

Research Questions

Students will work in cooperative groups to research one of the questions listed below and write a HyperCard program, brochure, or newsletter to present the material.

1. Find the names, chemical formulas, and uses for CFCs. Draw out the structures, indicate the geometry, bond angles, and the type of intermolecular bond that holds each CFC to another. (Good references are the data base called MERCK INDEX DRUG4, search for FREON, and the *McGraw Hill Encyclopedia of Science and Technology*.)
2. Research and report on ways of preventing ozone depletion in the stratosphere. Include CFC alternatives in your report.
3. Research and report on the causes of ozone depletion in the stratosphere. Include statistics on how bad it is now and predictions for how bad it could get. Countries such as Chile and New Zealand have been in the news lately. (Good references are *Time Magazine*, Feb. 17, 1992, p. 60, and the *CQ Researcher* Vol 2, No. 13 p. 289-312, Apr. 3, 1992.)
4. Research and report on legislative actions on the issue of CFCs and the ozone layer.

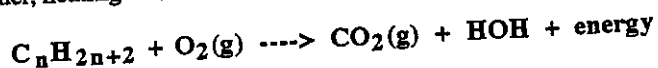
Enrichment Video "A Hole in the Sky" - NOVA

Watch "Ozone: The Hole Story," (60 min.) Have the librarian sign to indicate you watched the video. Take one page of notes as you watch the video (100 pts).

8.2 Reactions of Hydrocarbons

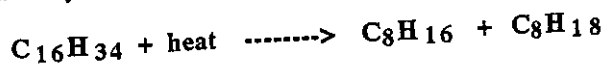
Petroleum products which we use everyday are hydrocarbons. These include gasoline, grease, lubricating and heating oils, roofing materials, candles, plastics, drugs, etc. All these petroleum products come from crude oil. About 50 million barrels of crude oil are used each day in order to meet the demand for these products.

Most of the 50 million barrels of crude oil that are consumed each day are used as fuel. Hydrocarbons have been used as fuels since fire was first discovered, because hydrocarbons react with oxygen to produce energy. This reaction is called **combustion**. The products of complete combustion of hydrocarbons are $\text{CO}_2(\text{g})$, $\text{HOH}(\text{g})$, and energy. It is this energy that drives our society. The major fuels obtained from crude oil are gasoline, diesel fuel, heating oil, kerosene, and jet fuel.



Hydrocarbons with 1-5 carbons are used as gaseous fuel; examples are methane gas which is natural gas and butane used in cigarette lighters. Those with 5-6 carbons are used as solvents for dry cleaning. Gasoline is made from hydrocarbon chains of 7-9 carbons. Jet fuel and diesel gasoline are made from 12-16 carbon hydrocarbons.

Gasoline is one of the primary hydrocarbon fuels used today. Gasoline is produced by cracking crude oil using Al_2O_3 as a catalyst.



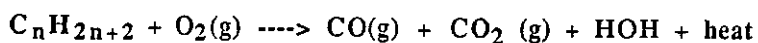
The main ingredients of gasoline are heptane, octane, and nonane. It was found that an isomer of octane, isooctane (2,2,4-trimethylpentane) performed well in cars, which were manufactured in the 1920s. An arbitrary performance rating scale was established based on isooctane. Gasoline that was 100% isooctane was assigned an octane rating of 100. Heptane was assigned an octane rating of zero, because it burned

rapidly, causing explosions that upset the motion of the pistons, with bad knocking the result. A mixture of 94% isooctane and 6% normal heptane was given a 94 octane rating.

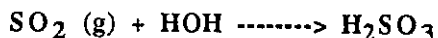
Tetraethyl lead (TEL) was added to mixtures of isooctane and heptane to increase the octane rating. TEL slowed the burning of the heptane and gave smoother firing. Chemists found that adding TEL to gas caused lead deposits to form in the engine which fouled up the works. Additives such as 1,2-dibromoethane or 1,2-dichloroethane reacted with the lead to produce volatile lead halide compounds, which were exhausted out of the car. These lead emissions were once the primary source of lead pollution. Today, safer additives give unleaded gasoline a high octane rating without adding TEL. Check the octane rating that the manufacturer suggests for your car since you should use a sufficiently high grade of gasoline to prevent knocking, but using gasoline with a higher octane will not improve your car's performance.



