Chemistry of aldehydes and ketones pdf

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Learning Objectives Describe the structure and properties of aldehydes and ketones. Name common aldehydes and ketones. Aldehydes and ketones are widespread in nature and are often combined with other functional groups. Examples of naturally occurring molecules which contain a aldehyde or ketone functional group are shown in the following two figures. The compounds in Figure \(\PageIndex{1}\) are found chiefly in plants or microorganisms and those in Figure \(\PageIndex{2}\) have animal origins. Aldehydes and ketones are known for their sweet and sometimes pungent odors. The odor from vanilla extract comes from the molecule vanillin. Likewise, benzaldehyde provides a strong scent of almonds and is this author's favorite chemical smell. Because of their pleasant fragrances aldehyde and ketone containing molecules are often found in perfumes. However, not all of the fragrances are pleasing. In particular, 2-Heptanone provides part of the sharp scent from blue cheese and (R)-Muscone is part of the musky smell from the Himalayan musk deer. Lastly, ketones show up in many important hormones such as progesterone (a female sex hormone) and testosterone (a male sex hormone). Notice how subtle differences in structure can cause drastic changes in biological activity. The ketone functionality also shows up in the anti-inflammatory steroid, Cortisone. Figure \(\PageIndex{1}\) Aldehyde and ketone containing molecules isolated from plant sources. Figure \(\PageIndex{1}\) Figure \(\PageIndex{2}\) Aldehyde and ketone containing molecules isolated from animal sources. Figure \(\PageIndex{1}\) Aldehydes and ketones are two related categories of organic compounds that both contain the carbonyl group, shown below The difference between aldehydes and ketones is the placement of the carbonyl group within the molecule. An aldehyde is an organic compound in which the carbonyl group is attached to a carbon atom at the end of a carbon chain. A ketone is an organic compound in which the carbonyl group is attached to a carbon atom within the carbon chain. The general formulas for each are shown below. For aldehydes, the \(\ce{R}\) group may be a hydrogen atom or any length carbon chain. Aldehydes are named by finding the longest continuous chain that contains the carbonyl group. Change the -e at the end of the name of the alkane to -al. For the common name of aldehydes start with the common parent chain name and add the suffix -aldehyde. The IUPAC system names are given on top while the common name is given on the bottom in parentheses. For ketones, \(\ce{R}\) and \(\ce{R'}\) must be carbon chains, of either the same or different lengths. The steps for naming ketones, followed by two examples, are shown below. Name the parent compound by finding the longest continuous chain that contains the carbonyl group. Change the -e at the end of the name of the alkane to -one. Number the carbon atoms in the chain in a way that the carbonyl group has the lowest possible number. Add the numerical prefix into the name before the name of the ketone. Use a hyphen between the number and the name of the ketone. The common name for ketones are simply the substituent groups listed alphabetically + ketone. Some common ketones are known by their generic names. Such as the fact that propanone is commonly referred to as acetone. The IUPAC system names are given on top while the common name is given on the bottom in parentheses. Top from left to right:propanone (acetone); acetophenone (methyl phenol ketone); benzophenone (diphenyl ketone; Bottom from left to right: 2 pentanone (methyl propyl ketone); 3 methyl 2 butanone (methyl isopropyl ketone); 3 hexanone (ethyl propyl ketone) Aldehydes and ketones can work weak hydrogen bonds with water through the carbonyl oxygen atom. The lower members of both series (3 carbons or fewer) are soluble in water in all proportions. As the length of the carbon chain increases, water solubility decreases. Similar to ethers, neither aldehydes nor ketones can hydrogen bond with themselves. As a result, their boiling points are generally lower than those of alcohols. Unlike alkanes however, aldehydes and ketones are polar molecules due to the more electronegative oxygen atom. The dipole-dipole interactions are stronger than the dispersion forces present in alkanes. The boiling points of aldehydes and ketones are intermediate between those of alkanes and alcohols. For example, the boiling point of ethane is \(-89^\text{o} \text{C}\), ethanal is \(20^\text{o} \text{C}\), and ethanol is \(78^\text{o} \text{C}\). Methanal, commonly known as formaldehyde, was once commonly used as a biological preservative for dead animals. In recent years formaldehyde has been shown to be a carcinogen and so has been replaced for the purpose by safer alternatives. Aldehydes are currently used in the production of resins and plastics. The simplest ketone, propanone, is commonly called acetone. Acetone is a common organic solvent that was one used in most nail polish removers, but has largely been replaced by other solvents. Formaldehyde, an aldehyde with the formula HCHO, is a colorless gas with a pungent and irritating odor. It is sold in an aqueous solution called formalin, which contains about 37% formaldehyde by weight. Formaldehyde causes coagulation of proteins, so it kills bacteria (and any other living organism) and stops many of the biological processes that cause tissue to decay. Thus, formaldehyde is used for preserving tissue specimens and embalming bodies. It is also used to sterilize soil or other materials. Formaldehyde