

13.3 SHAPES OF ORGANIC MOLECULES

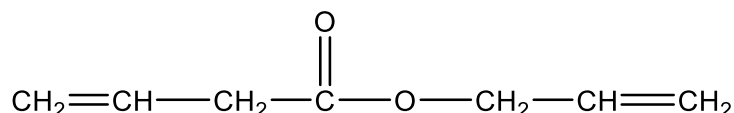
Learning outcomes

Candidates should be able to:

1. describe organic molecules as either straight-chained, branched or cyclic
2. describe and explain the shape of, and bond angles in, molecules containing sp , sp^2 and sp^3 hybridised atoms
3. describe the arrangement of σ and π bonds in molecules containing sp , sp^2 and sp^3 hybridised atoms
4. understand and use the term planar when describing the arrangement of atoms in organic molecules, e.g., ethene

Introduction

1. The diagram shows a molecule that has σ bonds and π bonds.



How many σ bonds are present in this molecule?

- A 15 B 17 C 18 D 21

2. How many σ bonds are present in one $\text{H}-\text{C}\equiv\text{C}-\text{C}(\text{CH}_3)=\text{CH}(\text{CH}_3)$ molecule?

- A 5 B 11 C 13 D 16

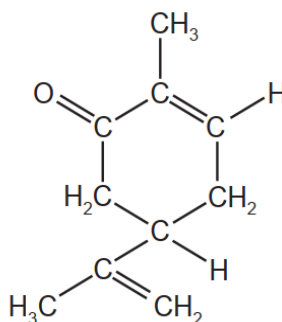
1. Complete the following to show the number of sigma bonds (σ) and pi bonds (π) present in a molecule of X.

X = $\text{CH}_3\text{CH}_2\text{CN}$

[2]

type of bond	number of bonds in X
sigma (σ)	
pi (π)	

1. Carvone is found in spearmint.



carvone

How many σ and π bonds are present in this molecule?

	σ	π
A	13	3
B	22	3
C	22	6
D	25	3

2. How many σ and π bonds are in the molecule $\text{HCCCH}_2\text{CH}_2\text{CHC}(\text{CH}_3)_2$?

A 17 σ 3 π

B 17 σ 5 π

C 18 σ 4 π

D 19 σ 3 π

3. Which row shows the correct number of covalent bonds in a molecule of methylpropene?

	total number of sigma (σ) bonds in the molecule	total number of pi (π) bonds in the molecule
A	10	1
B	10	2
C	11	1
D	11	2

4. Four compounds are shown.

C_2H_4

$\text{C}_2\text{H}_5\text{OH}$

CH_3CHO

$\text{CH}_3\text{CO}_2\text{H}$

How many of these compounds have an odd number of σ bonds?

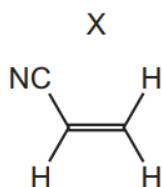
A 1

B 2

C 3

D 4

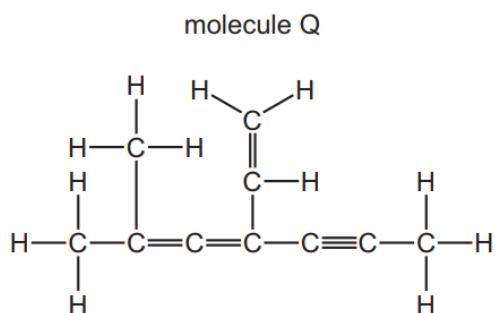
5. The diagram shows the structure of X.



Which row is correct?

	number of σ bonds in X	type of hybridisation of the carbon atoms in X
A	4	sp and sp^2
B	4	sp^2 and sp^3
C	6	sp and sp^2
D	6	sp^2 and sp^3

6. The diagram shows the structural formula of a hydrocarbon molecule Q.



How many of the carbon atoms in molecule Q are sp^2 hybridised?

A 3

B 4

C 7

D 10

2. Both σ and π bonds are present in a molecule of E as a result of different types of hybridisation in the carbon atoms.

