Tetrahedral Molecular Geometry Chemistry Questions with Solutions

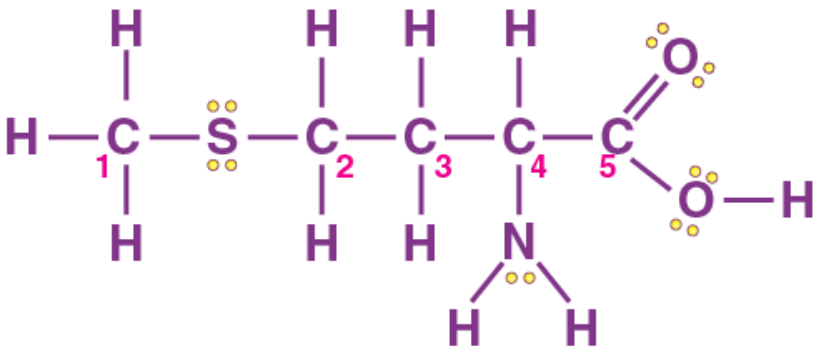
Q-1: Which of the following molecules has tetrahedral geometry?
a) SiH_2Br_2
b) $KrCl_2F_2$
c) PCl_5
d) SF_4

Answer: a) SiH_2Br_2
Explanation: In order to determine the molecular geometry, first calculate the steric number of Si in SiH_2Br_2.

Steric Number = Number of lone pairs on Si + Number of sigma bond pairs

We know that silicon has 4 valence electrons, and it has made four covalent bonds.
Therefore, number of lone pairs = 0
Number of sigma bond pairs = 4
Steric Number = 4
According to VSEPR theory, a steric number equal to 4 corresponds to tetrahedral molecular geometry.

Q-2: Which carbon in the molecule shown below will have a tetrahedral molecular geometry?

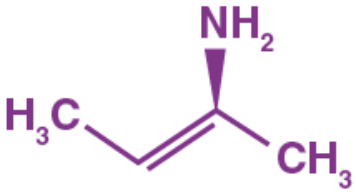


a) 1, 2, 3
b) 3, 4, 5
c) 1, 2, 3, 4
d) All of them

Answer: c) 1, 2, 3, 4

Explanation: The carbons 1, 2, 3, and 4 form four sigma bonds and have zero lone pair, giving them a steric number of four. According to VSEPR theory, a steric number of 4 corresponds to tetrahedral molecular geometry.

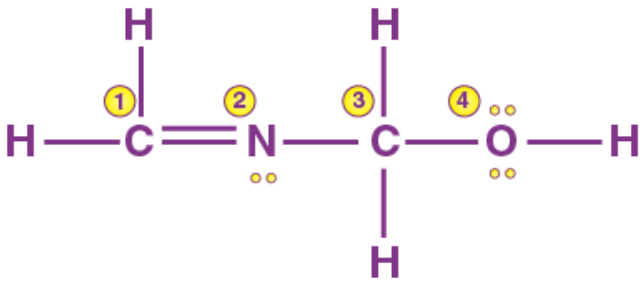
Q-3: Determine the molecular geometry of the nitrogen atom in the molecule.



a) Trigonal planar
b) Tetrahedral
c) Bent
d) Trigonal pyramidal

Answer: b) Tetrahedral
Explanation: The nitrogen atom in the molecule has three sigma bonds (two with H-atoms and one with C-atoms) and one lone pair. This gives it a steric number of four. According to VSEPR, it will have tetrahedral geometry.
Note: Lone pairs have no effect on the molecule's molecular geometry. They have an impact on the molecule's shape.

