Hydrocarbon Chemistry

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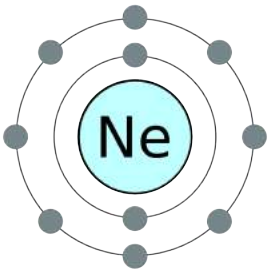
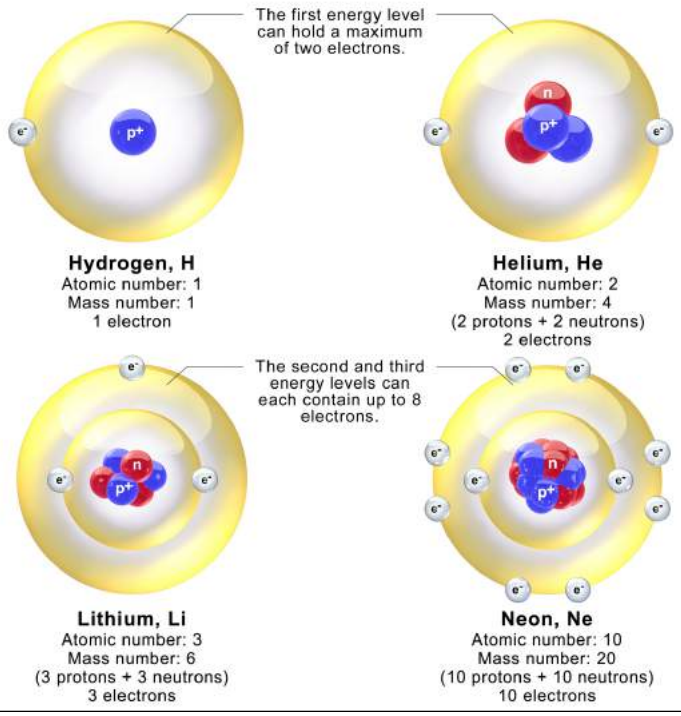
Chemistry

Chemistry revolves around an atom's electrons. An atom's valence electrons determine how that atom combines with other atoms to form molecules.

On a ball-and-stick model, this can be conceptualized and the number of holes in the ball that can serve as connection points, through bonds, to other atoms.

10: Neon 2,8


Ne


The first energy level can hold a maximum of two electrons.
p+
e-
Hydrogen, H
Atomic number: 1
Mass number: 1
1 electron
n
p+
e-
Helium, He
Atomic number: 2
Mass number: 4
(2 protons + 2 neutrons)
2 electrons
The second and third energy levels can each contain up to 8 electrons.
n
p+
e-
Lithium, Li
Atomic number: 3
Mass number: 6
(3 protons + 3 neutrons)
3 electrons
n
p+
e-
Neon, Ne
Atomic number: 10
Mass number: 20
(10 protons + 10 neutrons)
10 electrons

Valence electrons

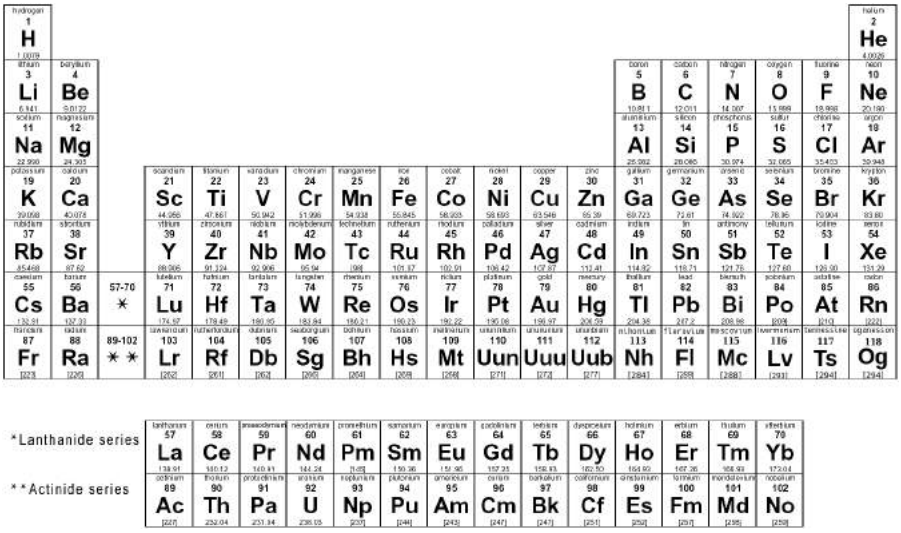
An atom's electrons fill up the lowest levels first before occupying the next level.

Valence electrons are electrons in the atom's outer shell.

An atom "wants" to fill up its outer shell with the full number of electrons for that shell.

Really, it's more that such a configuration of electrons is more stable.

For our purposes, the first three shells are "filled up" at 2, 8, 8. (Although it's actually more complicated than that.)



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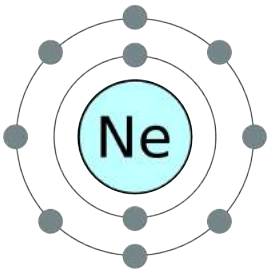
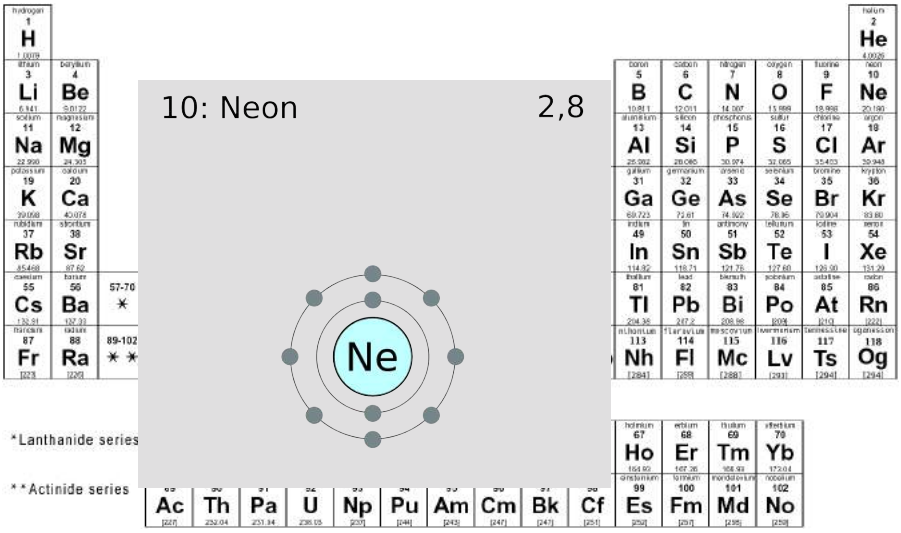
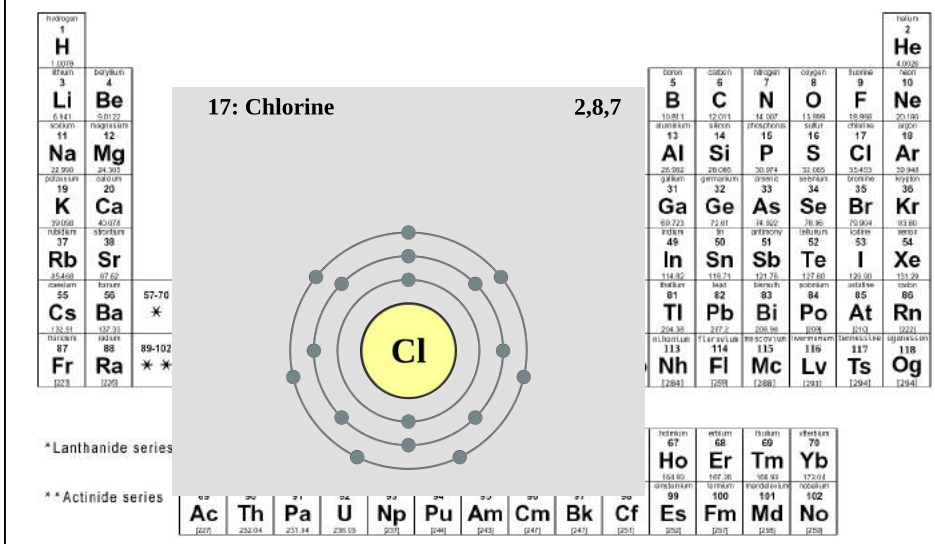
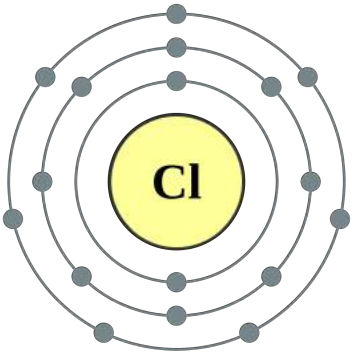
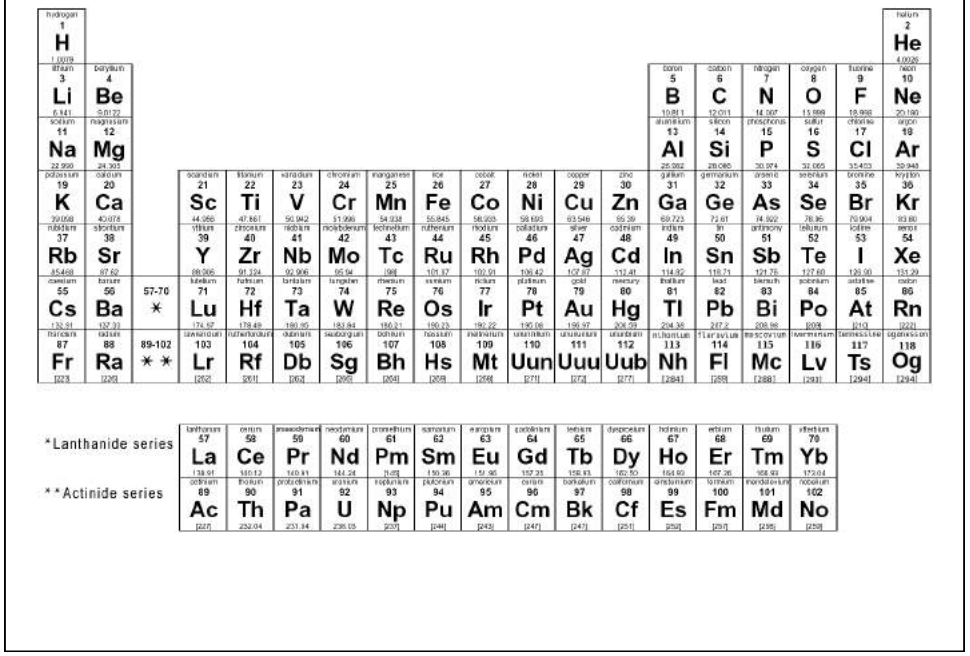




