose atoms all have the same number of protons

Identifier - a symbol or name that identifies something

Matter - physical substance in general, as distinct from mind and spirit

Minerals - a solid inorganic substance of natural occurrence

Oceans - a very large expanse of sea, in particular, each of the main areas into which the sea is divided geographically

Periodic Table - a tabular arrangement of the chemical elements, organized by their atomic number, electron configuration, and recurring chemical properties

Physical - relating to the body as opposed to the mind

Physiology - the branch of biology that deals with the normal functions of living organisms and their parts

Properties - a quality or trait belonging to an individual or thing

Protons - a stable subatomic particle occurring in all atomic nuclei

Rusting - the chemical reaction of iron and oxygen in the presence of water or moisture, leading to the formation of rust

Transition metals: Transition metals are a group of chemical elements in the periodic table that have partially filled d or f electron subshells. They exhibit multiple oxidation states and form complex ions. They are found in the central block of the periodic table.