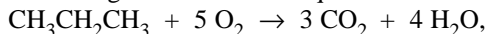


Making Connections

5. According to the balanced equation for the combustion of propane,



- 1 mol of propane reacts with 5 mol of oxygen to produce 3 mol of carbon dioxide and 4 mol of water vapour; that is, a total of 6 mol of gas reacts to produce a total of 7 mol of gas. The volume of gaseous product formed is greater than the volume of gaseous reactants, by a factor of 1 additional volume of product for each 6 volumes of reactants (17% increase).
6. Nonane would be the most effective solvent for removing oil stains because it is the least polar molecule, and would be most soluble with oil, which is nonpolar. The carbon–chlorine bonds and the carbon–oxygen bonds in the first two compounds are polar bonds (Cl and O are more electronegative than C), and thus, the molecules are more polar than nonane.
7. Trinitrotoluene (TNT) is a yellow, odourless solid produced by the substitution of three nitro (NO_2) groups for three hydrogen atoms in toluene ($\text{C}_6\text{H}_5\text{CH}_3$). The many nitro groups give the molecule excellent oxidizing properties, and allow it to react with the carbon atoms in the molecule to produce CO_2 and a large amount of energy. Consequently, TNT is one of the most stable of the high explosives and can be stored over long periods of time. It is the major component of dynamite. It does not attack metals, does not absorb moisture, and is practically insoluble in water.
- Swedish chemist Alfred Nobel created TNT in 1867 as a safe alternative to nitroglycerin, a highly volatile substance. Nobel created a substance that would absorb the nitroglycerin into an inert, solid form (typically “diatomaceous earth”). This form of the compound requires a detonation device to explode.
- TNT is used as an explosive in military shells, bombs, and grenades. It is also used for underwater blasting, blasting roads, demolishing buildings, mining, and creating tunnels.
- The misuse of TNT may result in environmental damage through waste waters and solid wastes caused from the manufacture of the compound, the processing and destruction of bombs and grenades, and the recycling of explosives.

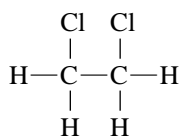
1.4 ORGANIC HALIDES

PRACTICE

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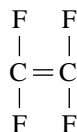
Understanding Concepts

1. (a)



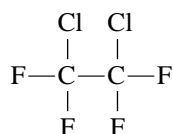
1,2-dichloroethane

- (b)

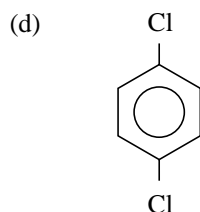


tetrafluoroethene

- (c)



1,2-dichloro-1,1,2,2-tetrafluoroethane



1,4-dichlorobenzene

2. (a) triiodomethane
 (b) 3-chloro-2-methylpropene
 (c) dichloromethane
 (d) 1,2,3-tribromopropane

PRACTICE

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Understanding Concepts

3. flow chart: Freon decomposed by UV radiation → reactive chlorine atoms → chlorine atoms react with ozone molecules in upper atmosphere → oxygen → ozone layer depleted, reducing protection from harmful UV radiation
 Reactions:
 $\text{CCl}_2\text{F}_{2(g)} (\text{Freon}) \rightarrow \text{CClF}_{2(g)} + \text{Cl}_{(g)} \text{ (reactive chlorine atoms)}$
 $\text{Cl}_{(g)} + \text{O}_{3(g)} \rightarrow \text{ClO}_{(g)} + \text{O}_{2(g)}$
 $\text{ClO}_{(g)} + \text{O}_{(g)} \rightarrow \text{Cl}_{(g)} + \text{O}_{2(g)}$
4. late 1800s: NH_3 , CH_3Cl , SO_2 used; leakage of these toxic refrigerants caused fatal accidents
 1930: Freon used; in 1970s, ozone holes in upper atmosphere discovered, attributed to reaction with Freon
 after 1970: HCFCs and HFCs studied for use as refrigerants, readily decomposed, less time to damage ozone layer
 1995: HFC-134a most commonly used refrigerant; contains no chlorine, the atom responsible for damage to ozone layer
5. (a) $\text{HCF}_2\text{Cl} + \text{OH} \rightarrow \text{CF}_2\text{Cl} + \text{H}_2\text{O}$
 $\text{HCF}_3 + \text{OH} \rightarrow \text{CF}_3 + \text{H}_2\text{O}$
 (b) The H atoms in these molecules react with OH^- ions in the air; CFCs contain no H atoms.
 (c) Since they decompose readily (because of their weaker bonds), they exist for a shorter time and thus, are less likely to cause damage.

Explore an Issue: Role Play: Can We Afford Air Conditioning?

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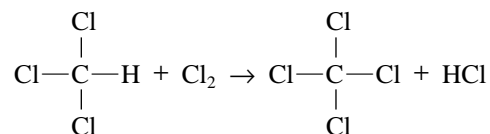
- (a) (Sample answers)
- financial cost: price of air conditioner to consumer, price of added gasoline required, cost to manufacturer, added taxes;
 - social: employment from manufacture and sale of air conditioners and cars;
 - environmental: cost of damage to air quality from coolants and added fuel consumption, raw materials used;
 - political: effect on revenue to shareholders, economy, pressure on government to manage environment, etc.
- (b) (Sample answers)
- union representative: more production means more employment for members;
 - local MP: increased employment means better economy, more votes;
 - environmentalist: air conditioning an unnecessary consumption of fossil fuel as well as possible damage by coolant to environment;
 - reporter from car magazine: debate on issue provides material for articles;
 - physician: air quality directly related to health, particularly elderly or people with respiratory problems; air conditioning offers relief in very hot temperatures;
 - shareholders in car company: give consumers what they want, responsibility is to make a profit.

