

## 11.9: Halogenated Hydrocarbons

### Learning Objectives

- To name halogenated hydrocarbons given formulas and write formulas for these compounds given names.

Many organic compounds are closely related to the alkanes. As we noted previously, alkanes react with halogens to produce halogenated hydrocarbons, the simplest of which have a single halogen atom substituted for a hydrogen atom of the alkane. Even more closely related are the cycloalkanes, compounds in which the carbon atoms are joined in a ring, or cyclic fashion.

The reactions of alkanes with halogens produce halogenated hydrocarbons, compounds in which one or more hydrogen atoms of a hydrocarbon have been replaced by halogen atoms:



The replacement of only one hydrogen atom gives an alkyl halide (or haloalkane). The *common names* of alkyl halides consist of two parts: the name of the alkyl group plus the stem of the name of the halogen, with the ending *-ide*. The IUPAC system uses the name of the parent alkane with a prefix indicating the halogen substituents, preceded by number indicating the substituent's location. The prefixes are *fluoro-*, *chloro-*, *bromo-*, and *iodo-*. Thus  $\text{CH}_3\text{CH}_2\text{Cl}$  has the common name ethyl chloride and the IUPAC name chloroethane. Alkyl halides with simple alkyl groups (one to four carbon atoms) are often called by common names. Those with a larger number of carbon atoms are usually given IUPAC names.

### ✓ Example 11.9.1

Give the common and IUPAC names for each compound.

- $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
- $(\text{CH}_3)_2\text{CHCl}$

#### Solution

- The alkyl group  $(\text{CH}_3\text{CH}_2\text{CH}_2-)$  is a propyl group, and the halogen is bromine (Br). The common name is therefore propyl bromide. For the IUPAC name, the prefix for bromine (bromo) is combined with the name for a three-carbon chain (propane), preceded by a number identifying the carbon atom to which the Br atom is attached, so the IUPAC name is 1-bromopropane.
- The alkyl group  $[(\text{CH}_3)_2\text{CH}-]$  has three carbon atoms, with a chlorine (Cl) atom attached to the middle carbon atom. The alkyl group is therefore isopropyl, and the common name of the compound is isopropyl chloride. For the IUPAC name, the Cl atom (prefix *chloro-*) attached to the middle (second) carbon atom of a propane chain results in 2-chloropropane.

### ? Exercise 11.9.1

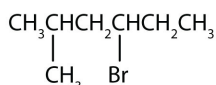
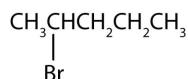
Give common and IUPAC names for each compound.

- $\text{CH}_3\text{CH}_2\text{I}$
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{F}$

### ✓ Example 11.9.2

Give the IUPAC name for each compound.

1.

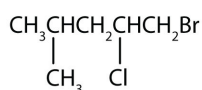
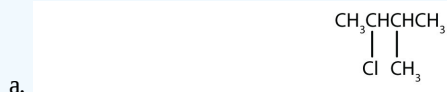


### Solution

1. The parent alkane has five carbon atoms in the longest continuous chain; it is pentane. A bromo (Br) group is attached to the second carbon atom of the chain. The IUPAC name is 2-bromopentane.
2. The parent alkane is hexane. Methyl (CH<sub>3</sub>) and bromo (Br) groups are attached to the second and fourth carbon atoms, respectively. Listing the substituents in alphabetical order gives the name 4-bromo-2-methylhexane.

### ? Exercise 11.9.2

Give the IUPAC name for each compound.



A wide variety of interesting and often useful compounds have one or more halogen atoms per molecule. For example, methane (CH<sub>4</sub>) can react with chlorine (Cl<sub>2</sub>), replacing one, two, three, or all four hydrogen atoms with Cl atoms. Several halogenated products derived from methane and ethane (CH<sub>3</sub>CH<sub>3</sub>) are listed in Table 11.9.1, along with some of their uses.

