

11.E: Organic Chemistry- Alkanes and Halogenated Hydrocarbons (Exercises)

12.1: Organic Chemistry

Concept Review Exercises

1. Classify each compound as organic or inorganic.
 - a. $\text{C}_3\text{H}_8\text{O}$
 - b. CaCl_2
 - c. $\text{Cr}(\text{NH}_3)_3\text{Cl}_3$
 - d. $\text{C}_{30}\text{H}_{48}\text{O}_3\text{N}$
2. Which compound is likely organic and which is likely inorganic?
 - a. a flammable compound that boils at 80°C and is insoluble in water
 - b. a compound that does not burn, melts at 630°C , and is soluble in water

Answers

1.
 - a. organic
 - b. inorganic
 - c. inorganic
 - d. organic
2.
 - a. organic
 - b. inorganic
1. Classify each compound as organic or inorganic.
 - a. C_6H_{10}
 - b. CoCl_2
 - c. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
2. Classify each compound as organic or inorganic.
 - a. CH_3NH_2
 - b. NaNH_2
 - c. $\text{Cu}(\text{NH}_3)_6\text{Cl}_2$
3. Which member of each pair has a higher melting point?
 - a. CH_3OH and NaOH
 - b. CH_3Cl and KCl
4. Which member of each pair has a higher melting point?
 - a. C_2H_6 and CoCl_2
 - b. CH_4 and LiH

Answers

1.
 - a. organic
 - b. inorganic
 - c. organic
- 3.

- a. NaOH
- b. KCl

12.2: Structures and Names of Alkanes

Concept Review Exercises

1. In the homologous series of alkanes, what is the molecular formula for the member just above C_8H_{18} ?
2. Use the general formula for alkanes to write the molecular formula of the alkane with 12 carbon atoms.

Answers

1. C_9H_{20}
2. $C_{12}H_{26}$

Exercises

1. What compounds contain fewer carbon atoms than C_3H_8 and are its homologs?
2. What compounds contain five to eight carbon atoms and are homologs of C_4H_{10} ?

Answer

1. CH_4 and C_2H_6

12.3: Branched-Chain Alkanes

Concept Review Exercises

1. In alkanes, can there be a two-carbon branch off the second carbon atom of a four-carbon chain? Explain.
2. A student is asked to write structural formulas for two different hydrocarbons having the molecular formula C_5H_{12} . She writes one formula with all five carbon atoms in a horizontal line and the other with four carbon atoms in a line, with a CH_3 group extending down from the first attached to the third carbon atom. Do these structural formulas represent different molecular formulas? Explain why or why not.

Answers

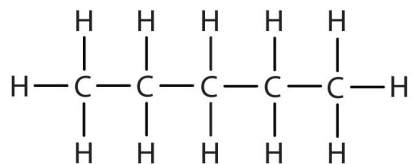
1. No; the branch would make the longest continuous chain of five carbon atoms.
2. No; both are five-carbon continuous chains.

Key Takeaway

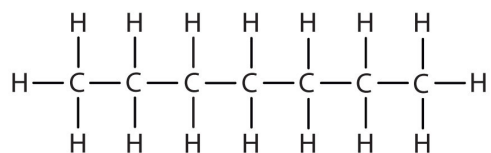
- Alkanes with four or more carbon atoms can exist in isomeric forms.

Exercises

1. Briefly identify the important distinctions between a straight-chain alkane and a branched-chain alkane.
2. How are butane and isobutane related? How do they differ?
3. Name each compound.



a.



b.

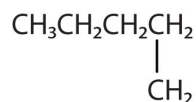
4. Write the structural formula for each compound.

a. hexane

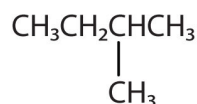
b. octane

5. Indicate whether the structures in each set represent the same compound or isomers.

a. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and



b. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ and



Answers

1. Straight-chain alkanes and branched-chain alkanes have different properties as well as different structures.

3.

a. pentane

b. heptane

5.