PRACTICE

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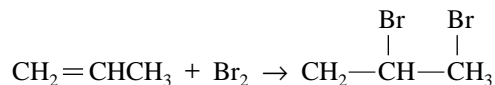
Understanding Concepts

6. (a) substitution



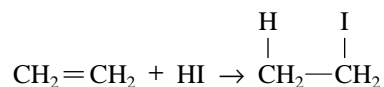
trichloromethane + chlorine \rightarrow tetrachloromethane + hydrogen chloride

(b) addition



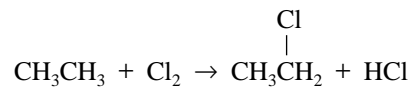
propene + bromine \rightarrow 1,2-dibromopropane

(c) addition



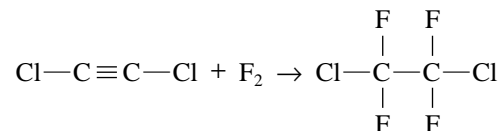
ethylene + hydrogen iodide \rightarrow iodoethane

(d) substitution



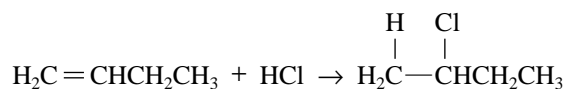
ethane + chlorine \rightarrow chloroethane + hydrogen chloride

(e) addition



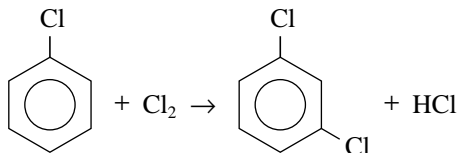
dichloroethyne + fluorine \rightarrow 1,2-dichloro-1,1,2,2-tetrafluoroethane

(f) addition



1-butene + hydrogen chloride \rightarrow 2-chlorobutane

(g) substitution



chlorobenzene + chlorine \rightarrow 1,3-dichlorobenzene + hydrogen chloride

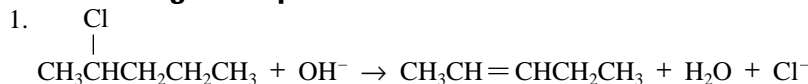
Extension

7. (Sample answer) DDT (dichloro, diphenyl trichloroethane) is a chlorinated hydrocarbon, a candidate for bioaccumulation. DDT has a half-life of 15 years, which means that it takes 15 years to reduce the amount of DDT by half. Since DDT has low solubility in water, it is not readily excreted by organisms that ingest it; it is thus stored in the fat tissues. The concentration of DDT is increased as these organisms are eaten by other organisms up the food chain.

SECTION 1.4 QUESTIONS

(Page 37)

Understanding Concepts



2-chloropentane + hydroxide ion \rightarrow 2-pentene + water + chloride ion

1-pentene, $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$, will also be formed.

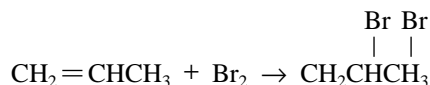
Conditions: presence of a base, OH^-

2. (a) substitution



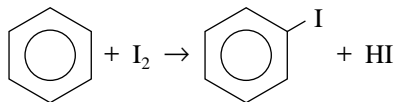
propane + chlorine \rightarrow 1-chloropropane + 2-chloropropane + hydrogen chloride

- (b) addition



propene + bromine \rightarrow 1,2-dibromopropane

- (c) substitution



benzene + iodine \rightarrow iodobenzene + hydrogen iodide

Applying Inquiry Skills

3. (a) Begin with ethyne and Cl_2 , in a 1:1 ratio in amount (in moles); the addition reaction produces 1,2-dichloroethene. Then the product is reacted with HCl gas; the addition reaction produces 1,1,2-trichloroethane.
(b) A mixture of products may be formed, as a result of 2 molecules of Cl_2 being added to one molecule of ethyne, producing 1,1,2,2-tetrachloroethane. The components of such a mixture are difficult to separate.

Making Connections

4. (Answers will vary, but should include evidence of research into the health, safety, or environmental problems of the selected topic. References should be cited.)
5. Mustard gas is an alkyl halide (formula: $\text{ClCH}_2\text{CH}_2\text{SCH}_2\text{CH}_2\text{Cl}$) that, when inhaled, reacts with water in the lungs to produce hydrochloric acid and other intermediate products, many of which damage lung and skin tissue.
Mustard gas causes mustard-coloured blisters, burns to mucous membranes, burning and swelling of the eyes, bronchitis, choking, and high levels can lead to death. During World War I, mustard gas could penetrate the materials used for clothing and masks. In more recent years, urethane has been discovered and used to resist exposure to mustard gas at a wide range of temperatures.
6. (a) HCFCs and HFCs are alternatives to CFCs that are still in use. They appear to be less damaging to the ozone layer than CFCs (although the “hole” in the ozone layer is still growing). However, HCFCs and HFCs may act as greenhouse gases, possibly leading to global warming.
(b) (Answers will vary, but should include a presentation of a product that will be sprayed under pressure, and a marketing strategy.)