AL HUDA SCIENCE ACADEMY

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Most Important Short Questions with Answers of Chemistry

Question No. 2 (Short Questions)

Q1: Why is there a need to divide Chemistry into many branches? Give three reasons. Chemistry is divided into branches to manage the subject's vast complexity and allow scientists to focus on specific aspects. Firstly, it enables researchers to concentrate on distinct areas of study to achieve targeted breakthroughs and advancements. Secondly, it provides a structured way to investigate how substances behave at different levels, such as the atomic or molecular scale. Thirdly, specialized branches like physical chemistry help optimize industrial conditions for chemical reactions.

Q2: Most of the molecules we study in biochemistry are organic in nature. Where does the difference exist in organic and biochemistry branches of Chemistry? Organic chemistry is the broad study of all carbon compounds, specifically hydrocarbons and their derivatives, excluding simple salts like carbonates. Biochemistry, however, is the specific study of chemical substances and vital processes that occur exclusively within living organisms. While organic chemistry looks at the structure and properties of carbon molecules in any context, biochemistry provides insights into the function of molecules like proteins and lipids in life processes.

Q3: Difference between organic and inorganic chemistry. Organic chemistry focuses on the study of carbon compounds, primarily hydrocarbons and their derivatives, which are found in and are essential for life. In contrast, inorganic chemistry deals with the synthesis, composition, and properties of elements and compounds that contain little or no carbon. Inorganic substances include metals, nonmetals, salts, acids, and bases, whereas organic chemistry is centered on the arrangement and reactions of carbon-containing matter.

Q4: Difference between environmental and Analytical chemistry. Environmental chemistry is the scientific study of chemical and biochemical phenomena in the air, soil, and water environments of our planet. Analytical chemistry is the branch that deals with the analysis of substances through separation, identification, and concentration determination of components. While environmental chemistry focuses on the causes and effects of pollution, analytical chemistry uses sophisticated instruments to determine the exact makeup of material things.

Q5: Difference between polymer and geochemistry. Polymer chemistry focuses on the properties, structure, and synthesis of large molecules called polymers and macromolecules, such as proteins and cellulose. Geochemistry is the study of the chemical composition of the Earth, including its minerals and natural sources. Polymer chemistry is often concerned with building blocks and synthesis, while geochemistry applies chemical mapping to minerals exploration and environmental monitoring.

Q6: What is meant by nuclear process? A nuclear process refers to the reactions and transformations that take place specifically within the nuclei of atoms. This field of study involves radioactivity and the changes that occur to fundamental particles inside the nucleus rather than just electron interactions. These processes have widespread applications in diverse fields such as medicine, agriculture, industry, and scientific research.

Q7: Write the importance of inorganic Chemistry. Inorganic chemistry is vital because it covers the study of metals, nonmetals, and their mixtures, which form the basis of many materials. Inorganic compounds are essential for modern life, as they are used to produce fertilizers, medicines, and

catalysts. Additionally, this branch is responsible for developing pigments and various coatings that are used extensively in industrial and commercial applications.

Q8: Define environmental chemistry with its scope. Environmental chemistry is the scientific study of chemical and biochemical phenomena that occur on Earth. Its scope includes the study of sources, reactions, effects, and the ultimate fates of chemical species in air, soil, and water. It is a critical discipline for understanding human impact on the environment and developing solutions for different types of pollution.

Q9: What do you know about analytical chemistry? Analytical chemistry is the branch of science dedicated to the systematic analysis of different material substances. It involves three main processes: the separation of components, their identification, and the determination of their concentration in a sample. Today, this field relies heavily on the use of modern and sophisticated instruments to provide precise data about the composition of matter.

Q10: Define nuclear chemistry and also write its application. Nuclear chemistry is the study of reactions, radioactivity, and transformations that occur specifically within the nucleus of an atom. It has a wide range of practical applications, including the improvement of crops in agriculture and diagnostic imaging in medicine. Furthermore, it is used in industrial processes for power generation and in scientific research to understand the fundamental building blocks of matter.

Q11: What are polymers? Also define polymer Chemistry. Polymers are very large molecules created by linking together a continuous series of smaller building blocks called monomers. Polymer chemistry is the specific branch that investigates the properties, structure, and chemical synthesis of these macromolecules. This field covers both synthetic materials and naturally occurring polymers found in living organisms, such as nucleic acids and proteins.

Q12: What is the role of Medicinal Chemistry in our life? Medicinal chemistry plays a critical role in human health by focusing on the design and synthesis of drugs and medicines. This branch involves discovering new treatments and studying how these substances are absorbed and metabolized in the human body. By understanding drug delivery and metabolism, medicinal chemists develop beneficial treatments that improve the quality of life for mankind.

Q13: Why compound show a chemical formula? Compounds are represented by chemical formulas because they are pure substances made of different elements combined in fixed ratios. The formula, such as H_2O for water, identifies the specific types of atoms and the exact number of each atom bonded together in one molecule. It provides a standardized way to communicate the composition of a compound and the chemical bonds that hold it together.

Q14: Differentiate between homogeneous mixture and heterogeneous mixture. A homogeneous mixture is a solution where the concentration and composition of components are uniform throughout the entire sample, like salt in water. In contrast, a heterogeneous mixture has a non-uniform composition, meaning the concentration of its constituents varies in different parts. An everyday example of a heterogeneous mixture is a sample of rock, which consists of various distinct minerals like granite and mica.

Q15: Differentiate between element and compound. An element is the simplest form of matter, consisting of a pure substance made of only one kind of atom that cannot be broken down further by

ordinary reactions. A compound is also a pure substance but is formed by the chemical combination of two or more different elements in a fixed ratio. Elements are represented by single symbols (e.g., Na), while compounds are represented by formulas that show multiple types of bonded atoms (e.g., NH_3).

Q16: Differentiate between compound and mixture. A compound is formed by the chemical combination of atoms in a fixed weight ratio, resulting in a substance with entirely new properties. A mixture is formed by physically mixing elements or compounds in any ratio, where each component retains its original identity and properties. Compounds can only be broken down by chemical reactions, whereas mixtures can be separated into their components through physical methods.

Q17: What is meant by symbol or element? Give example. A symbol is a short, standardized representation used for an element when it exists in the form of atoms. It typically consists of one or two letters derived from the element's name to identify it uniquely. For example, the element sodium is represented by the symbol Na, and the element calcium is represented by the symbol Ca.

Q18: Name the elements that exist in liquid state. While most elements on Earth exist as solids, a very small number are naturally present in liquid form. The primary examples of elements that exist in a liquid state under standard conditions are mercury (Hg) and bromine (Br). Mercury is a metallic element, whereas bromine is a non-metal that exists as a volatile fuming liquid.

Q19: Define solution. Give few characteristics of true solution. A solution is a homogeneous mixture in which solute particles are completely and uniformly distributed within a solvent. In a "true solution," the solute particles are so small that they cannot be seen with the naked eye. Key characteristics include that the particles do not settle upon standing and they pass through the pores of filter paper without leaving any residue.

Q20: Define suspension. Give few characteristics of suspension. A suspension is a heterogeneous mixture in which the solute particles do not dissolve in the solvent and remain visible to the eye. Characteristic features include that the particles eventually settle down if the mixture is left undisturbed. Furthermore, when a suspension is filtered, the particles are too large to pass through and are collected as a residue.

Q21: Define colloidal solution. Give few characteristics of colloidal solution. A colloidal solution is a type of mixture where solute particles do not homogenize with the solvent but are not large enough to be seen with the naked eye. Characteristics include that these particles are slightly larger than those in a true solution but do not settle over time. Like true solutions, colloidal particles can pass through standard filter paper during the process of filtration.

Q22: What are true solutions? True solutions are specific homogeneous mixtures where the solute particles have been completely distributed at a molecular level within the solvent. They are distinguished by their transparency and the fact that their solute components are invisible even under standard observation. Because of their extremely small particle size, they pass through filters perfectly and never settle to the bottom of a container.

Q23: Define a saturated solution and give example. A saturated solution is one in which the maximum possible amount of solute has been dissolved in a specific amount of solvent at a particular temperature. At this stage, any additional solute added to the beaker will not dissolve and will instead

settle at the bottom. An example is adding 36g of sodium chloride to 100g of water at 20°C, which forms a saturated solution.

Q24: Differentiate between saturated and unsaturated solution. A saturated solution contains the maximum amount of dissolved solute possible for a given volume and temperature, while an unsaturated solution can still dissolve more. In an unsaturated solution, adding more solute and stirring will result in further dissolution. In a saturated solution, however, the solvent's capacity is full, and additional solute will simply settle as a solid at the bottom.

Q25: Why is it said almost all the mass of an atom is concentrated in its nucleus? This statement is based on the fact that the nucleus contains both protons and neutrons, which are the heaviest fundamental particles of an atom. Electrons revolve in the space outside the nucleus but have such a tiny mass that they contribute negligibly to the total weight. Experimental evidence shows the nucleus occupies less than 1/100,000th of the atom's volume but holds over 99.9% of its mass.

Q26: Why does the energy of electron increase as we move from first shell to second shell? According to Bohr's atomic model, electrons revolve in specific orbits or shells that act as fixed energy levels. The energy of an electron is at its minimum when it is in the ground state, which is the shell closest to the nucleus (K shell). As an electron moves to a shell further away, such as the L shell, its energy increases successively because larger shells correspond to higher energy states.

Q27: Why is it needed to lower the pressure of the gas inside the discharge tube? Lowering the gas pressure is necessary to facilitate the passage of electricity and the emission of rays during discharge tube experiments. When high voltage is applied to a gas at very low pressure, it allows the cathode rays to travel through the tube and cause the glass surface to glow. This reduced pressure creates an environment where subatomic particles can be observed and their properties analyzed.

Q28: What is the classical concept of an electron? How has this concept changed with time? Classically, an electron was viewed as a negatively charged material particle that revolves around the nucleus in fixed, definite circular paths called orbits. With time, the modern approach has changed this view, describing electrons as "charged clouds" instead of particles in fixed paths. Due to the uncertainty principle, we now say there is only a certain probability of finding an electron at a probable distance from the nucleus.

Q29: Define nuclear force. Nuclear force is the strong, attractive force that exists specifically within the tiny central portion of an atom known as the nucleus. This force is responsible for holding the fundamental particles—protons and neutrons—tightly together. It is a powerful interaction that overcomes the electromagnetic repulsion between protons, ensuring the stability of the atom's core.

Q30: Differentiate between shell and sub shell with example of each. A shell, also called an orbit, is a main energy level where electrons revolve at a fixed distance from the nucleus, such as the K shell (n=1) or L shell (n=2). Each shell is further divided into sub-shells (orbitals) like s, p, d, and f, where the number of sub-shells equals the shell's value. For example, the second shell (L) contains two sub-shells: 2s and 2p.

Q31: Discuss characteristics of cathode rays. Cathode rays carry a negative charge, as demonstrated by their consistent deflection toward the positive plate in an electric field. They consist of material particles that are also diverted by magnetic fields, confirming their material nature. J.J. Thomson's experiments

proved these rays are made of electrons, which are universal subatomic particles present in all elements.

Q32: Write the contributions of Neil Bohr's. Niels Bohr proposed a revolutionary model for the hydrogen atom in 1913, introducing the concept of fixed circular paths called orbits or shells. He postulated that electrons revolve in these shells without radiating energy, and each shell has a fixed energy level. His model explained that energy is only absorbed or evolved when an electron moves between these specific orbits.

