Hydrocarbons

Learning Outcomes

1. Interpret ***and*** draw bond-line structures

2. Gain an appreciation for IUPAC nomenclature and know that each name corresponds to ***one***, unique, chemical structure

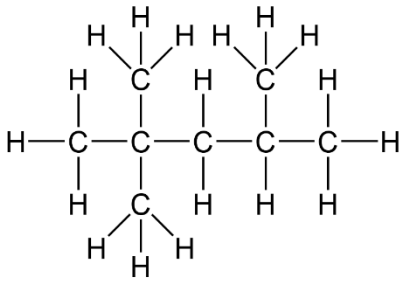
3. Identify constitutional isomers

4. Give examples of petroleum products and describe the path from hydrocarbons to plastics

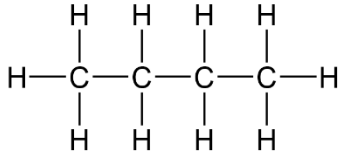
5. Predict trends in boiling points of hydrocarbons and know that London dispersion forces are the primary intermolecular forces that contribute to the physical properties (at-home learning objective)

Some Components of Gasoline

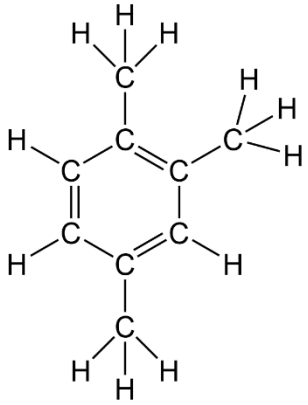
How are these molecules similar?