Q-4: Determine the molecular geometry around each atom in the molecule given below:

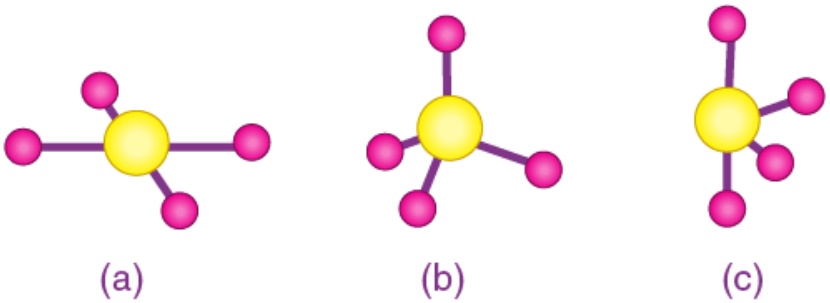


Answer:

Atoms	Number of Lone Pairs	Number of Sigma Bond Pairs	Steric Number	Geometry

C-1	0	3	3	Trigonal Planar
N	1	2	3	Trigonal Planar
C-3	0	4	4	Tetrahedral
O	2	2	4	Tetrahedral

Image linked to answer questions 5-8.



Q-5: Identify the shape for each.
Answer:
a) Square planar
b) Tetrahedral
c) Seesaw

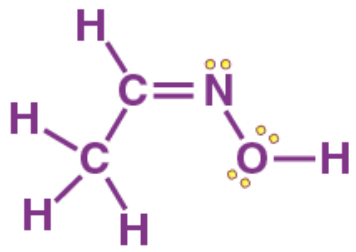
Q-6: Determine the electron domain geometry on which the molecular geometry is based.
Answer:
a) Octahedral
b) Tetrahedral
c) Trigonal bipyramidal

Q-7: How many lone pairs are on each central atom?
Answer:
a) Two
b) Zero
c) One

Q-8: Which of the following elements has the potential to be the central atom in shape c)?
Be, C, S, Si

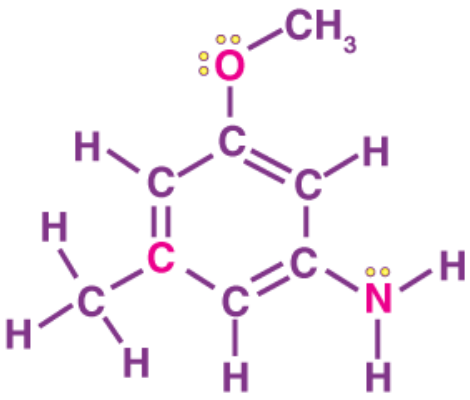
Answer: Because shape (c) has four bonds and only one lone pair, the central atom's valence shell must have six electrons, which is only possible in the case of S (sulphur).

Q-9: In the following compound, what is the geometry of the nitrogen atom?



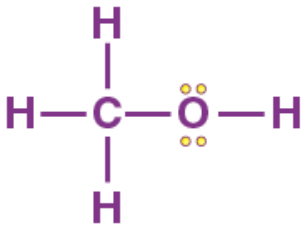
Answer: Nitrogen forms two sigma bonds and has one lone pair in the given compound. As a result, it will show the hybridisation of sp2 corresponding to trigonal planar geometry.

Q-10: Identify the molecular geometry around the atoms highlighted in red in the given organic molecule.



Answer:
Molecular geometry of Carbon: Trigonal Planar
Molecular geometry of Nitrogen: Tetrahedral
Molecular geometry of Oxygen: Tetrahedral

Q-11: What is the electron geometry of the electron groups on the oxygen atom shown below in methanol?



Answer: The oxygen atom in the methanol molecule shown has tetrahedral geometry because it has two lone pairs and two bond pairs, corresponding to a steric number of four.

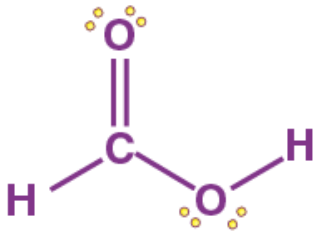
Q-12: Why is it that a tetrahedral complex of the type $[MA_2B_2]$ does not exhibit geometrical isomerism?

Answer: Because all positions of tetrahedral are the same in orientation, a tetrahedral complex of the type $[MA_2B_2]$ does not exhibit geometrical isomerism.

Q-13: $[NiCl_4]^{2-}$ is paramagnetic, whereas $[Ni(CO)_4]$ is diamagnetic, despite the fact that both are tetrahedral. Why?

