

شرح الدرس الثاني Alkanes من وحدة Hydrocarbons منهج انسابير



تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ← المناهج الإماراتية ← الصف الحادي عشر المتقدم ← كيمياء ← الفصل الثالث ← ملفات متنوعة ← الملف

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منهج انجليزي ا ملخصات وتقارير ا مذكرات وبنوك ا الامتحان النهائي للمدرس

المزيد من مادة
كيمياء:

إعداد: Mouad

التواصل الاجتماعي بحسب الصف الحادي عشر المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف الحادي عشر المتقدم والمادة كيمياء في الفصل الثالث

شرح الدرس الأول hydrocarbons to Introduction من وحدة Hydrocarbons منهج انسابير

1

حل مراجعة نهائية وفق الهيكل الوزاري الخطة C

2

الهيكل الوزاري الجديد منهج انسابير الخطة M المسار المتقدم

3

ملخص شرح وتدريبات في سرعة التفاعلات الكيميائية

4

ملخص مختصر في قوانين سرعة التفاعلات

5

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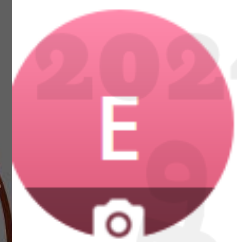
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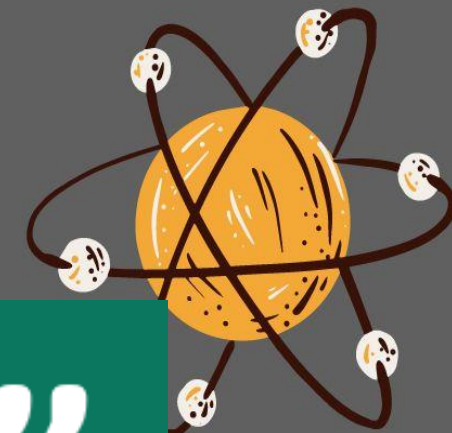


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CHEMISTRY



“Hydrocarbons” Alkanes

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Inspire Chemistry

Module 20

“Hydrocarbons”

Alkanes

Learning Outcomes:

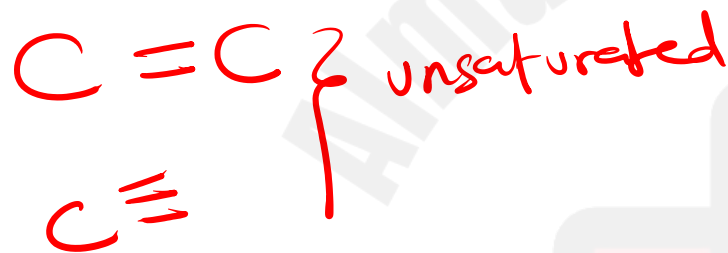
- ▶ **Name** ^{الأمكانات} alkanes by examining their structures.
- ▶ **Draw** the structure of an alkane when given its name.
- ▶ **Describe** the properties of alkanes.



Focus Question

number

What are the properties of hydrocarbons with a single bond?



C-C only
Saturated
Max # of "H"

New Vocabulary

- ✓ alkane
- ✓ homologous series
- ✓ parent chain
- ✓ substituent groups
- ✓ cyclic hydrocarbon
- ✓ cycloalkane

Review Vocabulary

system of Rules

IUPAC (International Union of Pure and Applied Chemistry): an international group that aids communication between chemists by setting rules and standards in areas such as chemical nomenclature, terminology, and standardized methods

Starter Quiz

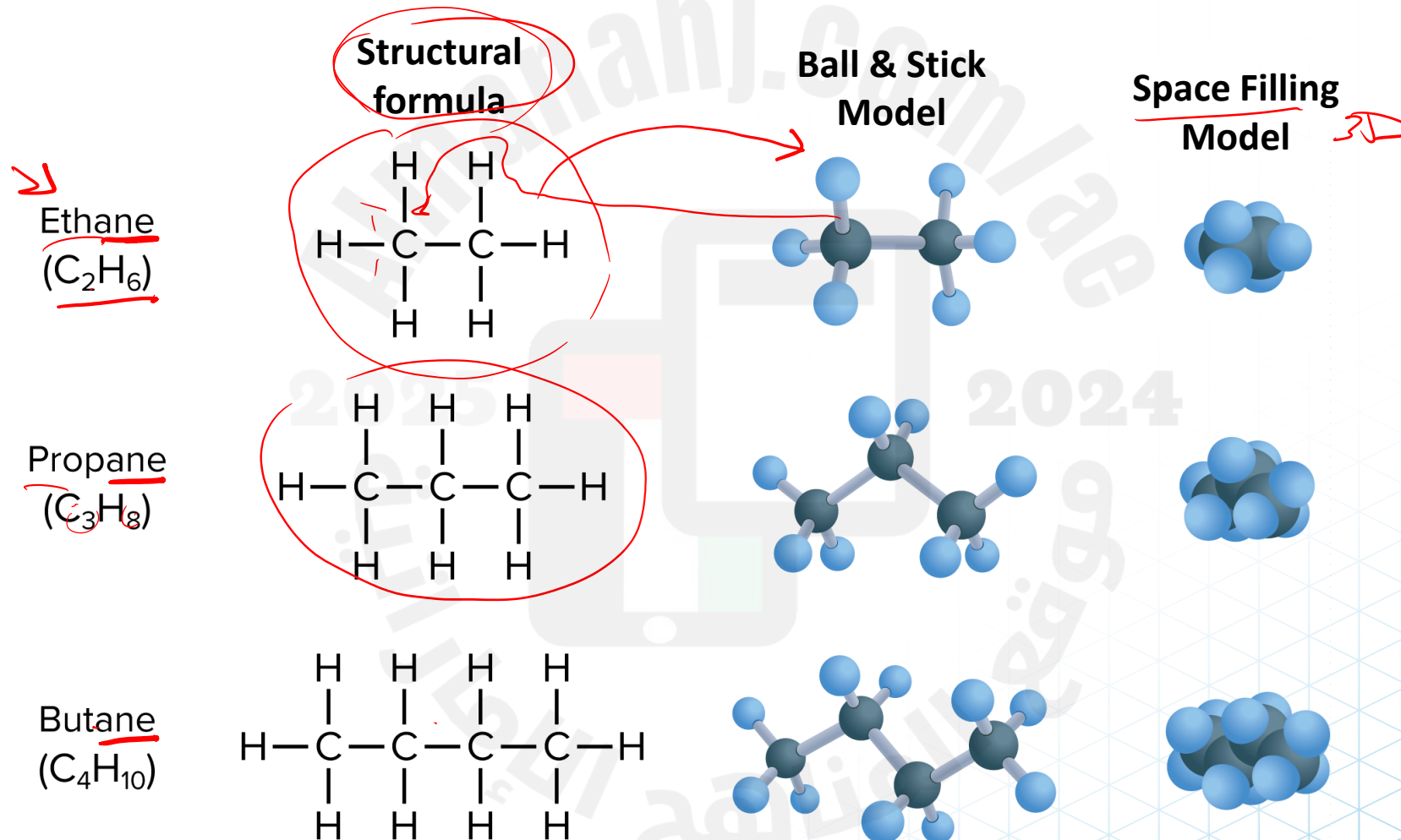
Which of the following elements do hydrocarbons contain?

Alkanes

- A carbon and oxygen only
- B carbon and hydrogen only**
- C carbon, hydrogen, and oxygen
- D nitrogen, phosphorus, oxygen, sulfur, and the halogens

Straight-Chain Alkanes

Alkanes are hydrocarbons that have only single bonds between atoms. $\text{C} \downarrow \text{C}$



Straight-Chain Alkanes

- The names of **alkanes** end in **-ane**.
- Alkanes **with five or more carbons** in a chain have names that use a prefix derived from the Greek or Latin word for the number of carbons in each chain.
 - Example: *pentane*

Table 2 First Ten of the Alkane Series		
Name	Molecular Formula	Condensed Structural Formula
Methane	CH ₄	CH ₄
Ethane	C ₂ H ₆	CH ₃ CH ₃
Propane	C ₃ H ₈	CH ₃ CH ₂ CH ₃
Butane	C ₄ H ₁₀	CH ₃ CH ₂ CH ₂ CH ₃
<u>Pentane</u>	C ₅ H ₁₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃
<u>Hexane</u>	C ₆ H ₁₄	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
<u>Heptane</u>	C ₇ H ₁₆	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
<u>Octane</u>	C ₈ H ₁₈	CH ₃ (CH ₂) ₆ CH ₃
<u>Nonane</u>	C ₉ H ₂₀	CH ₃ (CH ₂) ₇ CH ₃
<u>Decane</u>	C ₁₀ H ₂₂	CH ₃ (CH ₂) ₈ CH ₃

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Alkane

1C

meth ane

2C

eth —

3C

prop —

4C

but

5C

pent

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Methane	CH ₄	CH ₄
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Propane	C ₃ H ₈	CH ₃ <u>CH₂</u> CH ₃
Butane	C ₄ H ₁₀	CH ₃ <u>CH₂CH₂</u> CH ₃
<u>Pentane</u>	C ₅ H ₁₂	CH ₃ <u>CH₂CH₂CH₂</u> CH ₃
<u>Hexane</u>	C ₆ H ₁₄	CH ₃ <u>CH₂CH₂CH₂CH₂</u> CH ₃
<u>Heptane</u>	C ₇ H ₁₆	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
<u>Octane</u>	<u>C₈H₁₈</u>	CH ₃ (CH ₂) ₆ CH ₃
<u>Nonane</u>	C ₉ H ₂₀	CH ₃ (CH ₂) ₇ CH ₃
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homologous series