Q33: What are electrons and protons? Electrons are negatively charged fundamental subatomic particles that revolve around the nucleus in specific energy levels called shells. Protons are positively charged subatomic particles that reside within the central nucleus and are 1836 times heavier than electrons. While electrons carry a charge of -1.6022×10^{-19} C, protons carry an equal but opposite positive charge of $+1.6022 \times 10^{-19}$ C.

Q34: How did J.J Thomson discover the charge of the cathode rays? J.J. Thomson discovered the charge by passing cathode rays through a discharge tube equipped with two oppositely charged electric plates. He observed that the rays consistently bent toward the positively charged plate, proving they carried a negative charge. He also confirmed this result by using magnets on either side of the tube to observe their magnetic deflection.

Q35: Define shell according to Bohr's Atomic model. According to Bohr's model, a shell (or orbit) is a specific, fixed circular path around the nucleus where an electron revolves with a constant energy. Each shell represents a distinct energy level identified by letters like K, L, M, and N, or numbers like n=1, 2, 3. Electrons can only occupy these fixed shells and are not allowed to exist in the space between them.

Q36: Write postulates of Bohr's Atomic model. Bohr postulated that electrons revolve in fixed circular orbits around the nucleus, each having a specific, fixed amount of energy. A second postulate states that the energy of an electron remains constant as long as it stays in its specific orbit. Additionally, the orbit nearest to the nucleus has the lowest energy, and higher orbits possess successively greater energy.

Q37: What are energy levels? Give example. Energy levels are the fixed circular paths (shells) around the nucleus in which electrons revolve with a specific amount of constant energy. These levels are designated by the principal quantum number 'n' or letters K, L, M, and so on. For example, the K shell (n=1) is the first energy level and has the minimum energy, while the L shell (n=2) is the second level with higher energy.

Q38: How many subshells are present in each shell? Briefly explain. The number of sub-shells in any given shell is exactly equal to the principal quantum number 'n' of that shell. For the first shell (K, n=1), there is only one sub-shell called the 's' sub-shell. The second shell (L, n=2) contains two sub-shells, 's' and 'p', and this pattern continues as n increases to include d and f sub-shells.

Q39: Define proton number and Atomic number. The atomic number (symbolized as Z) is defined as the total number of protons present in the nucleus of an atom of an element. This number is unique to each element and serves as its fundamental identification in the periodic table. For example, oxygen has 8 protons in its nucleus, so its atomic number is 8.

Q40: Define Nucleon number and atomic mass. The nucleon number, or mass number (symbolized as A), is defined as the total sum of protons and neutrons in an atom's nucleus. Since electrons have very little mass, the nucleon number accounts for nearly the entire weight of the atom. For instance, an atom with 6 protons and 6 neutrons has a mass number of 12.

Q41: Why atom is neutral? An atom is electrically neutral because it contains an equal number of positively charged protons and negatively charged electrons. Since the positive charge of one proton exactly cancels out the negative charge of one electron, the net charge is zero. Protons are located in the nucleus, while an equal count of electrons revolves around it in shells.

Q42: Calculate the number of neutrons, protons and electrons in the following atoms: Mn-55, Pt-195, I-127.

1. **Manganese-55 (^{55}Mn)** — Atomic Number (Z): 25, Mass Number (A): 55
    - Protons = Z = 25
    - Electrons = Z = 25
    - Neutrons = A − Z = 55 − 25 = 30
2. **Platinum-195 (^{195}Pt)** — Atomic Number (Z): 78, Mass Number (A): 195
    - Protons = Z = 78
    - Electrons = Z = 78
    - Neutrons = A − Z = 195 − 78 = 117
3. **Iodine-127 (^{127}I)** — Atomic Number (Z): 53, Mass Number (A): 127
    - Protons = Z = 53
    - Electrons = Z = 53
    - Neutrons = A − Z = 127 − 53 = 74

Q43: Define atomic mass unit. Why is it needed? An atomic mass unit (amu) is defined as exactly one-twelfth (1/12th) of the mass of a single atom of carbon-12. It is needed because atoms are so incredibly small that their masses cannot be measured in standard units like grams or kilograms. The amu provides a convenient relative scale to compare the masses of different atoms.

Q44: Define relative isotopic mass. How relative atomic mass can be determined? Relative isotopic mass refers to the mass numbers of the individual isotopes that make up an element. The overall relative atomic mass of an element is determined by calculating the weighted average of these masses based on their natural abundance. This is done using a specific formula: (mass of isotope 1 × abundance + mass of isotope 2 × abundance ...) / 100.

Q45: What is meant by carbon dating or radio carbon dating? Radiocarbon dating is a scientific method used to find the age of historical organic objects using the radioactive isotope carbon-14 (^{14}C). By measuring the proportion of ^{14}C remaining in a sample, like a bone or piece of wood, scientists can calculate when the organism died. The older a sample is, the less radioactive carbon is detectable in it.

Q46: Define relative atomic mass. Also write its units. Relative atomic mass is defined as the average mass of an atom of an element compared to 1/12th the mass of a carbon-12 atom. It accounts for the different isotopes of the element and their respective abundances in nature. The standard unit used for this measurement is the atomic mass unit, abbreviated as amu.

Q47: Define atomic mass unit (amu). The atomic mass unit (amu) is a standard unit of mass used by chemists to quantify the mass of atoms and molecules. It is defined precisely as one-twelfth of the mass of a single atom of the carbon-12 isotope. One amu is numerically equal to approximately 1.67377×10^{-27} kilograms.

Q48: What type of elements lose their outer electron easily and what type of elements gain electron easily? Metals, such as alkali and alkaline earth metals, have low ionization energy and tend to lose their outer electrons easily to form positive ions. Conversely, non-metals have a high affinity for electrons and tend to gain them easily to become negatively charged ions. This difference is fundamental to how these elements form chemical bonds.

Q49: What is meant by duplet rule? The duplet rule is a principle of stability stating that atoms with only the first shell (like hydrogen and helium) are stable when they possess two electrons. Atoms will gain, lose, or share electrons specifically to complete this two-electron configuration. Achieving a duplet makes these atoms unreactive and energy-stable, similar to the noble gas helium.

Q50: What is meant by octet rule? The octet rule states that atoms are most stable and unreactive when they possess eight electrons in their outermost shell. Most elements react by transferring or sharing electrons to reach this stable configuration of noble gases like neon or argon. Completing an octet allows an atom to reach its lowest possible energy state.

Q51: Differentiate between Electropositive and Electronegative elements. Electropositive elements, which are mostly metals, have a strong tendency to lose electrons and form positive ions called cations. Electronegative elements, which are non-metals, have a high affinity for electrons and tend to gain them to form negative ions called anions. Electropositivity is related to reactivity in metals, while high electronegativity defines non-metals like fluorine.

Q52: How do atoms succeed in lowering their energy? Atoms lower their energy by combining with other atoms to form stable chemical bonds. They achieve this by either completely transferring electrons (ionic bond) or mutually sharing them (covalent bond) to complete their outermost shell. Forming these bonds results in a dominant force of attraction that lowers the total energy of the system.

Q53: Why Noble gases are stable elements? Noble gases are stable because they possess a complete outermost shell, with helium having a duplet and others having an octet. This full electronic configuration represents a state of maximum stability and minimum energy. Because their shells are full, they have no tendency to gain, lose, or share electrons with other atoms.

Q54: What is principle of stability? The principle of stability states that atoms naturally tend to decrease their total energy to reach a more stable state. They do this by interacting with other atoms to complete their duplet or octet electronic configurations. Achieving these complete shells through chemical bonding increases the atom's overall stability and reduces its reactivity.

Q55: Why do atoms form bonds? Atoms form bonds to satisfy the duplet or octet rule and achieve a stable electronic configuration similar to noble gases. By gaining, losing, or sharing electrons, they decrease their total energy and become more stable. The resulting attractive forces between atoms hold them together as stable molecules or compounds.

Q56: Write down dot and cross formula of HNO_3. The dot and cross formula of nitric acid (HNO_3) shows the arrangement of shared and donated electron pairs around the central nitrogen atom. Nitrogen forms one single covalent bond with an oxygen atom that is also bonded to hydrogen, one double bond with another oxygen, and a coordinate covalent bond with the third oxygen. The formula uses dots for one atom's electrons and crosses for the other to show these sharing relationships.

Q57: How many oxides does nitrogen form? Write down the formulae of oxides. Nitrogen forms several different types of oxides depending on the reaction conditions. These include Nitrous Oxide (N_2O), Nitric Oxide (NO), and Nitrogen Dioxide (NO_2). Other forms like Nitrogen Trioxide (N_2O_3) and Nitrogen Pentoxide (N_2O_5) are also possible. These oxides are often gases at room temperature.

Q58: Define electronic configuration. Electronic configuration is defined as the specific arrangement of electrons in various shells and sub-shells around the nucleus of an atom. It follows rules for filling the lowest energy levels (like s, p, d, and f) first until all electrons are accommodated. This arrangement is critical because it determines the chemical properties and bonding behavior of the element.

Q59: Define covalent bond with two examples. A covalent bond is a chemical bond formed by the mutual sharing of one or more electron pairs provided by the bonded atoms. Each atom contributes electrons to the shared pair to achieve a stable octet or duplet. Two classic examples are the hydrogen molecule (H_2), which has a single bond, and the oxygen molecule (O_2), which has a double bond.

Q60: Define coordinate covalent bond and show this bonding in hydroxonium ion. A coordinate covalent bond is a type of covalent bond where the entire shared electron pair is donated by only one of the bonded atoms. In the hydroxonium ion (H_3O^+), a water molecule (H_2O) acts as a donor by providing one of its lone pairs of electrons to a hydrogen ion (H^+). The proton (H^+) has an empty outer shell and acts as the acceptor for these electrons.

Q61: Describe the application of ionic compounds. Ionic compounds have numerous essential applications, such as sodium chloride, which is used as table salt and to produce sodium metal and chlorine gas via electrolysis. Many are used as medicines, fertilizers, and catalysts in industrial chemical processes. They also serve as pigments and coatings, and their properties are vital in the construction and electronics industries.

Q62: Why do the ionic compounds have high melting and boiling points? Ionic compounds have high melting and boiling points because they consist of oppositely charged ions held together by extremely strong electrostatic forces of attraction. These ions are arranged in a rigid, three-dimensional crystal lattice that requires a large amount of thermal energy to break. For example, sodium chloride has a high melting point of 801°C due to these powerful forces.

Q63: Ionic compounds are solids. Justify. Ionic compounds are typically solids because their oppositely charged ions are tightly held in a stable, repetitive arrangement called a crystal lattice. The strong electrostatic attraction between the ions pulls them close together, making the structure rigid and

incompressible. This stable three-dimensional arrangement ensures they remain in the solid state under standard room conditions.

Q64: What is meant by bonding electrons? Bonding electrons are those specific electrons in an atom's outermost shell that are directly involved in forming a chemical bond. In covalent bonding, these electrons are mutually shared between two nuclei to reach a stable configuration. In ionic bonding, they are the specific electrons that are completely transferred from one atom to another to create charged ions.

Q65: What is meant by covalent bond? A covalent bond is a force of attraction that holds atoms together through the mutual sharing of one or more electron pairs. It typically forms between non-metal atoms that have similar electronegativities. By sharing electrons, both bonded atoms succeed in acquiring the stable electronic configuration of the nearest noble gas.

Q66: What is meant by single covalent bond? A single covalent bond is formed when two atoms mutually share exactly one pair of electrons between them. It is represented by a single short line (-) drawn between the symbols of the two bonded atoms. Common examples of molecules containing single covalent bonds include hydrogen (H_2) and hydrogen chloride (HCl).