Answer: In $[NiCl_4]^{2-}$, Ni has a $3d^8$ configuration, and Cl^- is unable to pair up electrons, resulting in a paramagnetic complex. While Ni has a $3d^8\ 4s^2$ configuration in $[Ni(CO)_4]$, CO pairs up electrons. Because all of the electrons in $[Ni(CO)_4]$ are paired up, it is diamagnetic.

Q-14: What is the molecular geometry and hybridisation around the carbon atom based on the Lewis dot structure of formic acid shown below?



a) Trigonal bipyramidal, sp^3d
b) Tetrahedral, sp^3
c) Octahedral, sp^3d^2
d) Trigonal Planar, sp^2

Answer: d) Trigonal Planar, sp^2

Q-15: The shape of $[NiF_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ respectively are:

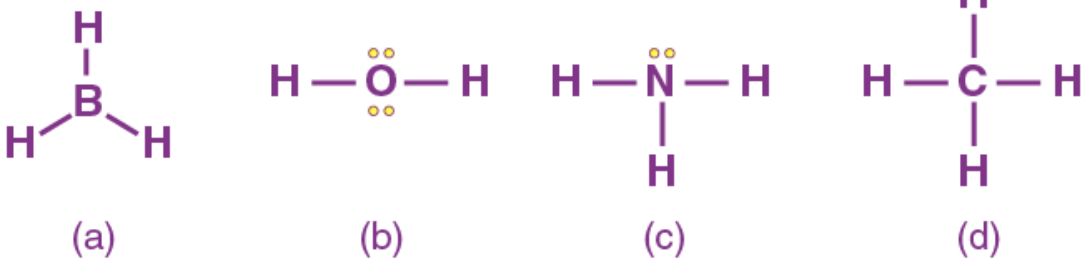
a) Square Planar, Square Planar
b) Tetrahedral, Square Planar
c) Tetrahedral, Tetrahedral
d) Square Planar, Tetrahedral

Answer: b) Tetrahedral, Square Planar

Explanation: Ni is in a +2 oxidation state with a d^8 configuration in both coordination complexes. The only difference is that F^- is a weak field ligand, and CN^- is a strong field ligand. In the presence of weak field ligands, no pairing occurs, resulting in sp^3 hybridisation of Ni in $[NiF_4]^{2-}$, which corresponds to tetrahedral geometry. In the presence of strong field ligands, however, pairing occurs, resulting in dsp^2 hybridisation and square planar geometry.

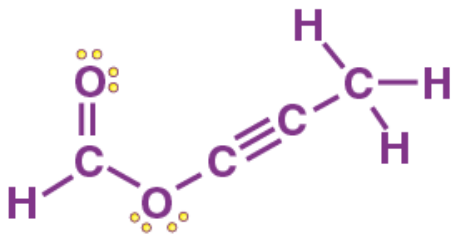
Practice Questions on Tetrahedral Molecular Geometry

Q-1: Which of the following structures has tetrahedral molecular geometry?



Answer: d) CH_4
Explanation: According to VSEPR theory, CH_4 will have a steric number equal to 4, which corresponds to tetrahedral geometry.

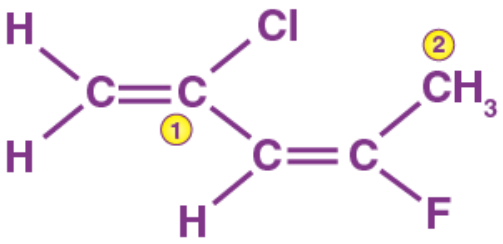
Q-2: How many of the atoms in this molecule are tetrahedral?



a) 1
b) 2
c) 3
d) 4

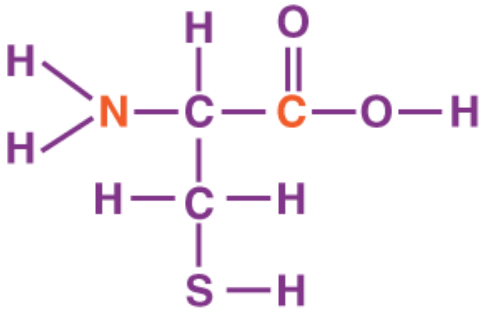
Answer: b) 2

Q-3: Consider the following molecule. Determine the molecular geometry and hybridisation of each labelled C-atom.



