Preparatory chemistry course

Organic Chemistry

Day 1

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Organic Chemistry

What Is Organic Chemistry?

Organic chemistry is the study of the structure, properties, composition, reactions, and preparation of carbon-containing compounds, which include not only hydrocarbons but also compounds with any number of other elements, including hydrogen (most compounds contain at least one carbon–hydrogen bond), nitrogen, oxygen, halogens, phosphorus, silicon, and sulfur.

Organic Chemistry

This branch of chemistry was originally limited to compounds produced by living organisms but has been broadened to include human-made substances such as plastics. The range of application of organic compounds is enormous and also includes, but is not limited to, pharmaceuticals, petrochemicals, food, explosives, paints, and cosmetics.

Organic Chemistry

Which Industries Hire Organic Chemists?

For example

The pharmaceutical industry develops, produces, and markets drugs licensed for use as medications for humans or animals. Some pharmaceutical companies deal in brand-name (i.e., has a trade name and can be produced and sold only by the company holding the patent) and/or generic (i.e., chemically equivalent, lower-cost version of a brand-name drug) medications and medical devices (agents that act on diseases without chemical interaction with the body). Pharmaceuticals (brand name and generic) and medical devices are subject to a large number of country-specific laws and regulations regarding patenting, testing, safety assurance, efficacy, monitoring, and marketing.

Organic Chemistry

The Importance of Organic Chemistry in Medicine

Organic chemistry is essential in biological and medical fields. All living organisms are composed of abundances of organic substances. Evolution of life has been postulated to have been developed from one single organic compound called a nucleotide. Nucleotides polymerize, or join together to form the building blocks of all life, DNA (deoxyribonucleic acid).

Organic Chemistry

Organic compounds constitute various substances in the body which are vital for life to be sustained. Proteins, carbohydrates and lipids are organic compounds that contribute to the structure of the human body. Organic compounds also make up enzymes and catalysts that are mandatory for essential biological processes to occur. Also, organic compounds are responsible for governing ion transport channels in the cell which function in carrying information from one cell to another and mediating cell to cell communication. Failure of ion transport may result in failure of important biological processes in the body.

Organic Chemistry

Pharmaceuticals are also comprised mainly of organic compounds. What doctor would be efficient if he or she was not familiar with the structure and function of the drugs they were administering? Organic chemistry of pharmaceuticals must be understood to properly prescribe a drug to a patient.

Organic Chemistry

The function of organic processes in the body must also be known by the doctor even before they attempt to administer any drugs. Many medical disorders are due to disruption of organic molecules in the body: for example, hemophilia. This is a disease in which caroxyglutamic acid is deficient in the body. This organic compound is essential for blood clotting to occur within the body. People who lack this substance may die due to a minor cut or small bruise. This demonstrates the importance of organic compounds in the body.

Organic Chemistry

Carbon monoxide poisoning is an example of a very simple, yet extremely toxic organic compound that even in small quantities can cause death. Many toxic substances are of organic descent. Doctors must be able to determine the effects of these toxic substances in the body, recognize the symptoms they are associated with, and prescribe the appropriate pharmaceutical to combat the poison.

Organic Chemistry

It is evident that organic molecules are essential for the sustenance of all life. Understanding these compounds is crucial in the medical field not only to understand basic biological functions, but also to predict scenarios in the body which may be due to disruption of organic substances, or adverse reactions due to foreign organic substances in the body. Complete medical efficiency will only be achieved when the science of organic chemistry is understood.

The role of chemistry in drug discovery and development

Drug discovery and development is one of the most complex and expensive activities within the framework of the pharmaceutical industry. It encompasses a wide array of end-to-end activities with a plethora of supply chain and support services. It is estimated that the average cost to research and develop each successful drug is between $800m to $1bn. Drug discovery and development can be classified into discovery phase, preclinical phase and early stage development, mid stage development and late stage development. Drug discovery has undergone many changes over the years but the goal has remained same: to uncover safer medicines for all diseases. Drug discovery and development is driven by the knowledge of chemistry of the molecules and their association with life process.