Q67: What is meant by double covalent bond? Give examples. A double covalent bond occurs when two atoms share two pairs of electrons, with each atom contributing two electrons to the bond. It is represented by two parallel lines (=) and is generally stronger than a single bond. Prime examples include the oxygen molecule (O=O) and the carbon-carbon bond in ethene (C_2H_4).

Q68: What is a triple covalent bond? Explain with an example. A triple covalent bond is formed when two atoms share three pairs of electrons, requiring each atom to contribute three of its own electrons. It is represented by three short lines (≡) and provides a very high bond strength. A well-known example is the nitrogen molecule (N_2), where two nitrogen atoms are linked by three shared electron pairs (N≡N).

Q69: Define coordinate covalent bond. A coordinate covalent bond is a specialized type of covalent bond where both electrons in the shared pair are provided by only one of the bonded atoms. The atom providing the pair is called the donor, while the one receiving it is the acceptor. It is represented by an arrow (→) pointing from the donor atom toward the acceptor atom.

Q70: How is coordinate covalent bond formed in NH_4^+? In the ammonium ion (NH_4^+), an ammonia molecule (NH_3) acts as a donor by providing its nitrogen's lone pair of electrons. A hydrogen ion (H^+), which has an entirely empty outer shell, acts as the acceptor for this pair. This sharing creates a coordinate covalent bond that binds the proton to the ammonia, spreading the positive charge over the entire ion.

Q71: Differentiate between donor and acceptor atom. In coordinate covalent bonding, the donor is the specific atom or molecule that possesses a lone pair of electrons and provides both to the bond. The acceptor is the species that has an empty outer shell or orbital capable of receiving that provided electron pair. For example, in the reaction between NH_3 and BF_3, ammonia is the donor and boron trifluoride is the acceptor.

Q72: Why is BF_3 electron deficient? Boron trifluoride (BF_3) is considered electron deficient because the central boron atom has only six electrons in its outermost shell after forming three bonds. Since it has

not reached a stable octet of eight electrons, it possesses a partially empty outer shell. This makes BF_3 an ideal acceptor species that can form coordinate covalent bonds with electron donors like ammonia.

Q73: How hydronium ion is formed? A hydronium ion (H_3O^+) is formed when an acid dissolves in water and releases a proton (H^+). This proton has an empty outer shell and accepts a lone pair of electrons from the oxygen atom in a water molecule. This resulting coordinate covalent bond links the proton to the water, creating the positively charged H_3O^+ species.

Q74: Define chemical bond. A chemical bond is a fundamental force of attraction that exists between atoms to hold them together in the form of a molecule or compound. It is formed when atoms interact to lower their total energy and achieve the stable electronic configuration of the nearest noble gas. Major types include ionic, covalent, coordinate covalent, and metallic bonds.

Q75: How single, double and triple covalent bonds are represented? Single covalent bonds are represented by a single short line (-) drawn between the symbols of the bonded atoms. Double covalent bonds are shown using two parallel lines (=), while triple covalent bonds are indicated by three parallel lines (≡). Additionally, these bonds can be illustrated using dot and cross diagrams to show the specific shared electron pairs.

Q76: Give examples of each double and triple covalent bond. A double covalent bond is found in the oxygen molecule (O=O) and in the carbon dioxide molecule (O=C=O). A triple covalent bond is present in the nitrogen molecule (N≡N) and in hydrogen cyanide (H−C≡N). In each case, multiple electron pairs are mutually shared to reach a stable octet for each atom.

Q77: Draw dot and cross structure of Ammonia and Hydrogen cyanide. For ammonia (NH_3), the central nitrogen atom shares three valence electrons with three separate hydrogen atoms, leaving one lone pair on nitrogen. For hydrogen cyanide (HCN), the carbon atom forms a single covalent bond with hydrogen and a triple covalent bond with the nitrogen atom. Dot and cross notation uses different symbols to represent which atom originally provided each electron.

Q78: Differentiate between polar covalent bond and non-polar covalent bond. A non-polar covalent bond forms between two identical atoms where the shared electron pair is equally attracted by both nuclei and lies in the middle. A polar covalent bond occurs between different atoms with unequal electronegativities, causing the shared pair to shift toward the more electronegative atom. This shift creates partial positive and negative charges at the opposite ends of the bond.

Q79: Define donor and acceptor. In the context of coordinate covalent bonding, a donor is an atom or molecule that provides both electrons to form a shared pair. An acceptor is a chemical species that possesses an empty orbital or shell and receives that pair of electrons to complete its octet. This one-sided donation is represented by an arrow pointing toward the acceptor species.

Q80: Give chemical reaction between ammonia and HCl. Ammonia (NH_3) reacts with hydrogen chloride (HCl) to form the ionic compound ammonium chloride (NH_4Cl). In this reaction, the nitrogen atom in ammonia donates its lone pair of electrons to the proton (H^+) released by HCl. This forms a coordinate covalent bond that creates the ammonium ion (NH_4^+), which then bonds ionically with the chloride ion (Cl^-).

Q81: What are the conditions for an ionic bond to be formed? For an ionic bond to form, one element must have a low ionization energy to lose electrons easily, while the other must have high affinity to gain them. There should be a significant difference in electronegativity between the reacting atoms. Finally, the resulting oppositely charged ions must be able to arrange themselves into a three-dimensional crystal lattice.

Q82: Draw electron dot and cross structure of the following compounds: SiH_4, PCl_3, SO_2, SO_3. *(See structural diagrams in the original source document.)*

Q83: How do metals conduct heat? Metals conduct heat due to the presence of mobile, delocalized electrons that move freely throughout the metal lattice. When one part of a metal is heated, these "free" electrons absorb kinetic energy and move rapidly to cooler regions. During their motion, they collide with other particles, quickly transferring thermal energy across the entire structure.

Q84: Define metallic bond. A metallic bond is a type of chemical bond specifically found in metals, consisting of the attraction between positive metal ions and a "sea" of mobile electrons. These electrons move freely between the vacant spaces in the metal lattice and are not attached to any single nucleus. This collective attraction between all nuclei and the mobile electrons holds the metal atoms together.

Q85: Write some properties of the metals. Metals typically exhibit a unique metallic lustre and are good conductors of both heat and electricity. They generally have high melting and boiling points and are described as being hard and heavy substances. Furthermore, most metals are malleable and ductile, meaning they can be shaped into sheets or wires without breaking.

Q86: State the physical properties of metals. Physically, metals are lustrous, opaque solids that have high densities and melting points due to strong metallic bonds. They are excellent conductors of electricity because their valence electrons are free to move throughout the structure. Additionally, metals are malleable and ductile, allowing them to be deformed into various industrial shapes like wires and sheets.

Q87: Metals are good conductor of electricity. Why? Metals are good conductors because they have many mobile, delocalized electrons that are not firmly held by any individual nucleus. These "free" electrons move through the vacant spaces in the atomic lattice and can easily carry an electric charge. When an electric voltage is applied, these electrons flow freely through the metal, creating an electric current.

Q88: What do you mean by malleable and ductile? Malleable refers to the property that allows a metal to be hammered or pressed into thin sheets without breaking. Ductile means that the metal can be easily drawn out into thin wires. These properties exist in metals because upper rows of atoms can slip past lower rows under pressure while still being held by the mobile electron sea.

Q89: Why metals lose electrons easily? Metals lose electrons easily because their atoms have relatively low values of ionization energy. This means that the outer valence electrons are loosely held by the nucleus and can be detached with little energy. In a metallic lattice, these electrons are set free to move, which defines the electropositive character of metals.

Q90: Why metallic bond in Mg is stronger than Na? The metallic bond in magnesium (Mg) is stronger because each magnesium atom contributes two mobile electrons compared to only one from sodium

(Na). Additionally, magnesium ions carry a higher positive charge (+2), which exerts a more powerful attraction on the delocalized electrons. This increased attraction makes the metallic structure more rigid and results in a higher melting point.

Q91: Give reasons of hardness of metals. The hardness of metals is primarily due to the strong electrostatic attraction between positively charged ions and the sea of mobile electrons. Furthermore, metal atoms are arranged in compact, orderly rows that are held tightly together by these binding forces. This close-packed arrangement makes them heavy and resistant to permanent deformation under standard conditions.

Q92: Give a comparison of metallic bond with an ionic bond. A metallic bond involves the attraction between positive ions and a sea of delocalized, mobile electrons that are not attached to any nucleus. An ionic bond, however, is a strong electrostatic attraction specifically between oppositely charged, localized ions (cations and anions). While metallic bonds allow for conductivity and malleability, ionic bonds result in brittle solids with localized charges.

Q93: Explain the electropositive character of metals. Electropositive character is the tendency of metal atoms to lose their valence electrons and form positively charged ions called cations. This property is a direct result of low ionization energy, which makes it easy for the outer electrons to be removed. Highly electropositive metals, such as sodium and potassium, are very reactive and undergo chemical reactions with great ease.

Q94: Why sodium is more reactive than calcium? Sodium is more reactive because it is an alkali metal with a lower ionization energy, allowing it to lose its outer electron more easily than calcium. Sodium is highly electropositive and reacts vigorously with substances like water and halogens at room temperature. Calcium, an alkaline earth metal, holds its outer electrons more firmly and reacts less vigorously in similar conditions.

Q95: Define electronegativity character of non-metals. Electronegativity is the character of non-metals to attract and gain electrons to form negatively charged ions called anions. These elements have a high affinity for electrons to complete their stable octet configuration. Fluorine is the most electronegative element, followed by others like oxygen and nitrogen, which makes them highly reactive with metals.

Q96: Write any two chemical properties of non-metals. First, non-metals have high electronegativity, which allows them to readily gain electrons to form negative ions (anions). Second, they can react with other non-metals through covalent bonding to form a diverse variety of molecular substances. They also typically form ionic bonds when they react with electropositive metals.

Q97: Why HF is a liquid while HCl is a gas? Hydrogen fluoride (HF) is a liquid because fluorine is extremely electronegative, leading to the formation of strong hydrogen bonds between its molecules. These powerful intermolecular forces require more energy to break, raising its boiling point above room temperature. In contrast, HCl only has weaker dipole-dipole forces, which are not strong enough to keep it in a liquid state at room temperature.

Q98: Define intermolecular forces with two types. Intermolecular forces are the attractive forces that exist between the individual molecules of elements and compounds. These forces are much weaker than the internal chemical bonds but significantly affect a substance's melting and boiling points. Two primary types are dipole-dipole forces and the special case of hydrogen bonding.

Q99: Define dipole-dipole forces with structure of HCl. Dipole-dipole forces are attractions between the partially positive end of one polar molecule and the partially negative end of another. In an HCl molecule, the chlorine atom is more electronegative (δ^-) and the hydrogen is partially positive (δ^+). These partial charges cause HCl molecules to align and attract each other through their opposite ends.

Q100: Define hydrogen bonding. Give example. Hydrogen bonding is a strong type of dipole-dipole attraction that occurs when hydrogen is covalently bonded to highly electronegative elements like F, O, or N. The large electronegativity difference makes the covalent bond highly polar, creating powerful attractive forces between molecules. A classic example is water (H_2O), where these bonds result in an unusually high boiling point.

Q101: Why water is liquid while H_2S is a gas? Water is a liquid because oxygen is highly electronegative and its small size allows for the formation of strong hydrogen bonds between water molecules. These strong attractions keep the molecules close together at room temperature. Sulfur in H_2S is less electronegative and larger, so it cannot form hydrogen bonds, leaving only weak forces that result in a gaseous state.