Answer: C-1 has 3 sigma bond pairs and 0 lone pairs. This corresponds to steric number 3 and trigonal planar geometry with sp^2 hybridisation. C-2, on the other hand, has formed 4 sigma bonds (3 with H-atoms and 1 with C-atom), giving it a steric number of 4 and a tetrahedral geometry with sp^3 hybridisation.

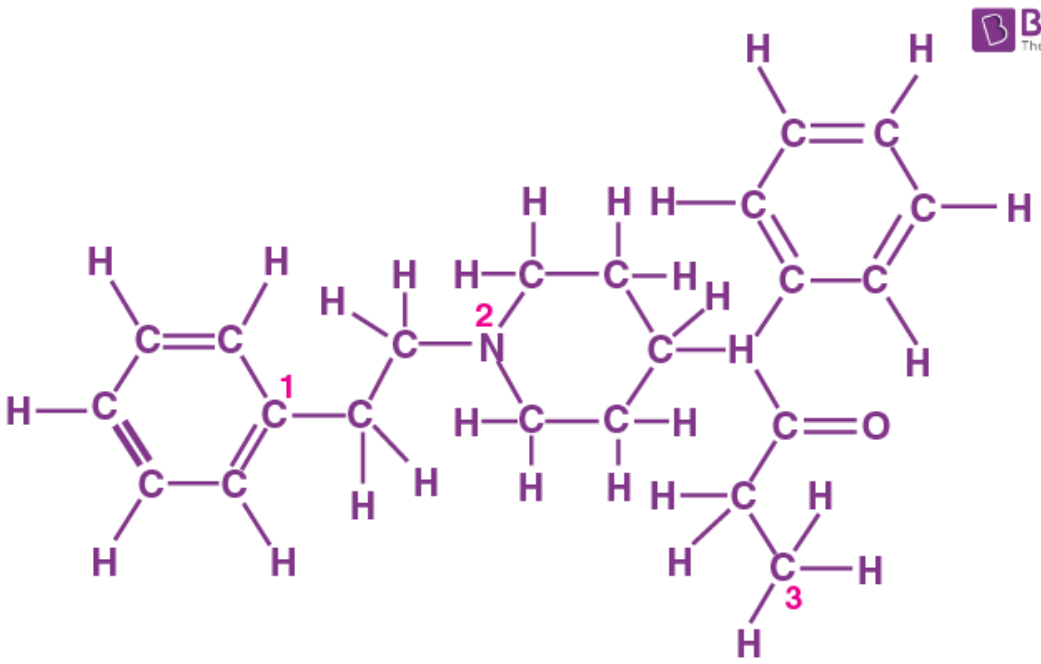
Q-4: An amino acid's structural formula is shown below. Determine the electron group geometry (EG) and molecular geometry (MG) of the atoms in red.



a) C: EG- trigonal planar, MG: trigonal planar; N: Tetrahedral, MG- trigonal pyramidal
b) C: EG- trigonal planar, MG: trigonal pyramidal; N: Tetrahedral, MG- trigonal pyramidal
c) C: EG- trigonal pyramidal, MG: trigonal pyramidal; N: trigonal pyramidal, MG- Tetrahedral
d) C: EG- trigonal pyramidal, MG: trigonal planar; N: Tetrahedral, MG- trigonal pyramidal

Answer: a) C: EG- trigonal planar, MG: trigonal planar; N: Tetrahedral, MG- trigonal pyramidal.

Q-5: The chemical structure of fentanyl is shown below. The IUPAC name is N-(1-phenethylpiperidin-4-yl)-N-phenylpropionamide. Give the molecular shape of the numbered atoms.



Answer:
C-1: Trigonal Planar
N-2: Trigonal pyramidal
C-3: Tetrahedral