In short, chemistry remains the most invaluable science and plays the most critical role in the drug development process. It serves as the backbone to framework the drug discovery and bolstering the growth of the pharmaceutical industry.

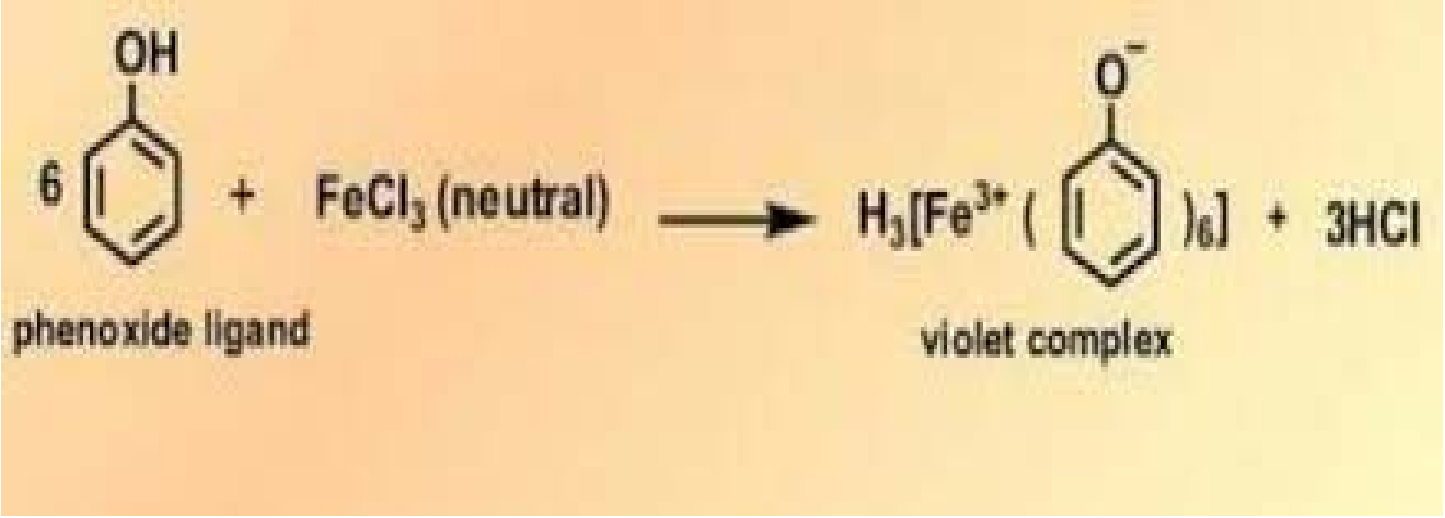
Exam of Chemistry

Program for Preparatory Course in Chemistry in English for Foreign Applicants

Alkanes, Alkenes, Alkynes, Arens, Hydroxyl Derivatives, Amines, Aldehydes and Ketons, Carboxylic acid and Derivatives, Aminocarboxylic acids and Carbohydrates.