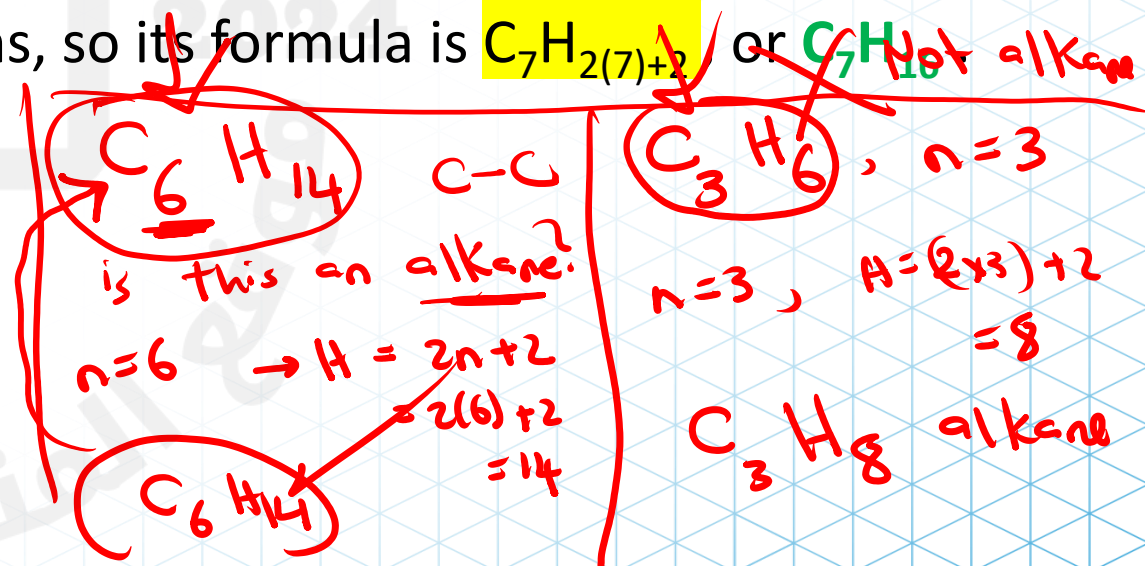
Straight-Chain Alkanes

- A series of compounds that differ from one another by a repeating unit is called a **homologous series**.
- A homologous series has a fixed numerical relationship among the numbers of atoms. **For alkanes**, the **relationship between the numbers of carbon and hydrogen atoms can be expressed as C_nH_{2n+2}** , where **n** is equal to the number of **carbon atoms** in the alkane.
- For example, heptane has **seven carbon** atoms, so its formula is **$C_7H_{2(7)+2}$** , or **C_7H_{16}** .

Straight-Chain Alkanes

- A series of compounds that differ from one another by a repeating unit is called a homologous series.
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Alkane
 $C=8$
 $n=8$



Names of Straight-Chain Alkanes

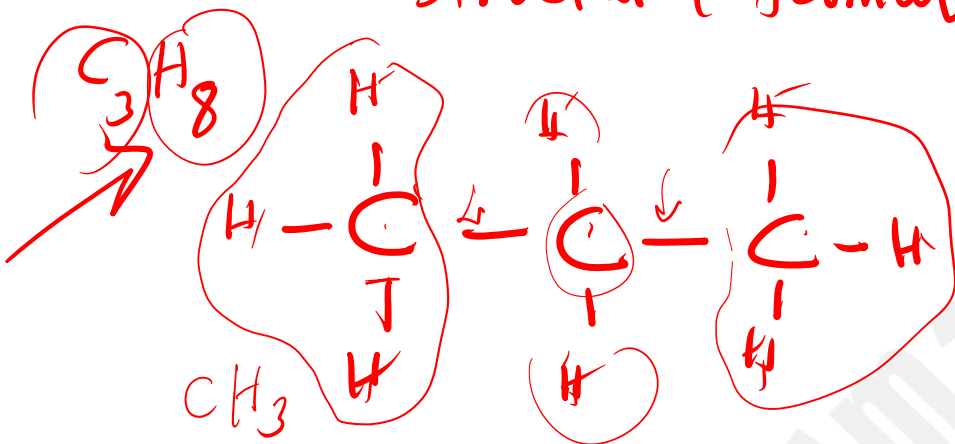
You need to memorize this (حفظ)

Table 2 First Ten of the Alkane Series		
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Butane	C ₄ H ₁₀	CH ₃ CH ₂ CH ₂ CH ₃
<u>Pentane</u>	C ₅ H ₁₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃
<u>Hexane</u>	C ₆ H ₁₄	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
<u>Heptane</u>	C ₇ H ₁₆	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
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Names of Straight-Chain Alkanes

Structural formula

You need to memorize this (حفظ)



Condensed
Structural
Formula

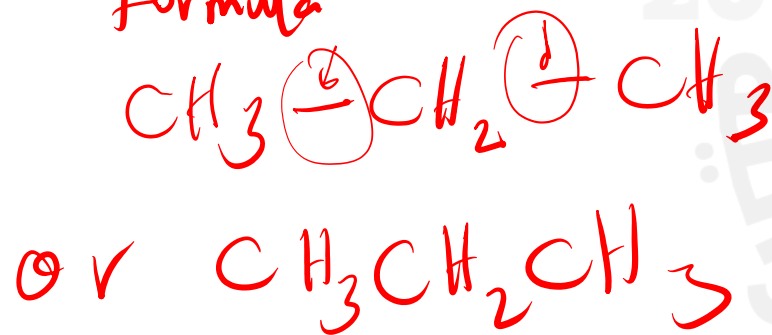
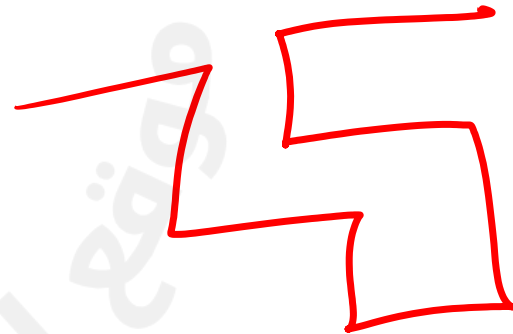
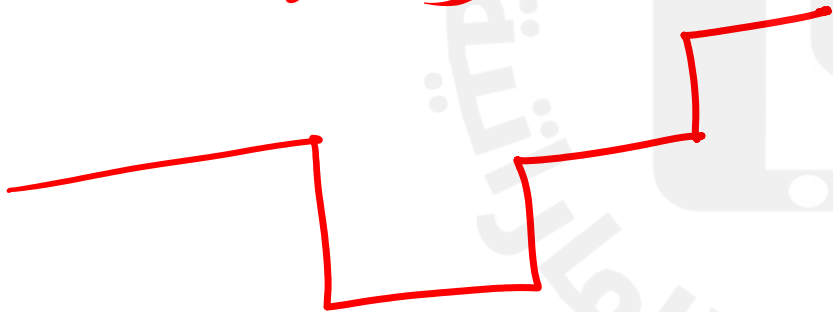
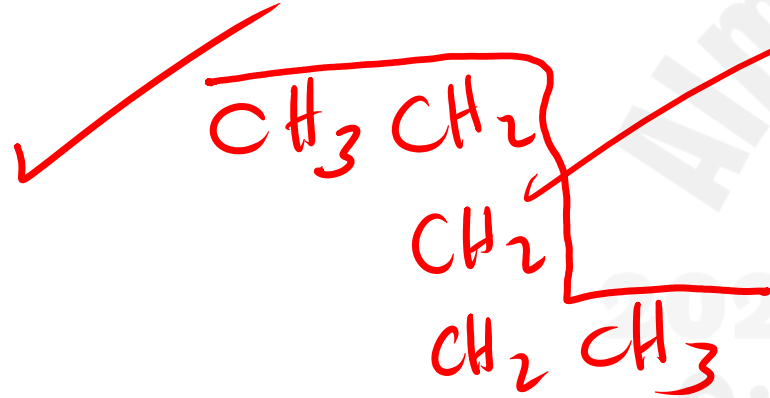
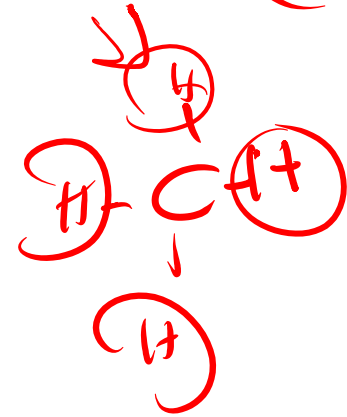
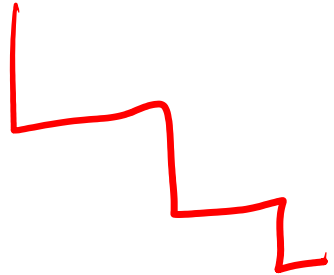


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Propane	C ₃ H ₈	CH ₃ CH ₂ CH ₃
Butane	C ₄ H ₁₀	CH ₃ CH ₂ CH ₂ CH ₃
Pentane	C ₅ H ₁₂	CH ₃ CH ₂ CH ₂ CH ₂ CH ₃
Hexane	C ₆ H ₁₄	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
Heptane	C ₇ H ₁₆	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃
Octane	C ₈ H ₁₈	CH ₃ (CH ₂) ₆ CH ₃
Nonane	C ₉ H ₂₀	CH ₃ (CH ₂) ₇ CH ₃
Decane	C ₁₀ H ₂₂	CH ₃ (CH ₂) ₈ CH ₃