Q102: Define intermolecular forces. Intermolecular forces are the forces of attraction that exist specifically between the molecules of a substance. They are generally weak compared to chemical bonds but are responsible for keeping molecules together in liquid and solid phases. The strength of these forces directly determines physical properties like the density, melting point, and boiling point of the material.

Q103: Write down the chemical formula of barium nitride. Barium nitride is an ionic compound formed by the chemical combination of barium cations (Ba^{2+}) and nitride anions (N^{3-}). By applying the crisscross method, the charges are crossed over to become the subscripts of the other ion. This results in the balanced chemical formula Ba_3N_2, which ensures the compound is electrically neutral.

Q104: Write down the chemical formulas of the following compounds: Calcium phosphate, Aluminium nitride, Sodium acetate, Ammonium carbonate and Bismuth sulphate. Calcium phosphate: $Ca_3(PO_4)_2$; Aluminium nitride: AlN; Sodium acetate: CH_3COONa; Ammonium carbonate: $(NH_4)_2CO_3$; Bismuth sulphate: $Bi_2(SO_4)_3$.

Q105: Differentiate between ionic and covalent compounds. Ionic compounds are typically brittle crystalline solids with high melting and boiling points, formed by the transference of electrons. Covalent compounds usually exist as discrete molecules and can be gases, liquids, or low-melting solids formed by electron sharing. Ionic compounds conduct electricity when molten or dissolved, whereas most covalent compounds are bad conductors.

Q106: Define chemical formula. A chemical formula is a standardized symbolic representation of an element or a compound. It shows the actual number and types of atoms present in one molecule of a covalent compound or the simplest ratio of ions in an ionic compound. For example, the formula H_2O indicates that one molecule of water contains exactly two hydrogen atoms and one oxygen atom.

Q107: What is the significance of stoichiometry? Stoichiometry is significant because it allows chemists to calculate the precise amounts of reactants needed and products formed in a reaction. It is based on the Law of Conservation of Mass, ensuring that the total mass of reactants equals the total mass of

products. In industry, it is essential for determining the correct proportions of raw materials for efficient production.

Q108: Define Stoichiometry. Stoichiometry is the branch of chemistry that deals with the quantitative relationships between the reactants and products in a balanced chemical equation. It uses stoichiometric coefficients to determine the mole and mass ratios of the participating substances. This concept is fundamental for performing laboratory and industrial calculations to predict reaction yields.

Q109: Write the use of stoichiometry. Stoichiometry is used extensively in the chemical industry to calculate the exact amount of raw materials required to produce specific quantities of goods like fertilizers and shampoos. It is also vital in scientific research to plan experiments and determine theoretical product yields. Furthermore, stoichiometry helps in monitoring chemical processes to ensure they obey the Law of Conservation of Mass.

Q110: What is molecular formula? Give examples. A molecular formula is a chemical formula that shows the actual number of atoms of each element present in a single molecule of a compound. It provides the exact composition of the molecule's bonded atoms. Classic examples include H_2O for water, NH_3 for ammonia, and $C_6H_{12}O_6$ for glucose.

Q111: Why H_2O has same empirical and molecular formula? Water (H_2O) has the same empirical and molecular formula because the 2:1 ratio of hydrogen atoms to oxygen atoms is already in its simplest possible whole-number form. An empirical formula represents the minimum ratio between atoms, and since the ratio in a water molecule cannot be reduced further, the two formulas are identical.

Q112: Write molecular formula and empirical formula of hydrogen peroxide. The molecular formula of hydrogen peroxide is H_2O_2, which shows that each molecule contains exactly two hydrogen and two oxygen atoms. Its empirical formula is HO, representing the simplest whole-number ratio (1:1) of the elements in the compound. The empirical formula is derived by dividing the actual atom counts by their greatest common divisor.

Q113: Write down the chemical formula of lithium oxide & magnesium nitride. The chemical formula for lithium oxide is Li_2O, formed from Li^+ and O^{2-} ions using the crisscross method. For magnesium nitride, the formula is Mg_3N_2, resulting from the combination of Mg^{2+} and N^{3-} ions. These formulas represent the simplest ratio of ions that result in an electrically neutral unit.

Q114: How can you differentiate between molecular formula and empirical formula? A molecular formula provides the actual number of atoms of each element present in one molecule of a compound. An empirical formula only shows the simplest whole-number ratio of those atoms. For example, the molecular formula of benzene is C_6H_6, while its empirical formula is simply CH.

Q115: Write steps for writing the formula of binary compounds. First, identify the symbols of the cation and anion along with their respective charges. Second, use the crisscross method to cross over the numerical value of each charge to become the subscript of the other ion. Third, drop the positive and negative signs and reduce the subscripts to the simplest whole-number ratio to form a neutral compound.

Q116: How molecular formula of a compound can be found out? The molecular formula is found by multiplying the compound's empirical formula by a whole number 'n'. To find 'n', you divide the

experimentally determined molar mass of the compound by its empirical formula mass. Once 'n' is calculated, multiply all subscripts in the empirical formula by this value to get the molecular formula.

Q118: How molecular formula is calculated from the empirical formula? The molecular formula is calculated using the relationship: Molecular Formula = n(Empirical Formula). Here, 'n' is a whole number obtained by dividing the compound's molar mass by its empirical formula mass. For example, if the empirical formula is HO and molar mass is 34, then n = 34/17 = 2, making the molecular formula H_2O_2.

Q119: Different compounds will never have the same molecular formula but they can have the same empirical formula. Explain. Every unique compound has a specific molecular formula that reflects the exact number of atoms in its molecule, which is part of its identity. However, because an empirical formula only shows the simplest whole-number ratio, multiple compounds can share that ratio. For instance, benzene (C_6H_6) and acetylene (C_2H_2) have different actual atom counts but both reduce to CH.

Q120: Write down the structural formula of sulphuric acid. The structural formula of sulphuric acid (H_2SO_4) shows a central sulfur atom bonded to four oxygen atoms. Two of the oxygen atoms are linked to the sulfur by double covalent bonds, while the other two are linked via single bonds and are also bonded to hydrogen atoms. This arrangement clearly illustrates the connectivity and bond types within the molecule.

Q121: Write down the molecular and structural formula of calcium carbonate. The molecular formula (actually a formula unit) of calcium carbonate is $CaCO_3$. Its structural formula depicts a calcium cation (Ca^{2+}) ionically bonded to a carbonate anion (CO_3^{2-}). In the carbonate ion, the central carbon atom is covalently bonded to three oxygen atoms in a specific geometric arrangement.

Q122: How many molecules are present in 1.5 g H_2O?

1. Molar mass of H_2O = (2 × 1.008) + 15.999 = 18.015 g/mol
2. Moles = 1.5 g ÷ 18.015 g/mol ≈ 0.0833 mol
3. Number of molecules = Moles × N_a = 0.0833 × (6.022×10^{23}) ≈ **5.01×10^{22}**

Q123: Why does Avogadro's number have an immense importance in chemistry? Avogadro's number is vital because it provides a bridge between the microscopic world of atoms and the macroscopic world we weigh in the lab. It allows chemists to express the masses of reacting elements and compounds in grams, which is a convenient laboratory unit. Without this number, we could not determine the precise mass ratios needed for chemical reactions.

Q124: Define Avogadro's number. Avogadro's number is defined as the total number of elementary units (atoms, molecules, or ions) present in exactly one mole of any substance. Its calculated value is 6.022×10^{23}. It is symbolized as N_a and is used as a universal constant to count extremely small particles by weighing matter.

Q125: What are the significance of Avogadro's number? The significance lies in its ability to quantify the huge number of particles in a sample based on its measurable mass. It enables the conversion of atomic mass units (amu) into grams, where 1.00 g = 6.022×10^{23} amu. This allows scientists to maintain correct ratios of reactants and products during chemical transformations.

Q126: What is the difference between a mole and Avogadro's number? A mole is a unit that represents a specific quantity of a substance containing N_a particles, similar to how a dozen represents twelve. Avogadro's number is the specific numerical constant (6.022×10^{23}) that defines exactly how many particles are in that one mole. While a "mole" is the amount of substance, "Avogadro's number" is the actual count of units within that amount.

Q127: Define molar mass. Molar mass is defined as the mass in grams of exactly one mole of a specific substance. It is numerically equal to the relative atomic or molecular mass but is expressed with the unit g/mol. For example, the molar mass of carbon is 12g, while the molar mass of water (H_2O) is 18.0g.

Q128: What is molar mass of $C_{12}H_{22}O_{11}$?

- Carbon: 12 × 12.011 = 144.132 g/mol
- Hydrogen: 22 × 1.008 = 22.176 g/mol
- Oxygen: 11 × 15.999 = 175.989 g/mol
- **Total = 342.30 g/mol**

Q129: Determine the molar mass of sulphuric acid H_2SO_4.

- Hydrogen: 2 × 1.008 = 2.016 g/mol
- Sulfur: 1 × 32.06 = 32.06 g/mol
- Oxygen: 4 × 15.999 = 63.996 g/mol
- **Total = 98.07 g/mol**

Q130: What is the molar mass of Glucose?

- Carbon: 6 × 12.011 = 72.066 g/mol
- Hydrogen: 12 × 1.008 = 12.096 g/mol
- Oxygen: 6 × 15.999 = 95.994 g/mol
- **Total = 180.16 g/mol**

Q131: Write down the chemical equation of the following reaction: Copper + Sulphuric acid → Copper sulphate + Sulphur dioxide + Water $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$. This equation shows that one atom of copper reacts with two molecules of acid to produce copper sulphate, sulphur dioxide gas, and two molecules of water.

Q132: Differentiate between reversible and irreversible reactions. An irreversible reaction proceeds in only one direction until the reactants are completely converted into products. A reversible reaction can proceed in both forward and backward directions, where products react to reform the original reactants. Reversible reactions are denoted by double arrows (⇌), whereas irreversible ones use a single arrow (→).

Q133: Differentiate between reactants and products. Reactants are the starting substances that undergo a chemical change and are customarily written on the left-hand side of an equation. Products

are the new substances produced as a result of that reaction and are written on the right-hand side. An arrow drawn between them points from the reactants toward the products to show the direction of the change.

Q134: Define reversible reaction. A reversible reaction is a type of chemical change that does not go to completion because it moves in both the forward and backward directions. The products formed have the ability to react among themselves to reform the original starting materials under the same conditions. Such reactions eventually reach a state of dynamic equilibrium where the rates of both directions are equal.

Q135: Write 4 steps to write a chemical equation. Step 1: Correctly identify and write the formulas for all reactants and products. Step 2: Place reactants on the left and products on the right, separated by an arrow. Step 3: Balance the equation so that the number and kind of atoms are equal on both sides. Step 4: Include state symbols like (s), (l), (g), or (aq) as subscripts for each substance.

Q136: Write importance of chemical equation. A chemical equation is important because it provides a concise way to represent a chemical change using symbols and formulas. It identifies the specific substances reacting and those being produced. Crucially, it provides the exact mole and mass ratios needed for laboratory and industrial stoichiometric calculations.

Question No. 3 (Short Questions)

Q1: Define System and Surrounding and also write one example. A system is defined as any physical or chemical change under study. Everything else that is not part of the system is called the surrounding. For example, if you are boiling water in a beaker, the water molecules are the system, while the beaker and burner are the surroundings.

Q2: Write differentiate between Exothermic reaction and Endothermic reaction. Exothermic reactions are chemical reactions in which heat energy is evolved and transferred from the system to the surroundings, causing the container to get hot. Endothermic reactions are those in which heat energy is absorbed from the surroundings, resulting in a decrease in the temperature of the container.

