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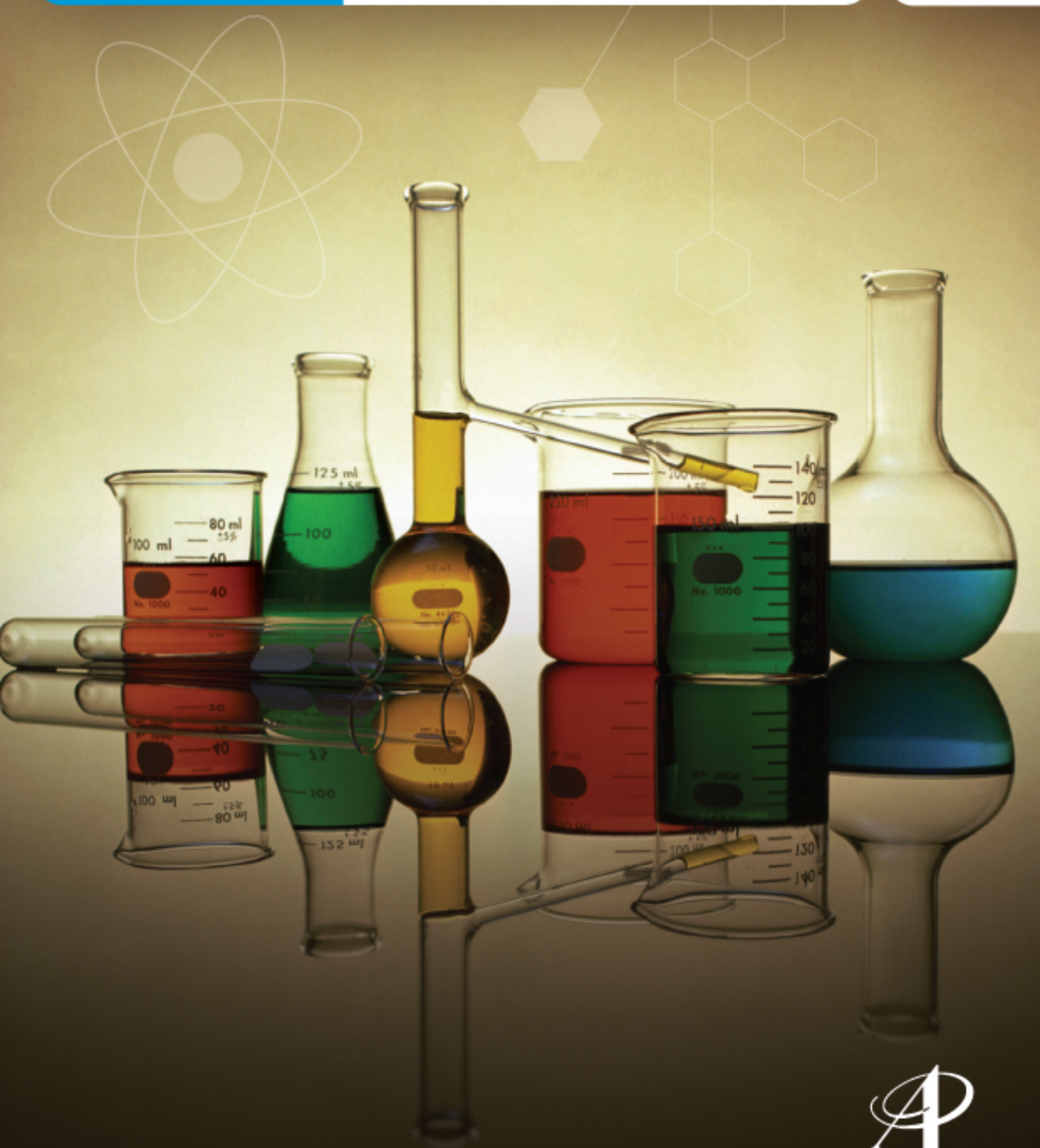