(سلسلة) سلسلة غير متفرعة straight chain



branched chain
سلسلة متفرعة

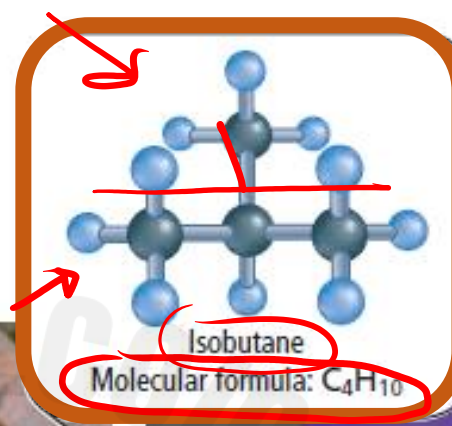
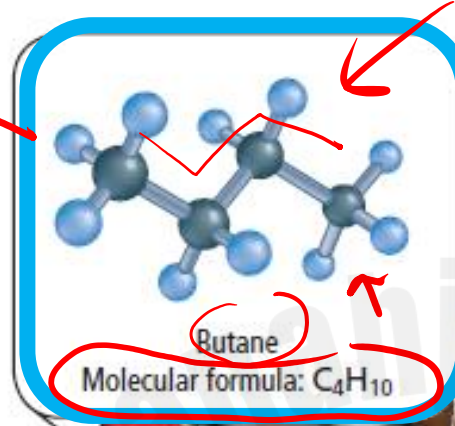
Alkan



branch

Branched-Chain Alkanes

straight-chain alkane



Branched-chain alkane

Branched Chain Alkanes

- Carbon atoms can bond to one, two, three, or four other carbon atoms, making a variety of branched-chain alkanes possible.
- A straight-chain and a branched-chain alkane can have the same molecular formula, but their structural arrangements are different.
- The order and arrangement of atoms in an organic molecule determine its identity.

Quiz

1. Which of the following is **NOT** true of alkanes?

A They are hydrocarbons. ^T

B Their names end in ~~-ene~~. ^X

ane

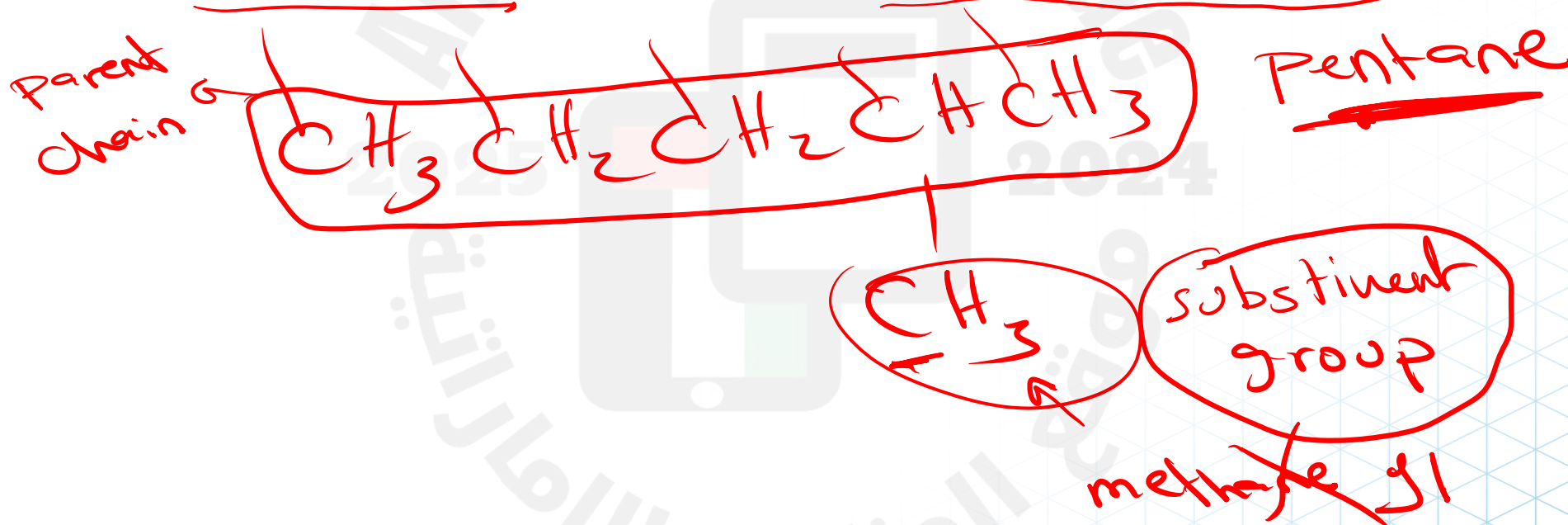
C They have single bonds. ^T

D Propane is an example. ^T

2024

Names of Branched-Chain Alkanes

- When naming branched-chain alkanes, the longest continuous chain of carbon atoms is called the parent chain. *السلسلة الأساسية*
- All the side branches are known as substituent groups.



Branched Chain Alkanes

- Each alkane-based ^{side} substituent group branching from the parent chain is named for the straight-chain alkane that has the same number of carbon atoms as the substituent.



- The ending -ane is replaced with the letters "-yl".
-
- An alkane-based substituent group is called an alkyl group.
- The general formula of an alkyl is C_nH_{2n+1}



Branched Chain Alkanes

Table 3 Common Alkyl Groups					
Name	methane Methyl	ethane Ethyl	propane Propyl	Isopropyl	Butyl
Condensed structural formula	CH₃—	CH₃CH₂—	CH₃CH₂CH₂— C ₃ H ₇	CH ₃ CH(CH ₃)— C ₃ H ₇	CH ₃ CH ₂ CH ₂ CH ₂ —
Structural formula	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ -\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \end{array}$

C_nH_{2n+2} C_nH_{2n+1}
Alkanes Vs. Alkyls

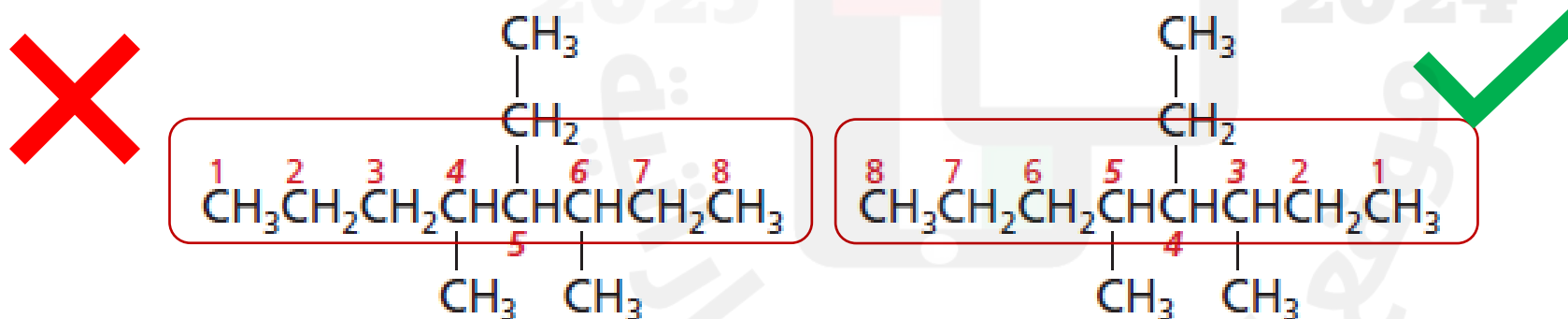
No. of C atoms	Name of alkane	Molecular formula	Name of alkyl group	Formula
1	Methane	<u>CH₄</u>	Methyl	<u>-CH₃</u>
2	Ethane	C ₂ H ₆	Ethyl	-C ₂ H ₅
3	Propane	C ₃ H ₈	Propyl	-C ₃ H ₇
4	Butane	C ₄ H ₁₀	Butyl	-C ₄ H ₉
5	<u>Pentane</u>	<u>C₅H₁₂</u>	Pentyl	-C ₅ H ₁₁
6	Hexane	C ₆ H ₁₄	Hexyl	-C ₆ H ₁₃
7	Heptane	C ₇ H ₁₆	Heptyl	-C ₇ H ₁₅
8	<u>Octane</u>	<u>C₈H₁₈</u>	Octyl	-C ₈ H ₁₇
9	Nonane	C ₉ H ₂₀	Nonyl	-C ₉ H ₁₉
10	Decane	C ₁₀ H ₂₂	Decyl	-C ₁₀ H ₂₁

Naming branched-chain alkanes

- To name organic structures, chemists use the following systematic rules approved by the International Union of Pure and Applied Chemistry (IUPAC).

Step 1. *Count the number of carbon atoms in the longest continuous chain.* Use the name of the straight-chain alkane with that number of carbons as the name of the parent chain of the structure.

Step 2. *Number each carbon in the parent chain.* Locate the end carbon closest to a substituent group. Label that carbon *Position 1*. This step gives all the substituent groups the lowest position numbers possible.