Q3: Define Thermodynamics. Thermodynamics is a broad field of chemistry that deals with energy changes during chemical reactions and how these changes affect the properties of a chemical system. It encompasses the study of energy flow and transformations within a defined system.

Q4: Write down about the work of Thomas Young. Thomas Young was a scientist who made a significant contribution to the field of physics in 1802. He was the first person to introduce and use the word 'energy' in this field.

Q5: Differentiate between system and surrounding. A system refers to the specific portion of matter or chemical process (like reactants and products) being studied. The surrounding includes everything else in the universe outside the system that can exchange energy with it.

Q6: Differentiate between chemical energy and heat energy. Chemical energy is the energy stored within a molecule where atoms are bonded to each other. Heat energy is the form of energy that is released when a chemical bond is formed and absorbed when a bond is broken during a reaction.

Q7: Define endothermic and exothermic reaction. An endothermic reaction is a chemical process that proceeds with the absorption of heat energy, often denoted by a positive enthalpy change (ΔH). An exothermic reaction is a process that takes place with the evolution of heat energy, characterized by a negative enthalpy change (ΔH).

Q8: Write the scope of chemical energetics. Chemical energetics is concerned with the energy changes, primarily the flow of heat, that occur during chemical reactions. Its scope includes studying how the making and breaking of bonds results in energy absorption or evolution and how this energy can be used for work.

Q9: What is the difference between enthalpy change and enthalpy? Enthalpy (H) is the total amount of thermal energy or heat content stored in a compound, which cannot be measured directly. Enthalpy change (ΔH) is the measurable difference in energy that a system undergoes during a reaction.

Q10: Define Enthalpy and write its unit. Enthalpy is defined as the total heat content or thermal energy stored in a thermodynamic system. It depends on the chemical composition, structure, and number of molecules present. The unit for measuring enthalpy is kJ/mol.

Q11: What is the importance of enthalpy? Enthalpy is important because it indicates the total amount of heat present in a system. Knowing this value is crucial because heat energy can be extracted to perform useful work in various applications.

Q12: Define standard enthalpy of reaction. The standard enthalpy of reaction (ΔH°) is the enthalpy change that occurs when reactants in their standard states react to produce products in their standard states. This value is also referred to as the heat of reaction at constant pressure.

Q13: Why it is not possible to calculate the enthalpy of a system? It is not possible to measure the total enthalpy (H) of a system directly because it accounts for the absolute internal energy stored in bonds and structures. However, the change in enthalpy (ΔH) can be measured easily as the heat evolved or absorbed at constant pressure.

Q14: Why is breaking of a bond an endothermic process? Breaking a chemical bond is an endothermic process because energy must be absorbed from the surroundings to overcome the forces holding the atoms together. This input of energy is required to separate the bonded atoms into a less stable, higher-energy state.

Q15: Explain why the reaction between atmospheric gases oxygen and nitrogen does not take place under normal conditions? But in the presence of lightning these gases react to give NO. The reaction stops as soon as the lightning stops. The reaction between nitrogen and oxygen to form nitric oxide (NO) is highly endothermic and requires a vast amount of energy. Under normal conditions, atmospheric energy is insufficient to break these strong bonds. Lightning provides the necessary high-energy source; once the lightning stops, the energy supply is removed, and the reaction ceases.

Q16: What is heat content? Heat content is another term for enthalpy (H), representing the total thermal energy stored within a chemical system. It is a property that depends on the system's structure and chemical composition.

Q17: Define heat of the reaction and give one example. The heat of reaction is the total amount of heat energy evolved or absorbed during a chemical change. For example, the reaction between hydrogen and oxygen gases to form liquid water evolves 571.6 kJ of heat energy.

Q18: Define combustion with example. Combustion is an exothermic process where substances in fuels react with oxygen in the air to produce heat. For example, solid carbon burns in oxygen gas to produce carbon dioxide and 393.5 kJ of heat energy.

Q19: Is melting of ice an endothermic or exothermic change? The melting of ice is an endothermic change. This is because it requires the absorption of heat energy from the surroundings to break the solid crystalline structure and convert it into liquid.

Q20: Define exothermic and endothermic reactions. Exothermic reactions are processes where chemical energy is converted to heat energy and released to the surroundings. Endothermic reactions are processes where heat energy is absorbed from the surroundings to facilitate the chemical change.

Q21: Depict the transition state for the following reaction: $H_2 + Cl_2 \rightarrow 2HCl$ In this reaction, the transition state is a high-energy, temporary configuration where the H−H and Cl−Cl bonds are breaking while new H−Cl bonds are simultaneously forming. This unstable arrangement exists at the peak of the reaction's energy profile.

Q22: Define excited molecule. Excited molecules are reactant molecules that possess more than the average kinetic energy of the system. These molecules are the only ones capable of undergoing successful collisions that lead to the formation of a transition state and products.

Q23: What is transition state? A transition state is a temporary, high-energy arrangement of atoms formed during a collision between excited reactant molecules. In this state, the original chemical bonds are partially cleaved while new bonds are in the process of being formed.

Q24: What is Activation energy? Activation energy (E_a) is the minimum amount of energy that colliding reactant particles must possess to transform into a transition state. It acts as an energy barrier that must be overcome for a successful chemical reaction to occur.

Q25: Give collision theory of reactions. Collision theory states that a chemical reaction occurs when reactant molecules collide with each other. For a collision to be successful, the particles must have sufficient kinetic energy to overcome the activation energy barrier and form a transition state.

Q26: How catalyst increases the rate of reaction? A catalyst increases the rate of reaction by providing an alternative reaction pathway that has a lower activation energy (E_a). This allows a greater number of reactant molecules to reach the transition state, thereby increasing the speed of product formation.

Q27: Define catalyst with an example. A catalyst is a substance that increases the rate of a chemical reaction by lowering the activation energy without being permanently changed itself. For example, Nickel (Ni) is used as a catalyst in the hydrogenation of oil to produce banaspati ghee.

Q28: What happens at transition state? At the transition state, reactant molecules reach their highest energy point where their bonds are in the process of breaking and forming. This state is very unstable and quickly either returns to the reactants or proceeds to form the final products.

Q29: What is the role of glycogen in our body? Glycogen is the primary storage form of glucose in the human body, found mainly in the liver and muscles. It serves as a readily available energy source that the body can break down into glucose when needed for metabolic activities.

Q30: Define glycolysis. Glycolysis is the initial stage of respiration where a single molecule of glucose is split into two molecules of pyruvate. This process occurs in the cytoplasm and involves a series of enzyme-catalyzed reactions that result in the net production of 2 ATP molecules.

Q31: Explain the role of lipid. Lipids, including fats and waxes, serve as the body's primary energy reserve stores. They provide approximately half of the fuel the body needs daily and are utilized during exercise or between meals when immediate food energy is unavailable.

Q32: What is total heat of content? Total heat of content is another name for enthalpy, representing all the thermal energy stored within a system under standard conditions. At constant pressure, any change in this total heat content is equal to the heat evolved or absorbed during a reaction.

Q33: Differentiate between aerobic and anaerobic respiration. Aerobic respiration occurs in the presence of oxygen and involves the complete oxidation of glucose into carbon dioxide and water with a large energy release. Anaerobic respiration occurs in the absence of oxygen, converting glucose into ethanol or other products with less energy evolution.

Q34: What happens during glycolysis? During glycolysis, glucose is enzymatically converted into two pyruvate molecules in the cell's cytoplasm. This metabolic pathway produces energy in the form of ATP, which cells use to perform various biological and metabolic activities.

Q35: Why are some reactions irreversible while others are reversible? Irreversible reactions go to completion because the products cannot react back to form reactants, often because a product escapes or is highly stable. Reversible reactions do not go to completion because products can react together to reform the original reactants under the same conditions.

Q36: Why are combustion reactions generally irreversible? Combustion reactions are generally irreversible because they release a massive amount of energy and produce stable gases like carbon dioxide that escape into the atmosphere. This prevents the products from reacting together to reform the original fuels in a closed system.

Q37: Write formula and colour of Anhydrous Cobalt chloride. The chemical formula for anhydrous cobalt chloride is $CoCl_2$. In its anhydrous state, this compound has a distinct blue colour.

Q38: Write two ways of disturbing a chemical reaction (at equilibrium). A chemical reaction at equilibrium can be disturbed by adding or withdrawing one or more of the reacting or product species. It can also be disturbed by changing the temperature of the reaction mixture.

Q39: What are irreversible reactions? Give few characteristics. Irreversible reactions are those that proceed in one direction only and go to completion. Their main characteristics are that they reach a final state where no reactants remain (if stoichiometric amounts are used) and they are shown by a single forward arrow (→).

Q40: Define reversible reactions. Write their two characteristics. Reversible reactions are processes where reactants form products and products can react back to give the original reactants. Two characteristics are that they never go to completion and they reach a state of dynamic equilibrium where all species are simultaneously present.

Q41: How does a reversible reaction go to completion? A reversible reaction can be forced to go to completion if one of the products is continuously removed from the reaction mixture as it forms. For example, if a gaseous product escapes from an open container, the backward reaction cannot occur.

Q42: What is meant by irreversible change? An irreversible change is a chemical or physical transformation where the process moves only forward until the reactants are fully converted into products. Such changes do not reach an equilibrium state because the products lack the capacity to reform the reactants.

Q43: Why does a reversible reaction never go to completion? A reversible reaction never goes to completion because as products are formed, they immediately begin to react back to reform the original reactants. In a closed system, this leads to a stable state where the rates of the forward and backward reactions are equal.

Q44: How is dynamic equilibrium different from static equilibrium? Dynamic equilibrium occurs when the forward and reverse reactions continue to happen at identical rates, so concentrations remain constant despite ongoing molecular activity. Static equilibrium, although not detailed in chemical context, would imply that all chemical and physical activity has completely stopped.

Q45: How can you decrease the time to attain the position of equilibrium in a reversible reaction? You can decrease the time taken to reach equilibrium by adding a suitable catalyst to the reaction mixture. A

catalyst increases the rates of both the forward and backward reactions equally, allowing the system to achieve its stable equilibrium state much faster.

Q46: Can you make an irreversible reaction reversible or irreversible and vice versa? An irreversible reaction can sometimes be made reversible by changing conditions like using a closed container to trap gaseous products. Conversely, a reversible reaction can be made irreversible by removing a product as it forms, preventing the backward reaction from occurring.

Q47: Define catalytic methanation. Catalytic methanation is a reversible chemical reaction used to produce methane (CH_4) and water from a mixture of carbon monoxide (CO) and hydrogen (H_2). This industrial process is carried out in the presence of a catalyst to achieve high conversion.

Q48: Define forward and reverse reaction. A forward reaction is the process where reactants react together to produce products. A reverse (or backward) reaction is the process where the newly formed products react among themselves or decompose to give back the original reactants.

Q49: Write characteristics of dynamic equilibrium. At dynamic equilibrium, the rates of the forward and backward reactions are exactly equal. Additionally, the concentrations of all reacting species (reactants and products) remain constant over time as long as the system is not disturbed.

Q50: How is dynamic equilibrium achieved? Dynamic equilibrium is achieved in a reversible system when the concentration of products becomes high enough for the reverse reaction to start. Eventually, the rate of this reverse reaction speeds up until it matches the rate of the forward reaction.