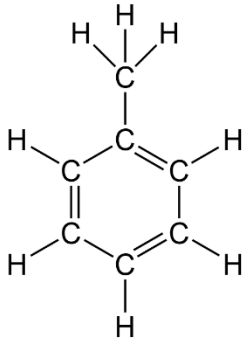
2,2,4-Trimethylpentane



Butane

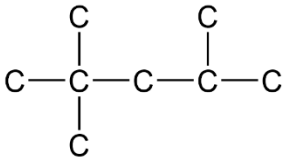


1,2,4-Trimethylbenzene

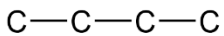


Toluene

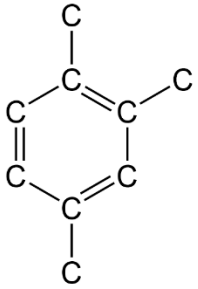
Carbon Skeletons



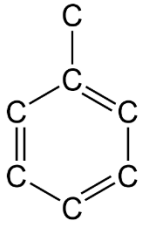
2,2,4-Trimethylpentane



Butane

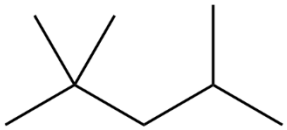


1,2,4-Trimethylbenzene

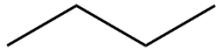


Toluene

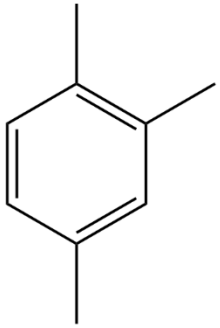
Bond-Line Structures



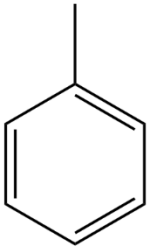
2,2,4-Trimethylpentane



Butane

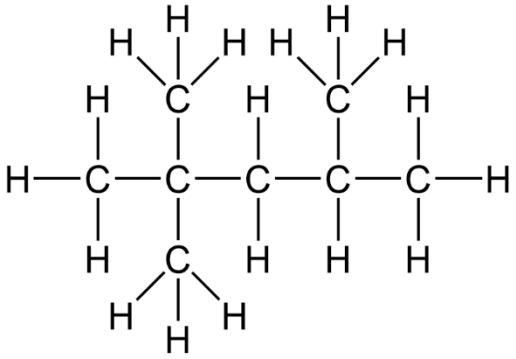


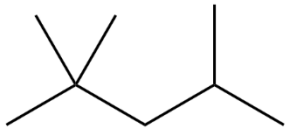
1,2,4-Trimethylbenzene



Toluene

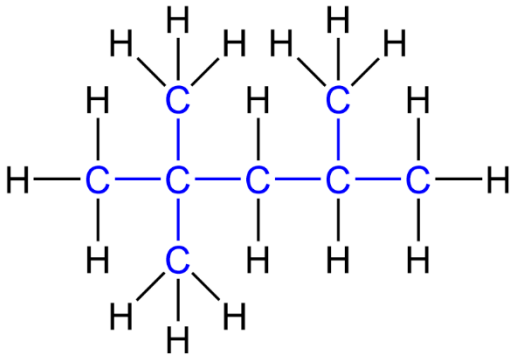
Bond-Line Structures Are The Way to Go To More-Easily Keep Track of the Carbon Skeleton!





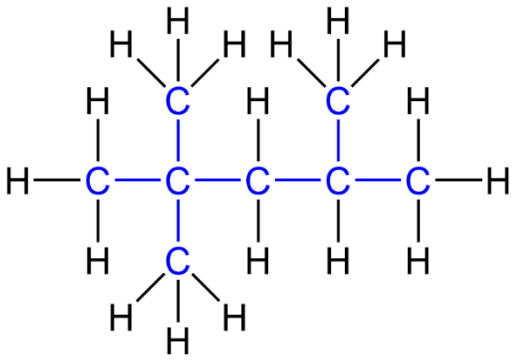
2,2,4-Trimethylpentane

Bond-Line Structures Are The Way to Go To More-Easily Keep Track of the Carbon Skeleton!

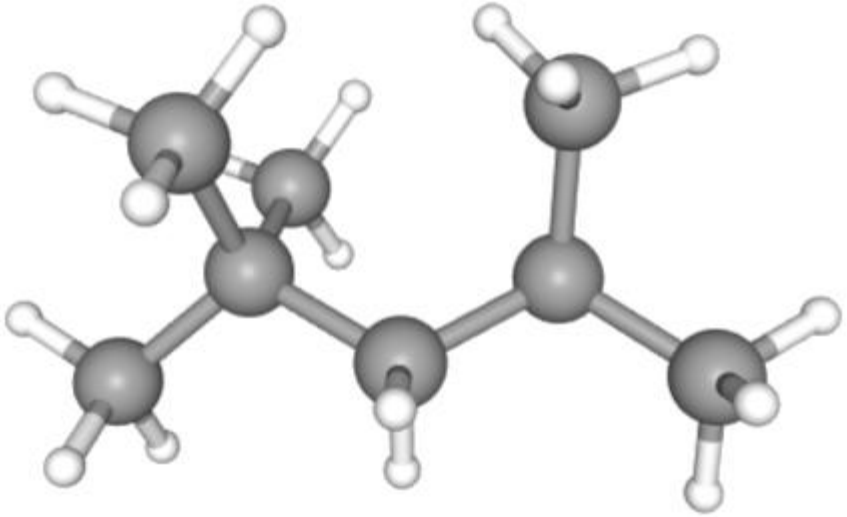


2,2,4-Trimethylpentane

Hand-Drawn Structures vs. 3-D Molecular Structure



2,2,4-Trimethylpentane



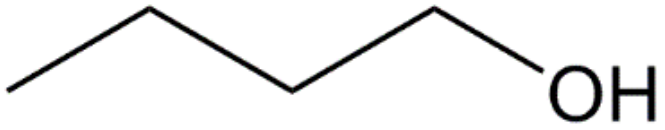
Interpreting a Bond-Line Structure: Guidelines

