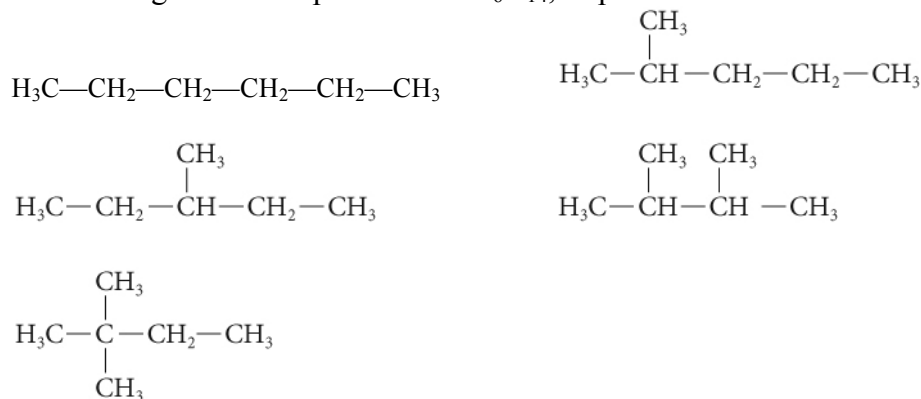


Section 1.1: Alkanes

Mini Investigation: Arranging Carbon Atoms, page 10

A. Three different molecules of C_5H_{12} are possible.

B. Five arrangements are possible for C_6H_{14} , as predicted:



Tutorial 1 Practice, page 14

1. (a) **Step 1:** There are 8 carbon atoms in the chain, so its root name is octane.

Step 2: This is an unbranched alkane. It has no substituent groups. So, the compound is named octane.

(b) **Step 1:** The longest chain has 5 carbon atoms, so its root name is pentane.

Step 2: The compound has one methyl group attached to the parent chain.

Step 3: Use the lowest numbers: 3 for the methyl group.

Step 4: The name of the compound is 3-methylpentane.

(c) **Step 1:** The ring contains 6 carbon atoms so it is a cyclohexane.

Step 2: The ring has three alkyl groups bonded to it: all methyl groups.

Step 3: Use the lowest numbers: 1, 1, and 3 for the three methyl groups.

Step 4: There are two methyl groups, so the name includes “trimethyl”.

Step 5: The name of the compound is 1,1,3-trimethylcyclohexane.

(d) **Step 1:** The longest chain has 6 carbon atoms, so its root name is hexane.

Step 2: The compound has two methyl groups attached to the parent chain.

Step 3: Use the lowest numbers: 2 and 4 for the two methyl groups.

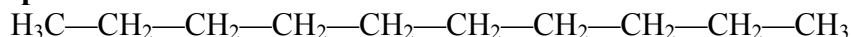
Step 4: The prefix is *di-* for two identical substituent groups.

Step 5: The name of the compound is 2,4-dimethylhexane.

2. (a) **Step 1:** Draw the parent chain from the last part of the compound name. The decane chain has 10 carbon atoms.

Step 2: There are no substituent groups.

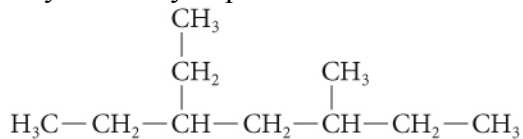
Step 3: The structural formula for decane is



(b) **Step 1:** Draw the parent chain from the last part of the compound name. The heptane chain has 7 carbon atoms.

Step 2: The ethyl group is attached to carbon atom 3, and the methyl group is attached to carbon atom 5.

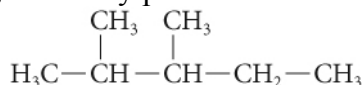
Step 3: Draw the substituents attached to the parent chain. The structural formula for 3-ethyl-5-methylheptane is:



(c) Step 1: Draw the parent chain from the last part of the compound name. The pentane chain has 5 carbon atoms.

Step 2: The two methyl groups are attached to carbon atoms 2 and 3.

Step 3: Draw the substituents attached to the parent chain. The structural formula for 2,3-dimethylpentane is:

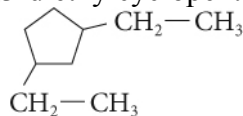


(d) Step 1: Draw the parent chain from the last part of the compound name.

Cyclopentane is a ring of 5 carbon atoms.

Step 2: The two ethyl groups are attached to carbon atoms 1 and 3.