Q51: Write significance of dynamic equilibrium in chemical reactions. Dynamic equilibrium is significant because it allows for the management and control of industrial reactions, such as the Haber process for ammonia. By understanding how conditions affect this state, chemists can shift the equilibrium to maximize the yield of desired products.

Q53: Differentiate between natural & mineral acids. Natural (organic) acids are obtained from natural sources like plants and fruits (e.g., citric acid from lemons). Mineral acids are man-made acids prepared from inorganic minerals like sodium chloride (e.g., hydrochloric acid).

Q54: Write down some organic acids and also their natural source. Some common organic acids and their sources include Acetic acid from vinegar, Citric acid from lemons or oranges, Lactic acid from sour milk or curd, and Oxalic acid from tomatoes.

Q55: Differentiate between organic acids and mineral acids. Give examples. Organic acids occur naturally in living things and include examples like Tartaric acid from tamarind and Formic acid from ant stings. Mineral acids are synthesized industrially and include examples like Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3).

Q56: Define neutralization reaction. A neutralization reaction is a chemical process where an acid and a base are mixed together in equal amounts, causing their properties to cancel each other. This reaction typically results in the formation of a salt and water.

Q57: Write down the uses of oxalic acid. Oxalic acid is a diprotic organic acid used commercially for bleaching materials such as straw and leather. It is also highly effective at removing stubborn rust and ink stains from various fabrics.

Q58: Name the bases that can burn your skin. Certain strong alkalis are extremely corrosive and dangerous to touch. Specifically, sodium hydroxide (caustic soda) and potassium hydroxide (caustic potash) can cause severe chemical burns to the skin.

Q59: How does calcium metal react with dilute H_2SO_4? Acids react with metals to give salts and hydrogen gas. Therefore, calcium reacts with dilute H_2SO_4 to produce calcium sulphate and hydrogen gas.

Q60: Which salt is formed when HCl reacts with $BaCO_3$? Acids react with carbonates to form salts, water, and carbon dioxide. Hydrochloric acid (HCl) reacting with barium carbonate ($BaCO_3$) forms barium chloride ($BaCl_2$) salt.

Q61: Why does Na_2CO_3 behave like a base in water? Sodium carbonate (Na_2CO_3) is basic because it can neutralize acids to form salts and water. Its carbonate component gives it this basic nature, allowing it to act as a mild alkali in aqueous solutions.

Q62: Is $NaHCO_3$ a base or an acid? Justify. Sodium hydrogen carbonate ($NaHCO_3$) is a base. Although it contains hydrogen, it reacts with acids in a neutralization process to form a salt, water, and carbon dioxide, which is a characteristic property of basic substances.

Q63: According to Arrhenius, what is neutralization? According to Arrhenius, neutralization is the reaction between a strong acid and a strong base in an aqueous solution. It involves the complete dissociation of these substances into ions, where H^+ and OH^- ions combine to form water.

Q64: Mineral acids are generally very strong acids. Justify. Mineral acids are considered strong because they dissociate completely into their constituent ions (like H^+) when dissolved in water. This high degree of ionization allows them to react more vigorously than weak organic acids.

Q65: How does sulphuric acid ionize in two steps? Sulphuric acid (H_2SO_4) is a diprotic acid that releases two protons. In the first step, it ionizes into H^+ and HSO_4^-; in the second step, the hydrogen sulphate ion further dissociates to release another H^+ ion.

Q66: What is the role of water in Arrhenius concept of acids and bases? In the Arrhenius concept, water is an essential solvent that facilitates the dissociation of molecules into ions. Water molecules surround and bond with the resulting protons (H^+) to form more stable hydroxonium ions (H_3O^+).

Q67: Write down limitations of Arrhenius concept. A major limitation is that the Arrhenius concept is restricted to aqueous (water) solutions only. It cannot explain the acidic or basic behavior of substances in non-aqueous solvents or the basicity of compounds like ammonia (NH_3) that do not contain OH^- groups.

Q68: How can hyperacidity be caused and what are its symptoms? Hyperacidity is caused by the excess production of hydrochloric acid in the stomach. Common symptoms include a painful burning sensation in the chest (heartburn) and general stomach discomfort.

Q69: Define acid according to Arrhenius. According to Arrhenius, an acid is a substance that dissociates in water to produce hydrogen ions (H^+) or hydroxonium ions (H_3O^+). This definition specifically links acidity to the behavior of a substance in an aqueous medium.

Q70: Justify the statement that oxides of metals are basic in nature. Metal oxides are basic because they react with acids to produce a salt and water through neutralization. For example, sodium oxide (Na_2O) reacts with water to produce hydroxide ions (OH^-), confirming its basic nature.

Q71: What is the role of hydrochloric acid in stomach? Hydrochloric acid (HCl) in the stomach is essential for the digestion of food. It provides the acidic environment necessary for enzymes to work and also kills harmful bacteria that may enter with food.

Q72: What is the treatment of hyperacidity? Hyperacidity is treated using antacids, which are mild bases. These bases react with the excess acid in the stomach via a neutralization reaction to form neutral salt and water, providing relief from heartburn.

Q73: How will you justify that HSO_4^- is a Bronsted-Lowry acid? The HSO_4^- ion is a Bronsted-Lowry acid because it has the ability to donate a proton (H^+). Since an acid is defined specifically as a proton donor in this theory, HSO_4^- qualifies by being able to release its remaining hydrogen atom.

Q74: What are the limitations of Arrhenius acids & bases? The Arrhenius definition is limited because it requires the substance to be in water and to contain H^+ or OH^- in its formula. It fails to account for acid-base reactions occurring in the gaseous state or in non-aqueous solvents.

Q75: Differentiate between Bronsted & Lowry acids & bases. In the Bronsted-Lowry concept, an acid is defined as a proton (H^+) donor. Conversely, a base is defined as a proton acceptor. This theory focuses on the transfer of protons between species rather than just dissociation in water.

Q76: What is meant by amphoteric? Give an example. An amphoteric substance is a compound that can act as both an acid and a base. A primary example is water (H_2O), which can accept a proton to act as a base or donate a proton to act as an acid.

Q77: Define Bronsted-Lowry acid and base. A Bronsted-Lowry acid is any chemical species that donates a proton (H^+) to another substance. A Bronsted-Lowry base is any chemical species that accepts a proton from an acid during a reaction.

Q78: Why does NH_3 act as a Bronsted-Lowry base? Ammonia (NH_3) acts as a base because it can accept a proton (H^+) from an acid to form an ammonium ion (NH_4^+). Its nitrogen atom has a lone pair of electrons that facilitates this proton acceptance.

Q79: What is the difference between Arrhenius base and Bronsted-Lowry base? An Arrhenius base is a substance that specifically releases OH^- ions in water. A Bronsted-Lowry base is more broadly defined as any substance that can accept a proton (H^+), which includes compounds that do not have OH^- in their formula.

Q80: How can you justify that NH_3 is a Bronsted-Lowry base but not an Arrhenius base? NH_3 is a Bronsted-Lowry base because it accepts a proton to form NH_4^+. It is not an Arrhenius base because it does not contain a hydroxyl group (OH) in its formula to release directly when dissolved in water.

Q81: Why is water called an amphoteric compound? Water is called amphoteric because it can exhibit both acidic and basic behavior. It can act as a base by accepting a proton from an acid to form H_3O^+, or as an acid by donating a proton to a base.

Q82: What chemical name will you give to soap as a compound? Soap is chemically a salt produced from the reaction of a base with organic fatty acids. It typically exists as a sodium or potassium salt of a long-chain carboxylic acid.

Q83: What is the difference between a strong acid and a concentrated acid? A strong acid is one that dissociates completely into ions in an aqueous solution. A concentrated acid refers to a solution that contains a large amount of acid relative to the amount of water (solvent) present.

Q84: Write some properties of bases. Bases are generally characterized by a bitter taste and a slippery or soapy feel to the touch. They also have the chemical ability to change red litmus paper to blue.

Q85: How does acid rain affect aquatic life? Acid rain lowers the pH of water bodies, making them too acidic for many organisms. This can lead to the death of fish by damaging their gills and can also cause toxic metals to leach into the water from the surrounding soil.

Q86: Why was atomic number chosen to arrange the elements in the periodic table? Atomic number was chosen because it represents the fixed number of protons in an atom, which is a unique identity for each element. Unlike atomic mass, it remains constant across isotopes and provides a more logical basis for periodic trends.

Q87: What is the significance of the word "periodic"? The word "periodic" refers to the fact that the properties of elements repeat at regular, predictable intervals when arranged by atomic number. This repetition allows elements with similar behaviors to be grouped together vertically.

Q88: On what is the modern periodic table based upon? The modern periodic table is based on the arrangement of elements according to their ascending atomic numbers. This organization reflects the underlying electronic configurations of the atoms, ensuring that elements with similar properties fall into the same group.

Q89: Why are the properties of elements different in a period and same in a group? Elements in a group have the same number of valence electrons, resulting in similar chemical properties. Elements in a period have different numbers of valence electrons and an increasing nuclear charge, leading to a progressive change in properties across the row.

Q90: How are elements arranged in the modern periodic table? Elements are arranged in ascending order of their atomic numbers. They are organized into horizontal rows called periods and vertical columns called groups, based on their atomic structure and electronic configurations.

Q91: Differentiate between group and period. Groups are vertical columns containing elements with similar chemical properties due to having the same number of valence electrons. Periods are horizontal rows where elements show a gradual change in properties as their atomic number and electron shells change.

Q92: What is meant by periodicity of the properties in periodic table? Periodicity is the predictable recurrence of chemical and physical properties of elements at certain intervals. This occurs because the electronic configurations of the valence shells repeat as the atomic number increases.

Q93: Why are the most electronegative elements present in the sixth and seventh groups? Elements in these groups (like Fluorine and Oxygen) have a high nuclear charge and a small atomic radius. This

allows their nuclei to attract and hold shared electrons more strongly than other elements, making them highly electronegative.

Q95: What is the first element of the periodic table? Will it lose an electron or gain it? The first element is Hydrogen (H). Depending on its environment, hydrogen can either lose its single electron to become a positive ion (H^+) or gain an electron to form a negative hydride ion (H^-).

Q96: Difference between lanthanides and actinides. Lanthanides are the series of elements from atomic numbers 57 to 71, whereas Actinides range from atomic numbers 89 to 103. While both series involve filling 'f' sub-shells, Actinides are specifically known for being radioactive and mostly unstable.

Q97: Define normal or representative elements. Normal or representative elements are those belonging to the 's' and 'p' blocks of the periodic table (Groups 1-2 and 13-18). Their properties are primarily determined by the number of electrons in their outermost shell.

Q98: Define transition elements. Transition elements are metals located in the 'd' block (Groups 3 to 12) of the periodic table. They are characterized by having partially filled 'd' sub-shells and often exhibit variable oxidation states and form coloured compounds.

Q99: Write any two general properties of periods. One property is that all elements in a given period have the same number of electron shells. Another is that as you move from left to right, the atomic number and nuclear charge increase, generally causing a decrease in atomic size.

Q100: What is meant by family of elements? Give an example. A family of elements refers to a group in the periodic table whose members share very similar chemical properties due to having the same number of outer electrons. An example is the Alkali Metals family (Group 1).

Q101: How did Mendeleev arrange the elements in the periodic table? While Mendeleev originally used properties and atomic mass, modern science has established that elements are correctly arranged by their ascending atomic numbers. This transition corrected earlier placement errors and aligns with the elements' true identity.

Q102: Define dipositive ions. A dipositive ion is a cation formed when an atom loses two electrons from its outermost shell. This results in a net positive charge of +2, as seen when a calcium atom becomes a Ca^{2+} ion.