Alpha Omega Publications®

SCIENCE 1109
CARBON CHEMISTRY: FUNCTIONAL GROUPS

CONTENTS

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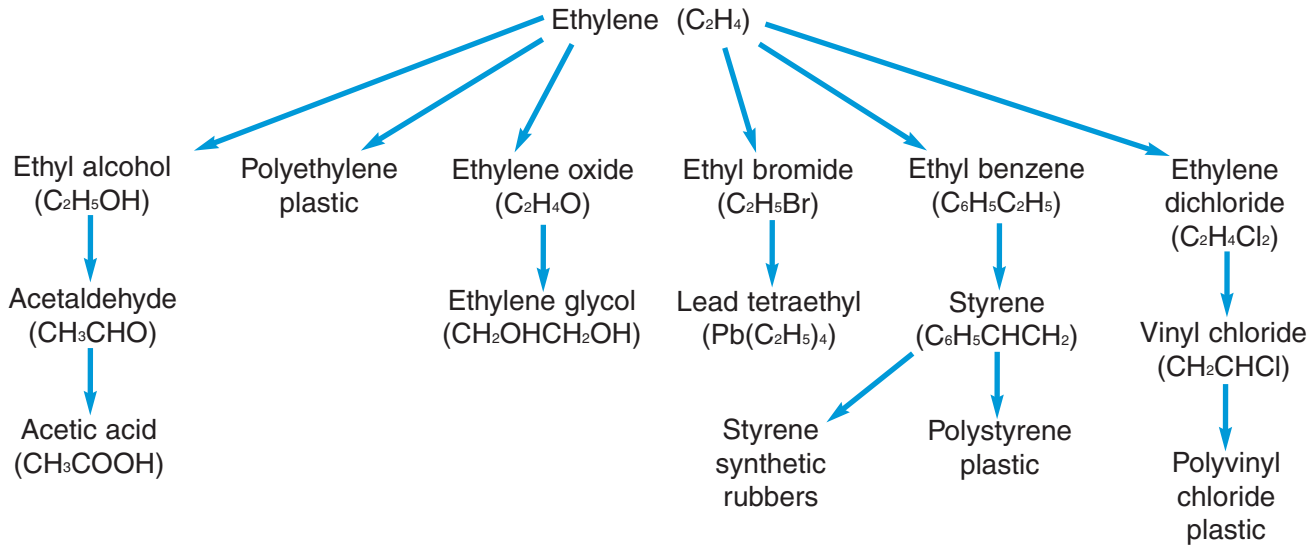
CARBON CHEMISTRY: FUNCTIONAL GROUPS

One of the most widely used (12 million tons annually) organic chemicals in industry is ethylene, C_2H_4, which is manufactured from ethane, C_2H_6, obtained from petroleum. Ethylene is formed according to the dehydrogenation reaction given by the equation:

$$C_2H_6 \rightarrow C_2H_4 + H_2.$$

The variety of substances produced from ethylene are indicated in the following diagram.



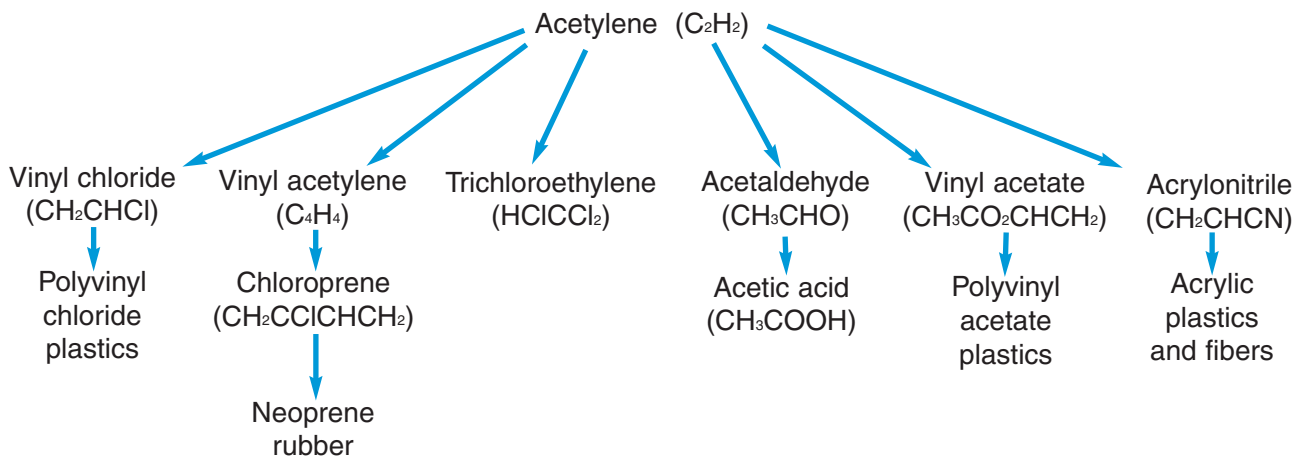
Another useful organic chemical is acetylene, C_2H_2, which is manufactured by heating CaO (lime) and C (coke) in an electric furnace to produce calcium carbide, CaC_2:

$$CaO + 3\ C \rightarrow CaC_2 + CO$$

Calcium carbide is then combined with water to give acetylene gas:

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$$

The uses of acetylene are summarized in the following diagram.