1. A vertex (or kink in the line) is an implied carbon atom.

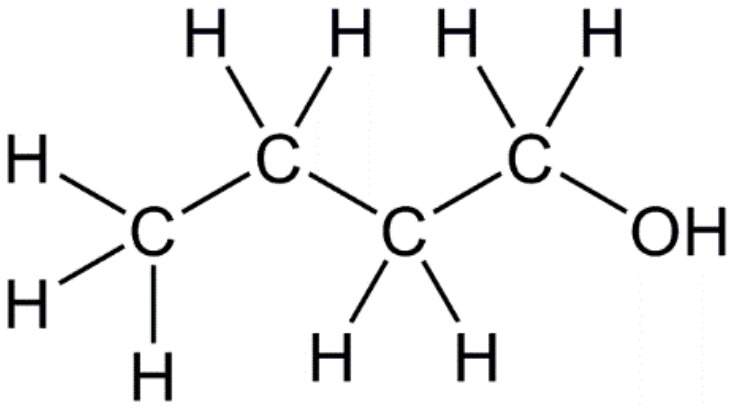
2. A link is a bond.

3. If a carbon atom does not share or have eight electrons, it is implied that carbon-hydrogen covalent bonds account for the difference.

4. Atoms other than C and H are drawn.

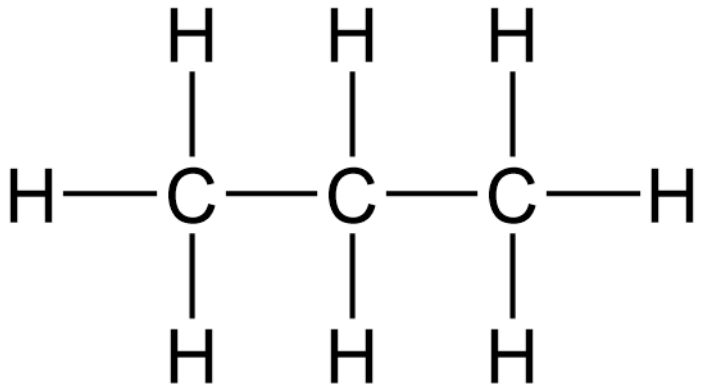


Butanol



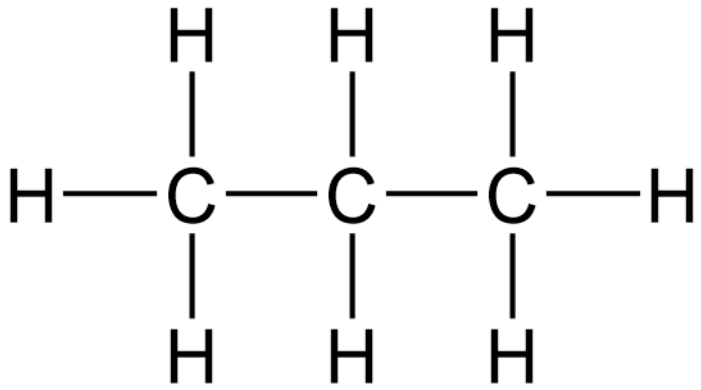
Problem 1

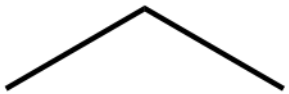
Draw the bond-line structure for butane.



Problem 1 - Solution

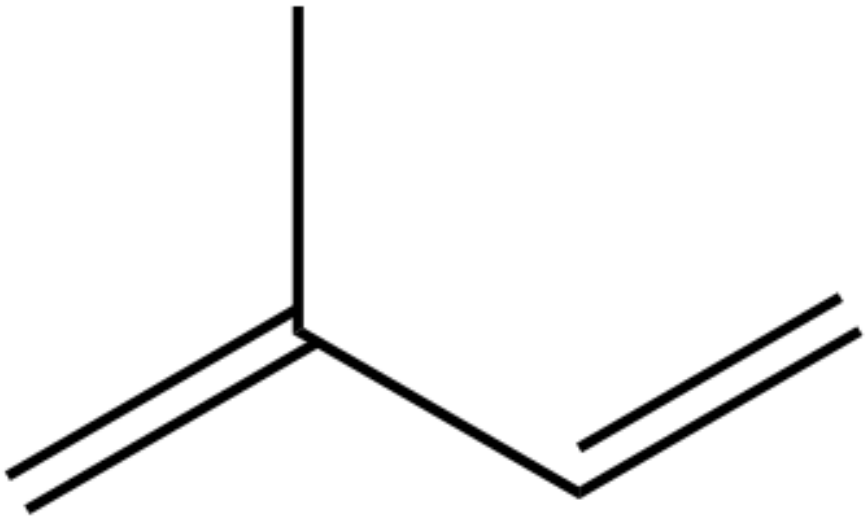
Draw the bond-line structure for butane.