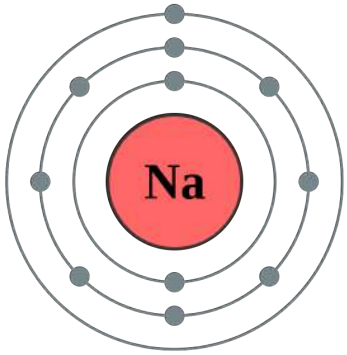


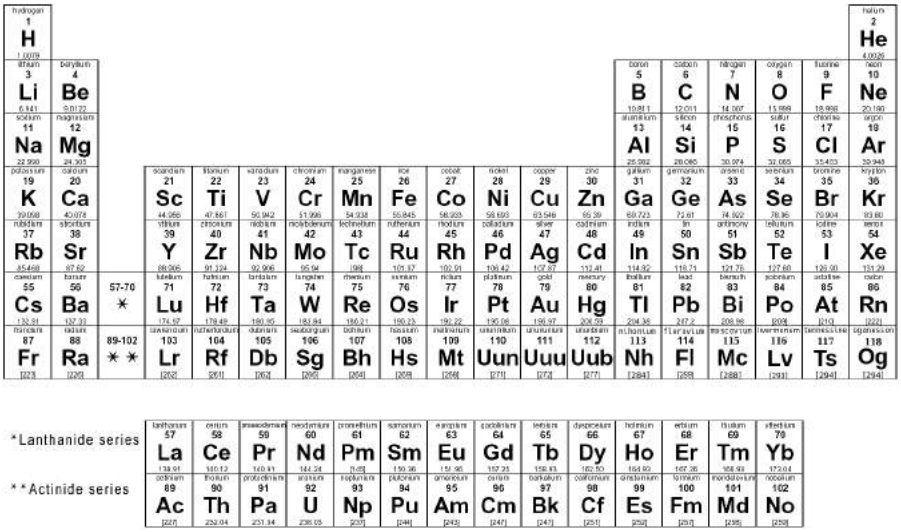
17: Chlorine **2,8,7**





11: Sodium **2,8,1**





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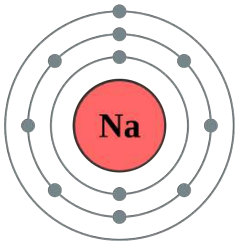
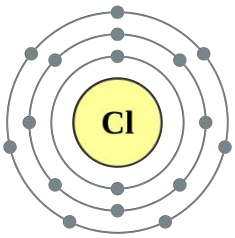
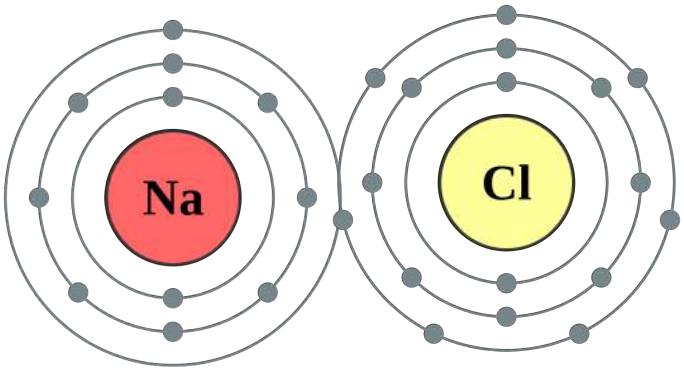
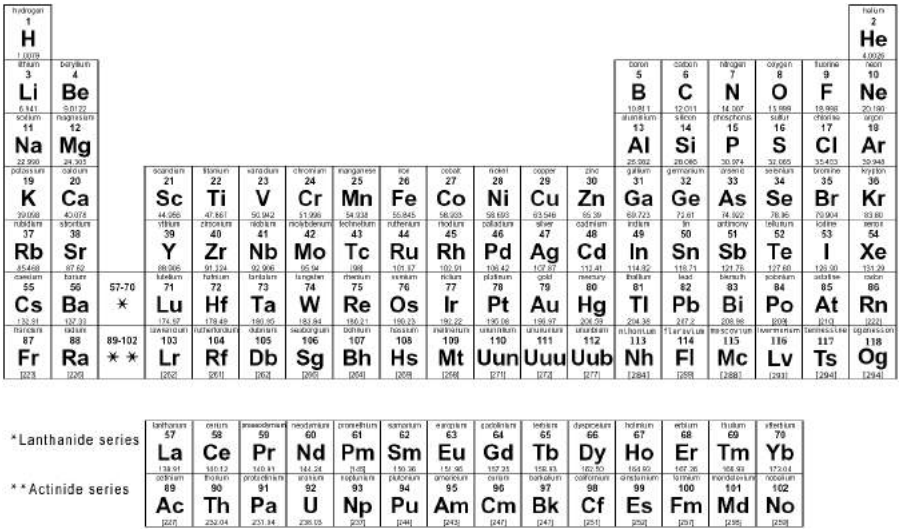
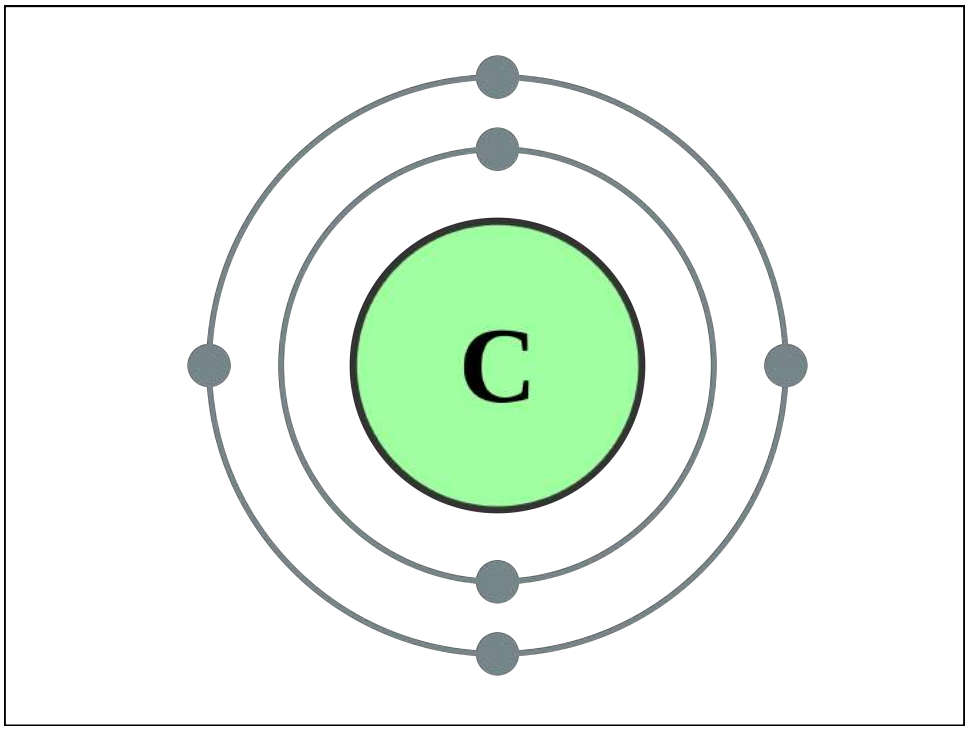