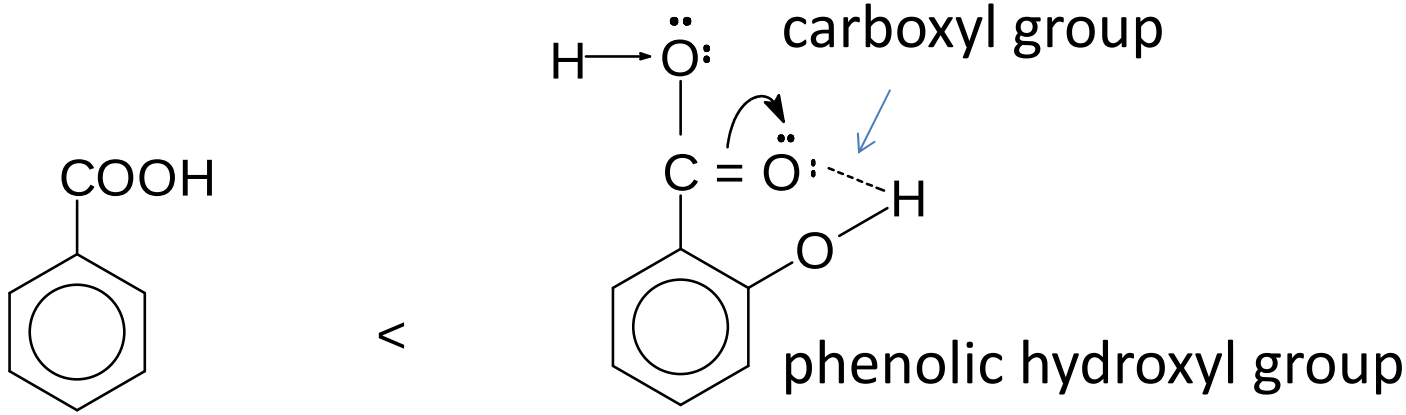
(7). Which of the following reagent can be used to distinguish phenol from benzyl alcohol?

Correct answer (D), because the phenol forms a violet complex with Fe(III)+, which is intensely colored.



(10). Salicylic acid is stronger than benzoic acid because:

Correct answer (B), an intramolecular hydrogen bond is formed between the two functional groups.



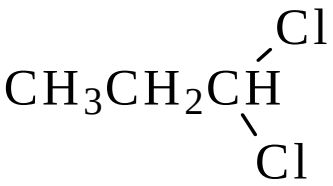
(20). What is the common name for $CH_2{=}{=}CHCH_2Cl$

Correct answer (C)

Allyl chloride is the organic compound with the formula $CH_2{=}CHCH_2Cl$.

$CCl_2{=}CH_2$ - vinylidene chloride

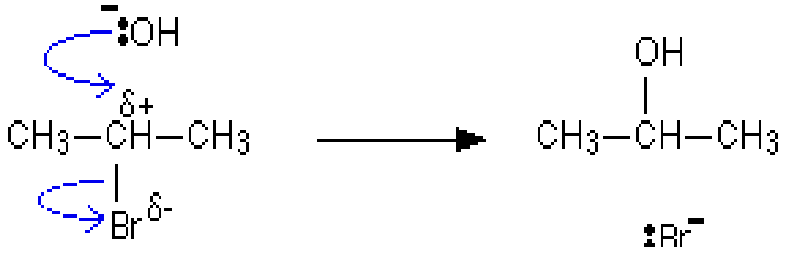
$H_2C{=}CHCl$ - vinyl chloride

propylidene chloride (1,1-dichloropropane) 

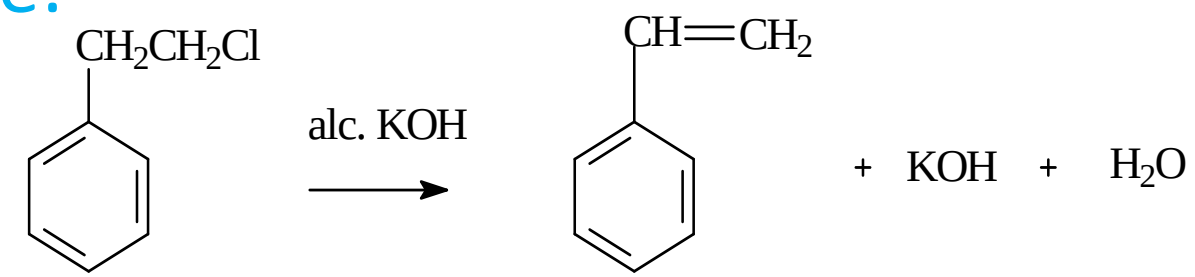
(33). The reaction of 2-bromopropane with an aqueous solution of potassium hydroxide gives:

Correct answer (A)

Aqueous NaOH is alkaline in nature i.e. it dissociates to produce a hydroxide ion. These hydroxide ions act as a strong nucleophile and replace the halogen atom in an alkyl halide. This results in the formation of alcohol molecules and the reaction is known as nucleophilic substitution reaction.