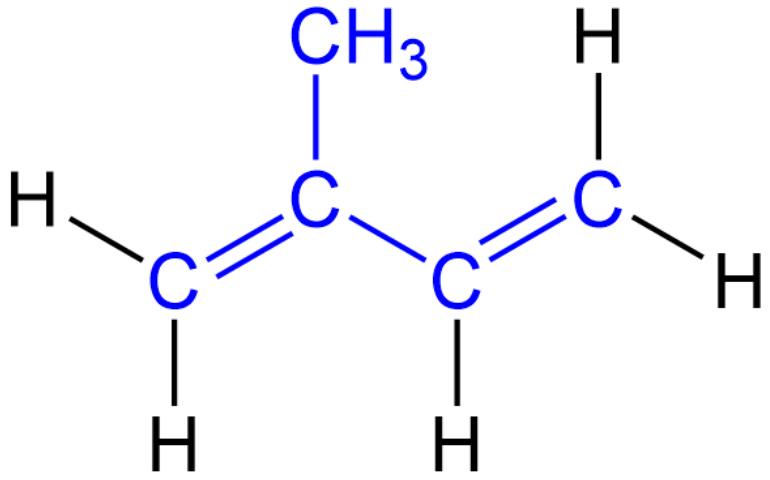
Problem 2

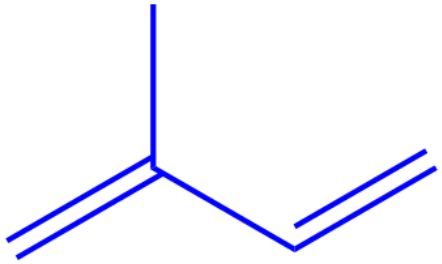
What is the molecular formula for isoprene?



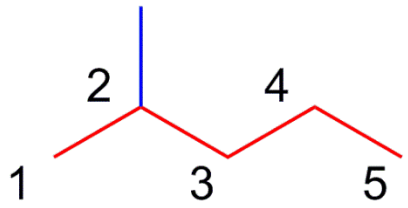
Problem 2 - Solution

C_5H_8





Naming Alkanes



Root
Designates number
of carbons in backbone

2-Methylpentane

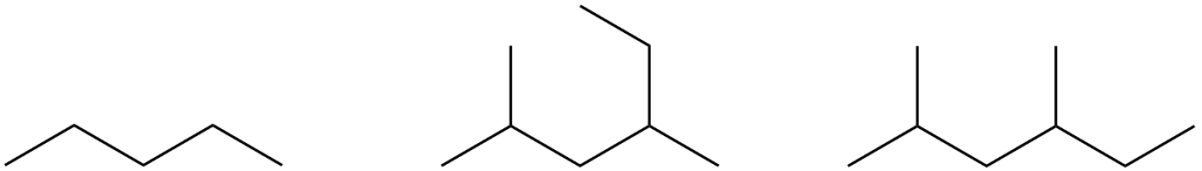
Number and Prefix:
Designates position
and number of
carbon
atoms in branch

Suffix:
Defines the
functional group

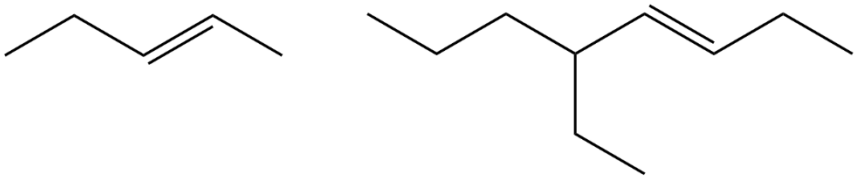
Number of Carbons	Root Prefix
1	meth-
2	eth-
3	prop-
4	but-
5	pent-
6	hex-
7	hept-
8	oct-
9	non-
10	dec-

Alkanes, Alkenes, and Alkynes: Oh My!

