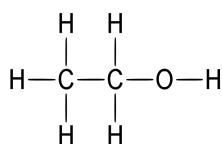


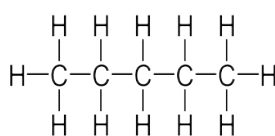
Introduction

The world runs on petroleum-based fuels, such as petrol and diesel. These come from crude oil, which was once called 'black gold'. Crude oil comes from underground reservoirs and is processed to produce a wide range of materials for the chemical and fuel industries.

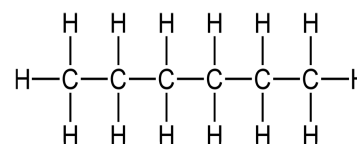
The main components of petroleum fuels are hydrocarbons. These are chemical compounds composed of hydrogen and carbon. The diagrams below show some typical hydrocarbons that are used as fuels.



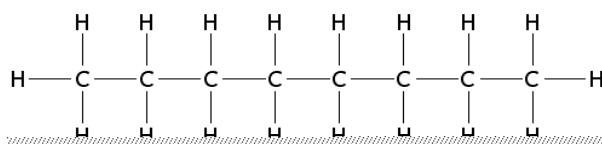
ethanol



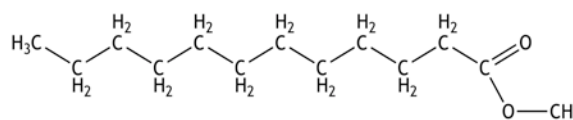
pentane



hexane



octane



biodiesel

In the following procedure you will explore some physical and chemical properties of these hydrocarbons.

Safety precautions

- Wear safety glasses at all times.
- Hydrocarbons are flammable. Do not use Bunsen burners or naked flames unless instructed to do so.

Materials (per group)

- safety glasses (per person)
- 5 test tubes and rack
- 5 metal spoons
- matches
- pentane, hexane, octane, diesel and biodiesel (from previous procedure)

Procedure

1. Collect 5 mL samples of each hydrocarbon in a test tube.
2. Look at test tubes. Is there colour variation between each of the five liquids? Record your observations in the table on the next page.
3. Swirl the liquid in each test tube around to observe any differences in thickness (or viscosity).
4. Using your hand, waft any odour from each test tube toward your nose. Carefully smell each fraction to determine any difference in odour of each fluid.
5. Test each liquid to see how easily it burns: pour a few drops of each liquid on a metal spoon then carefully ignite liquid with a match. Describe how easily each hydrocarbon ignites, how clean the flame is when burnt, and what the residue on each spoon looks like.

Observations

	pentane	hexane	octane	diesel	biodiesel
colour					
viscosity					
odour					
ease of lighting					
How clean is flame?					
appearance of residue on spoon					

Questions

1. List hydrocarbons in order of ease of lighting (easiest to hardest).

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2. List hydrocarbons in order of how cleanly they burn and then how much residue is left on the spoon.

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3. Which hydrocarbon would make the best clean-burning fuel?

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Combustion

Hydrocarbons, like those found in crude oil, are widely used as a fuel because they react with oxygen to produce large amounts of energy in a chemical reaction called combustion. Carbon dioxide and water are products of combustion if air supply is unrestricted. If air supply is limited, as is sometimes the case in engines, then water and carbon monoxide are produced instead.

4. Is combustion an exothermic or endothermic reaction? Explain.

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5. Write chemical equations for the combustion of each of the following hydrocarbons.

pentane C_5H_{12}

octane C_8H_{18}

hexane C_6H_{14}

butane C_4H_{10} in limited oxygen supply

6. Carbon dioxide and/or carbon monoxide are produced during combustion reactions. What impact does each of these gases have on the environment?

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7. Using your observations and data in the table below describe which fuel would be best for:

a) a camping cooker to be used inside a tent:

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b) an emergency external water heater for a remote nursing station:

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HYDROCARBON	HEAT OF COMBUSTION kJ mol^{-1}
pentane	890
hexane	3510
octane	5450
diesel	7863
biodiesel	6893