(35). What is the type of reaction,presented on the scheme:



Correct answer (D)

Elimination reaction, any of a class of organic chemical reactions in which a pair of atoms or groups of atoms are removed from a molecule, usually through the action of acids, bases, or metals and, in some cases, by heating to a high temperature. It is the principal process by which organic compounds containing only single carbon-carbon bonds (saturated compounds) are transformed to compounds containing double or triple carbon-carbon bonds (unsaturated compounds).

Elimination reactions are commonly known by the kind of atoms or groups of atoms leaving the molecule. The removal of a hydrogen atom and a halogen atom, for example, is known as dehydrohalogenation; when both leaving atoms are halogens, the reaction is known as dehalogenation. Similarly, the elimination of a water molecule, usually from an alcohol, is known as dehydration; when both leaving atoms are hydrogen atoms, the reaction is known as dehydrogenation.

Substitution reaction, any of a class of chemical reactions in which an atom, ion, or group of atoms or ions in a molecule is replaced by another atom, ion, or group. An example is the reaction in which the chlorine atom in the chloromethane molecule is displaced by the hydroxide ion, forming methanol.

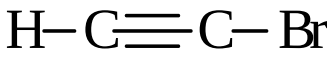
Addition reaction, any of a class of chemical reactions in which an atom or group of atoms is added to a molecule.

A typical addition reaction may be illustrated by the hydrochlorination of propene (an alkene), for which the equation is $CH_3CH = CH_2 + HCl \rightarrow CH_3C^+HCH_3 + Cl^- \rightarrow CH_3CHClCH_3$.

The mechanism involves a chain reaction. During a chain reaction, for every reactive species you start off with, a new one is generated at the end - and this keeps the process going.

The over-all process is known as free radical substitution, or as a free radical chain reaction.

(37). In which of the presented compounds the carbon-bromine bond is most polar?

Correct answer (C) 

Polar covalent bond is a chemical bond in which the electrons required to form a bond is unequally shared between two atoms. The atom which is more electronegative attracts more electrons from the bonded pair than the other atom. As a result there is a slight separation of charges in a molecule in which more electronegative atom (comparatively) carries a slight negative charge and less electronegative atom carries a positive charge.

Atoms stick together because of chemical attraction, meaning that various types of atoms are attracted to each other and come together in a bond. This attraction is created because of the electrostatic force caused by the attraction between electrons and nuclei.

There are various types of chemical bonds including:

Ionic Bonds;

Covalent Bonds;

Dative Bonds;

Network Covalent Bonds.

Ionic Bonds

One type of chemical bond is an ionic bond. Ionic bonds are formed by the electrostatic attraction of atoms that have opposite charges. An ion is an atom that has gained or lost one or more of its electrons in its outer shell, therefore giving the atom either a positive or negative charge.

Ionic bonds are typically formed between one metallic and one nonmetallic atom.

Sodium chloride, or NaCl, is an example of an ionic bond.

Ionic bonds are created because atoms want to have their outer shells full of electrons; so, when an atom has an outer shell that is not full, it will be attracted to other atoms that have extra electrons.

Covalent Bonds

A covalent bond is formed when two atoms with electronegativities share their electrons, rather than trading them as happens in ionic bonds. Two hydrogen atoms can share an electron to form the molecule H_2, and they are joined by a single covalent bond.

A double covalent bond is found in ethylene (C_2H_4), because two sets of valence electrons are shared.