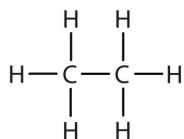
a. no

b. yes

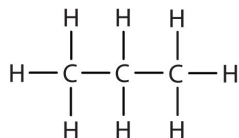
12.4: Condensed Structural and Line-Angle Formulas

Exercises

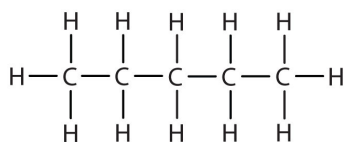
1. Write the condensed structural formula for each structural formula.



a.

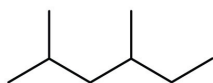


b.



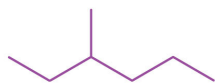
c.

2. A condensed structural formula for isohexane can be written as $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}_3$. Draw the line-angle formula for isohexane.
3. Draw a line-angle formula for the compound $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$.
4. Give the structural formula for the compound represented by this line-angle formula:



Answers

1.
 - a. CH_3CH_3
 - b. $\text{CH}_3\text{CH}_2\text{CH}_3$
 - c. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$



3.

12.5: IUPAC Nomenclature

Concept Review Exercises

1. What is a CH_3 group called when it is attached to a chain of carbon atoms—a substituent or a functional group?
2. Which type of name uses numbers to locate substituents—common names or IUPAC names?

Answers

1. substituent
2. IUPAC names

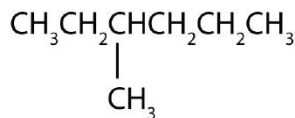
Exercises

1. Briefly identify the important distinctions between an alkane and an alkyl group.
2. How many carbon atoms are present in each molecule?
 - a. 2-methylbutane
 - b. 3-ethylpentane
3. How many carbon atoms are present in each molecule?
 - a. 2,3-dimethylbutane
 - b. 3-ethyl-2-methylheptane
4. Draw the structure for each compound.
 - a. 3-methylpentane
 - b. 2,2,5-trimethylhexane
 - c. 4-ethyl-3-methyloctane

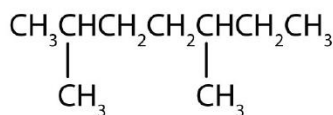
5. Draw the structure for each compound.

- 2-methylpentane
- 4-ethyl-2-methylhexane
- 2,2,3,3-tetramethylbutane

6. Name each compound according to the IUPAC system.

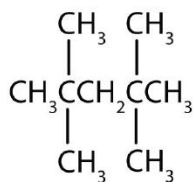


a.

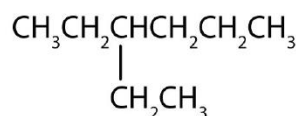


b.

7. Name each compound according to the IUPAC system.



a.



b.

8. What is a substituent? How is the location of a substituent indicated in the IUPAC system?

9. Briefly identify the important distinctions between a common name and an IUPAC name.

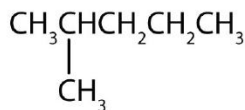
Answers

1. An alkane is a molecule; an alkyl group is not an independent molecule but rather a part of a molecule that we consider as a unit.

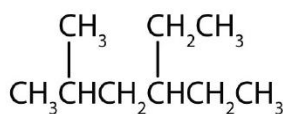
3.

- 6
- 10

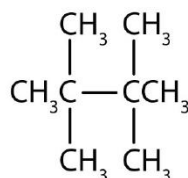
5.



a.



b.



c.

7.

- 2,2,4,4-tetramethylpentane
- 3-ethylhexane

9. Common names are widely used but not very systematic; IUPAC names identify a parent compound and name other groups as substituents.

12.6: Physical Properties of Alkanes

Concept Review Exercises

- Without referring to a table, predict which has a higher boiling point—hexane or octane. Explain.
- If 25 mL of hexane were added to 100 mL of water in a beaker, which of the following would you expect to happen? Explain.
 - Hexane would dissolve in water.
 - Hexane would not dissolve in water and would float on top.
 - Hexane would not dissolve in water and would sink to the bottom of the container.

Answers

- octane because of its greater molar mass
- b; hexane is insoluble in water and less dense than water.

Exercises

- Without referring to a table or other reference, predict which member of each pair has the higher boiling point.
 - pentane or butane
 - heptane or nonane
- For which member of each pair is hexane a good solvent?
 - pentane or water
 - sodium chloride or soybean oil

Answer

- pentane
 - nonane

12.7: Chemical Properties of Alkanes

Concept Review Exercises

- Why are alkanes sometimes called paraffins?
- Which halogen reacts most readily with alkanes? Which reacts least readily?

