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VCE Chemistry ½

Introduction to Organic Chemistry [2.5]

Homework Solutions

Admin Info & Homework Outline:

Student Name	
Questions You Need Help For	
Compulsory Questions	Pg 2-Pg 14
Supplementary Questions	Pg 15-Pg 30

Section A: Compulsory Questions (55 Marks)

Sub-Section [2.5.1]: Draw Structural, Semistructural & Skeletal Formulae of Straight-Chained & Branched Alkanes

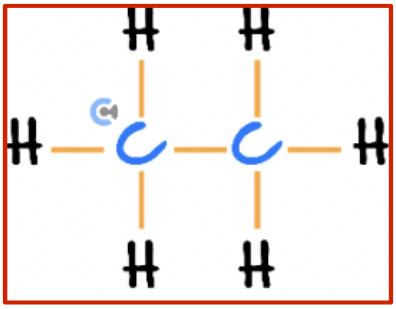
Question 1 (2 marks)

For a molecule of ethane, represent it in the following ways:

a. Molecular formula. (1 mark)

C_2H_6

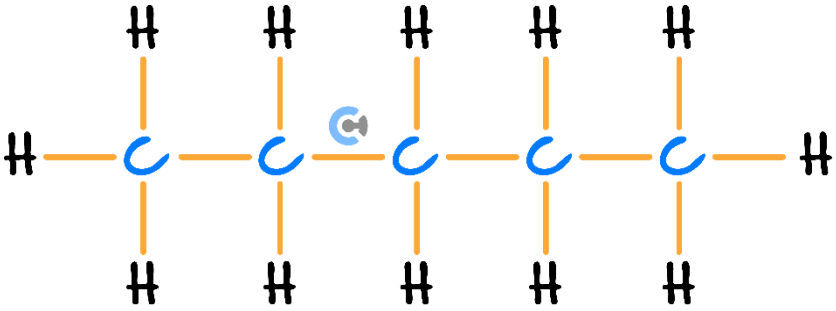
b. Structural formula. (1 mark)



Question 2 (3 marks)

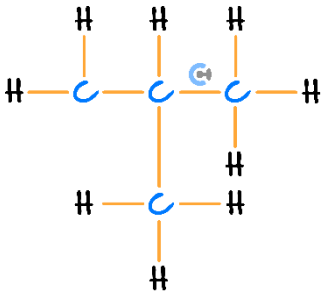
For the following structural formulae, write their semi-structural formulae:

a. (1 mark)



$CH_3CH_2CH_2CH_2CH_3$

b. (2 marks)

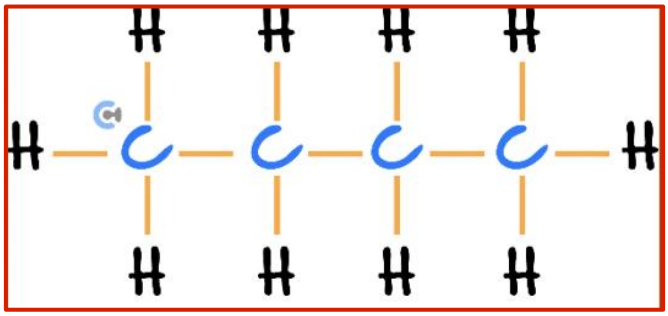


$CH_3CH(CH_3)CH_3$

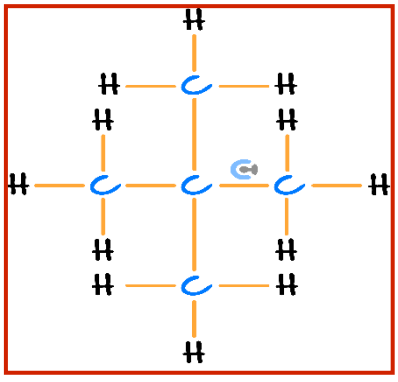
Question 3 (3 marks)

For the following semi-structural formulae, draw their structural formulae:

a. $CH_3CH_2CH_2CH_3$. (1 mark)



b. $CH_3C(CH_3)_2CH_3$. (2 marks)



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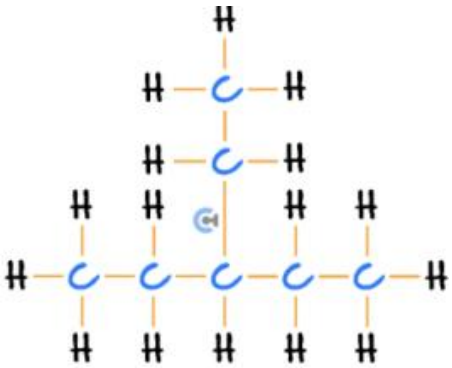
Sub-Section [2.5.2]: Write IUPAC Names of Branched/Unbranched Alkanes

Question 4 (2 marks)

Give the IUPAC name of the following compound:



3-ethylpentane

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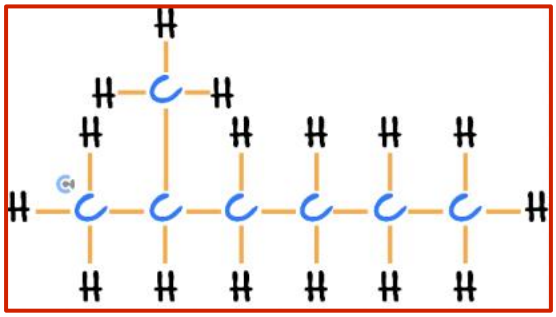
Question 5 (4 marks)

Given the names of the following molecules, draw their structural formulas and provide the semi-structural formulas.