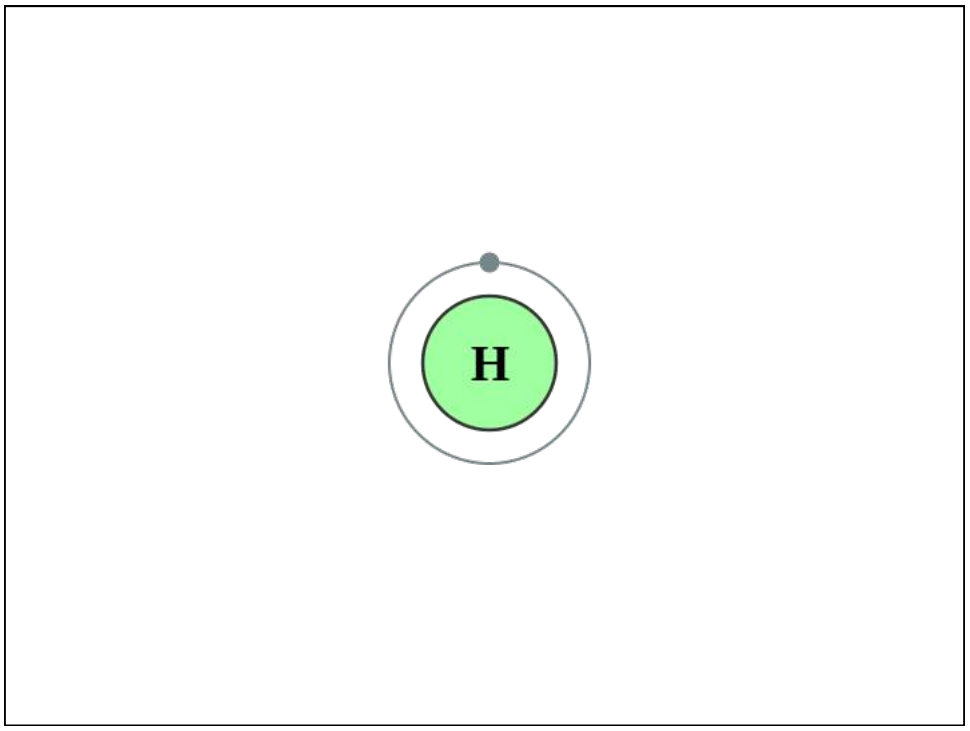

Na
Cl

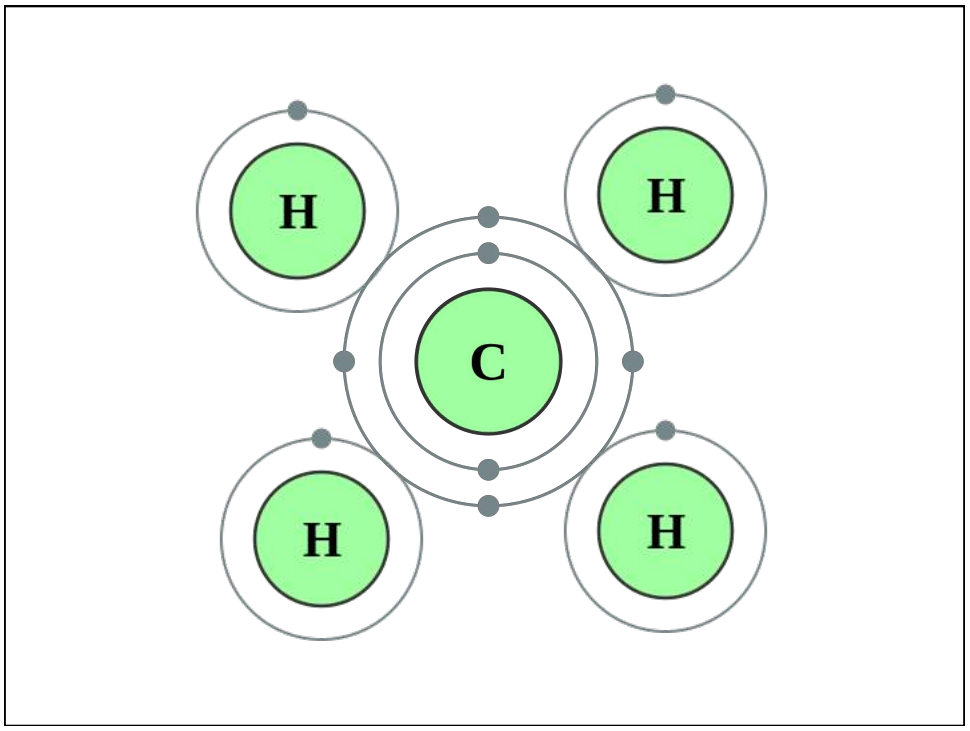

H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
Ar
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Kr
Rb
Sr
Y
Zr
Nb
Mo
Tc
Ru
Rh
Pd
Ag
Cd
In
Sn
Sb
Te
I
Xe
Cs
Ba
57-70
Lu
Hf
Ta
W
Re
Os
Ir
Pt
Au
Hg
Tl
Pb
Bi
Po
At
Rn
Fr
Ra
89-102
Lr
Rf
Db
Sg
Bh
Hs
Mt
Uun
Uuu
Uub
Nh
Fl
Mc
Lv
Ts
Og
*Lanthanide series
**Actinide series
La
Ce
Pr
Nd
Pm
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Ac
Th
Pa
U
Np
Pu
Am
Cm
Bk
Cf
Es
Fm
Md
No

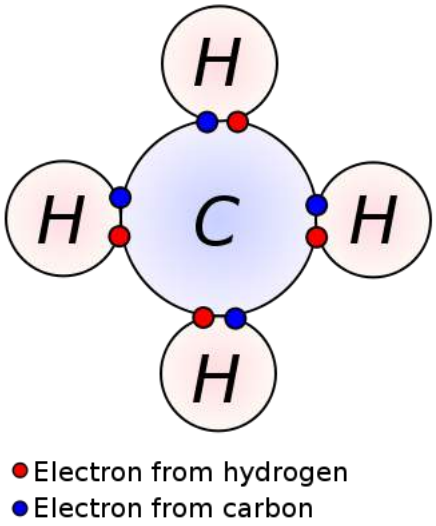


H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	57-70	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	89-102	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Nh	Fl	Mc	Lv	Ts	Og

*Lanthanide series	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
**Actinide series	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No


H

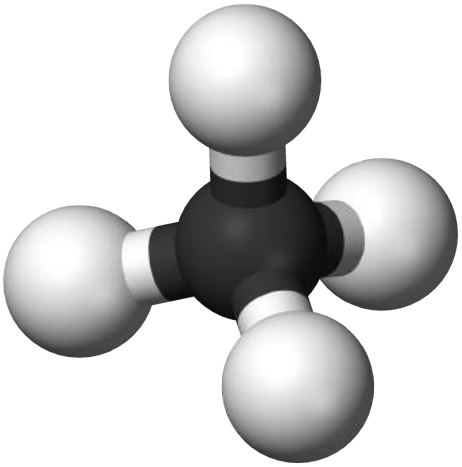

H
H
C
H
H



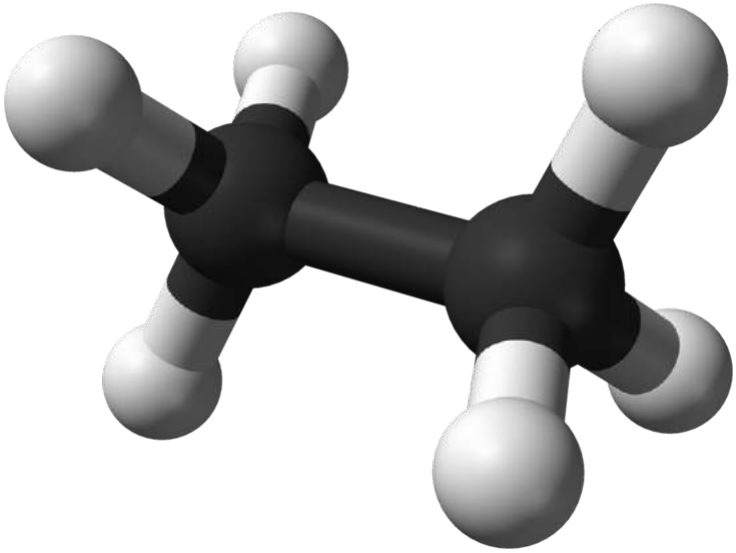
Hydrocarbons

Hydrocarbons are molecules composed entirely of carbon atoms and hydrogen atoms.