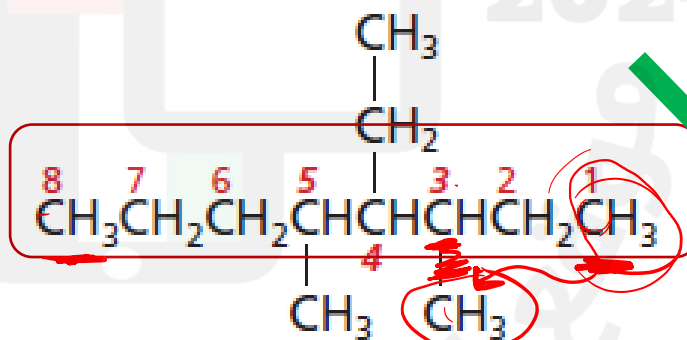
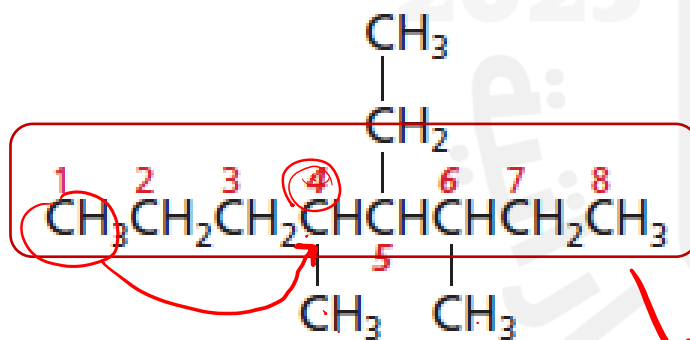
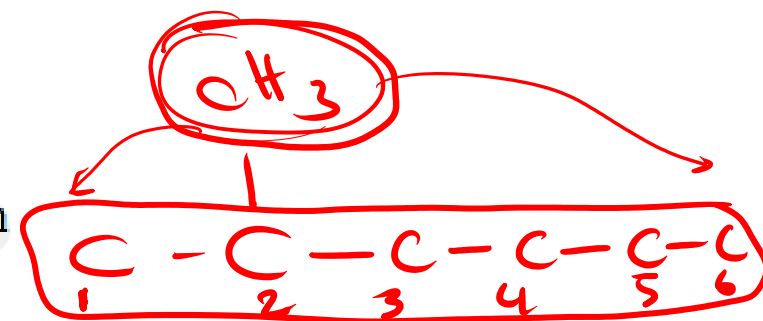


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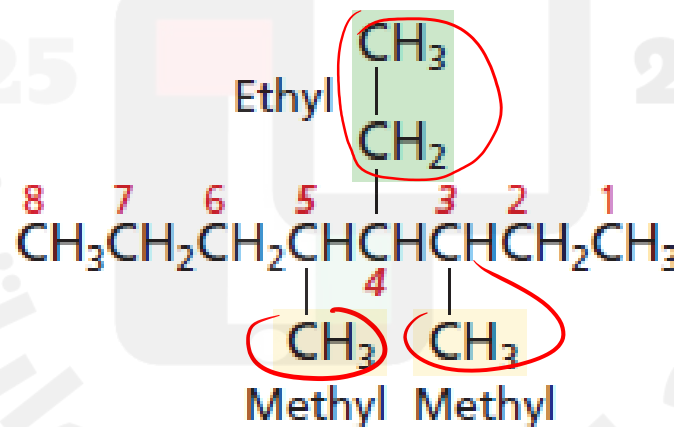
Step 2. Number each carbon in the parent chain. Locate the end carbon closest to a substituent group. Label that carbon *Position 1*. This step gives all the substituent groups the lowest position numbers possible.



Octane

Naming branched-chain alkanes

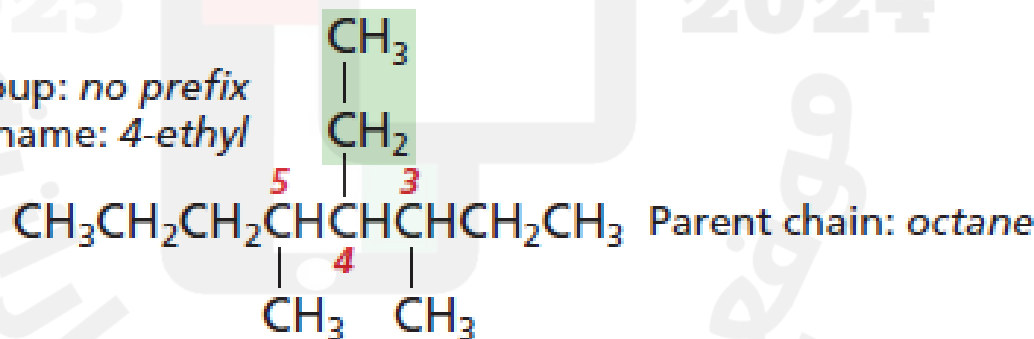
Step 3. *Name each alkyl group substituent.* Place the name of the group before the name of the parent chain.



Naming branched-chain alkanes

Step 4. *If the same alkyl group occurs more than once as a branch on the parent structure, use a prefix (di-, tri-, tetra-, and so on) before its name to indicate how many times it appears. Then, use the number of the carbon to which each is attached to indicate its position.*

One ethyl group: *no prefix*
Position and name: 4-ethyl

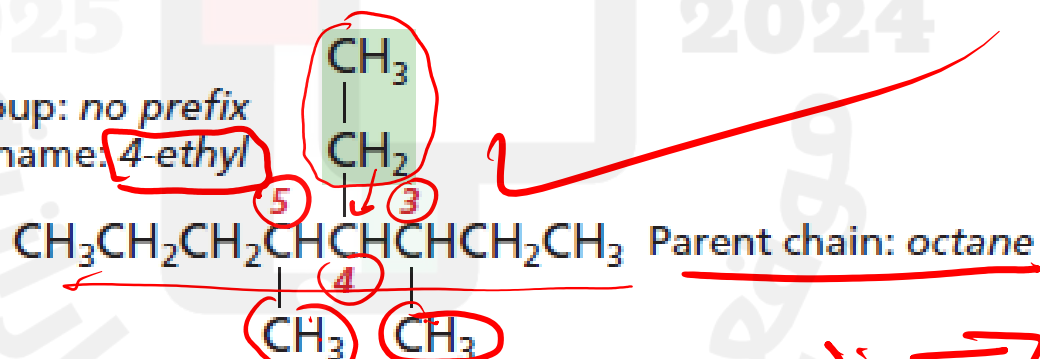


Two methyl groups: use *dimethyl*
Position and name: 3,5-dimethyl

Naming branched-chain alkanes

Step 4. If the same alkyl group occurs more than once as a branch on the parent structure, use a prefix (di², tri³, tetra⁴, and so on) before its name to indicate how many times it appears. Then, use the number of the carbon to which each is attached to indicate its position.

One ethyl group: no prefix
Position and name: 4-ethyl



Two methyl groups: use dimethyl
Position and name: 3,5-dimethyl

di \Rightarrow ②

ethyl methyl

A b c d -- (e) --- (m)

Naming branched-chain alkanes

Step 5. When different alkyl groups are attached to the same parent structure, place their names in alphabetical order. Do not consider the prefixes (di-, tri-, and so on) when determining alphabetical order.

parent chain:-
octane

4-ethyl
3,5-dimethyl

Step 6. Write the entire name, using hyphens to separate numbers from words and commas to separate numbers. Do not add a space between the substituent name and the name of the parent chain.



4-ethyl-3,5-dimethyloctane

branches parent chain

Branched Chain Alkanes

Naming branched-chain alkanes:

Step 1. Count the number of carbon atoms in the longest continuous chain.

Step 2. Number each carbon in the parent chain.

Step 3. Name each alkyl group substituent.

Step 4. If the same alkyl group occurs more than once as a branch on the parent structure, use a prefix (*di-*, *tri-*, *tetra-*, and so on) before its name to indicate how many times it appears.

Branched Chain Alkanes

Step 5. When different alkyl groups are attached to the same parent structure, place their names in alphabetical order.

Step 6. Write the entire name, using hyphens to separate numbers from words and commas to separate numbers.

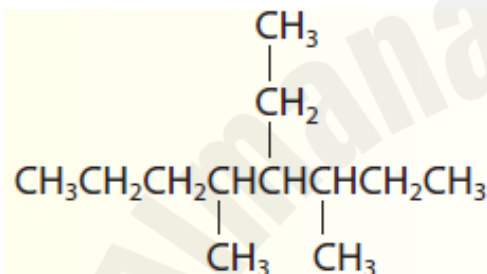
NAMING BRANCHED-CHAIN ALKANES

IN-CLASS EXAMPLE

Use with Example Problem 1.

Problem

Name the alkane shown.



Response

ANALYZE THE PROBLEM

You are given a structure. To determine the name of the parent chain and the names and locations of branches, follow the IUPAC rules.

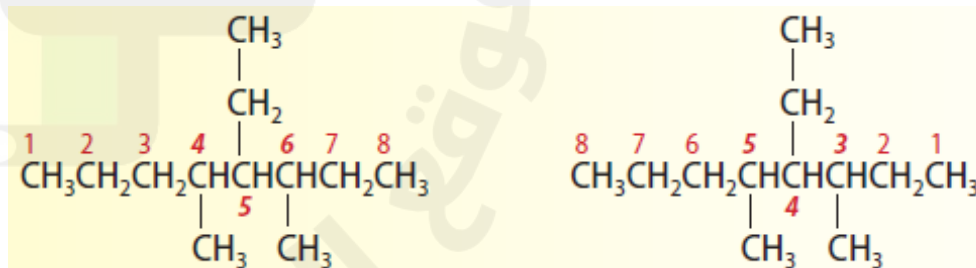
SOLVE FOR THE UNKNOWN

Step 1. Count the number of carbon atoms in the longest continuous chain. Because structural formulas can be written with chains oriented in various

ways, you need to be careful in finding the longest continuous carbon chain. In this case, it is easy. The longest chain has eight carbon atoms, so the parent name is *octane*.

Step 2. Number each carbon in the parent chain.

Number the chain in both directions, as shown below. Numbering from the left puts the alkyl groups at Positions 4, 5, and 6. Numbering from the right puts alkyl groups at Positions 3, 4, and 5. Because 3, 4, and 5 are the lowest position numbers, they will be used in the name.