a. 2-methylpentane:

i. Structural formula. (1 mark)

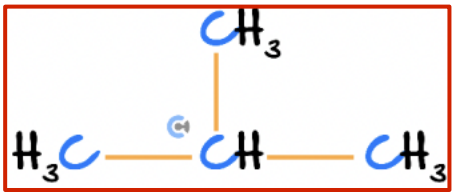


ii. Semi-structural formula. (1 mark)

$CH_3CH(CH_3)CH_2CH_2CH_3$

b. Methylpropane:

i. Structural formula. (1 mark)



ii. Semi-structural formula. (1 mark)

$CH_3CH(CH_3)CH_3$

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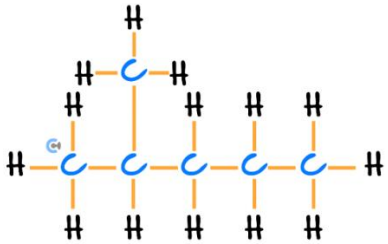
Question 6 (6 marks)

Name each of the following molecules & draw their semi-structural and skeletal formulae.

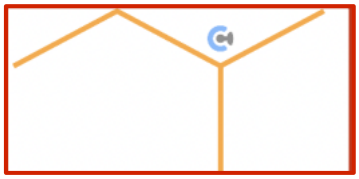
a. Compound *A*:



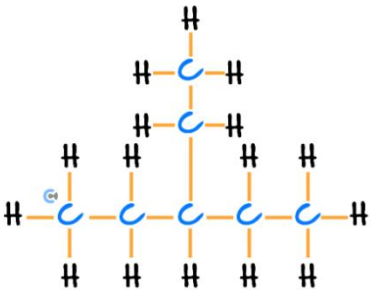
i. Name and semi-structural formulae. (2 marks)

Methylbutane - $CH_3CH(CH_3)CH_2CH_3$

ii. Skeletal diagram. (1 mark)



b. Compound *B*:



i. Name and semi-structural formulae. (2 marks)

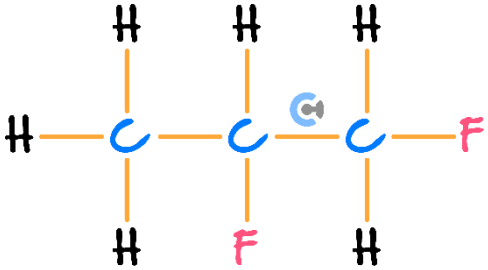
3-ethylpentane - $CH_3CH_2CH(CH_2CH_3)CH_2CH_3$

ii. Structural formula. (1 mark)

Sub-Section [2.5.3]: Draw Structural, Semistructural & Skeletal Formulae of Straight-Chained & Branched Haloalkanes

Question 7 (2 marks)

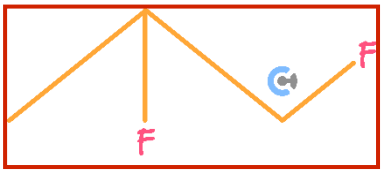
Convert this structural formula of a haloalkane into its semi-structural and skeletal representations.



a. Semi-structural. (1 mark)

$CH_3CHFCHF$

b. Skeletal diagram. (1 mark)



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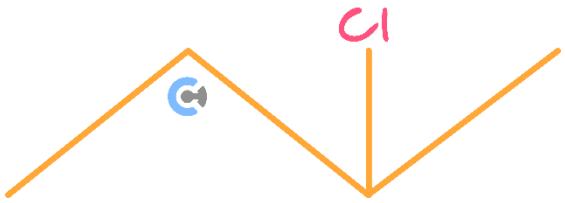
Question 8 (3 marks)

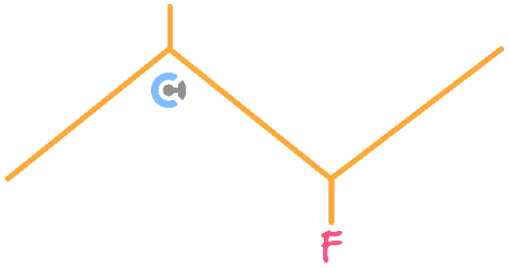
Given the following skeletal formulae, write their semi-structural formulae.

a. Compound *A*. (1 mark)



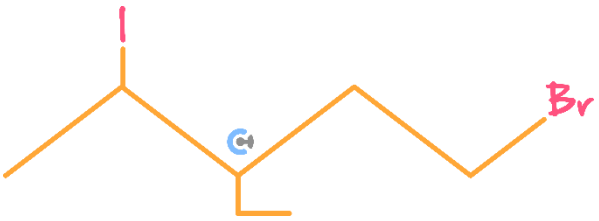
$CH_3CH_2CHClCH_3$

b. Compound *B*. (1 mark)



$CH_3CH(CH_3)CHFCH_3$

c. Compound *C*. (1 mark)



$CH_3CHICH(CH_2CH_3)CH_2CH_2Br$

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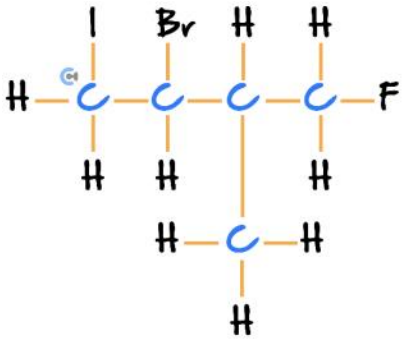
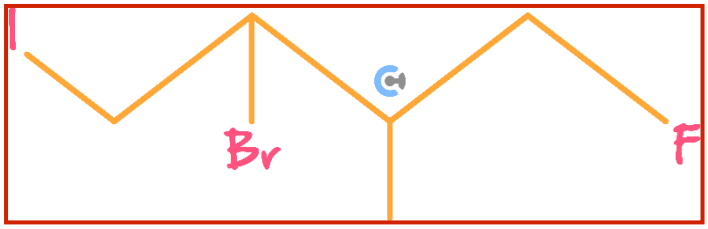
Question 9 (4 marks)

Consider the following compound:



a. Represent the compound as a skeletal diagram. (1 mark)



b. What are some advantages associated with a skeletal diagram as opposed to using the normal structural formulae? Explain. (3 marks)

By using a skeletal diagram, we can condense the essential information that we need, such as the sidechains and halogens, without worrying about the less important stuff like carbon and hydrogen.