Step 3: Draw the substituents attached to the ring. The structural formula for 1,3-diethylcyclopentane is:



Section 1.1 Questions, page 17

1. (a) An organic compound is a molecular compound containing carbon with the exception of carbon monoxide, CO(g), carbon dioxide, CO₂(g), and hydrogen cyanide, HCN(g).

(b) An alkane is a saturated hydrocarbon.

(c) A structural isomer is a compound that has the same molecular formula as another compound but a different structure.

(d) A substituent group is an atom or group that replaces a hydrogen atom in an organic compound.

(e) An alkyl group is one or more carbon atoms that form a branch off the main chain of a hydrocarbon.

(f) An alkyl halide is an alkane in which one or more hydrogen atoms have been substituted with one or more halogen atoms.

2. (a) Step 1: The longest chain has 4 carbon atoms, so its root name is butane.

Step 2: The compound has two methyl groups attached to the parent chain.

Step 3: Use the lowest numbers: 2 and 2 for the two methyl groups.

Step 4: The prefix is *di-* for two identical substituent groups.

Step 5: The name of the compound is 2,2-dimethylbutane.

(b) Step 1: The longest chain has 7 carbon atoms, so its root name is heptane.
Step 2: The compound has two methyl groups and one ethyl group attached to the parent chain.

Step 3: Use the lowest numbers: 2 and 3 for the methyl groups and 5 for the ethyl group.

Step 4: The prefix is *di-* for two identical substituent groups.

Step 5: List substituents in alphabetical order, ignoring prefixes. The name of the compound is 5-ethyl-2,3-dimethylheptane.

(c) Step 1: The longest chain has 8 carbon atoms, so its root name is octane.

Step 2: The compound has two methyl groups and one propan-2-yl group attached to the parent chain.

Step 3: Use the lowest numbers: 2 and 6 for the methyl groups and 4 for the propan-2-yl group.

Step 4: The prefix is *di-* for two identical substituent groups.

Step 5: List substituents in alphabetical order, ignoring prefixes. The name of the compound is 2,6-dimethyl-4-propan-2-yl octane.

(d) Step 1: The longest chain has 5 carbon atoms, so its root name is pentane.

Step 2: The compound has one chlorine atom and one bromine atom attached to the parent chain.

Step 3: Use the lowest numbers: 2 and 4 for the chlorine and bromine atoms.

Step 4: List substituents in alphabetical order. So, the name of the compound is 2-bromo-4-chloropentane.

(e) Step 1: The ring has 6 carbon atoms, so its root name is cyclohexane.

Step 2: The ring has two methyl groups bonded to it.

Step 3: Use the lowest numbers: 1 and 1 for the methyl groups.

Step 4: The name of the compound is 1,1-dimethylcyclohexane.

(f) Step 1: The ring has 5 carbon atoms, so its root name is cyclopentane.

Step 2: The ring has one propan-2-yl group bonded to it.

Step 3: The number 1 does not have to be included if only one substituent is present on the ring.

Step 4: The name of the compound is propan-2-ylcyclopentane.

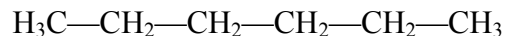
(g) Step 1: The longest chain has 6 carbon atoms, so its root name is hexane.

Step 2: The compound has one methyl group attached to the parent chain.

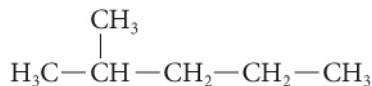
Step 3: Use the lowest number: 3 for the methyl group.

Step 4: The name of the compound is 3-methylhexane.

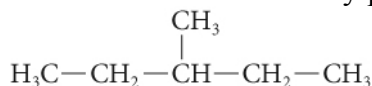
3. The five structural isomers that have the molecular formula C_6H_{14} are:



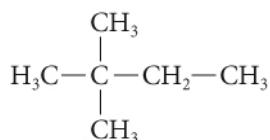
This isomer is called hexane.



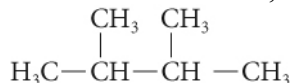
This isomer is called 2-methylpentane.



This isomer is called 3-methylpentane.

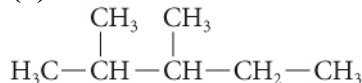


This isomer is called 2,2-dimethylbutane.



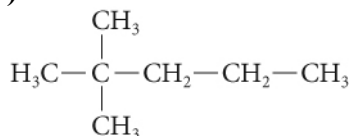
This isomer is called 2,3-dimethylbutane.

4. (a) The structural formula for 3,4-dimethylheptane, or 2,3-dimethylpentane, is



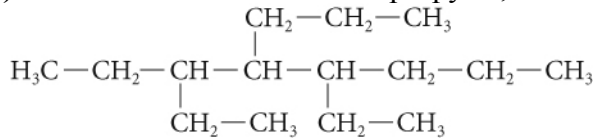
The molecular formula is C_9H_{17} .