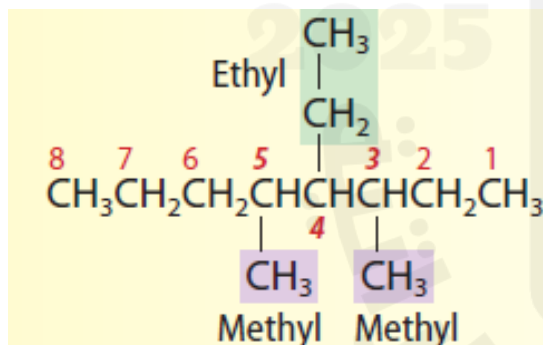
NAMING BRANCHED-CHAIN ALKANES

IN-CLASS EXAMPLE

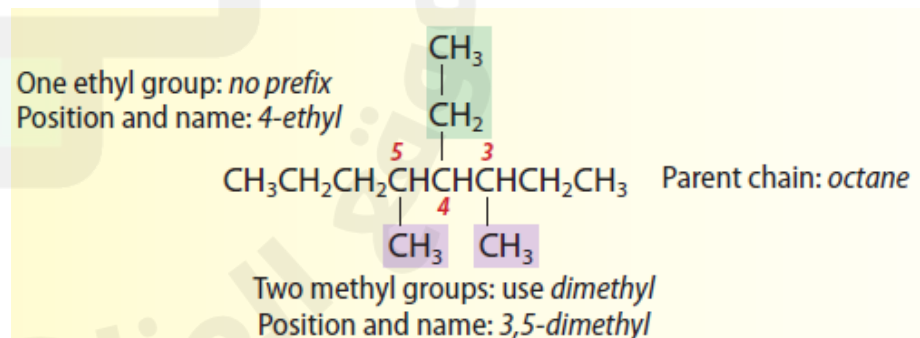
SOLVE FOR THE UNKNOWN (continued)

Step 3. Name each alkyl group substituent.

Identify and name the alkyl groups branching from the parent chain. There are one-carbon methyl groups at Positions 3 and 5, and a two-carbon ethyl group at Position 4.



Step 4. If the same alkyl group occurs more than once as a branch on the parent structure, use a prefix (di-, tri-, tetra-, and so on) before its name to indicate how many times it appears. Look for and count the alkyl groups that occur more than once. Determine the prefix to use to show the number of times each group appears. In this example, the prefix *di-* will be added to the name *methyl* because two methyl groups are present. No prefix is needed for the one ethyl group. Then show the position of each group with the appropriate number.



NAMING BRANCHED-CHAIN ALKANES

IN-CLASS EXAMPLE

SOLVE FOR THE UNKNOWN (continued)

Step 5. *Whenever different alkyl groups are attached to the same parent structure, place their names in alphabetical order. Place the names of the alkyl branches in alphabetical order, ignoring the prefixes. Alphabetical order puts the name ethyl before dimethyl.*

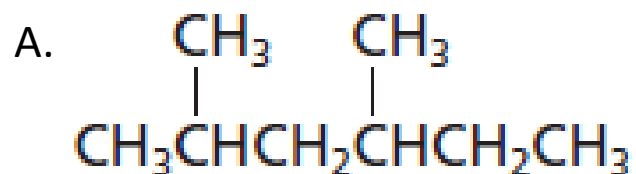
Step 6. *Write the entire name, using hyphens to separate numbers from words and commas to separate numbers. Write the name of the structure, using hyphens and commas as needed. The name should be written as 4-ethyl-3,5-dimethyloctane.*

EVALUATE THE ANSWER

The longest continuous carbon chain has been found and numbered correctly. All branches have been designated with correct prefixes and alkyl group names. Alphabetical order and punctuation are correct.

Your Turn!

- Use the IUPAC rules to name the following structures.



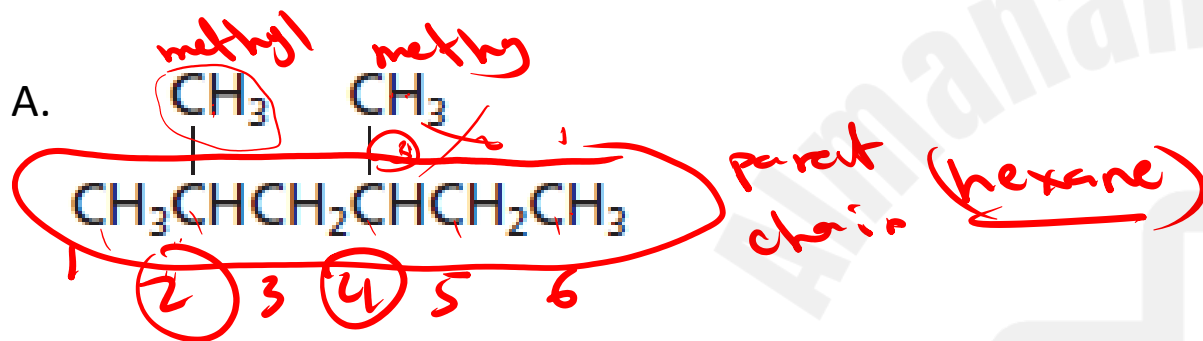
2,4-dimethylhexane

(=) (≡)

Your Turn!

alkane

- Use the IUPAC rules to name the following structures.

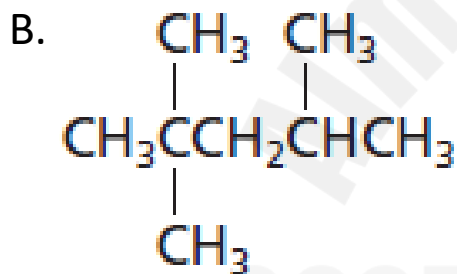


2,4-dimethylhexane

2,4-dimethylhexane

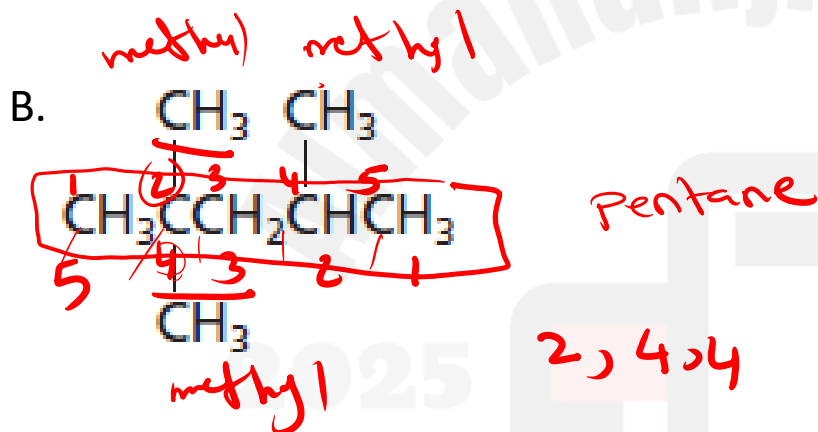
Your Turn!

- Use the IUPAC rules to name the following structures.



Your Turn!

- Use the IUPAC rules to name the following structures.



2, 2, 4

Your Turn!

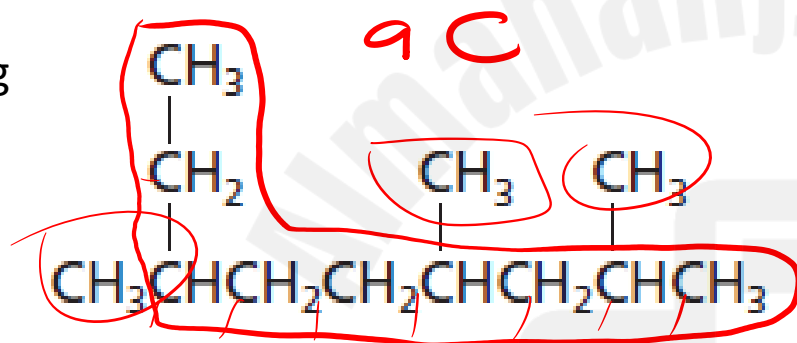
- Use the IUPAC rules to name the following structures.



Your Turn!

- Use the IUPAC rules to name the following structures.

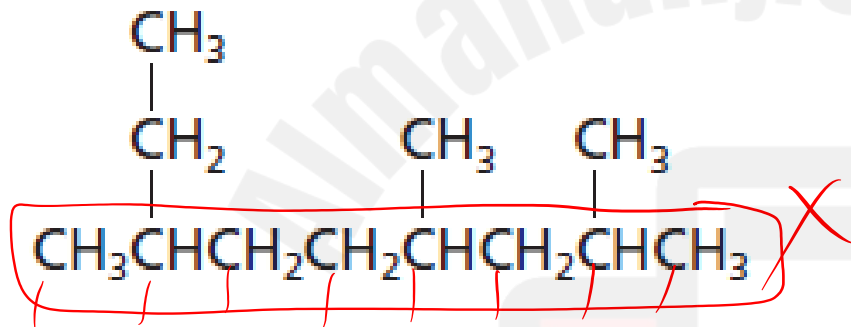
C. Challenging



Your Turn!

- Use the IUPAC rules to name the following structures.

C. Challenging

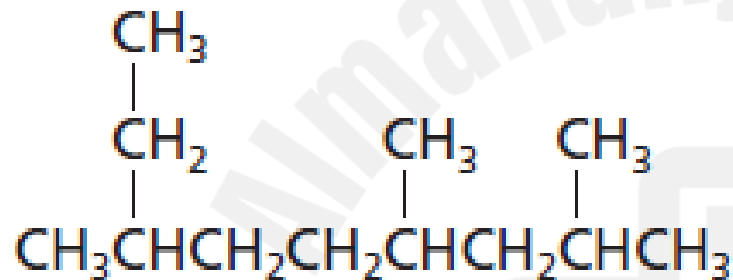


2,4,7-trimethylnonane

Your Turn! *Page 224*

- Use the IUPAC rules to name the following structures.