Incomplete combustion causes carbon monoxide to be formed in addition to carbon dioxide.



Carbon monoxide binds to the heme of the hemoglobin in your blood where oxygen normally binds and starves the brain of oxygen. This reaction can be very dangerous if you are backed up on a freeway for a long period of time. If you are a smoker, you are particularly susceptible to carbon monoxide poisoning because some of your heme molecules are already tied up with carbon monoxide from the cigarette smoke. Because of this, catalytic converters (made with platinum or palladium) were added to cars to catalyze the reaction to produce carbon dioxide. Catalytic converters are destroyed by leaded gasoline, so gas in-takes on cars with catalytic converters were designed so the gas nozzles from leaded gasoline pumps would not fit. This has improved two environmental problems, lead and carbon monoxide. Unfortunately, another environmental problem resulted. The catalytic converters also catalyze the reaction of sulfur contaminants found in the gasoline with oxygen from the air producing sulfur dioxide, which reacts with water in the atmosphere to produce sulfuric acid, acid rain. This is a problem for Chapter 10.



Trucks and some cars use diesel fuel, which is cetane, $C_{16}H_{34}$. Like octane ratings for gasoline, diesel fuel has cetane ratings (Vertanian). A problem with diesel fuel results from its freezing point. Cetane freezes at a higher temperature than gasoline because of stronger intermolecular dispersion bonding. If you live in a cold climate, you will find that your diesel-fueled car will not start on a cold winter day because the cetane has turned to a "gel" in the gas tank. Diesel-fueled cars use block warmers to melt the diesel fuel. Diesel engines do not use spark plugs to activate the combustion reaction; they use pressure and heat. When a combustion engine continues running after it has been turned off, we say that it is "dieseling." The combustion engine is acting like a diesel engine; the heat and pressure continue firing the gasoline in the cylinders.

Most commercial jet fuels are kerosene with formulas $C_{12}H_{26}$ to $C_{16}H_{34}$. Military jet fuel comes from a mixture of gasoline and kerosene. Furnace oils and lubricants are made of hydrocarbons from $C_{15}H_{32}$ to $C_{18}H_{38}$. Paraffins, waxes, petroleum jelly, tars, and asphalts are made from hydrocarbons from $C_{20}H_{44}$ and up. Note that waxes, petroleum jellies, and tars are semi-solids because of stronger dispersion bonding. Asphalts also seem to be semisolids on very hot days. If you don't believe me, try walking on an asphalt driveway in heels next July. Speaking of driveways, it is important to know that asphalt dissolves in gasoline because both are non-polar. I experienced this the hard way right after my husband and I bought our first house. When putting gasoline into the lawn mower, I spilled some gasoline on the asphalt, which created pits in the driveway. Another interesting note comes from one of my students who cautions us to be careful with flames which might activate a combustion reaction if gasoline is spilled on a driveway; his neighbor's asphalt driveway totally burned.

GASOLINE AND ITS ADDITIVES

- List 5 petroleum products
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- Most crude oil is used to make _____.
- The reaction of hydrocarbons with oxygen is called _____.
- Hydrocarbons with 1-5 carbon are in the form of (solids, liquids, or gases).
- Those that contain 5-6 carbons are most often used in the _____ business as solvents.
- Gasoline components usually have _____ carbons in their molecules.
- A fuel with an octane rating of 100 has _____% isooctane in it.
- Why is heptane not a good fuel for cars?
- An octane rating of 96 would have _____% isooctane and _____% heptane.
- TEL contains the heavy metal _____.
- Will using a gasoline with a higher octane rating than recommended by the manufacturer improve car performance?
- What are the four products of incomplete combustion?
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- What oxygen carrying molecule does carbon monoxide bind to?
- Why are traffic jams potentially hazardous?
- What GOOD thing does a catalytic converter do?
- What is BAD about catalytic converters?

17. What is the major problem with diesel fuel?

18. What is "dieseling"?

19. What happens if you spill gasoline on asphalt? why?