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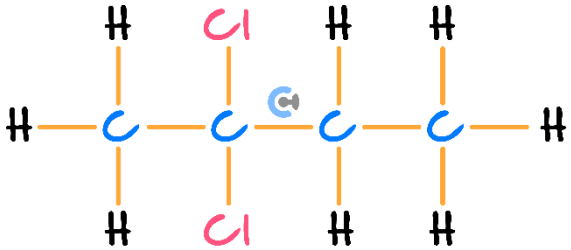
Sub-Section [2.5.4]: Write IUPAC Names of Branched/Unbranched Haloalkanes

Question 10 (2 marks)

Give the IUPAC name of the following compound:

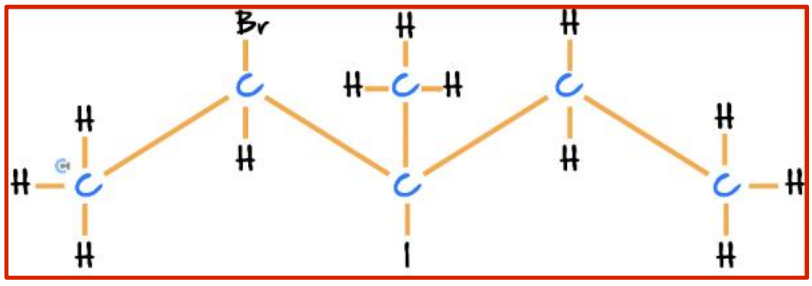


2, 2-dichlorobutane

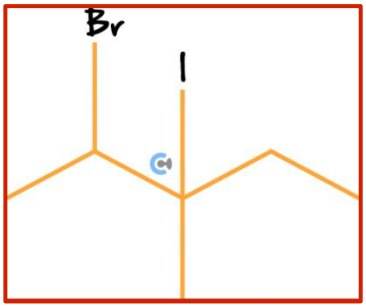
Question 11 (3 marks)

Consider the following haloalkane, 2-bromo-3-iodo-3-methylpentane.

a. Draw its structural formula. (2 marks)



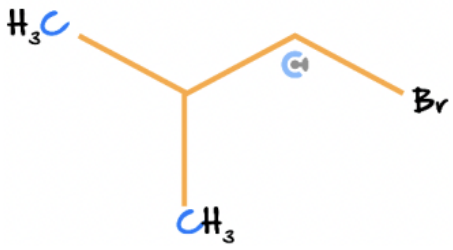
b. Draw its skeletal diagram. (1 mark)



Question 12 (4 marks)

Name each of the following molecules and give their semi-structural formula.

a. Compound *A*:



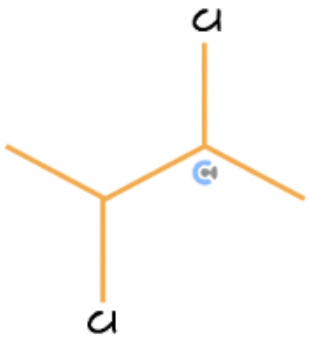
i. IUPAC name. (1 mark)

1-bromo-2-methylpropane

ii. Semi-structural formula. (1 mark)

$CH_3BrCH(CH_3)_2$

b. Compound *B*:



i. IUPAC name. (1 mark)

2, 3-dichlorobutane

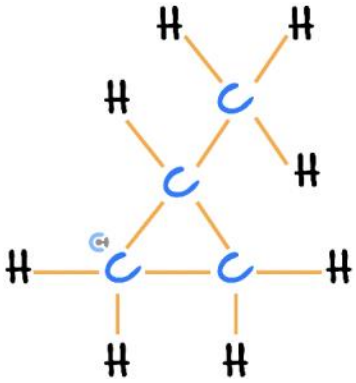
ii. Semi-structural formula. (1 mark)

$CH_3CHClCHClCH_3$

Sub-Section [2.5.5]: Identify, Draw & Write IUPAC Names of Simple Cycloalkanes

Question 13 (2 marks)

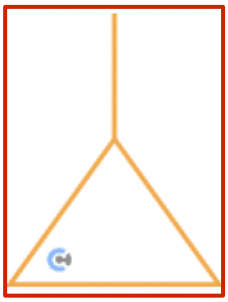
Consider the molecule below:



a. Give its IUPAC name. (1 mark)

Methylcyclopropane

b. Draw the skeletal diagram. (1 mark)



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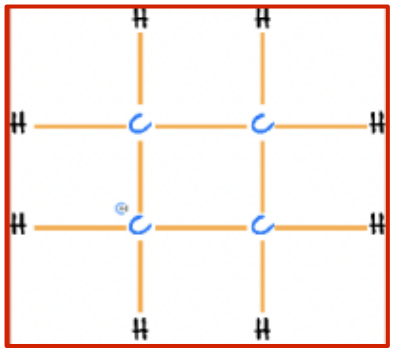
Question 14 (4 marks)

Answer the following questions regarding ringed molecules:

a. Name and draw the structural formula for a cyclic molecule with 4 carbons. (2 marks)



Cyclobutane

b. Given the formula C_4H_8, how many cyclic molecules can be formed? Justify your answer by naming the possible molecules. (2 marks)

2 → cyclobutane and methyl-cyclopropane

Question 15 (3 marks)

How many cyclic molecules can you create with the molecular formula C_5H_{10}?