C. Challenging



2,4,7-trimethylnonane

Plenary *Page* 224

Draw the structures of the following branched-chain alkanes.

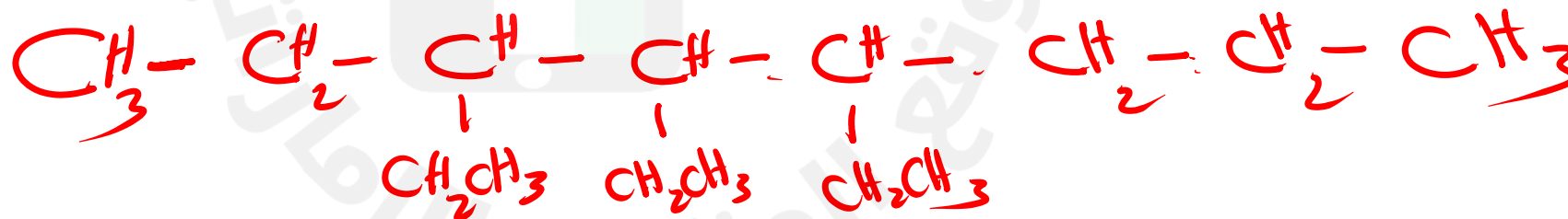
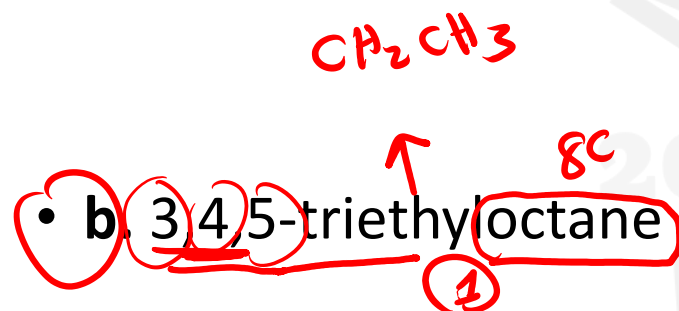
- a. 2,3-dimethyl-5-propyldecane
- b. 3,4,5-triethyloctane

Plenary Page 224



Draw the structures of the following branched-chain alkanes.

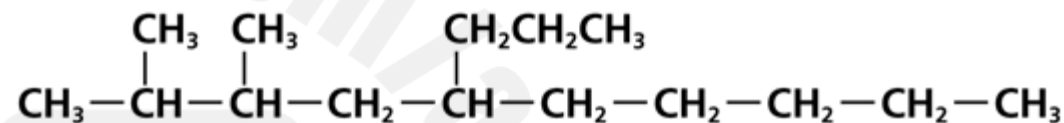
- a. 2,3-dimethyl-5-propyldecane



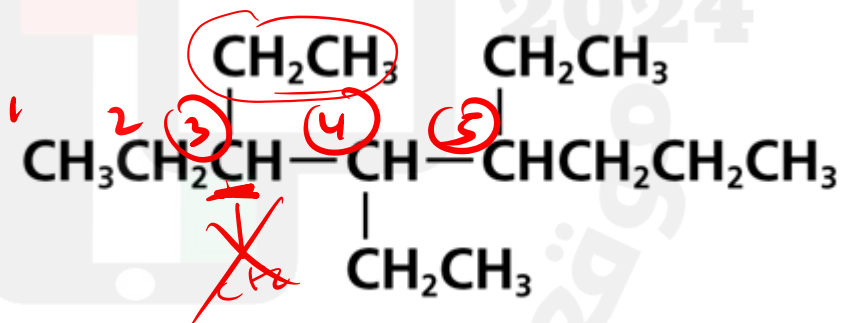
Plenary Page 224

Draw the structures of the following branched-chain alkanes.

- a. 2,3-dimethyl-5-propyldecane



- b. 3,4,5-triethyloctane



Plenary

How many carbon atoms are in a molecule of pentane?

 3

 4

 c

5

CORRECT



6

Starter

In a hydrocarbon, what is the name of the longest continuous chain of carbon atoms?

 substituent chain

 **B** parent chain **CORRECT**

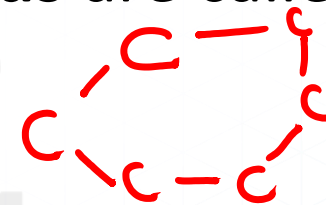
 main chain

 alkyl group

straight chain
branched chain

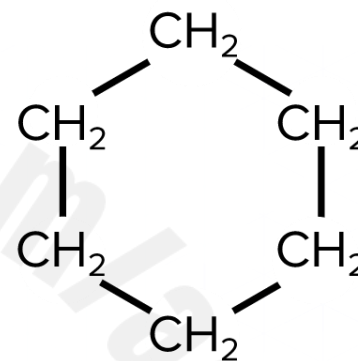
Cycloalkanes (rings)

- An organic compound that contains a hydrocarbon ring is called a **cyclic hydrocarbon**. (Cyclic = ring-like structure)
- Cyclic hydrocarbons that contain **only single bonds** are called **cycloalkanes**. Example: cyclohexane $6C$
- The relationship between numbers of carbon and hydrogen atoms in cycloalkanes can be expressed as: C_nH_{2n}

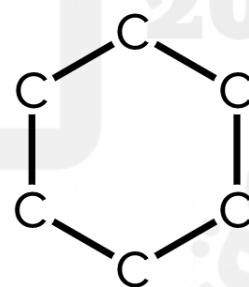


Cycloalkanes

Cyclic hydrocarbons such as cyclohexane are represented by **condensed**, **skeletal**, and **line structures**.



Condensed structural
formula



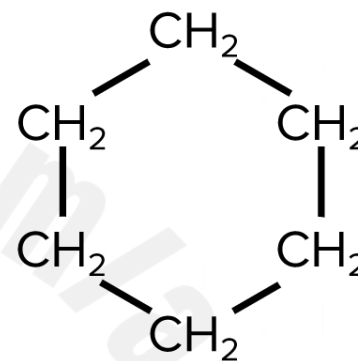
Skeletal
structure



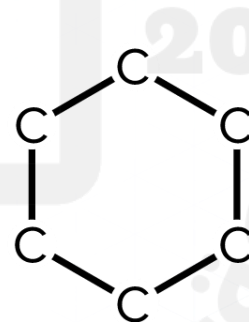
Line
structure

Cycloalkanes

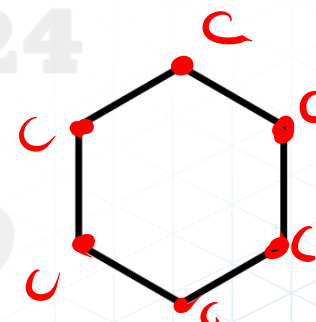
Cyclic hydrocarbons such as cyclohexane are represented by **condensed**, **skeletal**, and **line structures**.



Condensed structural formula



Skeletal structure



Line structure

Quiz

What is a cycloalkane?



a cyclic hydrocarbon

B

a cyclic hydrocarbon that contains
only single bonds

CORRECT



a cyclic hydrocarbon with at least
one alkyl group

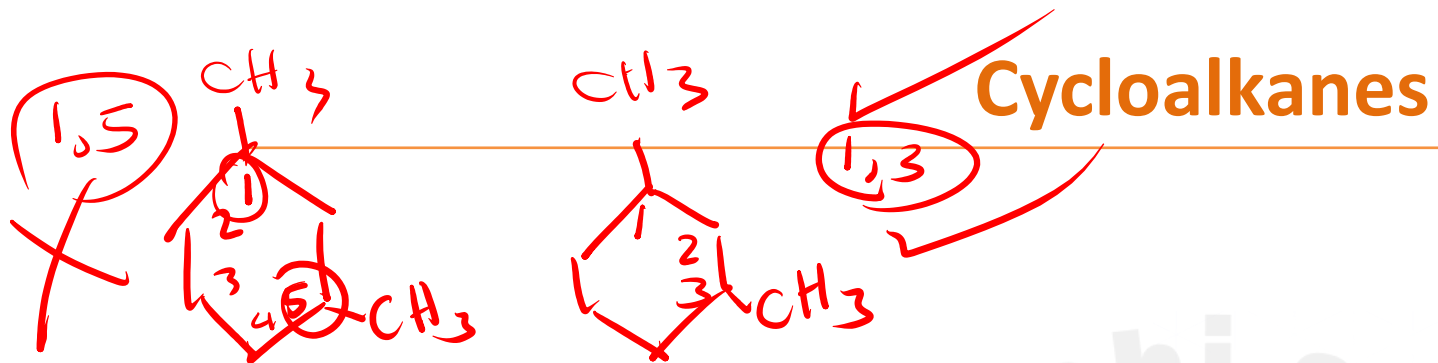


a six-carbon alkane in the shape of a ring

Naming Cycloalkanes

Substituted cycloalkanes are named by following the same IUPAC rules used for straight-chain alkanes, but with a few modifications.

- The ring is always considered the parent chain.
- Numbering is started on the carbon that is bonded to the substituent group.



- When there are two or more substituents, the carbons are numbered around the ring in a way that gives the lowest-possible set of numbers for the substituents.
- If only one group is attached to the ring, no number is necessary.