This LIFEPAC® is designed to help you study some of the chemistry of the functional groups of organic chemistry. You will learn the chemistry of saturated and unsaturated molecules, oxygen derivatives, and nitrogen containing organic molecules. You will also learn that God's great design of protein molecules leaves no doubt that a Creator made our universe and all life in it. Study the preceding diagrams to see how Science LIFEPAC 1108 fits this LIFEPAC.

OBJECTIVES

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC.

When you have finished this LIFEPAC, you should be able to:

1. Diagram the reaction between an alkane and a halogen.
2. Describe the reaction between an alkane and a halogen.
3. List some examples of halides of the alkane series.
4. Diagram the reaction between halogens and unsaturated molecules.
5. Describe the reaction between halogens and unsaturated molecules.
6. List some examples of halides of the unsaturated series.
7. Classify and identify oxygen families by functional group.
8. Describe the properties of the different oxyorganic functional groups.
9. Balance reactions involving the oxygen functional groups.
10. List some common examples of each of the oxygen functional groups.
11. Classify and identify amines and amides.
12. Describe the chemical properties of some common nitrogen-containing organic compounds.
13. Describe amino acids and identify the peptide linkage.
14. Describe proteins.
15. Explain how proteins give evidence of God's Creation.

Survey the LIFEPAC. Ask yourself some questions about this study. Write your questions here.

I. HYDROCARBON CHEMISTRY

The reactions of hydrocarbons are the basis of the chemistry for many other organic compounds. (See the Introduction to this Science LIFEPAC.) In this section you will study the basic reactions of saturated and unsaturated molecules when reacted with halogens, the reaction types of substitution and addition will be reviewed, and examples of organic halides will be listed.

SECTION OBJECTIVES

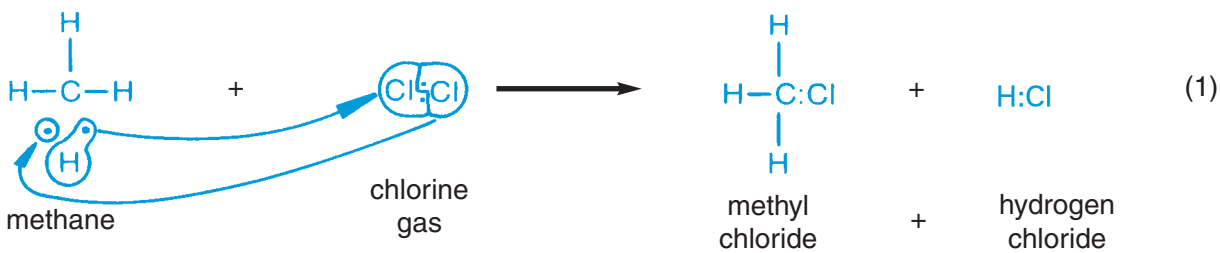
Review these objectives. When you have completed this section, you should be able to:

1. Diagram the reaction between an alkane and a halogen.
2. Describe the reaction between an alkane and a halogen.
3. List some examples of halides of the alkane series.
4. Diagram the reaction between halogens and unsaturated molecules.
5. Describe the reaction between halogens and unsaturated molecules.
6. List some examples of halides of the unsaturated series.

SATURATED

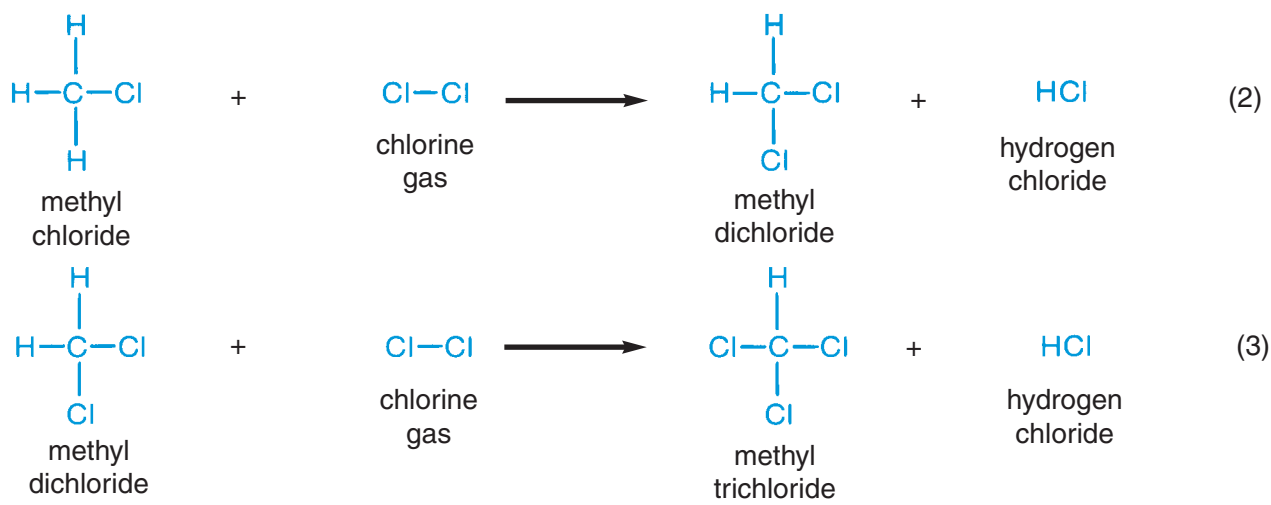
Compounds formed from the reaction of halogens and saturated hydrocarbons are very common. Some compounds in this halide group have been significant in making history. In this section you will study how saturated halides are formed and learn some examples of this family that are important to us today.