Cyclopentane, methylcyclobutane, ethylcyclopropane, dimethylcyclopropane

Sub-Section: The 'Final Boss'

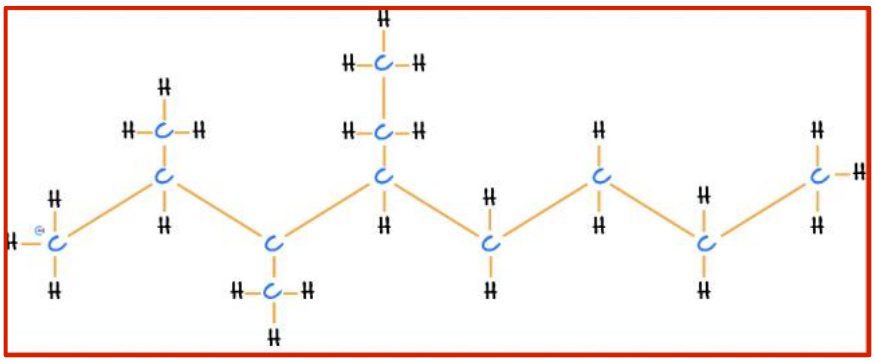
Question 16 (8 marks)

A student is interested in unconventional organic molecules.

a. Explain what is meant by 'organic' molecules. (2 marks)

Molecules that are mainly comprised of carbon and hydrogen.

b. Draw the structural formula of 2, 3-dimethyl-4-ethyloctane. (2 marks)



c. Now, give its semi-structural formula. (1 mark)

$CH_3CH(CH_3)CH(CH_3)CH(CH_2CH_3)CH_2CH_2CH_2CH_3$

d. If we replaced a hydrogen with a chlorine atom at the first methyl branch that appears, how would this change the naming of the molecule? Explain. (3 marks)

This would force the methyl branch to become part of the main carbon chain that comprises the molecule and hence become the first carbon, but since the main chain is still 8 carbons long, the name wouldn't change much.
The name would be: 1-chloro-2,3-dimethyl-4-ethyloctane.

Section B: Supplementary Questions (79 Marks)

Sub-Section [2.5.1]: Draw Structural, Semistructural & Skeletal Formulae of Straight-Chained & Branched Alkanes

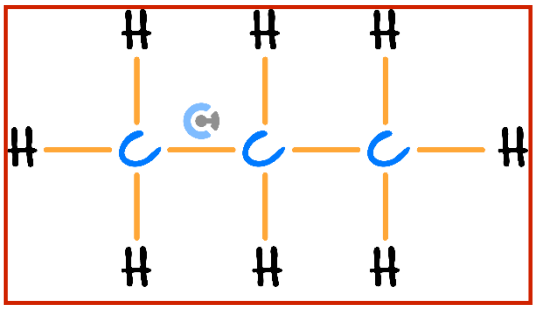
Question 17 (2 marks)

For a molecule of propane, represent it in the following ways:

a. Molecular formula. (1 mark)

C_3H_8

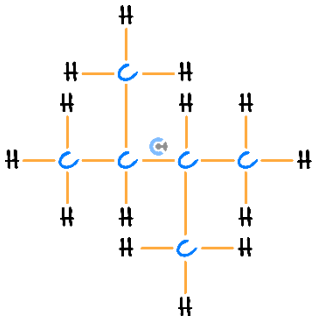
b. Structural formula. (1 mark)



Question 18 (3 marks)

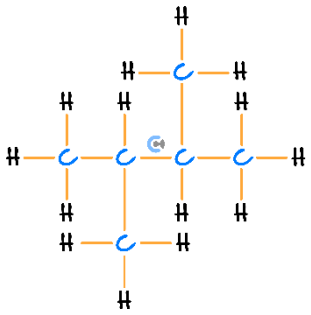
For the following structural formulae, write their semi-structural formulae.

a. (2 marks)



$CH_3CH(CH_3)C(CH_3)CH_3$

b. (1 mark)

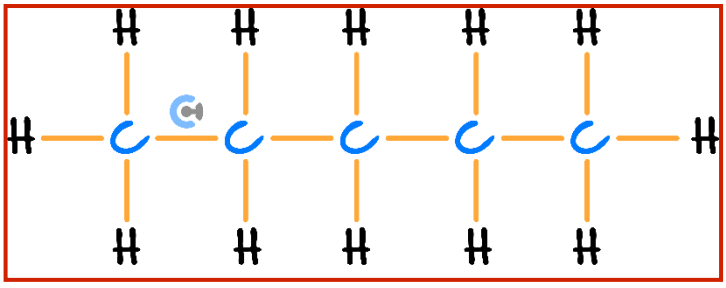


$CH_3CH(CH_3)CH_2CH_3$

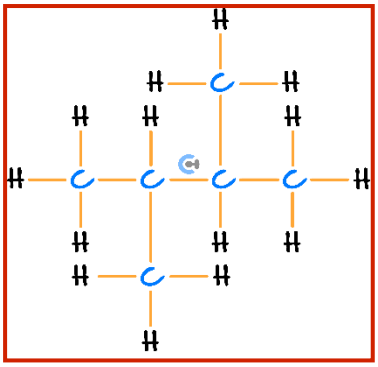
Question 19 (3 marks)