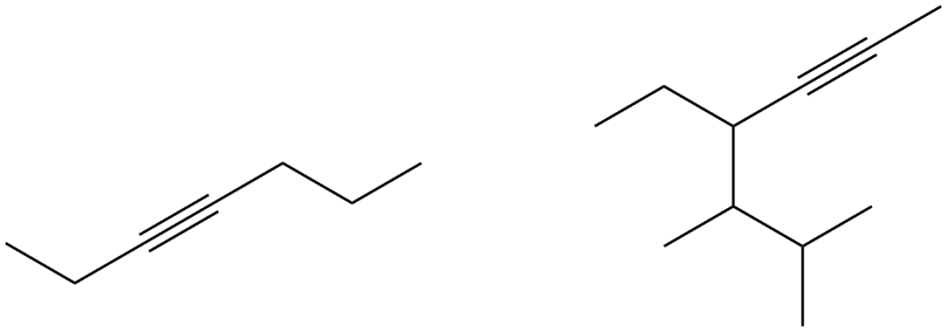
Alkanes



Alkenes

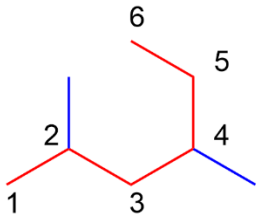


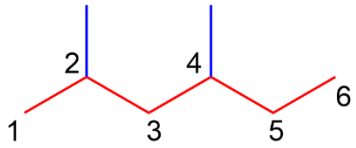
Alkynes



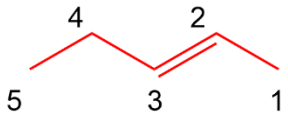
Naming Alkanes, Alkenes, and Alkynes: Oh My!