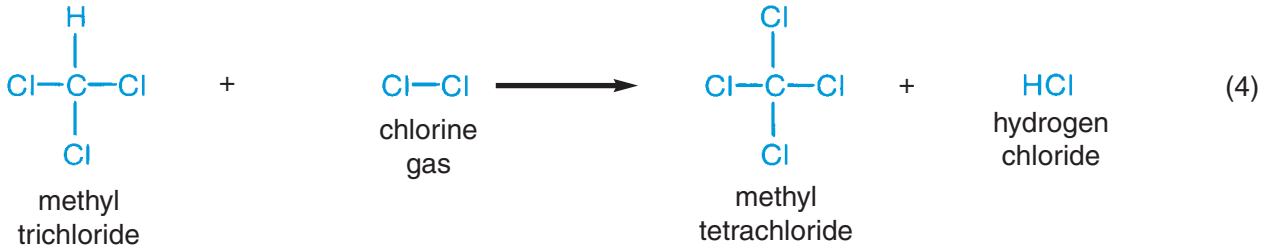
Reactions. The formation of saturated halide hydrocarbons is one of replacement (substitution). A typical example is the reaction between chlorine gas (Cl:Cl) and methane. In the presence of ultraviolet light, this reaction occurs at a very rapid rate. The ultraviolet light provides energy of just the right amount to cause the reactants to break apart and react with each other.



(EACH — IS THE SAME AS : IN A BOND. EACH — AND EACH : REPRESENTS A PAIR OF BONDING ELECTRONS.)

If the methane-chlorine mixture is left to continue reacting, successive hydrogens will be replaced and the substitution reaction will continue until all hydrogens have been replaced.





(4)

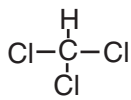
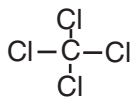
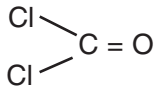
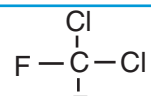
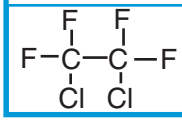
This substitution series is an equilibrium series and will finally become a mixture of all four methyl halides. The equilibrium can be shifted to the right in each case by the removal of hydrogen chloride and the use of excess chlorine gas. (If you need a review of equilibriums, review Science LlFEPACs 1106 and 1107.) Since the HCl is an acid and is very soluble in water, the reaction mixture can be pumped through water and the HCl removed.

This process leaves the methyl halide to react with chlorine gas until complete substitution has been accomplished. This reaction procedure is common in the production of halides from saturated hydrocarbons.

Examples. Many saturated halide hydrocarbons are common to us in our everyday life. A few examples are listed in Table 1.

Table 1

Examples of Saturated Halide Hydrocarbons

Structure	Formula	Common Name	Uses
	$CHCl_3$	chloroform	anesthetic (dangerous to use)
	CCl_4	carbon tetrachloride	dry cleaning solvent, fire extinguisher (dangerous to use; inhaling vapors causes liver damage)
	$COCl_2$	phosgene	poisonous gas used in warfare, especially World War I
	CCl_2F_2	Freon 12	dispersing gas in aerosols, refrigerant (may cause damage to ozone layer of our atmosphere)
	$C_2Cl_2F_4$	Freon 114	dispersing gas in aerosols, refrigerant (may cause damage to ozone layer of our atmosphere)

Do these activities.

1.1 Assume a single Br replacement in the reaction of methane and Br_2. Use a structural diagram to show the reaction between CH_4 and Br_2.