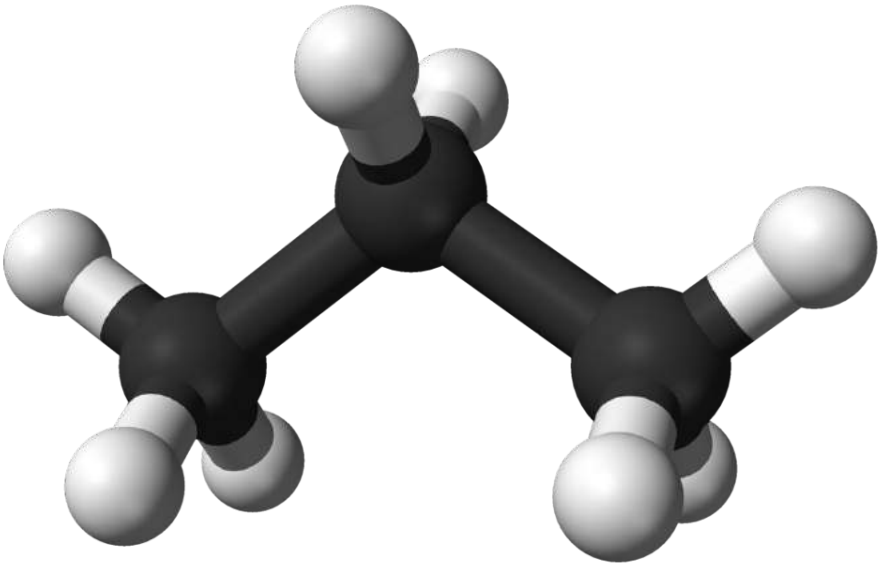
Methane



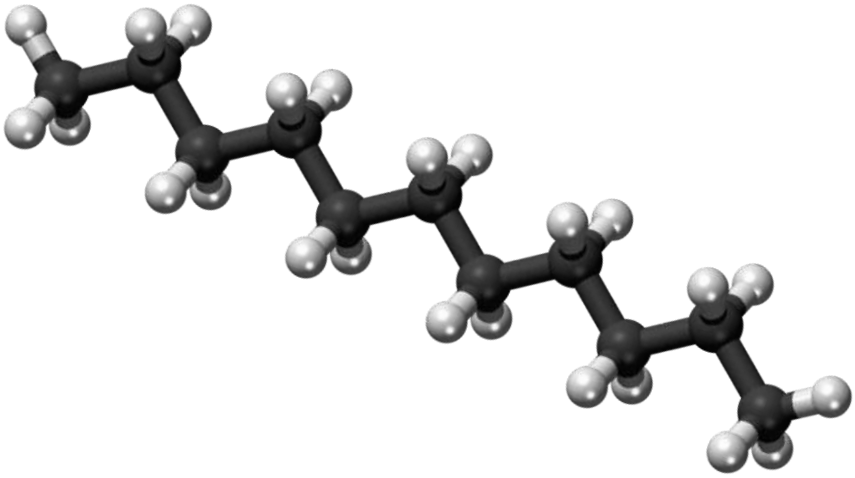
Ethane



Propane



Undecane

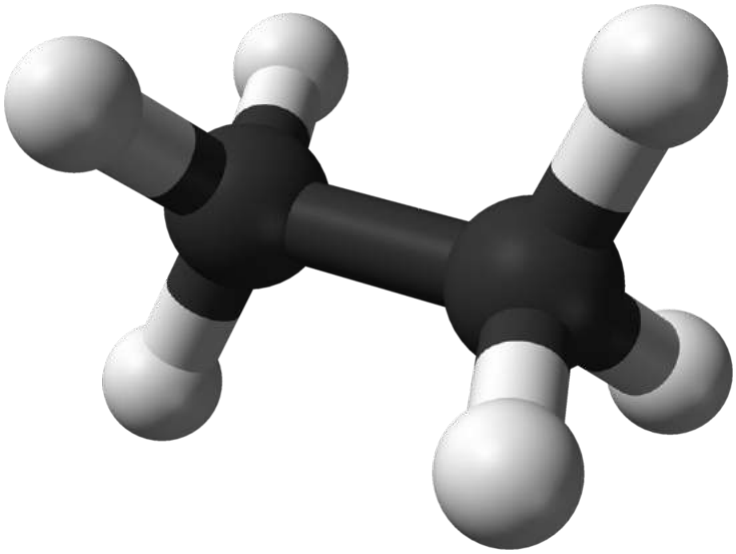


Hydrocarbons

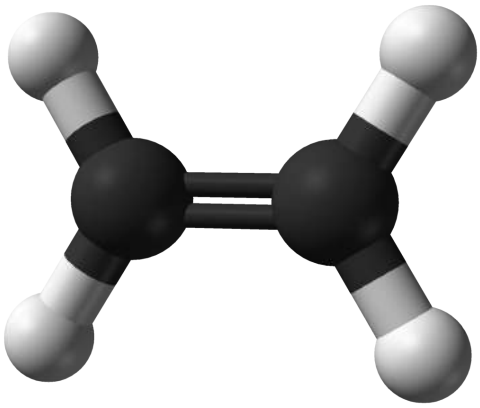
Hydrocarbons are molecules composed entirely of carbon atoms and hydrogen atoms.

A carbon atom is capable of bonding not only to hydrogen atoms but also to other carbon atoms, so there are essentially limitless varieties of hydrocarbons.