Pentane

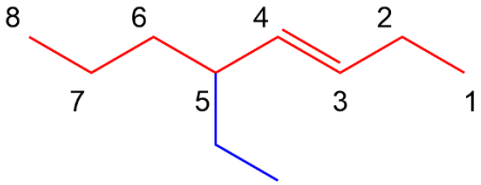




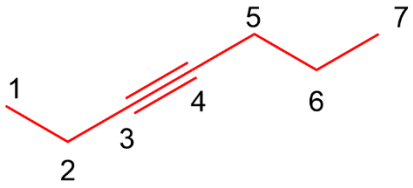
2,4-Dimethylhexane



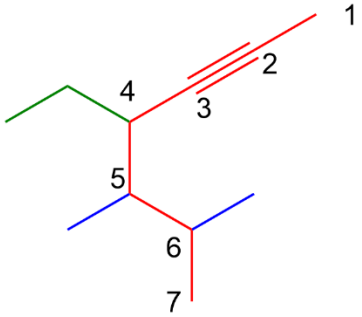
2-Pentene



5-Ethyl-3-octene



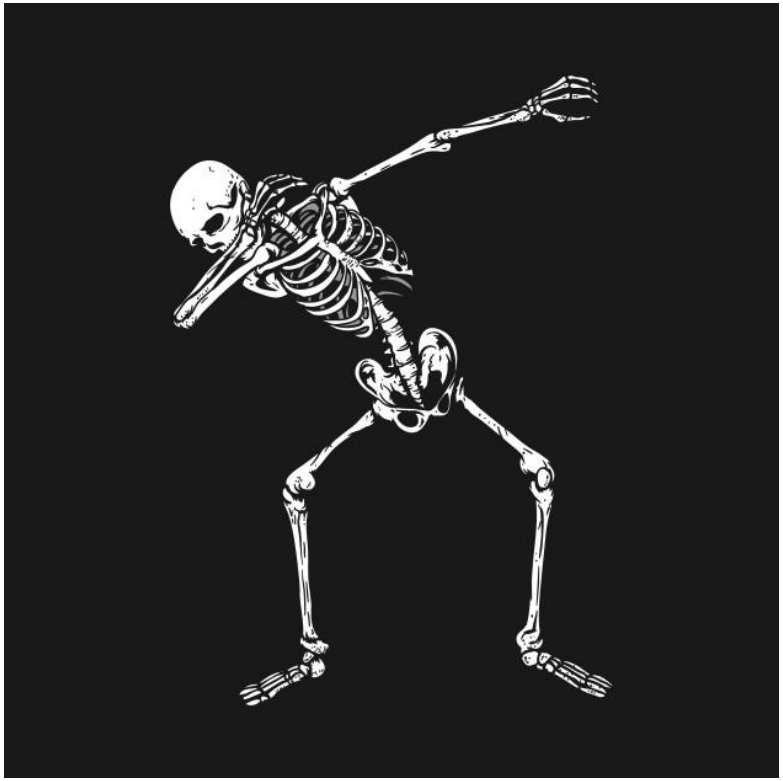
3-Heptyne



4-Ethyl-5,6-Dimethyl-2-heptyne

Isomers Are A Set of Molecules That Have The Same Molecular Formula, But Different Molecular Structure

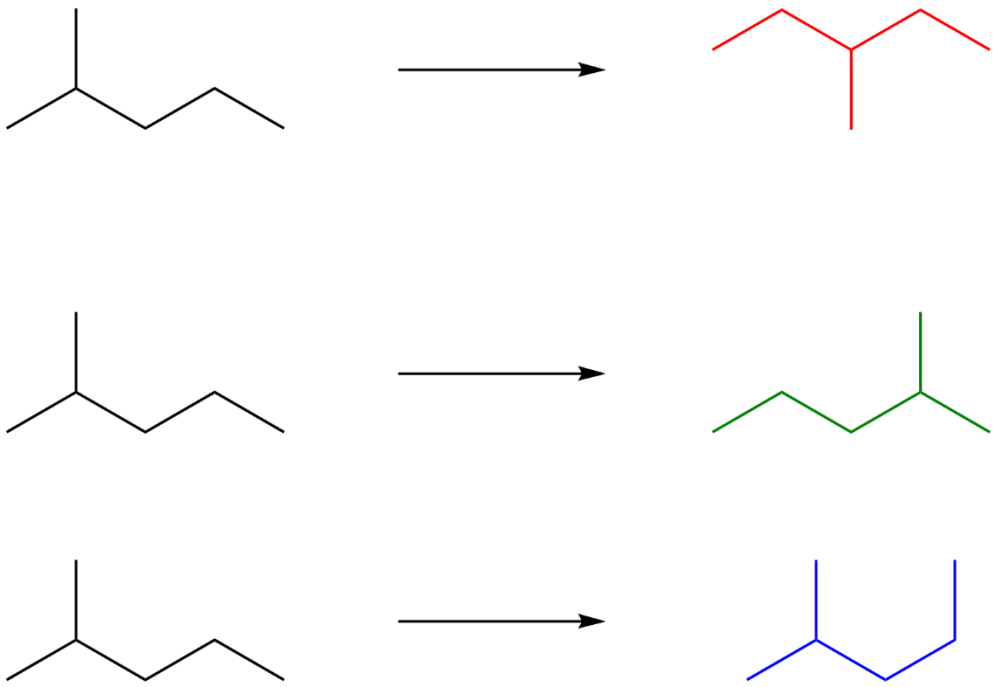
Constitutional (Skeletal/Structural) Isomers: One molecule in a set of isomers that differ In the order of the atoms connected. The atoms are the same among the different atoms, but the connectivity differs.



Problem 3

What is the relationship between the following structures (same molecule, different molecule, constitutional isomers)?