is used in the manufacture of Bakelite, a hard plastic having high chemical and electrical resistance. Formaldehyde is produced industrially by the catalytic oxidation of methanol according to the chemical equation: 2 CH3OH + O2 → 2 CH2O + 2 H2O Acetaldehyde (systematic name ethanal) is an organic chemical compound with the formula CH3CHO, sometimes abbreviated by chemists as MeCHO (Me = methyl). It is one of the most important aldehydes, occurring widely in nature and being produced on a large scale in industry. Acetaldehyde occurs naturally in coffee, bread, and ripe fruit, and is produced by plants. In 2003, global production was about 1 million tonnes. Before 1962, ethanol and acetylene were the major sources of acetaldehyde. Since then, ethylene is the dominant feedstock. The main method of production is the oxidation of ethylene by the Wacker process, which involves oxidation of ethylene using a homogeneous palladium/copper system: 2 CH2=CH2 + O2 → 2 CH3CHO Propionaldehyde or propanal is the organic compound with the formula CH3CH2CHO. It is a saturated 3-carbon aldehyde and is a structural isomer of acetone. It is a colorless liquid with a slightly irritating, fruity odor. Butyraldehyde, also known as butanal, is an organic compound with the formula CH3(CH2)2CHO. This compound is the aldehyde derivative of butane. It is a colourless flammable liquid with an unpleasant smell. It is miscible with most organic solvents. A major use of butyraldehyde is in the production of bis(2-ethylhexyl) phthalate, a major plasticizer. Benzaldehyde (C6H5CHO) is an organic compound consisting of a benzene ring with a formyl substituent. It is the simplest aromatic aldehyde and one of the most industrially useful.It is a colorless liquid with a characteristic almond-like odor. The primary component of bitter almond oil, benzaldehyde can be extracted from a number of other natural sources. Synthetic benzaldehyde is the flavoring agent in imitation almond extract, which is used to flavor cakes and other baked goods Traces of many aldehydes are found in essential oils and often contribute to their favorable odors, e.g. cinnamaldehyde, cilantro, and vanillin. In terms of scale, the most important ketones are acetone, methylethyl ketone, and cyclohexanone. They are also common in biochemistry, but less so than in organic chemistry in general. Dimethyl ketone, CH3COCH3, commonly called acetone, is the simplest ketone. Acetone is a colorless liquid. Among its many uses are as a solvent for lacquer (including fingernail polish), cellulose acetate, cellulose nitrate, acetylene, plastics, and varnishes; as a paint and varnish remover; and as a solvent in the manufacture of pharmaceuticals and chemicals. Acetone is produced directly or indirectly from propylene. Approximately 83% of acetone is produced via the cumene process; as a result, acetone production is tied to phenol production. In the cumene process, benzene is alkylated with propylene to produce cumene, which is oxidized by air to produce phenol and acetone: Other processes involve the direct oxidation of propylene (Wacker-Hoechst process), or the hydration of propylene to give 2-propanol, which is oxidized to acetone. Butanone, also known as methyl ethyl ketone (MEK), is an organic compound with the formula CH3C(O)CH2CH3. This colorless liquid ketone has a sharp, sweet odor reminiscent of butterscotch and acetone. It is produced industrially on a large scale, and also occurs in trace amounts in nature. It is soluble in water and is commonly used as an industrial solvent. Butanone is an effective and common solvent and is used in processes involving gums, resins, cellulose acetate and nitrocellulose coatings and in vinyl films. For this reason it finds use in the manufacture of plastics, textiles, in the production of paraffin wax, and in household products such as lacquer, varnishes, paint remover, a denaturing agent for denatured alcohol, glues, and as a cleaning agent. It has similar solvent properties to acetone but boils at a higher temperature and has a significantly slower evaporation rate. Cyclohexanone is the organic compound with the formula (CH2)5CO. The molecule consists of six-carbon cyclic molecule with a ketonefunctional group. This colorless oil has an odor reminiscent of that of acetone. Over time, samples of cyclohexanone assume a yellow color. Cyclohexanone is slightly soluble in water and miscible with common organic solvents. Billions of kilograms are produced annually, mainly as a precursor to nylon. Classify each compound as an aldehyde or a ketone. a. This compound has the carbonyl group on an end carbon atom, so it is an aldehyde. b. This compound has the carbonyl group on an interior carbon atom, so it is a ketone. c. This compound has the carbonyl group between two alkyl groups, so it is a ketone. Classify each compound as an aldehyde or a ketone. a. ketone b. aldehyde c. ketone An aldehyde is an organic compound in which the carbonyl group is attached to a carbon atom at the end of a carbon chain. A ketone is an organic compound in which the carbonyl group is attached to a carbon atom within the carbon chain.The common names of aldehydes are taken from the names of the corresponding carboxylic acids: formaldehyde, acetaldehyde, and so on. The common names of ketones, like those of ethers, consist of the names of the groups attached to the carbonyl group, followed by the word ketone. Stem names of aldehydes and ketones are derived from those of the parent alkanes, using an -al ending for an aldehydes and an -one ending for a ketone. Contributors and Attributions

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