For the following semi-structural formulae, draw their structural formulae.

a. $CH_3(CH_2)_3CH_3$. (1 mark)



b. $CH_3CH(CH_3)CH(CH_3)CH_3$. (2 marks)



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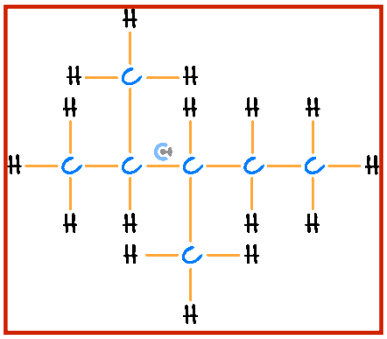
Question 20 (7 marks)

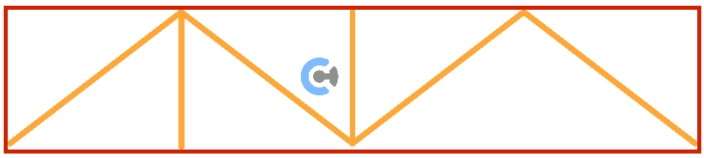
Consider the following semi-structural formulae:

$$CH_3CH(CH_2CH_3)CH(CH_3)CH_3$$

a. Draw its structural formula. (2 marks)



b. Now represent it as a skeletal diagram. (2 marks)



c. Define what an alkane is, and why we observe 4 bonds to each carbon. (3 marks)

An alkane comprises single carbon-hydrogen bonds, and we observe that carbon has 4 bonds because it has 4 valence electrons and hence requires 4 more to fulfill the Octet Rule, meaning it can make 4 bonds in an alkane, as all bonds are single bonds.

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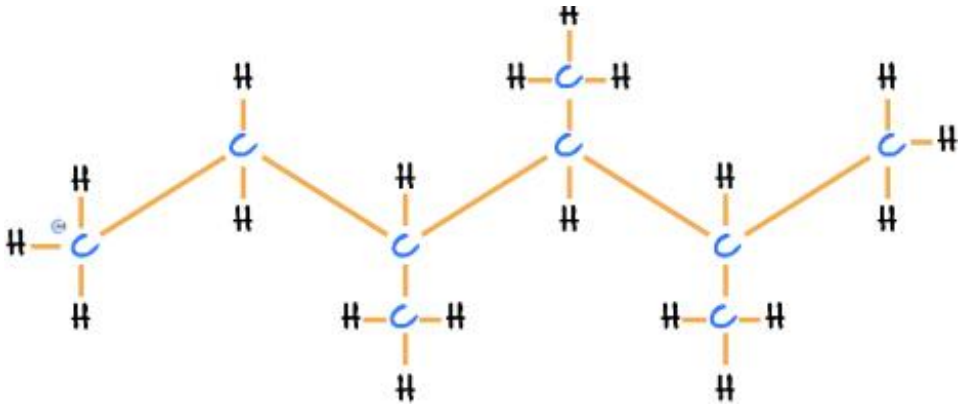
Sub-Section [2.5.2]: Write IUPAC Names of Branched/Unbranched Alkanes

Question 21 (2 marks)

Give the IUPAC name of the following compound:



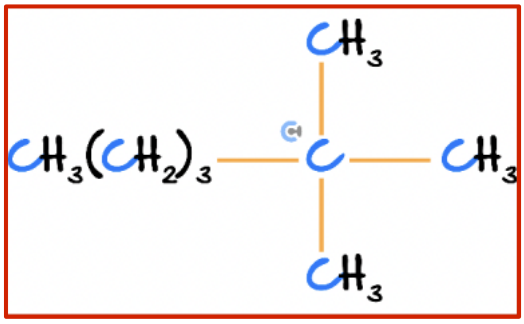
2,3,4-trimethylhexane

Question 22 (5 marks)

For the following molecules, draw their structural formula and give the semi-structural formula.

a. 2, 2-dimethylhexane:

i. Structural formula. (1 mark)

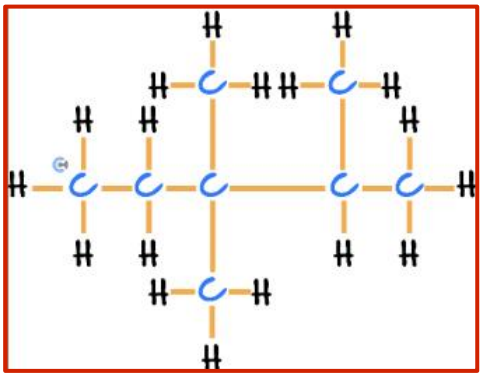


ii. Semi-structural formula. (1 mark)

$CH_3CH_2CH_2CH_2C(CH_3)_2CH_3$

b. 2, 3, 3-trimethylpentane:

i. Structural formula. (2 marks)



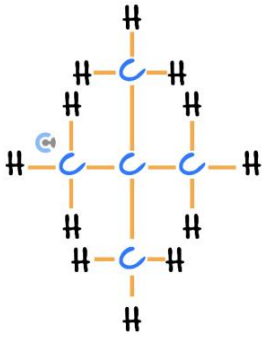
ii. Semi-structural formula. (1 mark)

$CH_3CH_2C(CH_3)_2CH(CH_3)CH_3$

Question 23 (6 marks)

Name each of the following molecules & draw their semi-structural and skeletal formulae.