Answers

1. Alkanes do not react with many common chemicals. They are sometimes called paraffins, from the Latin parum affinis, meaning “little affinity.”
2. most readily: F_2 ; least readily: I_2

Exercises

1. Why do alkanes usually not react with ionic compounds such as most laboratory acids, bases, oxidizing agents, or reducing agents?
2. Write an equation for the complete combustion of methane (CH_4), the main component of natural gas).
3. What is the most important reaction of alkanes?
4. Name some substances other than oxygen that react readily with alkanes.

Answers

1. Alkanes are nonpolar; they do not attract ions.

12.8: Halogenated Hydrocarbons

Concept Review Exercises

1. What is the IUPAC name for the HFC that has the formula CH_2FCF_3 ? (Hint: you must use a number to indicate the location of each substituent F atom.)
2. What is the IUPAC name for the HCFC that has the formula $CHCl_2CF_3$?

Answers

1. 1,1,1,2-tetrafluoroethane
2. 1,1,1-trifluoro-2,2-dichloroethane

Exercises

1. Write the condensed structural formula for each compound.
 - a. methyl chloride
 - b. chloroform
2. Write the condensed structural formula for each compound.
 - a. ethyl bromide
 - b. carbon tetrachloride
3. Write the condensed structural formulas for the two isomers that have the molecular formula C_3H_7Br . Give the common name and the IUPAC name of each.
4. Write the condensed structural formulas for the four isomers that have the molecular formula C_4H_9Br . Give the IUPAC name of each.
5. What is a CFC? How are CFCs involved in the destruction of the ozone layer?
6. Explain why each compound is less destructive to the ozone layer than are CFCs.
 - a. fluorocarbons
 - b. HCFCs

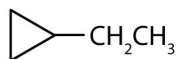
Answers

1. a. CH_3Cl
b. $CHCl_3$
3. $CH_3CH_2CH_2Br$, propyl bromide, 1-bromopropane; $CH_3CHBrCH_3$, isopropyl bromide, 2-bromopropane
5. compounds containing Cl, F, and C; by releasing Cl atoms in the stratosphere

12.9: Cycloalkanes

Concept Review Exercises

1. What is the molecular formula of cyclooctane?
2. What is the IUPAC name for this compound?

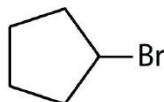


Answers

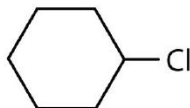
1. C_8H_{16}
2. ethylcyclopropane

Exercises

1. Draw the structure for each compound.
 - a. ethylcyclobutane
 - b. propylcyclopropane
2. Draw the structure for each compound.
 - a. methylcyclohexane
 - b. butylcyclobutane
3. Cycloalkyl groups can be derived from cycloalkanes in the same way that alkyl groups are derived from alkanes. These groups are named as cyclopropyl, cyclobutyl, and so on. Name each cycloalkyl halide.

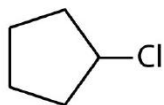


a.



b.

4. Halogenated cycloalkanes can be named by the IUPAC system. As with alkyl derivatives, monosubstituted derivatives need no number to indicate the position of the halogen. To name disubstituted derivatives, the carbon atoms are numbered starting at the position of one substituent (C1) and proceeding to the second substituted atom by the shortest route. Name each compound.

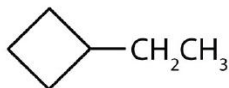


a.

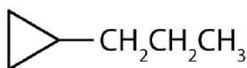


b.

Answers



1. a.



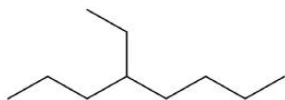
b.