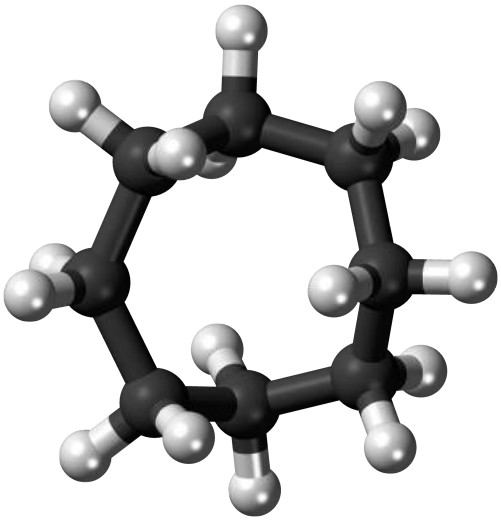
Ethane



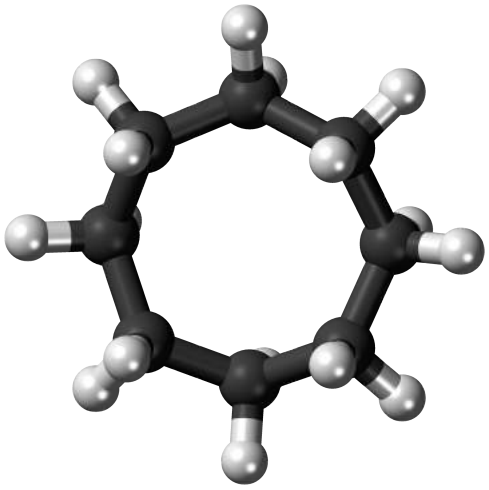
Ethylene



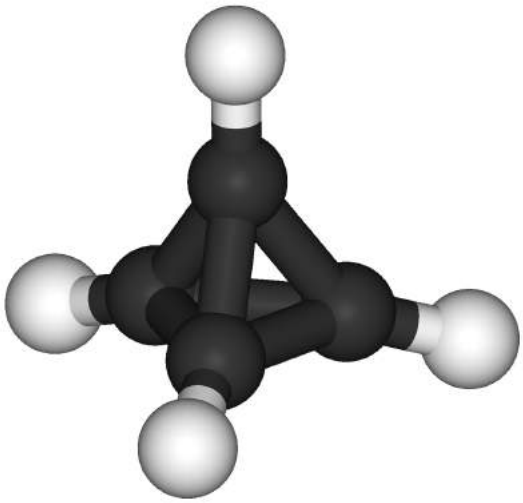
Cyclooctane



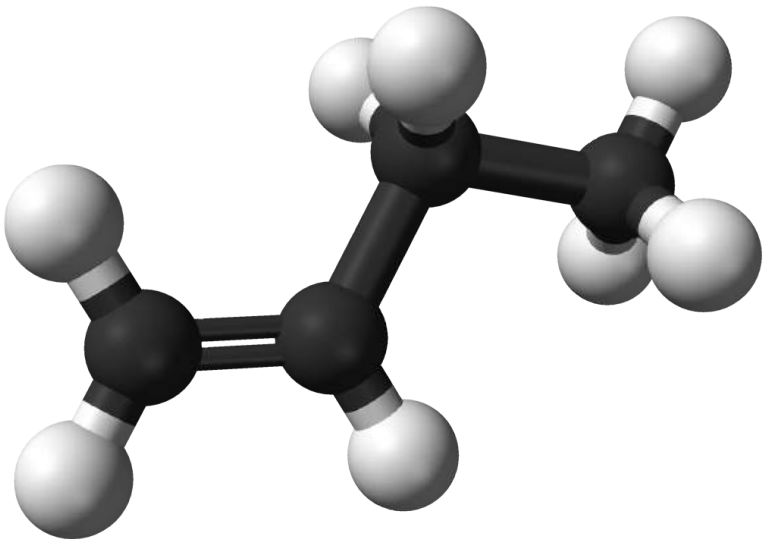
Cyclooctane



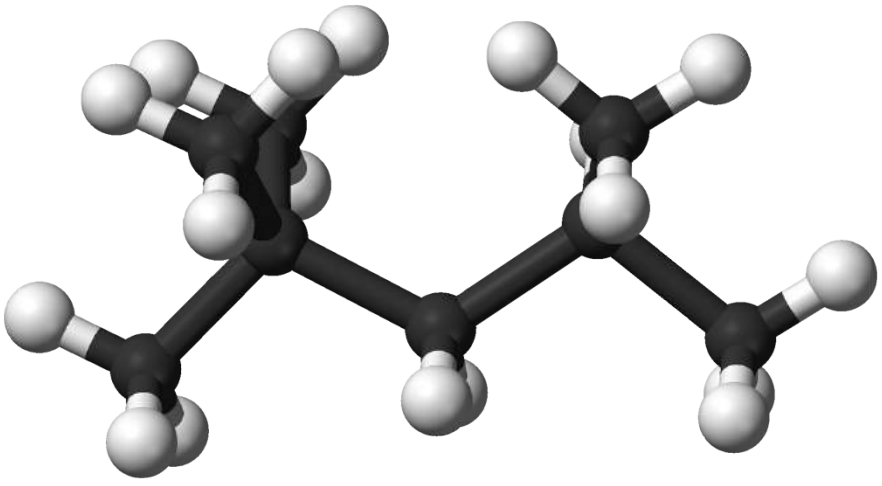
Tetrahedrane

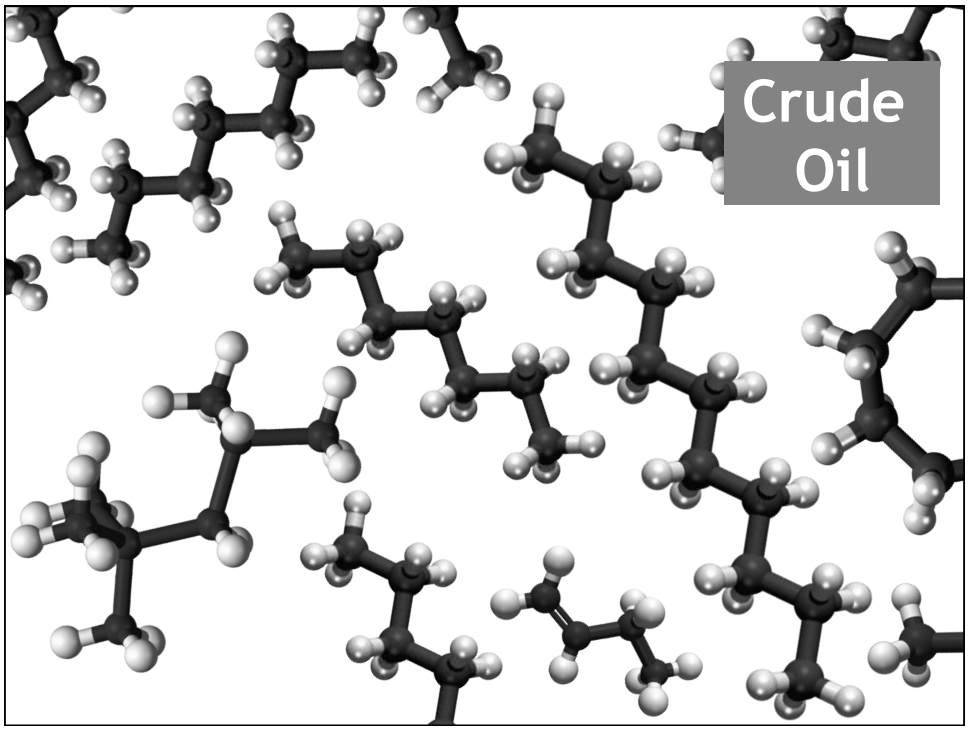


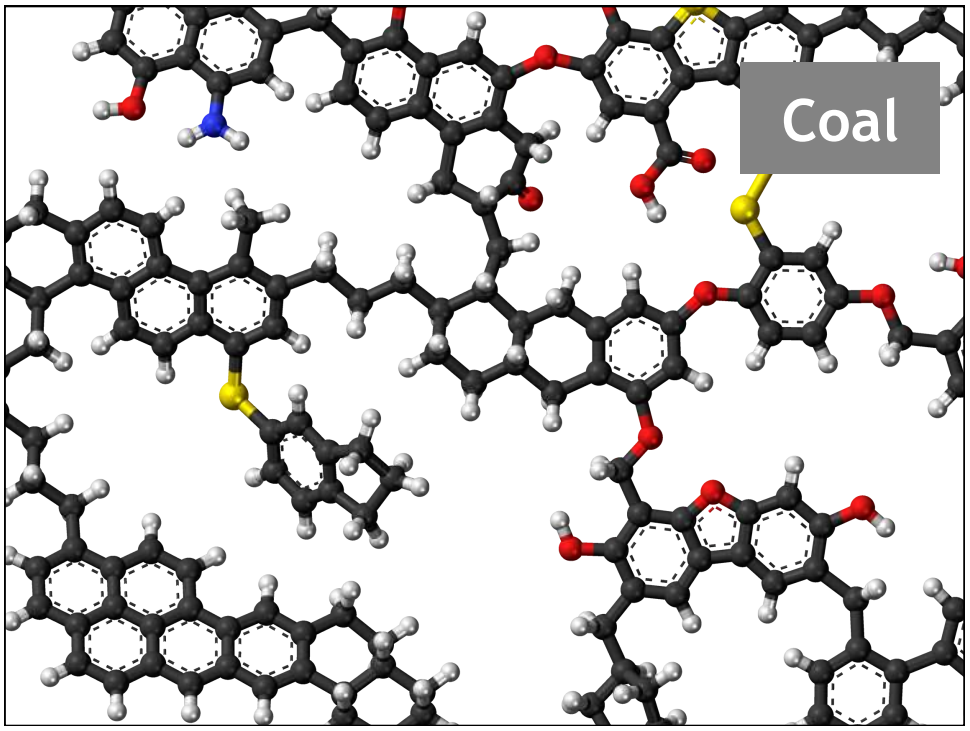
Ethylethylene



Isooctane




Crude
Oil


Coal

Some types of hydrocarbons by chemical bonds

Alkanes – only single bonds, no rings

Cycloalkanes – online single bonds, 1 ring

Alkenes – at least one carbon-carbon double bond

Alkynes – at least one carbon-carbon triple bond

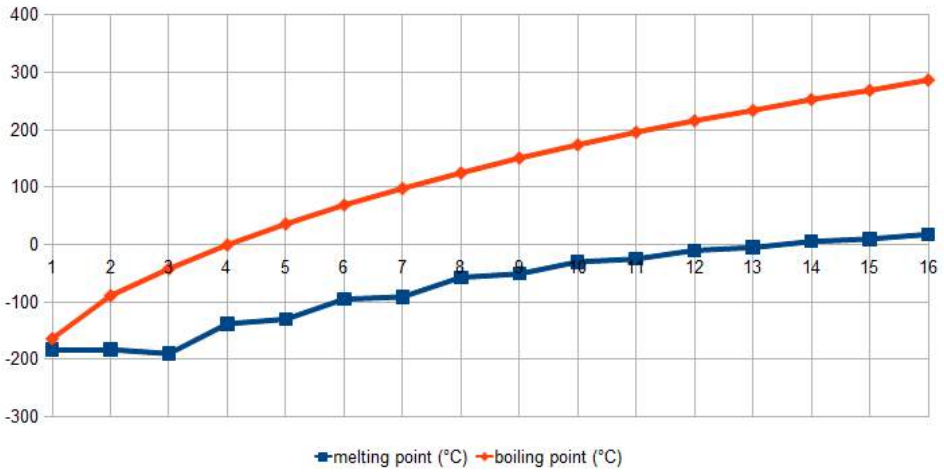
Some types of alkanes by melting, boiling point

Gas – e.g., methane, propane

Liquid – e.g., hexane, heptane, octane

Wax – e.g., triacontane, pentacosane, heptatriacontane

Some types of alkanes by melting, boiling point



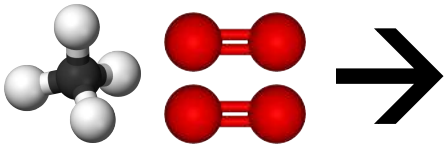
Alkanes by numbers of carbon atoms			
	1	CH_4	methane
	2	C_2H_6	ethane
	3	C_3H_8	propane
	4	C_4H_{10}	butane
	5	C_5H_{12}	pentane
	6	C_6H_{14}	hexane
	7	C_7H_{16}	heptane
	8	C_8H_{18}	octane
	9	C_9H_{20}	decane
	20	$C_{20}H_{42}$	icosane
	30	$C_{30}H_{62}$	triacontane
	40	$C_{40}H_{82}$	tetracontane

1	CH_4	methane	
2	C_2H_6	ethane	GASES
3	C_3H_8	propane	
4	C_4H_{10}	butane	
5	C_5H_{12}	pentane	
6	C_6H_{14}	hexane	
7	C_7H_{16}	heptane	LIQUIDS
8	C_8H_{18}	octane	
9	C_9H_{20}	decane	
20	$C_{20}H_{42}$	icosane	
30	$C_{30}H_{62}$	triacontane	WAXES
40	$C_{40}H_{82}$	tetracontane	

Combustion of hydrocarbons

Combustion of methane:

$CH_4 + 2\ O_2 \rightarrow$



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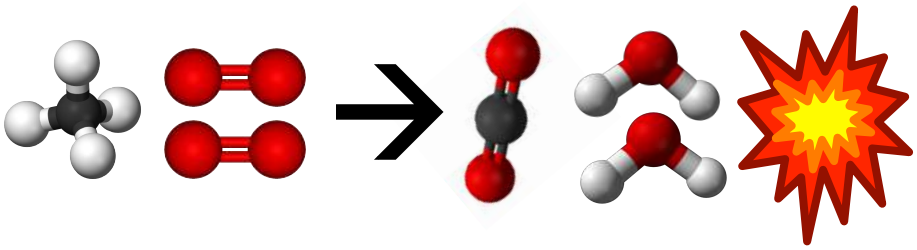
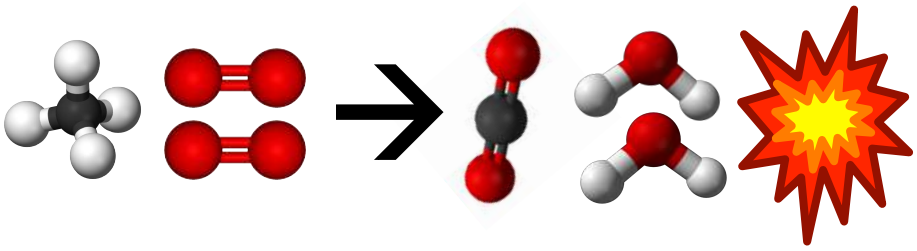


Combustion of hydrocarbons

Combustion of methane:

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$ + energy



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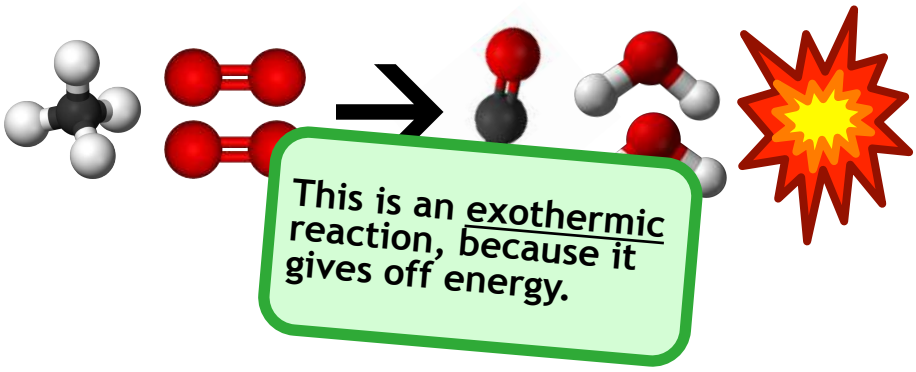
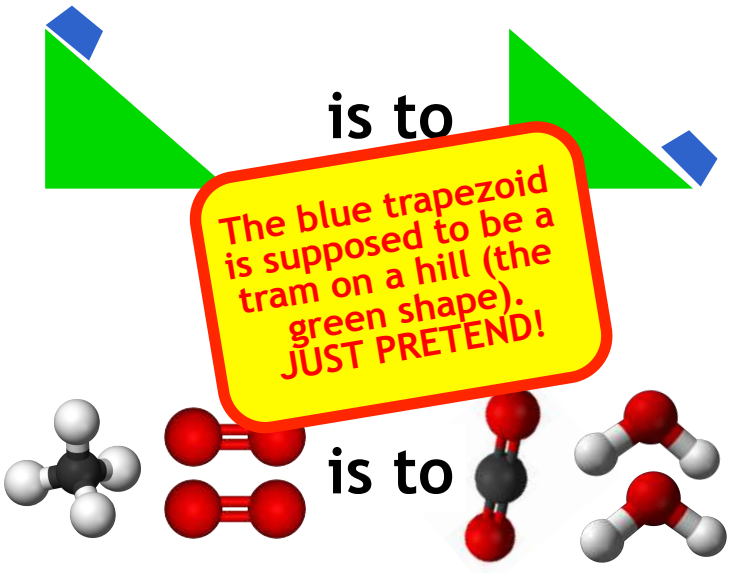
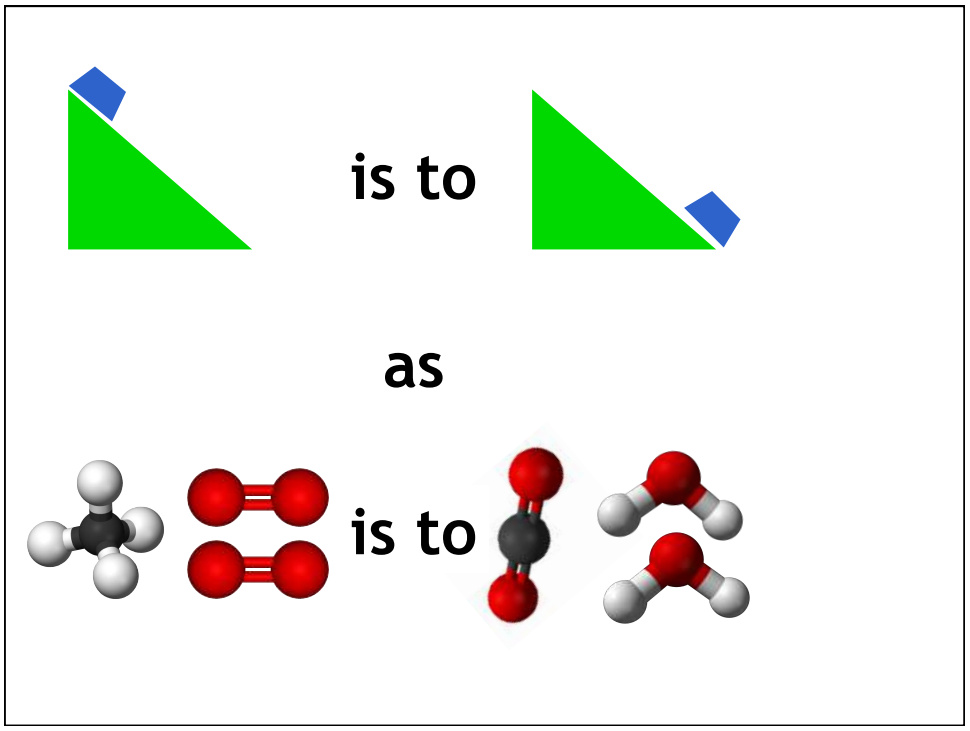
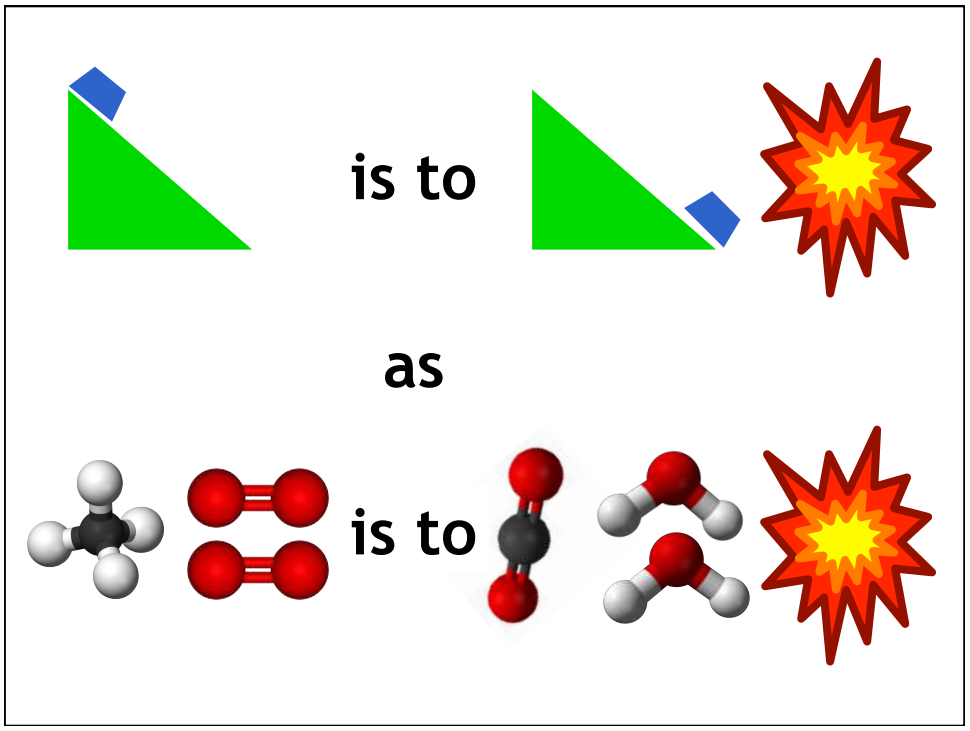





is to
as
is to


is to
as
is to

Energy differences

methane
$CH_4 + 2\ O_2$

ethanol
$C_2H_5OH + 3\ O_2$

glucose
$C_6H_{12}O_6 + 6\ O_2$

-50.1 kJ/g

-28.9 kJ/g

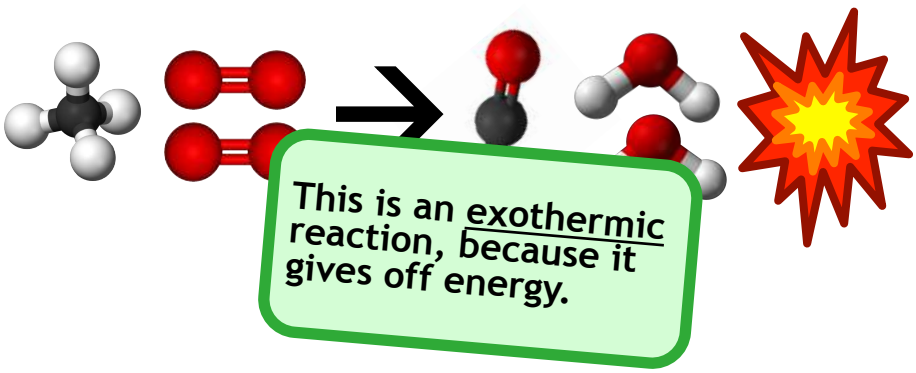
-14.2 kJ/g

$CO_2 + 2\ H_2O$ $2\ CO_2 + 3\ H_2O$ $6\ CO_2 + 6\ H_2O$

Combustion of hydrocarbons

Combustion of methane:

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$ + energy



Combustion of hydrocarbons

Combustion of methane:

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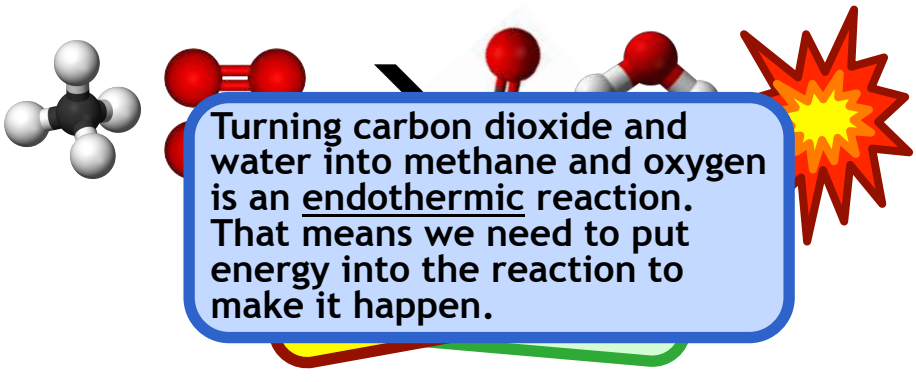
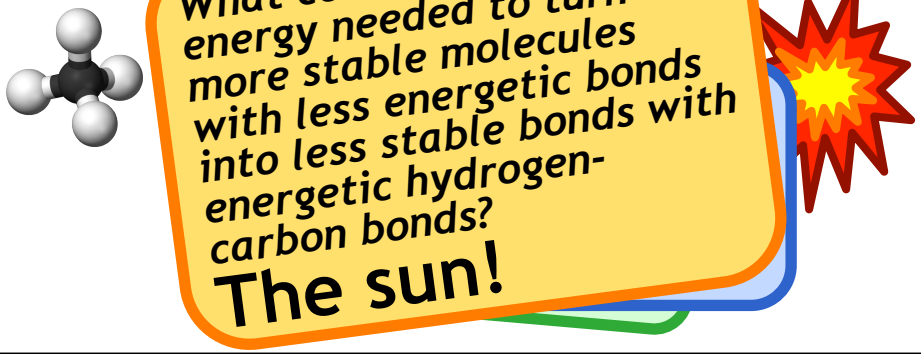


Combustion of hydrocarbons

Combustion of methane:

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$ + energy



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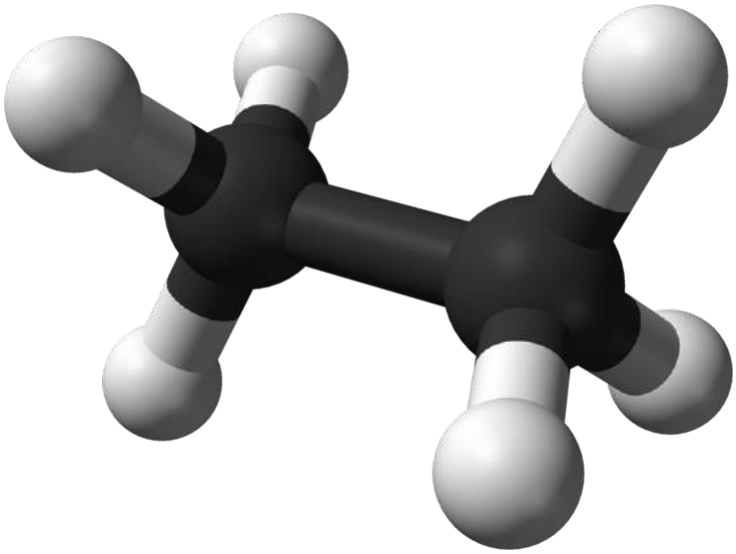
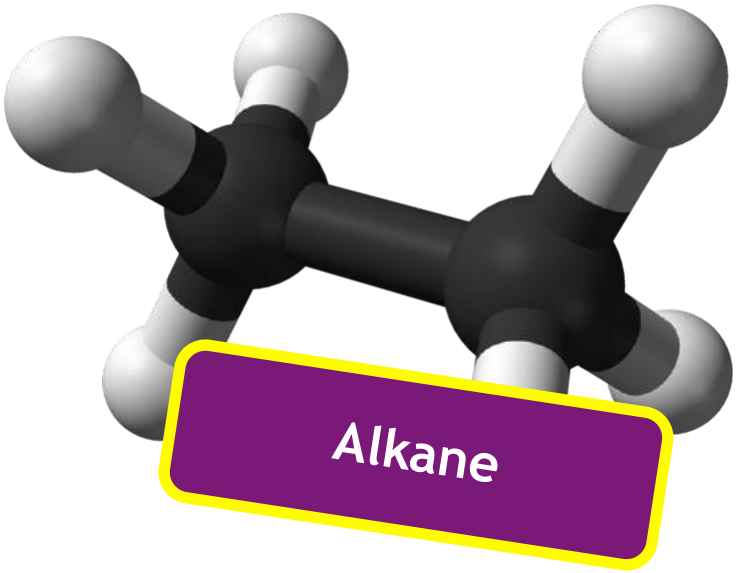
Can you categorize the following?