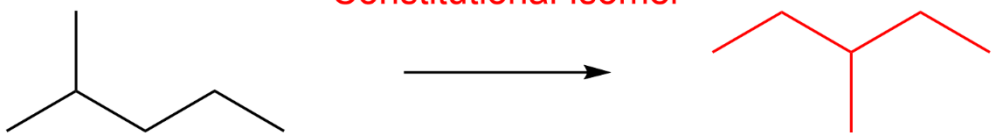
C_6H_{14}



Problem 3 - Solution

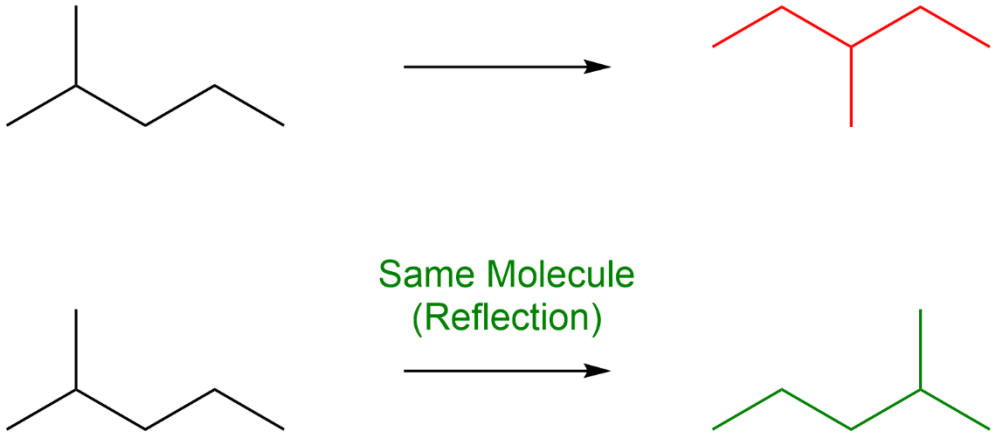
C_6H_{14}

Constitutional Isomer



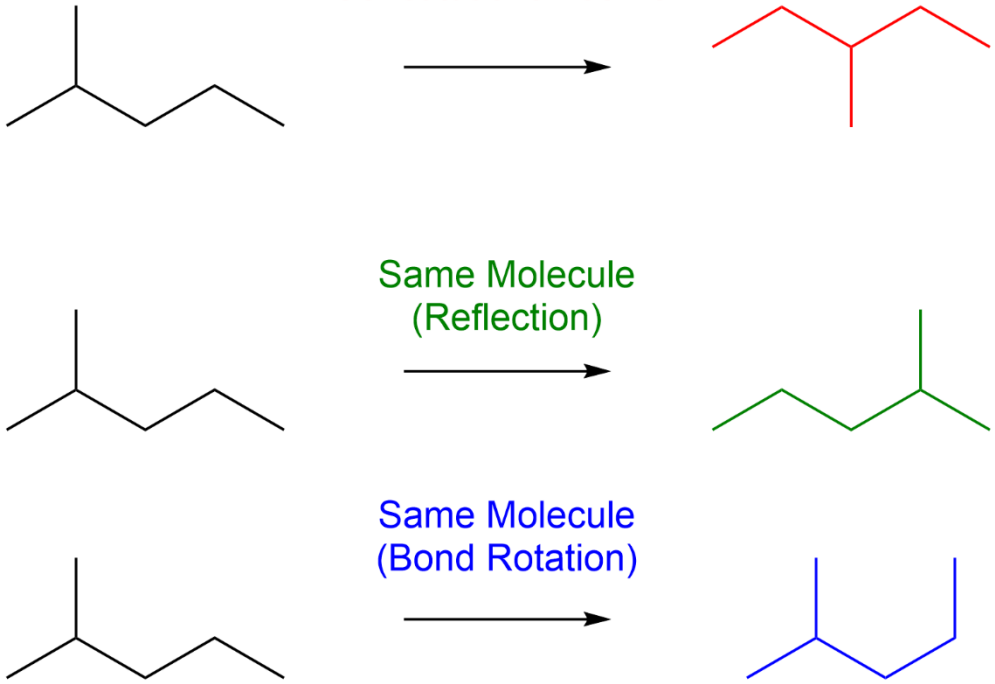
Problem 3 - Solution

C_6H_{14}



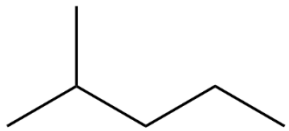
Problem 3 - Solution

C_6H_{14}

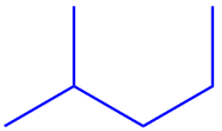


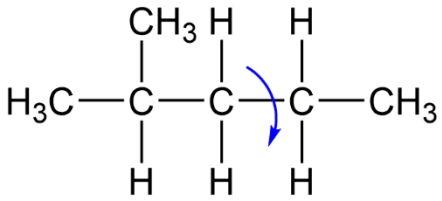
Problem 3 - Solution

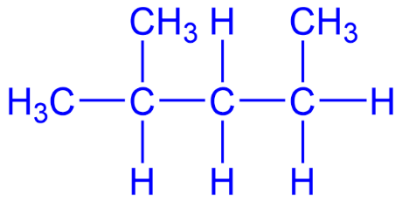
C_6H_{14}



Same Molecule
(Bond Rotation)

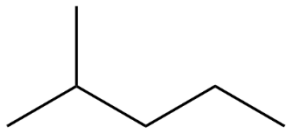






Problem 3 - Solution

C_6H_{14}



Same Molecule
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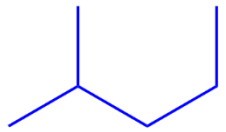
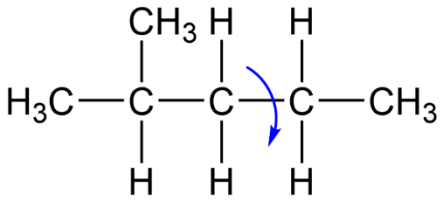
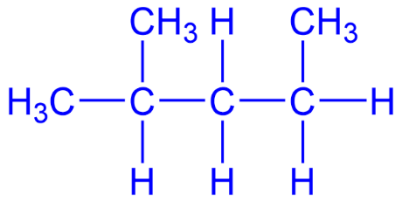
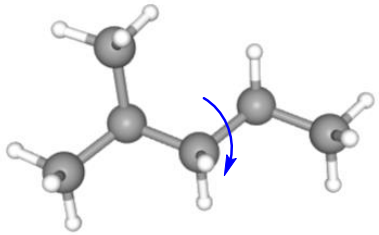