3. a. cyclopentyl bromide
b. cyclohexyl chloride

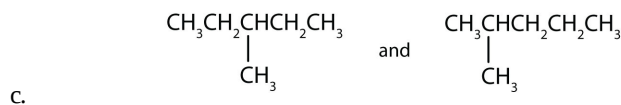
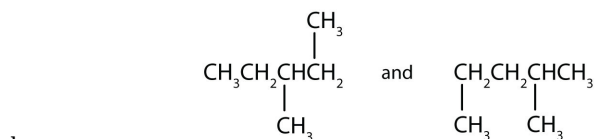
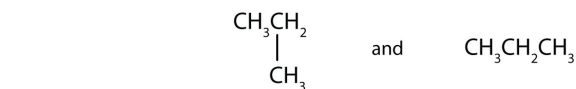
12.10: Chapter Summary

Additional Exercises

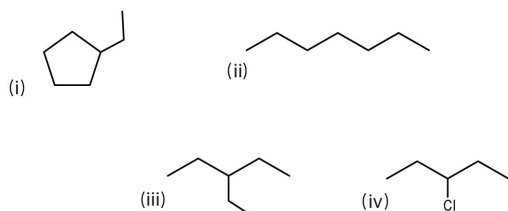
1. You find an unlabeled jar containing a solid that melts at 48°C. It ignites readily and burns readily. The substance is insoluble in water and floats on the surface. Is the substance likely to be organic or inorganic?
2. Give the molecular formulas for methylcyclopentane, 2-methylpentane, and cyclohexane. Which are isomers?
3. What is wrong with each name? (Hint: first write the structure *as if* it were correct.) Give the correct name for each compound.
 - a. 2-dimethylpropane
 - b. 2,3,3-trimethylbutane
 - c. 2,4-diethylpentane
 - d. 3,4-dimethyl-5-propylhexane
4. What is the danger in swallowing a liquid alkane?
5. Distinguish between lighter and heavier liquid alkanes in terms of their effects on the skin.
6. Following is the line formula for an alkane. Draw its structure and give its name.



7. Write equations for the complete combustion of each compound.
 - a. propane (a bottled gas fuel)
 - b. octane (a typical hydrocarbon in gasoline).
8. The density of a gasoline sample is 0.690 g/mL. On the basis of the complete combustion of octane, calculate the amount in grams of carbon dioxide (CO₂) and water (H₂O) formed per gallon (3.78 L) of the gasoline when used in an automobile.
9. Draw the structures for the five isomeric hexanes (C₆H₁₄). Name each by the IUPAC system.
10. Indicate whether the structures in each set represent the same compound or isomers.



11. Consider the line-angle formulas shown here and answer the questions.



- Which pair of formulas represents isomers? Draw each structure.
- Which formula represents an alkyl halide? Name the compound and write its condensed structural formula.
- Which formula represents a cyclic alkane? Name the compound and draw its structure.
- What is the molecular formula of the compound represented by (i)?

Answers

1. organic

3.

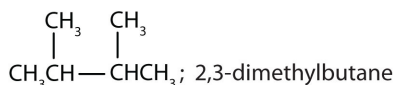
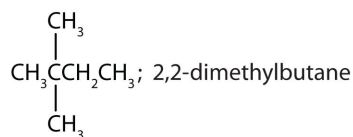
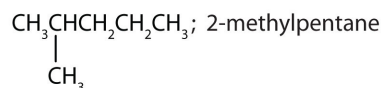
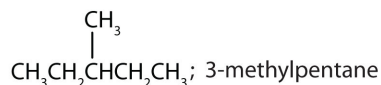
- Two numbers are needed to indicate two substituents; 2,2-dimethylpropane.
- The lowest possible numbers were not used; 2,2,3-trimethylbutane.
- An ethyl substituent is not possible on the second carbon atom; 3,5-dimethylheptane.
- A propyl substituent is not possible on the fifth carbon atom; 3,4,5-trimethyloctane.

5. Lighter alkanes wash away protective skin oils; heavier alkanes form a protective layer.

7.

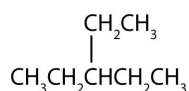
- $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$
- $2\text{C}_8\text{H}_{18} + 25\text{O}_2 \rightarrow 16\text{CO}_2 + 18\text{H}_2\text{O}$

9. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$; hexane



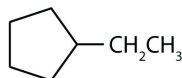
11.

- ii and iii; $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ and



b. iv; 3-chloropentane; $\text{CH}_3\text{CH}_2\text{CHClCH}_2\text{CH}_3$

c. i; ethylcyclopentane;



d. C_7H_{14}

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