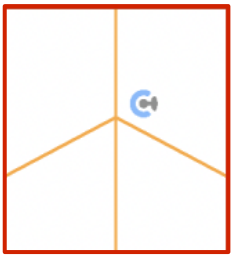
a. Compound *A*:



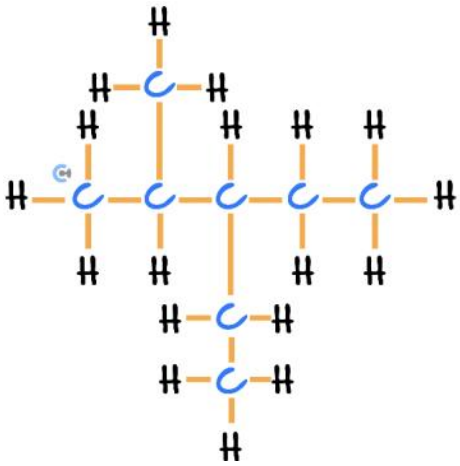
i. Name and molecular formula. (2 marks)

Dimethylpropane: C_5H_{12}

ii. Skeletal diagram. (1 mark)



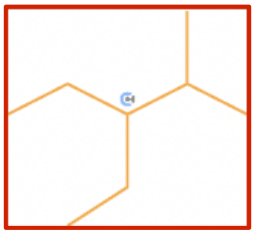
b. Compound *B*:



i. Name and semi-structural formulae. (2 marks)

3-ethyl-2-methylpentane, $CH_3CH(CH_3)CH(CH_2CH_3)CH_2CH_3$

ii. Structural formula. (1 mark)



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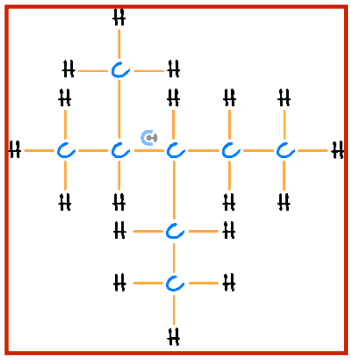
Question 24 (7 marks)

Consider the compound of 3-ethyl-2-methylpentane.

a. Draw its structural formula. (2 marks)



b. Give its semi-structural formula. (1 mark)

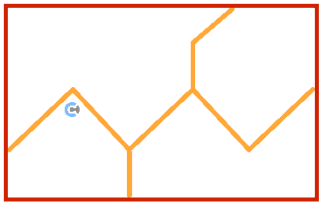
$CH_3CH(CH_3)CH(CH_2CH_3)CH_2CH_3$

c. Now, consider if we changed the methyl group to another ethyl group.

i. How would the naming of the compound change? Justify and hence give the new name. (3 marks)

As the new longest sidechain would be six carbons long, we would need to rename it from that main chain. New name: 4-ethyl-3-methylhexane.

ii. Find the mass of the excess reagent that is left over. (1 mark)



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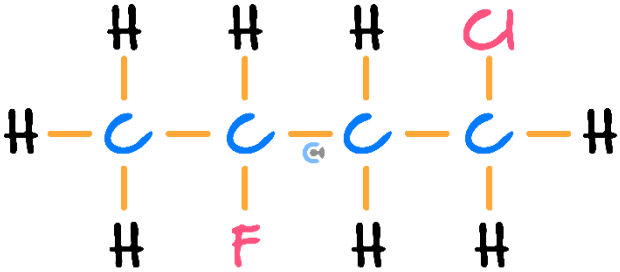
Sub-Section [2.5.3]: Draw Structural, Semistructural & Skeletal Formulae of Straight-Chained & Branched Haloalkanes

Question 25 (2 marks)

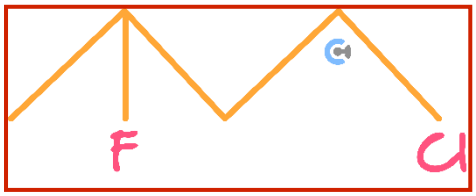
Convert this structural formula of a haloalkane into its semi-structural and skeletal representations:



a. Semi-structural. (1 mark)

$CH_3CHFCH_2CH_2Cl$

b. Skeletal diagram. (1 mark)



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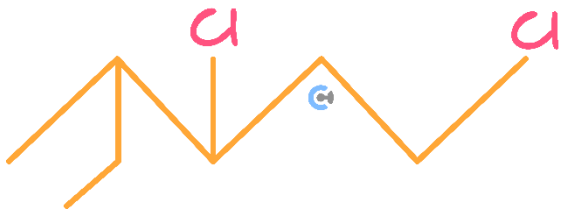
Question 26 (3 marks)

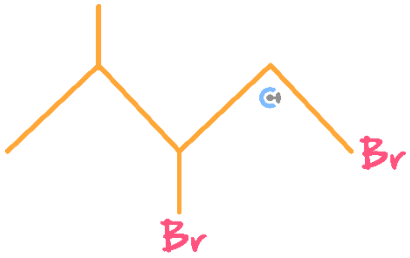
Given the following skeletal formulae, write their semi-structural formulae.

a. Compound *A*. (1 mark)



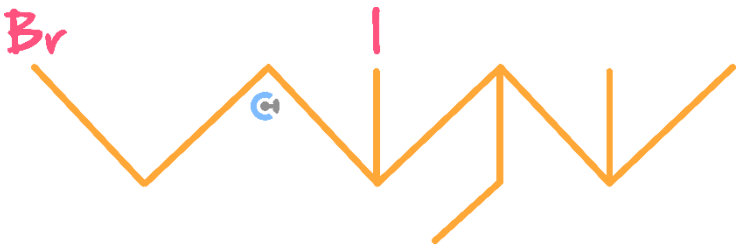
$CH_3CH(CH_2CH_3)CHClCH_3CH_2Cl$

b. Compound *B*. (1 mark)