Table 11.9.1: Some Halogenated Hydrocarbons

Formula	Common Name	IUPAC Name	Some Important Uses
<b>Derived from CH<sub>4</sub></b>			
CH <sub>3</sub> Cl	methyl chloride	chloromethane	refrigerant; the manufacture of silicones, methyl cellulose, and synthetic rubber
CH <sub>2</sub> Cl <sub>2</sub>	methylene chloride	dichloromethane	laboratory and industrial solvent
CHCl <sub>3</sub>	chloroform	trichloromethane	industrial solvent
CCl <sub>4</sub>	carbon tetrachloride	tetrachloromethane	dry-cleaning solvent and fire extinguishers (but no longer recommended for use)
CBrF <sub>3</sub>	halon-1301	bromotrifluoromethane	fire extinguisher systems
CCl <sub>3</sub> F	chlorofluorocarbon-11 (CFC-11)	trichlorofluoromethane	foaming plastics
CCl <sub>2</sub> F <sub>2</sub>	chlorofluorocarbon-12 (CFC-12)	dichlorodifluoromethane	refrigerant
<b>Derived from CH<sub>3</sub>CH<sub>3</sub></b>			
CH <sub>3</sub> CH <sub>2</sub> Cl	ethyl chloride	chloroethane	local anesthetic
ClCH <sub>2</sub> CH <sub>2</sub> Cl	ethylene dichloride	1,2-dichloroethane	solvent for rubber
CCl <sub>3</sub> CH <sub>3</sub>	methylchloroform	1,1,1-trichloroethane	solvent for cleaning computer chips and molds for shaping plastics

### To Your Health: Halogenated Hydrocarbons

Once widely used in consumer products, many chlorinated hydrocarbons are suspected carcinogens (cancer-causing substances) and also are known to cause severe liver damage. An example is carbon tetrachloride (CCl<sub>4</sub>), once used as a dry-cleaning solvent

and in fire extinguishers but no longer recommended for either use. Even in small amounts, its vapor can cause serious illness if exposure is prolonged. Moreover, it reacts with water at high temperatures to form deadly phosgene ( $\text{COCl}_2$ ) gas, which makes the use of  $\text{CCl}_4$  in fire extinguishers particularly dangerous.

Ethyl chloride, in contrast, is used as an external local anesthetic. When sprayed on the skin, it evaporates quickly, cooling the area enough to make it insensitive to pain. It can also be used as an emergency general anesthetic.

Bromine-containing compounds are widely used in fire extinguishers and as fire retardants on clothing and other materials. Because they too are toxic and have adverse effects on the environment, scientists are engaged in designing safer substitutes for them, as for many other halogenated compounds.

### 📌 To Your Health: Chlorofluorocarbons and the Ozone Layer

Alkanes substituted with both fluorine (F) and chlorine (Cl) atoms have been used as the dispersing gases in aerosol cans, as foaming agents for plastics, and as refrigerants. Two of the best known of these chlorofluorocarbons (CFCs) are listed in Table 11.9.1.

Chlorofluorocarbons contribute to the greenhouse effect in the lower atmosphere. They also diffuse into the stratosphere, where they are broken down by ultraviolet (UV) radiation to release Cl atoms. These in turn break down the ozone ( $\text{O}_3$ ) molecules that protect Earth from harmful UV radiation. Worldwide action has reduced the use of CFCs and related compounds. The CFCs and other Cl- or bromine (Br)-containing ozone-destroying compounds are being replaced with more benign substances. Hydrofluorocarbons (HFCs), such as  $\text{CH}_2\text{FCF}_3$ , which have no Cl or Br to form radicals, are one alternative. Another is hydrochlorofluorocarbons (HCFCs), such as  $\text{CHCl}_2\text{CF}_3$ . HCFC molecules break down more readily in the troposphere, and fewer ozone-destroying molecules reach the stratosphere.

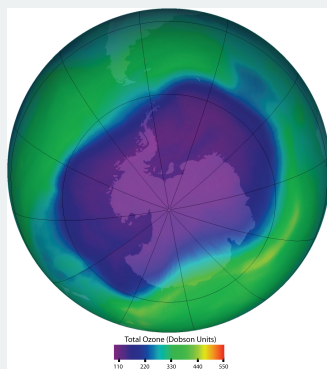


Figure 11.9.1: Ozone in the upper atmosphere shields Earth's surface from UV radiation from the sun, which can cause skin cancer in humans and is also harmful to other animals and to some plants. Ozone "holes" in the upper atmosphere (the gray, pink, and purple areas at the center) are large areas of substantial ozone depletion. They occur mainly over Antarctica from late August through early October and fill in about mid-November. Ozone depletion has also been noted over the Arctic regions. The largest ozone hole ever observed occurred on 24 September 2006. Source: Image courtesy of NASA, [Ozone watch \(opens in new window\)](#) [ozonewatch.gsfc.nasa.gov].

### Key Takeaway

- The replacement of an hydrogen atom on an alkane by a halogen atom—F, Cl, Br, or I—forms a halogenated compound.

This page titled 11.9: Halogenated Hydrocarbons is shared under a CC BY-NC-SA 4.0 license and was authored, remixed, and/or curated by Eden Francis via source content that was edited to the style and standards of the LibreTexts platform.

- 12.8: Halogenated Hydrocarbons by Anonymous is licensed CC BY-NC-SA 3.0. Original source: <https://2012books.lardbucket.org/books/introduction-to-chemistry-general-organic-and-biological>.