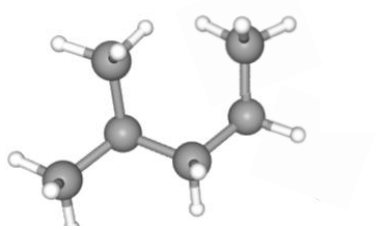








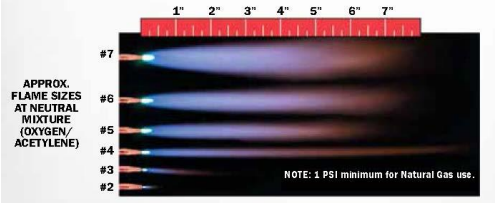


Combustion of Hydrocarbons

Fuel sources:

Methane: Natural Gas

Ethane: Used to produce ethyne (acetylene)



Propane: BBQs

Butane: Lighter fluid

Hydrocarbon Combustion Chemical Equations

Methane: $CH_4 + 2\ O_2 \rightarrow 2\ H_2O + CO_2$

Ethane: $2\ C_2H_6 + 7\ O_2 \rightarrow 6\ H_2O + 4\ CO_2$

Propane: $C_3H_8 + 5\ O_2 \rightarrow 4\ H_2O + 3\ CO_2$

Butane: $2\ C_4H_{10} + 13\ O_2 \rightarrow 10\ H_2O + 8\ CO_2$

Daily-Life Applications of Petroleum

https://www.youtube.com/watch?v=57oP8GhY9zc

Note, “petroleum” refers to crude oil or the mixture of hydrocarbons processed from crude oil

Plastics in Medicine

Where Does Plastic Come From?

https://www.youtube.com/watch?v=ggh0Ptk3VGE