A triple covalent bond is seen in atomic nitrogen (N_2).

Dative Bond

A dative bond, also called a coordinate covalent bond, is created when one atom gives both electrons needed to form a single covalent bond.

This can be seen with ammonium (NH_4^+). Nitrogen contributes the two electrons needed to bond with hydrogen and therefore form the ammonium with a dative bond.

Network Covalent Bond

Sometimes elements will form covalent bonds over and over in a material, repeating the same structure to form very large molecules. When this occurs, the bonds formed are described as a network covalent.

An example of this is seen in diamonds. Carbon bonds to itself, with each carbon atom forming four covalent bonds to four other carbon atoms. This forms one large molecule that is a diamond crystal.

There are several different kinds of chemical bonds that can form; but, the similarity between all of them is the attraction of two atoms.

The polarity of molecules

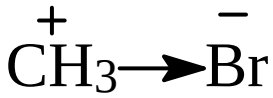
There are three main properties of chemical bonds that must be considered—namely, their strength, length, and polarity. The polarity of a bond is the distribution of electrical charge over the atoms joined by the bond. Specifically, it is found that, while bonds between identical atoms (as in H2) are electrically uniform in the sense that both hydrogen atoms are electrically neutral, bonds between atoms of different elements are electrically inequivalent. In hydrogen chloride, for example, the hydrogen atom is slightly positively charged whereas the chlorine atom is slightly negatively charged. The slight electrical charges on dissimilar atoms are called partial charges, and the presence of partial charges signifies the occurrence of a polar bond.

The polarity of a bond arises from the relative electronegativities of the elements. Electronegativity, it will be recalled, is the power of an atom of an element to attract electrons toward itself when it is part of a compound. Thus, although a bond in a compound may consist of a shared pair of electrons, the atom of the more electronegative element will draw the shared pair toward itself and thereby acquire a partial negative charge. The atom that has lost its equal share in the bonding electron pair acquires a partial positive charge because its nuclear charge is no longer fully canceled by its electrons.

Carbon bonding

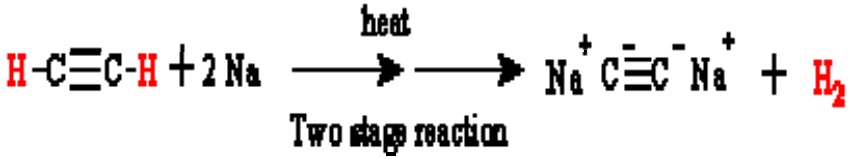
The carbon atom is unique among elements in its tendency to form extensive networks of covalent bonds not only with other elements but also with itself. Because of its position midway in the second horizontal row of the periodic table, carbon is neither an electropositive nor an electronegative element; it therefore is more likely to share electrons than to gain or lose them. Moreover, of all the elements in the second row, carbon has the maximum number of outer shell electrons (four) capable of forming covalent bonds. . The possibilities for diversity are increased by the presence of atoms other than carbon in organic compounds, especially hydrogen (H), oxygen (O), nitrogen (N), halogens (fluorine [F], chlorine [Cl], bromine [Br], and iodine [I]), and sulfur (S).

An inductive effect is an electronic effect due to the polarisation of σ bonds within a molecule or ion.
This is typically due to an electronegatvity difference between the atoms at either end of the bond.
The more electronegative atom pulls the electrons in the bond towards itself creating some bond polarity for example the C-Br bond in the following example:



Terminal alkynes have acidic hydrogen atoms which are easily replaced by metal ions.

When ethyne is passed over heated sodium only one of the terminal hydrogens is replaced initially. Heating this monosodium salt will give the disodium salt and ethyne.



Comparison of acidity between alkynes, alkenes and alkanes : Alkanes and alkenes do not undergo above reactions that suggests that alkynes are more acidic than alkanes and alkenes. Among hydrocarbons, acidity follows the order :

Alkyne > Alkene > Alkane