Q103: What are dinegative ions? Dinegative ions are anions formed when an atom gains two electrons to complete its outer shell. This results in a net negative charge of -2, as seen with the oxide ion (O^{2-}).

Q104: What do you mean by group number and period number? The group number indicates which vertical column an element is in and usually tells the number of valence electrons. The period number corresponds to the horizontal row and tells the total number of electron shells the atom has.

Q105: Why are elements of group 1 electropositive in nature? Group 1 elements (Alkali Metals) are highly electropositive because they have only one electron in their valence shell. It is energetically very easy for them to lose this single electron to achieve a stable noble gas configuration.

Q106: How do alkali metals react with water? Alkali metals react vigorously or even violently with water. This reaction produces a metal hydroxide and releases hydrogen gas, reflecting the metals' high reactivity and electropositive nature.

Q107: Write the reaction of alkali metals with halogens. Alkali metals react readily with halogens (Group 17) to form stable ionic compounds called halides. For example, sodium reacts with chlorine to produce sodium chloride (NaCl) through the complete transfer of an electron.

Q108: Why are elements of group 17 called halogens? Group 17 is a distinct family of non-metals. They are highly reactive because they need only one more electron to complete their octet.

Q109: Why does the size of an element increase as we move down the periodic table (in a group)? The size increases down a group because each successive element has an additional shell of electrons. This addition of whole new energy levels increases the atom's radius, even as the nuclear charge increases.

Q110: Which element has the maximum atomic radius and which element has the minimum atomic radius in the third period? In the third period, Sodium (Na) has the maximum atomic radius because it has the lowest nuclear charge in that row. Chlorine (Cl) has the minimum atomic radius (excluding noble gases) due to its higher nuclear charge pulling electrons closer.

Q111: The first ionization energy value of magnesium is less than the second one. Give reason. The first ionization energy is lower because it removes an electron from a neutral atom. The second electron is harder to remove because it must overcome the stronger electrostatic pull of a now-positive ion.

Q112: Atomic radii of boron and aluminum are 88 pm and 125 pm respectively. Which element is expected to lose electron(s) easily? Aluminum (Al) is expected to lose electrons more easily than Boron (B). Its larger atomic radius means its valence electrons are further from the nucleus and less tightly held, resulting in lower ionization energy.

Q113: How would you find the atomic radius of an atom? The atomic radius is found by measuring the distance between the nuclei of two bonded identical atoms and halving that value. This measurement represents the average size of the atom in its bonded state.

Q114: Define first ionization energy. First ionization energy is the minimum amount of energy required to remove the most loosely held electron from the outermost shell of an isolated neutral atom. This process results in the formation of a positive cation.

Q115: Why is second ionization energy greater than first ionization energy? It is greater because the second electron is being removed from a positive ion, which exerts a much stronger pull on its remaining electrons. Overcoming this increased nuclear attraction requires significantly more energy than removing the first electron.

Q116: Describe the trends of electronegativity in a period and group. Electronegativity generally increases across a period from left to right as the nuclear charge increases and atomic size decreases. In a group, it decreases from top to bottom because the increasing number of shells puts valence electrons further from the nucleus.

Q117: Define atomic radius. Give example. Atomic radius is half the distance between the nuclei of two identical atoms that are bonded together. For example, the atomic radius of boron is 88 pm, while that of aluminum is larger at 125 pm.

Q118: Define ionization energy. Ionization energy is the energy required to remove an electron from an atom or ion. It is a critical factor in determining an element's chemical reactivity and its tendency to form positive ions.

Q119: Why does electron affinity decrease in a group? Electron affinity decreases down a group because the atomic radius increases as new electron shells are added. This larger distance weakens the nuclear attraction for an incoming electron, making it less likely to be gained.

Q120: What is the difference between first and second electron affinities? First electron affinity is usually an exothermic process where energy is released when a neutral atom gains an electron. Second electron affinity is typically endothermic because energy is required to push another electron into an already negative ion.

Q121: Define electronegativity. Write the electronegativity trend of Nitrogen and Oxygen. Electronegativity is the ability of an atom in a molecule to attract a shared pair of electrons toward itself. Oxygen is the second most electronegative element, followed by nitrogen.

Q122: Why does the size of an atom increase in a group? The size increases because each successive element in a group adds a whole new electron shell. This increases the average distance of the valence electrons from the nucleus, resulting in a larger atomic radius.

Q123: What is the trend of ionization energy in groups and periods? In a group, ionization energy decreases from top to bottom as atoms get larger. In a period, it generally increases from left to right as the nuclear charge grows stronger and atoms become smaller.

Questions No. 4 (Short Questions)

Q1: Why does it become easier to cut an alkali metal when we move from top to bottom in Group I? Moving down Group I, the atomic size increases and the strength of the metallic bond decreases. As the attraction between the nucleus and the valence electrons weakens, the metals become softer, making them easier to cut with a knife.

Q2: Name any three elements in the periodic table which exist as liquids. Three elements that exist in liquid state are Mercury (Hg), Bromine (Br), and Francium (Fr). Mercury is the only metal that is liquid at room temperature.

Q3: What are alkali metals? The elements of Group 1 (except Hydrogen) are called alkali metals. They include Lithium, Sodium, Potassium, Rubidium, Cesium, and Francium. They are highly reactive metals with one electron in their outermost shell.

Q4: Why does reactivity of metals increase down the group? Reactivity increases down the group because the atomic size increases, which decreases the ionization energy. This makes it easier for the metal atoms to lose their valence electrons and form positive ions.

Q5: How do alkali metals react with water? Alkali metals react vigorously with water to form metal hydroxides and release hydrogen gas. The reaction is highly exothermic; for example, $2Na + 2H_2O \rightarrow 2NaOH + H_2 + heat$.

Q6: Why does density of the atoms in a group increase gradually? Although atomic volume increases down a group, the atomic mass increases much more rapidly. Since density is mass per unit volume, the significant increase in mass leads to an overall increase in density.

Q7: Predict the reactivity of potassium towards halogens. Potassium is an extremely reactive alkali metal and reacts violently with halogens to form potassium halides (KX). For example, it reacts with Chlorine to form Potassium Chloride ($2K + Cl_2 \rightarrow 2KCl$).

Q9: Why does iodine exist in the solid state at room temperature? Iodine molecules (I_2) are large in size, which results in very strong London dispersion forces between them. These strong intermolecular forces hold the molecules together in a solid structure at room temperature.

Q10: How does an alkali metal react with chlorine? Alkali metals react directly with chlorine gas to form ionic metal chlorides. For example, sodium reacts with chlorine to form sodium chloride: $2Na + Cl_2 \rightarrow 2NaCl$.

Q11: How can the water of a swimming pool be sterilized? Swimming pool water is sterilized through chlorination. Chlorine or chlorine compounds are added to the water to kill bacteria, algae, and other harmful microorganisms, making the water safe for swimming.

Q12: What is the trend/variation of reactivity of halogens? The reactivity of halogens decreases down the group. Fluorine is the most reactive, followed by Chlorine, Bromine, and Iodine. This is because their ability to accept an electron decreases as the atomic size increases.

Q13: How are metal halides formed? Metal halides are formed by the direct reaction between a metal and a halogen. They can also be formed by the reaction of an acid (hydrogen halide) with a metal, metal oxide, or metal carbonate.

Q14: Define oxidation and reducing agent. Give example. Oxidation is the loss of electrons by an atom or ion. A reducing agent is a substance that donates electrons and is itself oxidized. For example, in $2Na + Cl_2 \rightarrow 2NaCl$, Sodium (Na) is the reducing agent.

Q15: Define reduction and oxidizing agent. Reduction is the gain of electrons by an atom or ion. An oxidizing agent is a substance that accepts electrons from another substance and is itself reduced during the process.

Q16: Why are the melting and boiling points of Bromine and Iodine higher than those of chlorine and fluorine? Bromine and Iodine have larger atoms and molecules than Chlorine and Fluorine. This results in stronger intermolecular forces (London dispersion forces), which require more energy to overcome, leading to higher melting and boiling points.

Q17: Why does the reactivity of halogens decrease down the group? Reactivity decreases because down the group the atomic radius increases and the nuclear pull on incoming electrons weakens. This makes it harder for the atoms to gain an electron to complete their octet.

Q18: Write the colour of Bromine and Iodine. At room temperature, Bromine is a reddish-brown liquid, and Iodine is a shiny grayish-black solid that produces violet vapors upon heating.

Q19: Write the trend of thermal stability of hydrogen halides. The thermal stability of hydrogen halides decreases down the group (HF > HCl > HBr > HI). This is because the bond strength decreases as the size of the halogen atom increases.

Q20: How do halogens react with water? Fluorine reacts violently with water to release oxygen. Chlorine and Bromine react with water to form a mixture of hydrohalic acid and hypohalous acid. Iodine does not react significantly with water.

- $2F_2(g) + 2H_2O(l) \rightarrow 4HF(aq) + O_2(g)$
- $Cl_2(g) + H_2O(l) \rightleftharpoons HCl(aq) + HOCl(aq)$
- $Br_2(l) + H_2O(l) \rightleftharpoons HBr(aq) + HOBr(aq)$
- $I_2(s) + H_2O(l) \rightarrow$ No Reaction (at STP)

Q21: Why are transition elements different from normal elements? Transition elements have partially filled 'd' subshells, whereas normal elements have 's' or 'p' valence shells. This gives transition elements unique properties like variable oxidation states, coloured compounds, and catalytic activity.

Q22: What is the use of nickel as a catalyst? Nickel is extensively used as a catalyst in the hydrogenation of vegetable oils to produce solid banaspati ghee (margarine). It facilitates the addition of hydrogen to unsaturated carbon-carbon bonds.

Q23: What are transition elements? Transition elements are elements located in the 'd' block (Groups 3-12) of the periodic table. They are all metals characterized by partially filled d-orbitals in their atoms or common ions.

Q24: Write any four properties of transition elements.

1. They are all metals with high melting points. 2) They show variable oxidation states. 3) They form coloured compounds. 4) They act as effective catalysts.

Q25: What is the role of iron in the Haber process? In the Haber process for the synthesis of ammonia, finely divided iron acts as a catalyst. It increases the rate of reaction between nitrogen and hydrogen without being consumed itself.

Q26: What is a catalytic converter? A catalytic converter is a device fitted to automobile exhausts. It uses transition metals (like platinum or palladium) as catalysts to convert toxic gases like carbon monoxide and nitrogen oxides into less harmful substances like CO_2 and N_2.

Q27: Write one application of nickel. A major application of nickel is in the industrial hydrogenation of vegetable oils. It is also used in making stainless steel and other corrosion-resistant alloys.

Q28: Which noble gas has the lowest boiling point and why? Helium (He) has the lowest boiling point. This is because it has the smallest atomic size and only two electrons, resulting in the weakest intermolecular forces (London dispersion forces) among all elements.

Q29: What are noble elements? Noble elements (Noble gases) are the elements of Group 18, including Helium, Neon, Argon, Krypton, Xenon, and Radon. They have completely filled valence shells and are chemically very stable.

Q30: Why do noble gases show very little chemical reactivity? Noble gases have a complete octet (or duplet for Helium) in their outermost shells. Because their electronic configuration is exceptionally stable, they have no tendency to gain, lose, or share electrons under normal conditions.

Q31: What is the main objective of environmental education? The main objective is to create awareness among people about environmental issues and the importance of protecting natural resources. It aims to develop a sense of responsibility toward maintaining a clean and sustainable ecosystem.