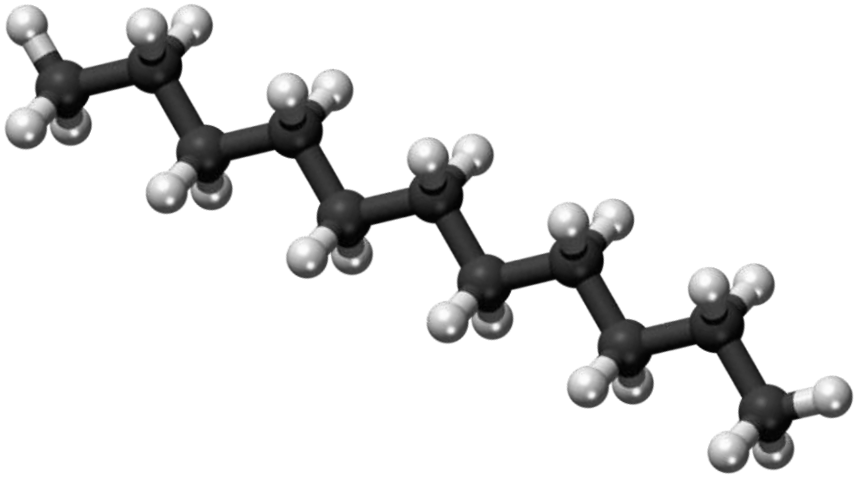
Ethane



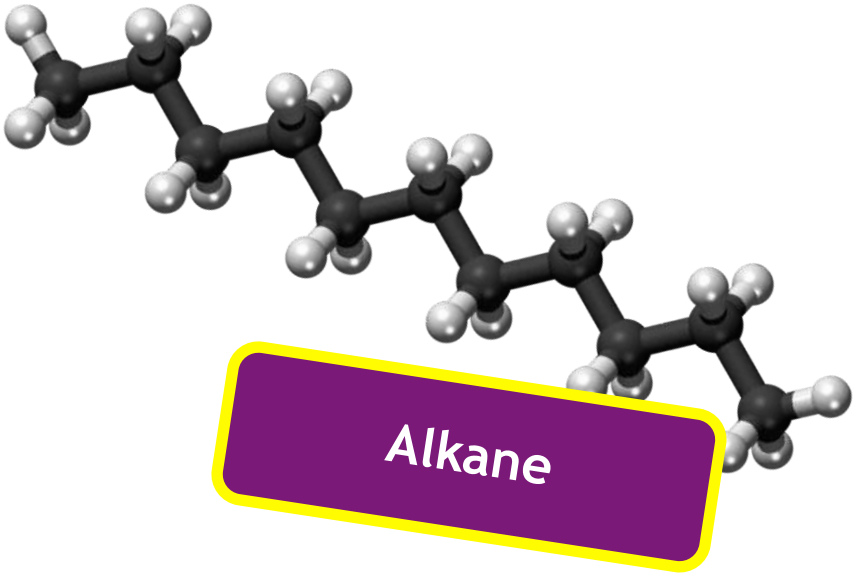
Ethane



Undecane

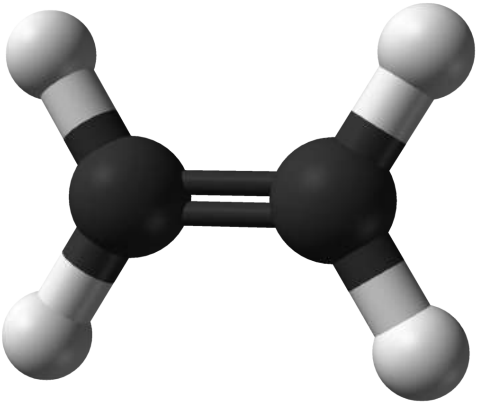


Undecane



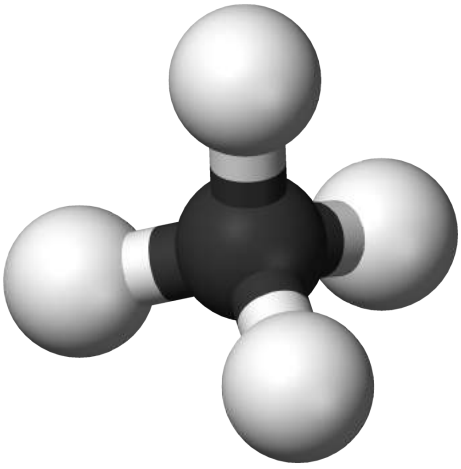
Alkane

Ethylene



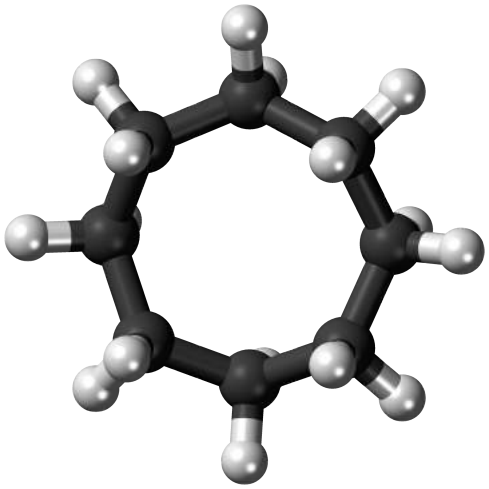
Ethylene

Methane

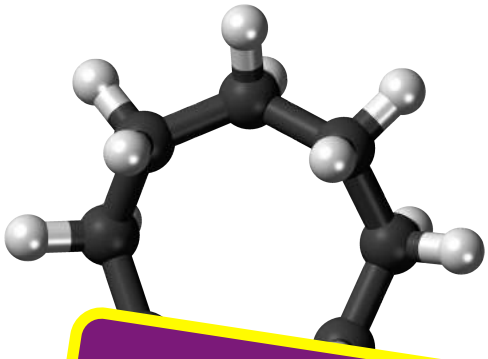


Methane

Cyclooctane

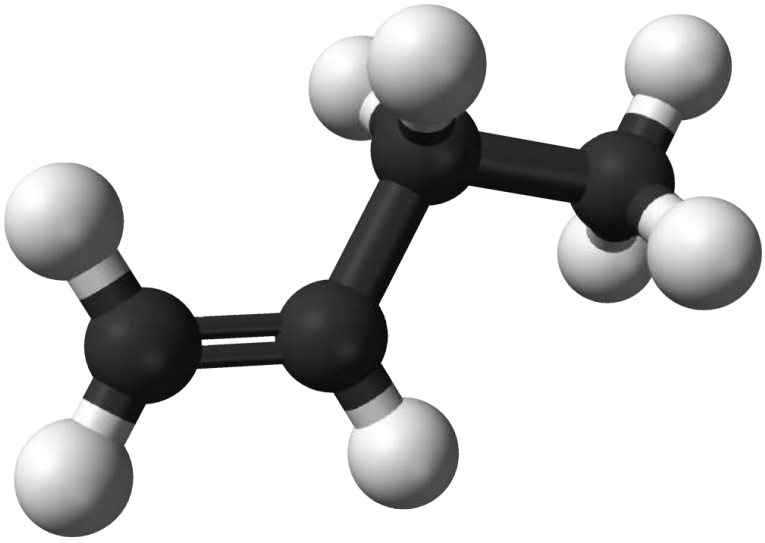


Cyclooctane

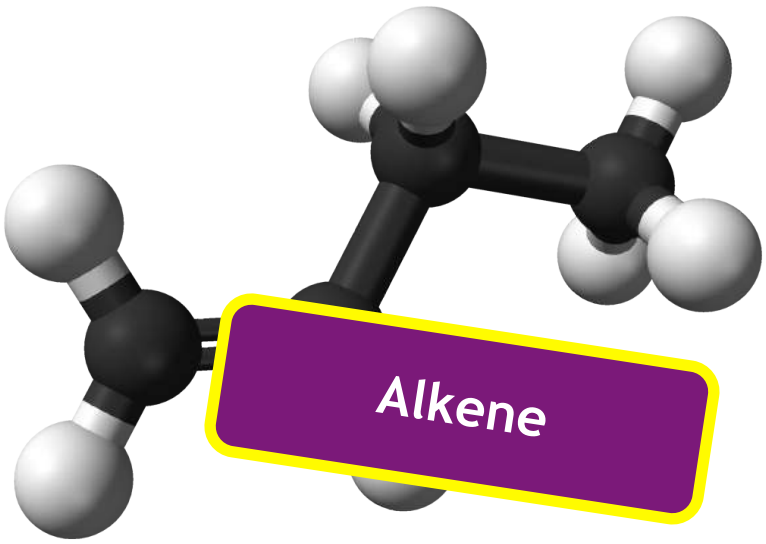


Cycloalkane

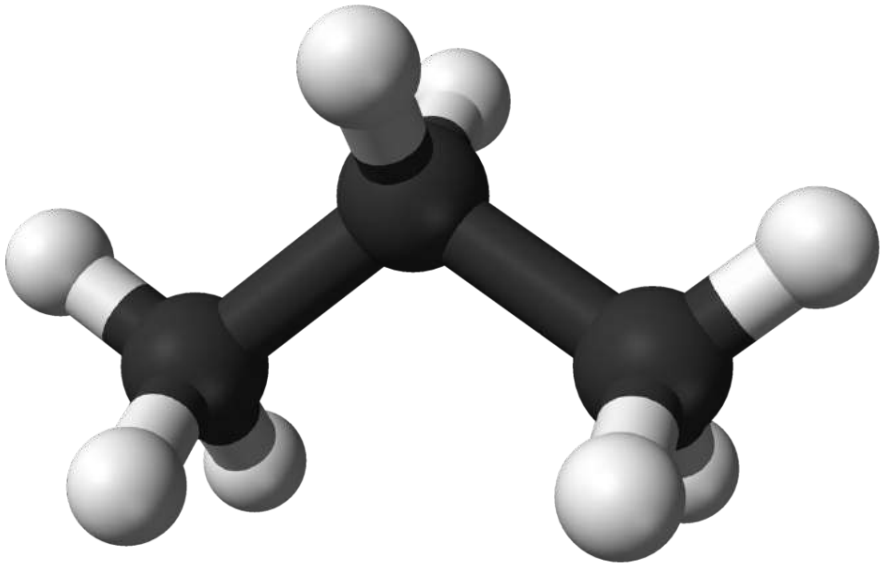
Ethylethylene



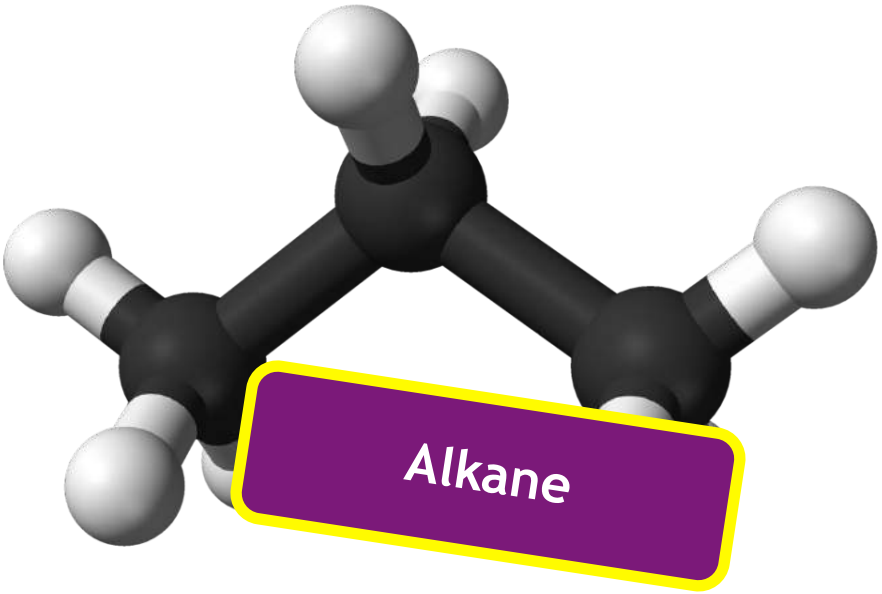
Ethylethylene



Propane

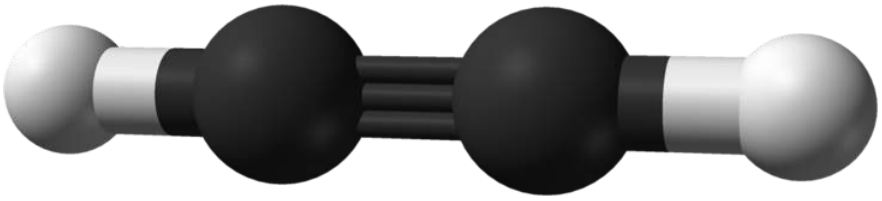


Propane

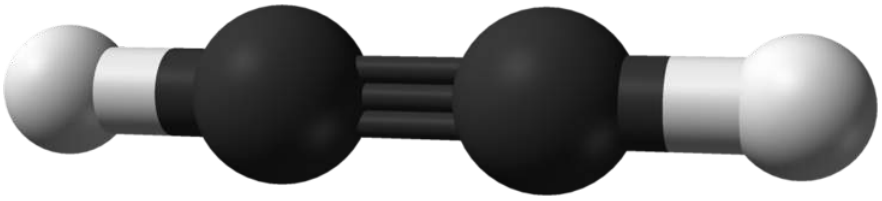


Alkane

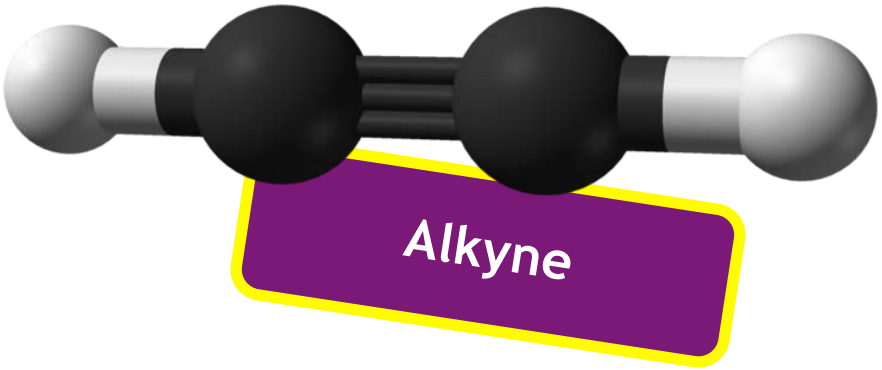
What is this?



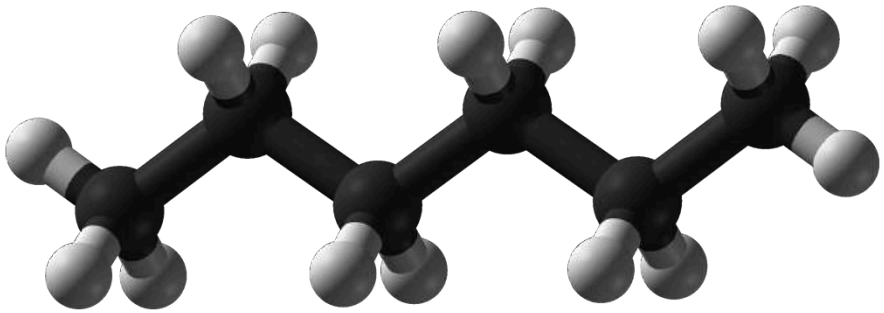
Acetylene (a/k/a ethyne)



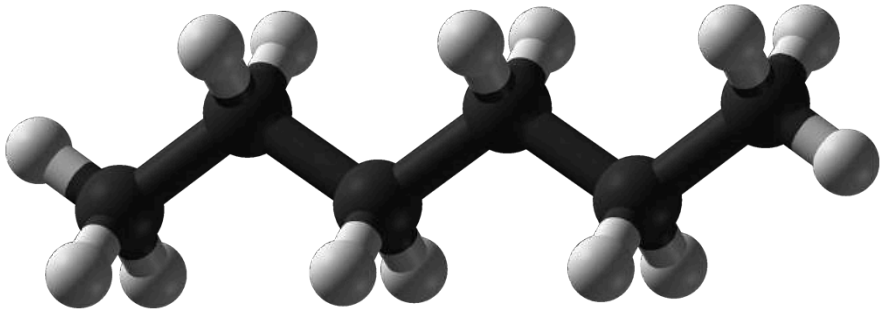
Acetylene (a/k/a ethyne)



What is this?



Hexane



Hexane

Alkanes by numbers of carbon atoms

Can you categorize these?

1	CH_4	methane
2	C_2H_6	ethane
3	C_3H_8	propane
4	C_4H_{10}	butane
5	C_5H_{12}	pentane
6	C_6H_{14}	hexane
7	C_7H_{16}	heptane
8	C_8H_{18}	octane
9	C_9H_{20}	decane
20	$C_{20}H_{42}$	icosane
30	$C_{30}H_{62}$	triacontane
40	$C_{40}H_{82}$	tetracontane

1	CH_4	methane	
2	C_2H_6	ethane	GASES
3	C_3H_8	propane	
4	C_4H_{10}	butane	
5	C_5H_{12}	pentane	
6	C_6H_{14}	hexane	