$CH_3CH(CH_3)CHBrCH_3CH_2Br$

c. Compound *C*. (1 mark)



$CH_2BrCH_3CHICH(CH_2CH_3)CH(CH_3)CH_3$

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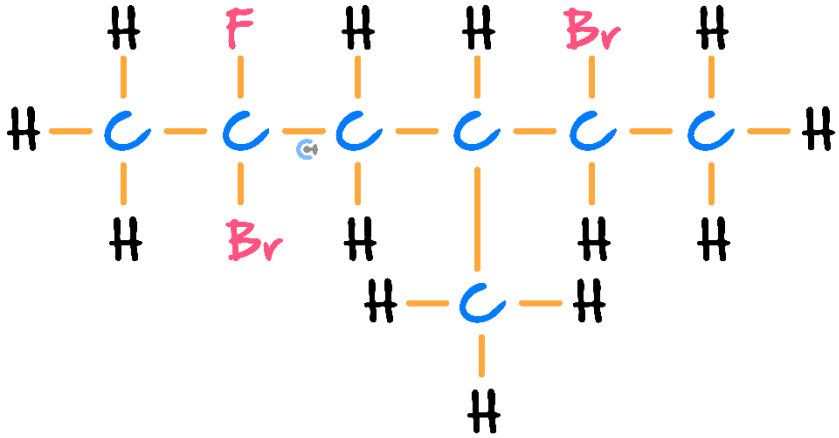
Question 27 (4 marks)

Consider the following compound:



a. Represent the compound as a skeletal diagram. (1 mark)

b. Compare a skeletal diagram to a semi-structural formula, giving a reason why you would prefer one over the other. (3 marks)

A skeletal diagram is a more compact representation, whereas a semi-structural diagram is a written form that condenses the structure, whilst still retaining everything in the actual structure itself. A skeletal diagram shows visually which is more helpful for larger molecules, but a semi-structural diagram provides a quick view of everything.

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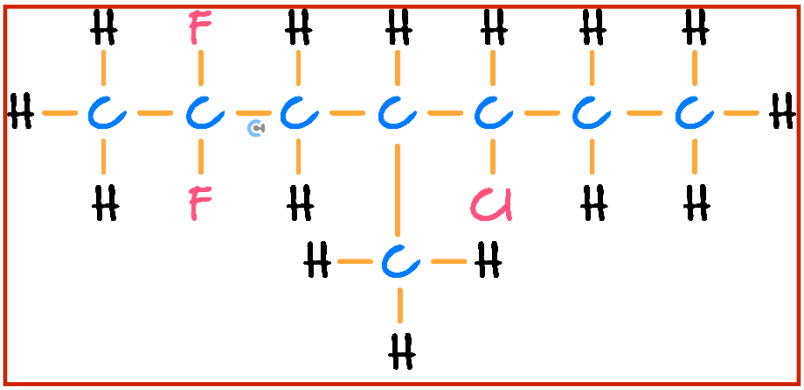
Question 28 (6 marks)

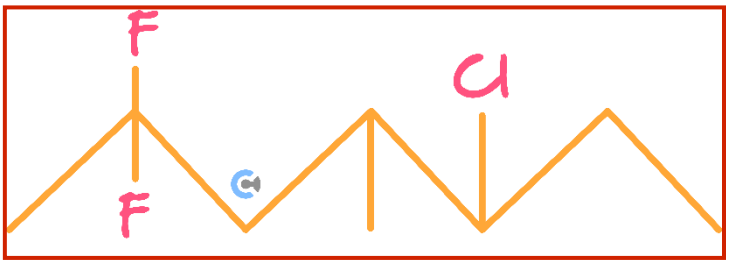
Given the semi-structural formula below:

$$CH_3CF_2CH_2CH(CH_3)CHClCH_2CH_3$$

a. Draw its structural formula. (2 marks)



b. Give its skeletal diagram. (1 mark)



c. If we compared this molecule against $CH_3CBr_2CH_2CHFCH(CH_3)CH_2CH_3$, which representation would be best suited to compare them efficiently? Justify your answer. (3 marks)

Structural- Takes too long to draw since it's a bigger molecule.
Semi-structural- Hard to see what's going on as everything is condensed.
Skeletal- Good because most of the two molecules are the same except for the side chains, and so this format emphasises the side chains clearly, so it's easy to compare.

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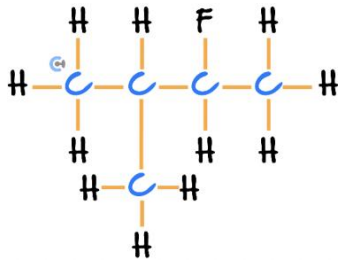
Sub-Section [2.5.4]: Write IUPAC Names of Branched/Unbranched Haloalkanes

Question 29 (2 marks)

For the following compound, identify its IUPAC name and semi-structural formula:

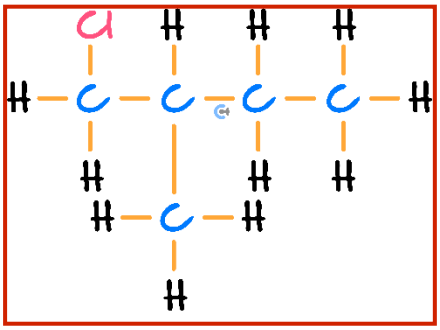


2-fluoro-3-methylbutane and $CH_3CHFCH(CH_3)_2$

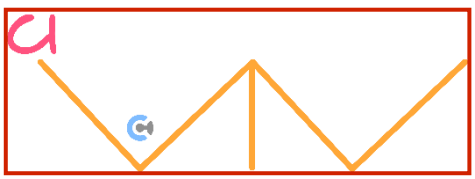
Question 30 (3 marks)

Consider the following haloalkane, 1-chloro-2-methylbutane.

a. Draw its structural formula. (2 marks)



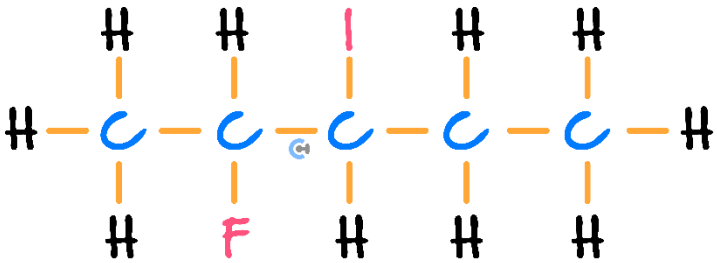
b. Draw its skeletal diagram. (1 mark)



Question 31 (4 marks)

Name each of the following molecules and give their semi-structural formula.

a. Compound *A*:



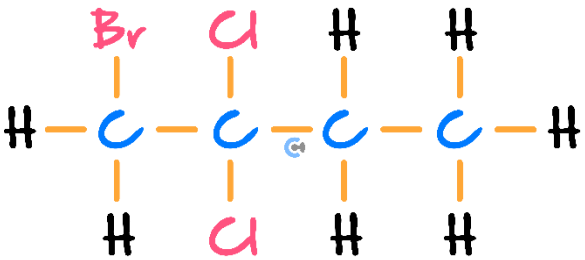
i. IUPAC name. (1 mark)

2-fluoro-3-iodopentane

ii. Semi-structural formula. (1 mark)

$CH_3CHFCHICH_2CH_3$

b. Compound *B*:



i. IUPAC name. (1 mark)

1-bromo-2,2-dichlorobutane

ii. Semi-structural formula. (1 mark)

$CH_3BrCCl_2CH_2CH_3$

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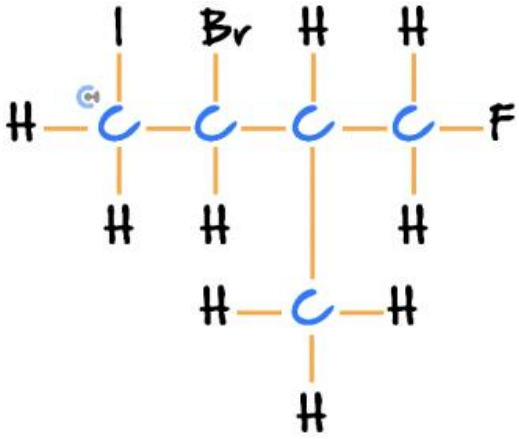
Question 32 (6 marks)

Consider the following compound below:



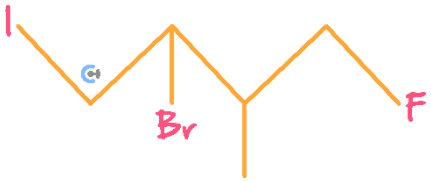
a. Give its IUPAC name. (1 mark)

2-bromo-4-fluoro-1-iodo-3-methylbutane

b. Now, give its semi-structural formula. (1 mark)

$CH_2ICHBrCH(CH_3)CH_2F$

c. Draw its skeletal diagram. (2 marks)



d. What would need to change for this compound to be a straight-chained haloalkane? Give the IUPAC name of the new compound you've chosen. (2 marks)

The methyl group needs to be a part of the main chain; if that's the case, the student will just need to insert an extra carbon on the main chain, and it would have 'pentane' in the new name.

Sub-Section [2.5.5]: Identify, Draw & Write IUPAC Names of Simple Cycloalkanes

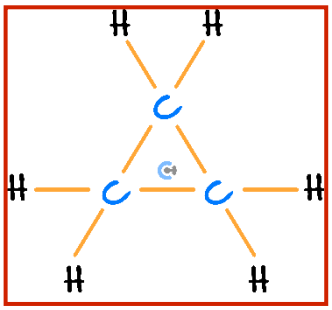
Question 33 (1 mark)

Give the IUPAC name of the following compound:

Cyclobutane

Question 34 (4 marks)

a. Name and draw the structural formula for a cyclic molecule with 3 carbon atoms. (2 marks)



Cyclopropane

b. Given the number of carbons above, can you make any other cyclic molecules? Explain. (2 marks)

No, because 3 is the minimum number of carbons required for a cyclic molecule, so no other variants can be made.

Question 35 (3 marks)

A student says that, given that they have pentane, we can get cyclopentane by just rearranging pentane into a cyclic molecule. Evaluate this student's statement.

They are incorrect, as cyclic molecules have a general formula of C_nH_{2n} whereas regular alkanes have a general formula of C_nH_{2n+2} which means there is a difference of two hydrogens due to the closed-loop nature of cyclic molecules.

Question 36 (6 marks)

How many cyclic molecules can you create with the molecular formula C_6H_{12}?

Cyclohexane, methylcyclopentane, ethylcyclobutane, dimethylcyclobutane, propylcyclopropane, trimethylcyclopropane, ethylmethylcyclopropane

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