Q32: Name two effects of excessive use of fertilizers. Two major fertilizers used excessively are Urea and Ammonium Nitrate. Their over-application can lead to soil degradation and water pollution through leaching into nearby water bodies (eutrophication).

Q33: Define atmosphere and name the major gases in its composition. The atmosphere is the layer of gases surrounding the Earth, held by gravity. Its major gases include Nitrogen (78%), Oxygen (21%), Argon (0.9%), and Carbon Dioxide (0.04%).

Q34: What is the difference between atmosphere and environment? The atmosphere is specifically the gaseous envelope surrounding the Earth. The environment is a broader term that includes the atmosphere, hydrosphere, lithosphere, and biosphere—all the surroundings in which organisms live.

Q35: Write the composition of air. Air is a mixture of gases: Nitrogen (~78%), Oxygen (~21%), Argon (~0.9%), Carbon Dioxide (~0.04%), and trace amounts of noble gases and water vapor.

Q36: In what way does sulphur present in fossil fuels become dangerous? When fossil fuels are burned, the sulfur present in them reacts with oxygen to form sulfur dioxide (SO_2). This gas is a major air pollutant and a primary cause of acid rain, which damages buildings and ecosystems.

Q37: The percentage of CO_2 in air is only 0.04%. Then how does it become harmful for the ecosystem? Even at 0.04%, CO_2 is a greenhouse gas that traps heat in the atmosphere. Increasing levels due to human activity lead to global warming and climate change, which disrupts weather patterns and habitats.

Q38: What are air pollutants? How can their concentration be expressed? Air pollutants are harmful substances (gases or particulates) that contaminate the atmosphere. They are often expressed in terms of their concentration, such as parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$).

Q39: Which factors are responsible for environmental pollution? Factors include industrial emissions, burning of fossil fuels in vehicles, deforestation, improper waste disposal, and the excessive use of pesticides and fertilizers in agriculture.

Q40: How is ozone formed? Ozone (O_3) is formed in the upper atmosphere when ultraviolet (UV) radiation from the sun splits oxygen molecules (O_2) into individual oxygen atoms, which then react with other O_2 molecules to form O_3.

Q41: Define smog. Smog is a type of air pollution formed by the combination of smoke and fog (smoke + fog = smog). It often contains harmful chemicals like nitrogen oxides and ozone, which reduce visibility and cause respiratory issues.

Q42: What are the harmful effects of hydrocarbons? Hydrocarbons can act as air pollutants that contribute to the formation of photochemical smog. Some are also carcinogenic (cancer-causing) and can cause respiratory irritation and environmental damage.

Q43: What is the difference between a pollutant and a contaminant? A pollutant is a substance that causes harm to the environment or organisms. A contaminant is any substance added to the environment that was not there naturally, though it may not always be harmful in small amounts.

Q44: How are sulphur-containing compounds emitted naturally? Sulfur compounds are naturally emitted through volcanic eruptions, decomposition of organic matter by bacteria in wetlands, and sea spray.

Q45: CO is a hidden enemy. Explain its action. Carbon monoxide (CO) is called a hidden enemy because it is colorless and odorless. When inhaled, it binds to hemoglobin in the blood more strongly than oxygen, preventing oxygen transport and leading to suffocation or death.

Q46: State the major sources of CO and CO_2 emission. Major sources include the burning of fossil fuels in vehicles and power plants, industrial processes, forest fires, and volcanic activity. CO_2 is also released through cellular respiration and decomposition.

Q47: Write the names of major air pollutants. Major air pollutants include Carbon Monoxide (CO), Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2), Nitrogen Oxides (NO_x), Methane (CH_4), and particulate matter.

Q48: What are natural processes that cause air pollution? Natural processes include volcanic eruptions (releasing gases and ash), forest fires, dust storms, and the decomposition of organic matter.

Q49: Write the harmful effects of oxides of carbon. Carbon monoxide (CO) causes poisoning and suffocation. Carbon dioxide (CO_2) is a major greenhouse gas that leads to global warming and climate change.

Q50: Highlight the harmful effects of smog. Smog causes severe respiratory problems (like asthma), eye irritation, and reduces visibility. It also damages plants and reduces crop yields by interfering with photosynthesis.

Q51: How does acid rain affect forests? Acid rain leaches essential nutrients from the soil and damages the leaves and needles of trees. This weakens the trees, making them more susceptible to diseases, pests, and extreme weather.

Q52: How is the excessive use of insecticides and pesticides harmful for birds? These chemicals can enter the food chain; birds that eat poisoned insects or seeds accumulate toxins in their bodies. This can lead to thin eggshells, reproductive failure, or direct death.

Q53: How are acid droplets formed? Acid droplets are formed when air pollutants like SO_2 and NO_2 react with water vapor and oxygen in the atmosphere to produce sulfuric acid and nitric acid, respectively.

Q54: What are the effects of acid rain on soil? Acid rain lowers the soil pH, which leaches vital nutrients like calcium and magnesium. It also releases toxic metals like aluminum from the soil, which can harm plant roots and enter water systems.

Q55: How is acid rain produced? Acid rain is produced when sulfur dioxide (SO_2) and nitrogen oxides (NO_x) are released into the air, react with water, oxygen, and other chemicals to form acidic compounds that fall to the ground as rain.

Q56: Write the adverse effect of acid rain on soil. It increases soil acidity, making it difficult for many plants to grow. It also destroys beneficial soil microorganisms and makes the land less fertile by removing essential minerals.

Q57: What is the significance of plants for soil on hills and mountain areas? Plants are vital on slopes because their roots bind the soil together, preventing erosion and landslides. They also help in retaining water and maintaining the structural integrity of the mountainside.

Q58: What happens to the soil if trees are destroyed by acid rain? If trees are destroyed, the soil loses its protective cover and binding roots. This leads to massive soil erosion, loss of fertility, and increased risk of floods and landslides during heavy rain.

Q59: Differentiate between an organic and an inorganic compound. Organic compounds primarily contain carbon and hydrogen and are often associated with living things (e.g., glucose). Inorganic compounds do not typically contain carbon-hydrogen bonds and are derived from minerals (e.g., NaCl).

Q60: Why are organic compounds found in large numbers? They are found in large numbers due to carbon's unique ability for catenation (forming long chains), its tetravalency (forming four bonds), and its ability to form stable single, double, and triple bonds with many elements.

Q61: How are organic compounds useful for us? Organic compounds are essential for life as they make up our food (carbohydrates, proteins), medicines, fuels (petroleum), clothes (cotton, nylon), and plastics.

Q62: Write down the names of five organic compounds that exist naturally. Five naturally occurring organic compounds are Glucose, Cellulose, Methane (natural gas), Acetic acid (in vinegar), and Citric acid.

Q63: How do you compare the melting and boiling points of inorganic and organic compounds? Generally, inorganic compounds have much higher melting and boiling points because they are often ionic. Organic compounds usually have lower melting and boiling points because they are held together by weaker intermolecular forces.

Q64: What are hydrocarbons? Hydrocarbons are organic compounds that consist entirely of carbon and hydrogen atoms. They are the simplest organic compounds and are the main components of fossil fuels like petroleum and natural gas.

Q65: What do LPG and CNG stand for? LPG stands for Liquefied Petroleum Gas. CNG stands for Compressed Natural Gas. Both are used as clean-burning fuels for heating and transport.

Q66: Define organic compounds. Organic compounds are the compounds of carbon (excluding oxides, carbonates, and cyanides) that contain carbon-hydrogen bonds. They are the study of carbon-based chemistry.

Q67: Define catenation and give an example. Catenation is the ability of an element (like carbon) to link with other atoms of the same element to form long chains or rings. For example, carbon forms long chains in alkanes like octane.

Q68: Why does carbon form covalent bonds? Carbon has four electrons in its valence shell. Instead of losing or gaining four electrons (which would require too much energy), it shares its electrons with other atoms to achieve a stable octet, forming covalent bonds.

Q69: What are saturated compounds? How are they represented? Saturated compounds are hydrocarbons in which all carbon-carbon bonds are single bonds (alkanes). They are represented by structural formulas showing only single lines (−) between carbon atoms.

Q70: Define structural formula with examples. A structural formula shows the actual arrangement of atoms in a molecule and how they are bonded together. For example, the structural formula of Methane is CH_4 shown with four H atoms surrounding a central C.

Q71: Write the importance of hydrocarbons. Hydrocarbons are of great importance as they are the primary source of energy (coal, oil, gas). They also serve as raw materials for making plastics, synthetic rubbers, fibers, and many chemicals.

Q72: Write down the molecular formula, structural formula and condensed structural formula for iso-butane. Molecular formula: C_4H_{10}; Structural formula: shows the branched arrangement with a central CH carbon bonded to three CH_3 groups; Condensed formula: $(CH_3)_3CH$.

Q73: Give the structural formula of Isopentane and Isobutane. *(See structural diagrams in the original source document.)*

Q74: Why are alkanes called paraffins? Alkanes are called paraffins (from Latin 'parum affinis' meaning 'little affinity') because they are chemically very stable and have little tendency to react with acids, bases, or oxidizing agents under normal conditions.

Q75: Write dot and cross structure of methane, ethane and propane. Methane (CH_4): 1 C atom sharing electrons with 4 H atoms. Ethane (C_2H_6): 2 C atoms sharing 1 pair between them and 3 H atoms each. Propane (C_3H_8): 3 C atoms in a chain, each sharing with H atoms to satisfy tetravalency.

Q76: What is meant by IUPAC nomenclature? IUPAC nomenclature is a systematic method of naming chemical compounds developed by the International Union of Pure and Applied Chemistry. It provides a unique, standardized name for every compound based on its structure.

Q77: Write structural and dot formula of butane. *(See structural diagrams in the original source document.)*

Q78: How is naphtha fraction decomposed to give lower hydrocarbons? Naphtha is decomposed through a process called "Cracking" or "Steam Cracking," where it is heated to high temperatures in the presence of steam to break long-chain hydrocarbons into smaller, more useful molecules like ethene and propene.

Q79: What do you know about hydrogenation of alkenes? Hydrogenation is the addition of hydrogen (H_2) to the double bond of an alkene to form a saturated alkane. It usually requires a catalyst like Nickel or Platinum; for example, $C_2H_4 + H_2 \rightarrow C_2H_6$.

Q80: What is the importance of cracking of petroleum? Cracking is important because it converts large, less-demanded hydrocarbon molecules into smaller, high-demand products like gasoline (petrol) and chemicals for the plastic industry.

Q81: How is margarine produced? Margarine is produced by the catalytic hydrogenation of vegetable oils (unsaturated fats). Hydrogen is bubbled through the oil in the presence of a Nickel catalyst to convert it into a solid saturated fat (banaspati ghee).

Q82: What is meant by cracking? Cracking is the chemical process of breaking down large, complex, long-chain hydrocarbon molecules into smaller, simpler ones by using heat, pressure, or catalysts.

Q83: How is naphtha produced? Naphtha is produced during the fractional distillation of crude oil. It is one of the light fractions that boils off after gases and petrol but before kerosene.

Q84: How can alkane be prepared from alkenes and alkynes? Alkanes are prepared by the addition of hydrogen (hydrogenation) to alkenes or alkynes in the presence of a catalyst like Nickel or Palladium at specific temperatures.

Q85: Convert chloromethane into methane. Chloromethane can be converted into methane through "Reduction," typically by reacting it with zinc and hydrochloric acid (Zn/HCl), which replaces the chlorine atom with a hydrogen atom: $CH_3Cl + 2[H] \rightarrow CH_4 + HCl$.