7	C_7H_{16}	heptane	LIQUIDS
8	C_8H_{18}	octane	
9	C_9H_{20}	decane	
20	$C_{20}H_{42}$	icosane	
30	$C_{30}H_{62}$	triacontane	WAXES
40	$C_{40}H_{82}$	tetracontane	

Credits

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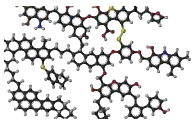
Molecule models, periodic table, and gas cylinder picture by others. Sunoco gas pump picture, candles picture, explosion illustration, and oil-and-gas-law course logo photo-illustration by EEJ.



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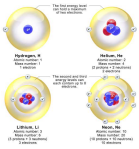

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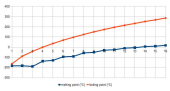
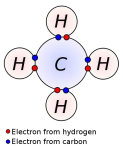


https://en.wikipedia.org/wiki/Alkane#/media/File:AlkaneBoilingMeltingPoint.png Melting (blue) and boiling (orange) points of the first 16 n-alkanes in °C. Techstepp. CC BY-SA 3.0 File:AlkaneBoilingMeltingPoint.png



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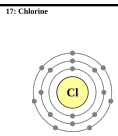

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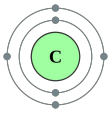

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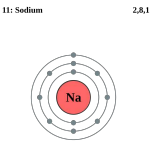

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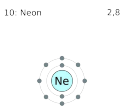

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