Complete Table 4.2 to show the number of carbon atoms with each type of hybridisation in a molecule of E.

	number of carbon atoms		
	sp hybridised	sp^2 hybridised	sp^3 hybridised
E			

3. Complete the following table to show the number of sp^2 and sp^3 hybridised carbon atoms in a molecule of X. [2]

X

type of hybridisation	sp^2	sp^3
number of carbon atoms in X		

4. Complete the following table to show the number of sp^2 and sp^3 hybridised carbon atoms that are present in a molecule of V. [2]

V

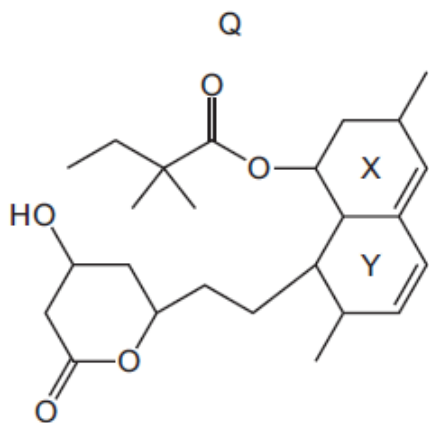
type of hybridisation	sp^2	sp^3
number of carbon atoms in V		

7. Cyclohexene, C_6H_{10} , is a hydrocarbon with a six-membered ring of carbon atoms. It has several structural isomers that are straight-chain alkenes. The number of double bonds in each of these molecules is P.

What is the shape of the cyclohexene molecule and what is the value of P?

	shape	P
A	planar	1
B	planar	2
C	non-planar	1
D	non-planar	2

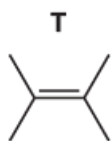
8. The diagram shows the structure of compound Q.



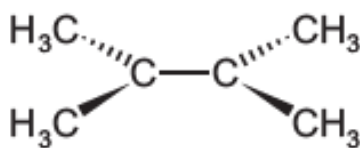
Two of the rings, X and Y, contain a C=C bond.
Which row is correct?

	number of ester groups in one molecule of Q	description of rings X and Y
A	1	both are planar
B	1	neither is planar
C	2	both are planar
D	2	neither is planar

5. Compound **T** is an isomer of C₆H₁₂.



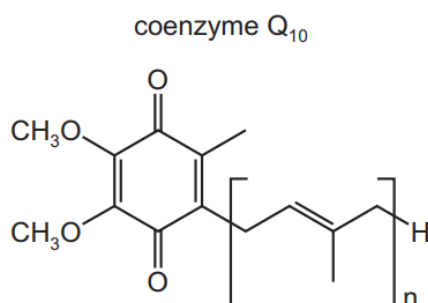
Each carbon atom in **T** forms a sigma (σ) bond to at least one other carbon atom, as shown.



(i) On the diagram, draw the orbitals that represent the pi (π) bond that is also present in **T**. [1]

(ii) State the hybridisation of the two carbon atoms between which the pi (π) bond forms. [1]

9. The diagram shows a simplified structure of coenzyme Q₁₀.



10. Which row describes the structure of coenzyme Q10 correctly?

	the coenzyme is	number of π bonds in one molecule
A	an aldehyde	$n + 2$
B	an aldehyde	$n + 4$
C	a ketone	$n + 2$
D	a ketone	$n + 4$

11. Consider the following four compounds.

1 $(\text{CH}_3)_3\text{CH}$

2 $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

3 $\text{CH}_3\text{CH}_2\text{CH}_2\text{SH}$

4 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

What is the order of increasing boiling point of the compounds (lowest first)?

A $1 \rightarrow 4 \rightarrow 2 \rightarrow 3$

B $1 \rightarrow 4 \rightarrow 3 \rightarrow 2$

C $4 \rightarrow 1 \rightarrow 2 \rightarrow 3$

D $4 \rightarrow 1 \rightarrow 3 \rightarrow 2$

***This is not a complete note. It is to guide you. It is recommended to study the prescribed textbooks along with this material. ***