(b) The structural formula for 2,2-dimethylpentane is



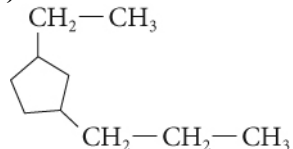
The molecular formula is C_7H_{16} .

(c) The structural formula for 4-propyl-3,5-diethyloctane is



The molecular formula is $\text{C}_{15}\text{H}_{32}$.

(d) The structural formula for 1-ethyl-3-propylcyclohexane is



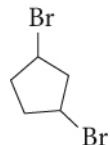
The molecular formula is $\text{C}_{11}\text{H}_{22}$.

5. (a) **Step 1:** Draw the parent chain from the last part of the compound name.

Cyclopentane is a ring of 5 carbon atoms.

Step 2: The two bromine atoms are attached to carbon atoms 1 and 3.

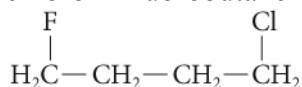
Step 3: Draw the substituents attached to the ring. So, the structural formula for 1,3-dibromocyclopentane is:



(b) Step 1: Draw the parent chain from the last part of the compound name. The butane chain has 4 carbon atoms.

Step 2: The fluorine atom is attached to carbon atom 1, and the chlorine atom is attached to carbon atom 4.

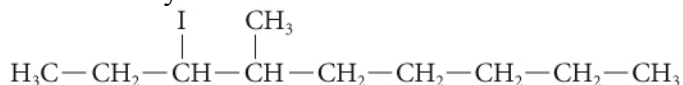
Step 3: Draw the substituents attached to the parent chain. So, the structural formula for 4-chloro-1-fluorobutane is



(c) Step 1: Draw the parent chain from the last part of the compound name. The nonane chain has 9 carbon atoms.

Step 2: The iodo group is attached to carbon atom 3, and the methyl group is attached to carbon atom 4.

Step 3: Draw the substituents attached to the parent chain. So, the structural formula for 3-iodo-4-methylnonane is



6. (a) Hydrocarbons are made up of carbon and hydrogen—two elements that have similar electronegativities. So, the bonds between carbon and hydrogen are close to being non-polar. The non-polar molecules of liquid hydrocarbons are therefore not attracted to the polar molecules of water. So, most liquid hydrocarbons do not mix with water.

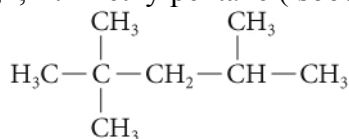
(b) Answers may vary. Sample answer: Since hydrocarbons are less dense than water, an oil spill, which contains mainly hydrocarbons, will float on the surface of a still lake. This confines the spill to the water surface, making the cleanup easier.

(c) Answers may vary. Sample answer: For organic halides that are denser than water, an organic halide spill may sink to the bottom of a river, making the cleanup more difficult.

7. Step 1: Draw the parent chain from the last part of the compound name. The pentane chain has 5 carbon atoms.

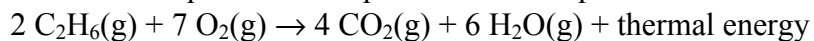
Step 2. The three methyl groups are attached to carbon atoms 2, 2, and 4.

Step 3. Draw the substituents attached to the parent chain. So, the structural formula for 2,2,4-trimethylpentane (isooctane) is



8. Answers may vary. Sample answer: As the carbon chain of an alkane gets longer, the boiling point gets higher. Methane, a small alkane of 1 carbon atom, is a highly flammable gas fuel. Paraffin is a long-chain alkane of more than 40 carbon atoms that is difficult to ignite until heated to a temperature at which it vaporizes. Therefore, a methane leak can pose an extreme fire and explosion hazard while a paraffin leak is typically not a significant hazard.

9. Look at the equation that represents the complete combustion of ethane with oxygen:



Since all the carbon in carbon dioxide comes from the alkane, the number of moles of carbon dioxide produced per molecule of alkane equals the number of carbon atoms in one molecule of the alkane. For 1 mol of ethane (2 carbon atoms per molecule), 2 mol of carbon dioxide will be produced; for 1 mol of pentane, 5 mol of carbon dioxide will be produced; for 1 mol of nonane, 9 mol of carbon dioxide will be produced; and for 1 mol of dodecane, 12 mol of carbon dioxide will be produced. Therefore, dodecane will produce the largest volume of carbon dioxide.