Naming substituted cycloalkanes

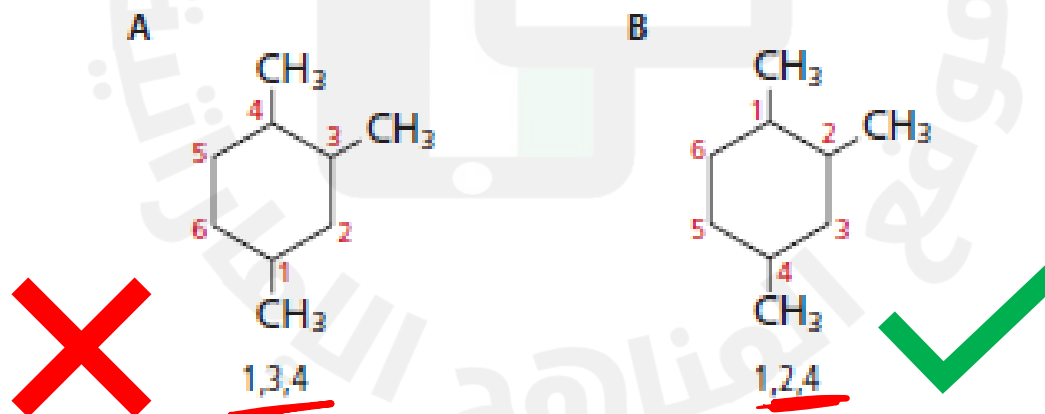
- Name the cycloalkane shown.



1,2,4-trimethyl cyclohexane

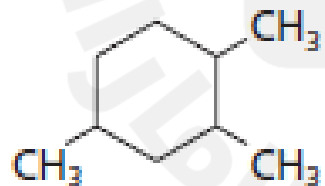
Step 1. Count the carbons in the ring, and use the name of the parent cyclic hydrocarbon. In this case, the ring has six carbons, so the parent name is *cyclohexane*.

Step 2. Number the ring, starting from one of the CH₃— branches. Find the numbering that gives the lowest possible set of numbers for the branches. Here are two ways of numbering the ring.



Naming substituted cycloalkanes

- **Step 3.** Name the substituents. All three are the same—**carbon methyl groups (CH₃)**.
- **Step 4.** Add the prefix to show the number of groups present. Three methyl groups are present, so you add the prefix *tri-* to the name *methyl* to make *trimethyl*.
- **Step 5.** Alphabetical order can be ignored because only one type of group is present.
- **Step 6.** Put the name together using the name of the parent cycloalkane. Use commas between separate numbers, and hyphens between numbers and words. Write the name as *1,2,4-trimethylcyclohexane*.



1,2,4-trimethylcyclohexane.

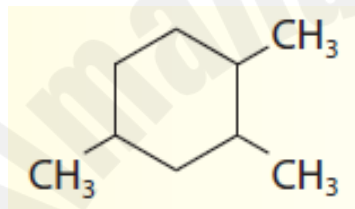
NAMING CYCLOALKANES (Page 226)

IN-CLASS EXAMPLE

Use with Example Problem 2.

Problem

Name the cycloalkane shown.



Response

ANALYZE THE PROBLEM

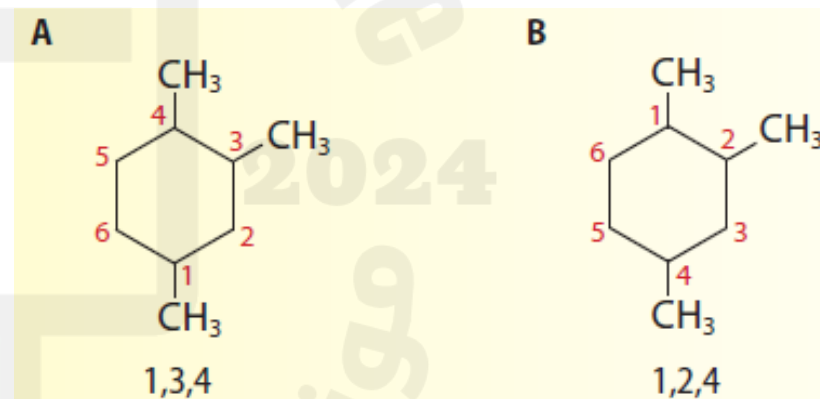
You are given a structure. To determine the parent cyclic structure and the location of branches, follow the IUPAC rules.

SOLVE FOR THE UNKNOWN

Step 1. Count the carbons in the ring, and use the name of the parent cyclic hydrocarbon. In this case, the ring has six carbons, so the parent name is *cyclohexane*.

SOLVE FOR THE UNKNOWN (continued)

Step 2. Number the ring, starting from one of the CH_3 branches. Find the numbering that gives the lowest possible set of numbers for the branches. Here are two ways of numbering the ring.



Numbering from the carbon atom at the bottom of the ring puts the CH_3 groups at Positions 1, 3, and 4 in Structure A.

NAMING CYCLOALKANES

IN-CLASS EXAMPLE

SOLVE FOR THE UNKNOWN (continued)

Numbering from the carbon at the top of the ring gives Positions 1, 2, and 4. All other numbering schemes place the CH_3 — groups at higher position numbers. Thus, 1, 2, and 4 are the lowest possible position numbers and will be used in the name.

Step 3. Name the substituents. All three are the same—carbon methyl groups.

Step 4. Add the prefix to show the number of groups present. Three methyl groups are present, so you add the prefix *tri-* to the name *methyl* to make *trimethyl*.

Step 5. Alphabetical order can be ignored because only one type of group is present.

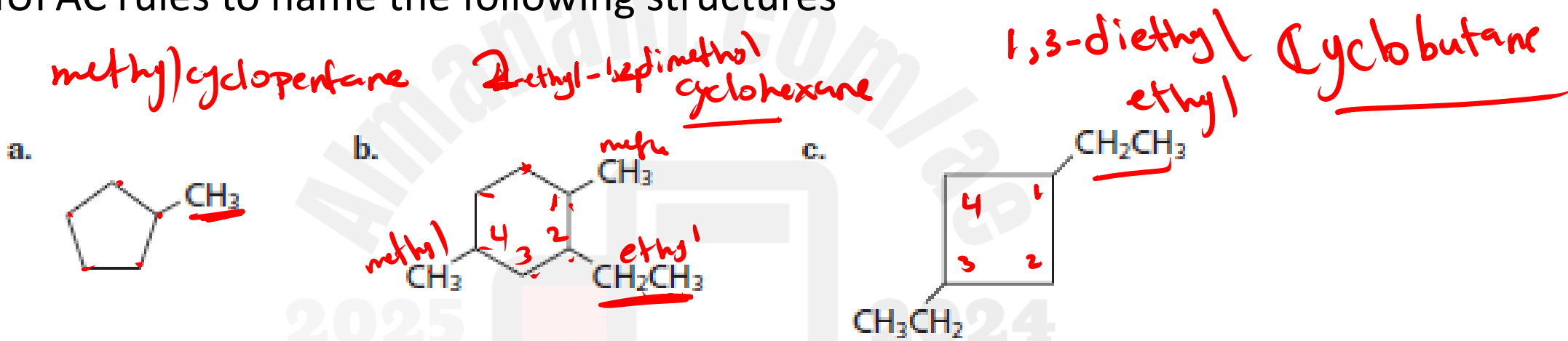
Step 6. Put the name together using the name of the parent cycloalkane. Use commas between separate numbers, and hyphens between numbers and words. Write the name as *1,2,4-trimethylcyclohexane*.

EVALUATE THE ANSWER

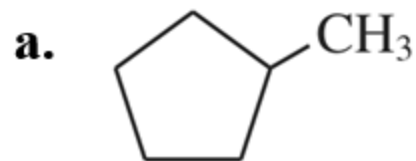
The parent-ring structure is numbered to give the branches the lowest possible set of numbers. The prefix *tri-* indicates that three methyl groups are present. No alphabetization is necessary because all branches are methyl groups.

Activity (Practice Problems page 226)

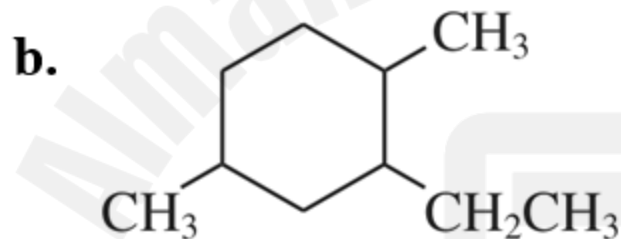
- Use IUPAC rules to name the following structures



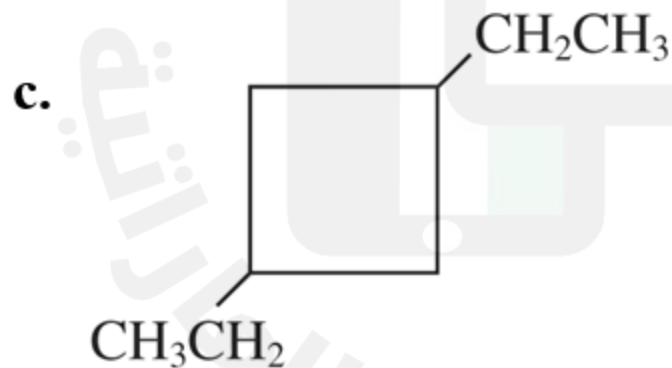
Activity (Practice Problems page 226)



methylcyclopentane



2-ethyl-1,4-dimethylcyclohexane

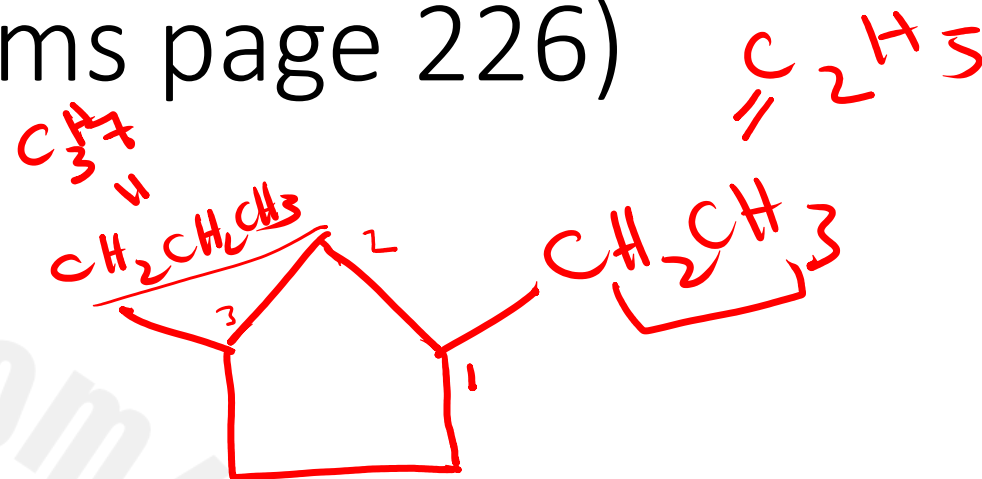


1,3-diethylcyclobutane

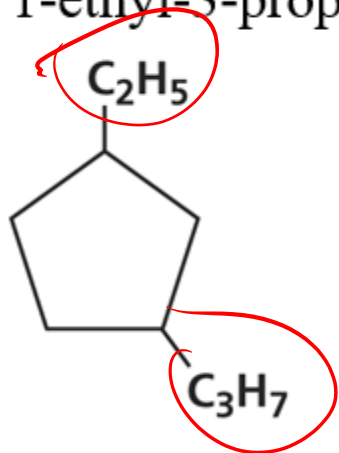
Activity (Practice Problems page 226)

Draw the structures of the following cycloalkanes.

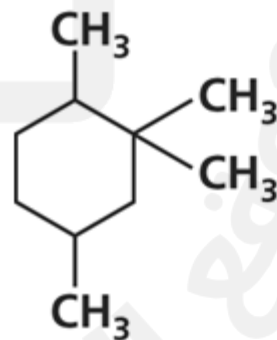
- a. 1-ethyl-3-propylcyclopentane
- b. 1,2,2,4-tetramethylcyclohexane



- a. 1-ethyl-3-propylcyclopentane



- b. 1,2,2,4-tetramethylcyclohexane



Properties of Alkanes

Physical properties of
alkanes

Chemical properties
of alkanes

Properties of Alkanes: Physical properties

Hint: polarity
and
intermolecular
forces

Try to explain the
difference in B.pt an m.pt.
between water and
Methane



Comparing Physical Properties		
Substance and formula	Water (H ₂ O)	Methane (CH ₄)
Molecular mass	18 amu	16 amu
State at room temperature	liquid	gas
Boiling point	100°C	−162°C
Melting point	0°C	−182°C

Properties of Alkanes

- The structure of a molecule affects its properties.
- Alkanes are nonpolar. They have little intermolecular attraction and do not form hydrogen bonds like water.
- As a result, **they boil and melt at lower temperatures than water.**
- Also, they are more soluble in solvents composed of nonpolar molecules than in water.

Table 4 Comparing Physical Properties		
Substance and formula	Water (H ₂ O)	Methane (CH ₄)
Molecular mass	18 amu	16 amu
State at room temperature	liquid	gas
Boiling point	100°C	−162°C
Melting point	0°C	−182°C

Properties of Alkanes: Chemical properties

- The main chemical property of alkanes is their **low reactivity**. Why?
- Molecules such as alkanes, in which atoms are connected by **nonpolar bonds**, have no charge. As a result, they have little attraction for ions or polar molecules.
- The low reactivity of alkanes can also be attributed to the **relatively strong C–C and C–H bonds**.



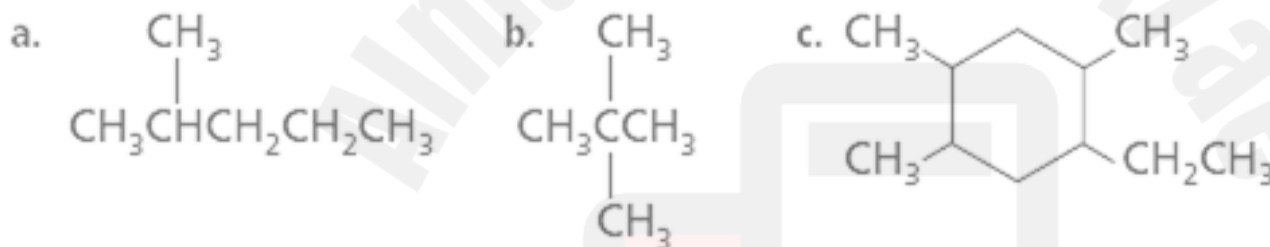
Learning Outcomes:

- ▶ **Name** alkanes by examining their structures.
- ▶ **Draw** the structure of an alkane when given its name.
- ▶ **Describe** the properties of alkanes.



Plenary

1. Name the following structures using IUPAC rules.



2. Draw the molecular structure for each of the following

a. 3, 4-diethylheptane

b. 4-isopropyl-3-methyldecane

c. 1-ethyl-4-methylcyclohexane

d. 1,2-dimethylcyclopropane

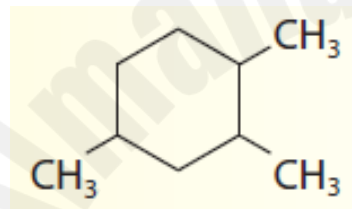
NAMING CYCLOALKANES

IN-CLASS EXAMPLE

Use with Example Problem 2.

Problem

Name the cycloalkane shown.



Response

ANALYZE THE PROBLEM

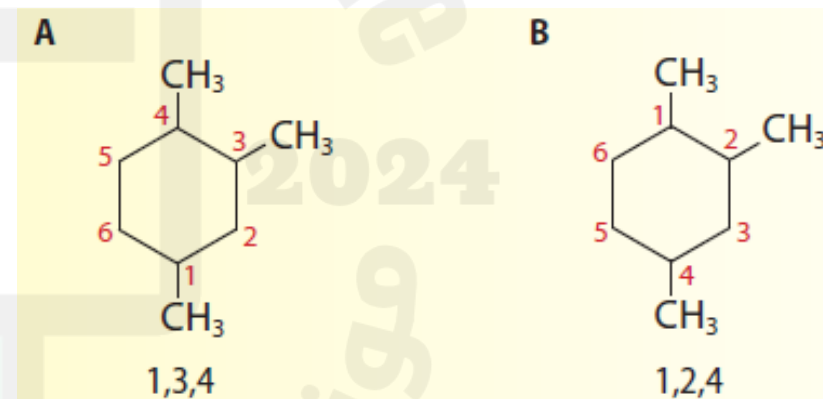
You are given a structure. To determine the parent cyclic structure and the location of branches, follow the IUPAC rules.

SOLVE FOR THE UNKNOWN

Step 1. Count the carbons in the ring, and use the name of the parent cyclic hydrocarbon. In this case, the ring has six carbons, so the parent name is *cyclohexane*.

SOLVE FOR THE UNKNOWN (continued)

Step 2. Number the ring, starting from one of the CH_3 branches. Find the numbering that gives the lowest possible set of numbers for the branches. Here are two ways of numbering the ring.



Numbering from the carbon atom at the bottom of the ring puts the CH_3 groups at Positions 1, 3, and 4 in Structure A.

NAMING CYCLOALKANES

IN-CLASS EXAMPLE

SOLVE FOR THE UNKNOWN (continued)

Numbering from the carbon at the top of the ring gives Positions 1, 2, and 4. All other numbering schemes place the CH_3 — groups at higher position numbers. Thus, 1, 2, and 4 are the lowest possible position numbers and will be used in the name.

Step 3. Name the substituents. All three are the same—carbon methyl groups.

Step 4. Add the prefix to show the number of groups present. Three methyl groups are present, so you add the prefix *tri-* to the name *methyl* to make *trimethyl*.

Step 5. Alphabetical order can be ignored because only one type of group is present.

Step 6. Put the name together using the name of the parent cycloalkane. Use commas between separate numbers, and hyphens between numbers and words. Write the name as *1,2,4-trimethylcyclohexane*.

EVALUATE THE ANSWER

The parent-ring structure is numbered to give the branches the lowest possible set of numbers. The prefix *tri-* indicates that three methyl groups are present. No alphabetization is necessary because all branches are methyl groups.

Quiz

2. Identify the relationship between the number of carbon and hydrogen atoms in alkanes.

 C_nH_{2n+2} **CORRECT**

 C_nH_n

 C_nH_{2n-2}

 There is no relationship between the number of carbon and hydrogen atoms in alkanes.

Quiz

3. How many carbon atoms are in a molecule of pentane?

 3

 5

CORRECT

 4

 6

2025

2024

Quiz

4. In a hydrocarbon, what is the name of the longest continuous chain of carbon atoms?

 substituent chain


B parent chain **CORRECT**


 main chain

 alkyl group

Quiz

5. What is a cycloalkane?

 a cyclic hydrocarbon

 a cyclic hydrocarbon that contains only single bonds

CORRECT

 a cyclic hydrocarbon with at least one alkyl group

 a six-carbon alkane in the shape of a ring