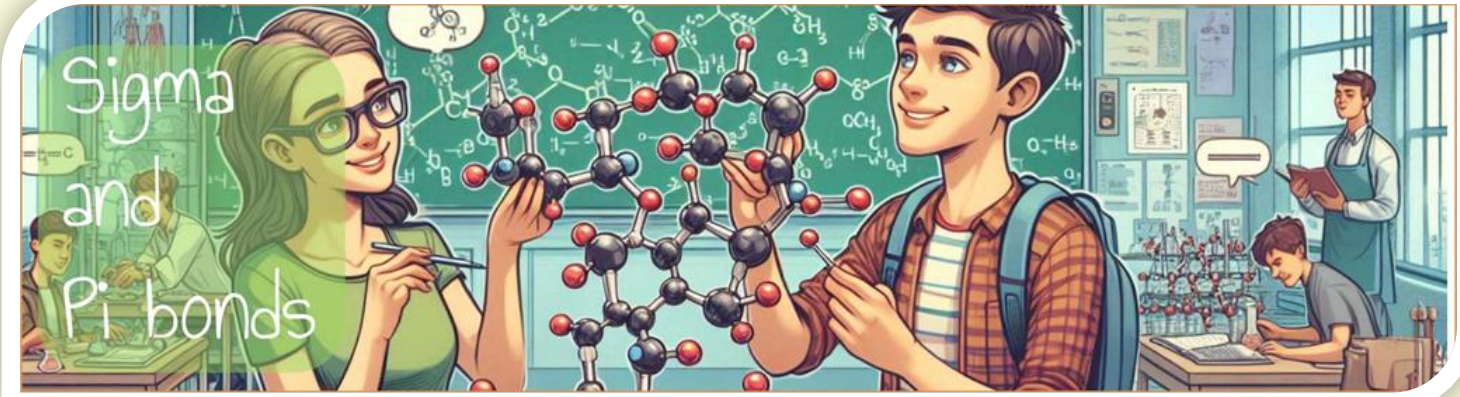

Answer all the questions below as fully as you can then check your answers

The questions are arranged in order of increasing difficulty.

1. Which statement about sigma (σ) and pi (π) bonds is correct?

A. Pi bonds are formed by head-on overlap of orbitals
B. Sigma bonds are weaker than pi bonds
C. Every covalent bond contains at least one sigma bond
D. Pi bonds allow free rotation about a C=C bond

2. Explain what is meant by a sigma (σ) bond.

3. Explain why pi (π) bonds are generally weaker than sigma (σ) bonds.

4. State the number of sigma (σ) and pi (π) bonds present in each molecule:

a) H_2 b) O_2 c) N_2

5. Ethene (C_2H_4) contains a carbon–carbon double bond.

a) State how many sigma and pi bonds are present in an ethene molecule.
b) Explain why ethene does not freely rotate about the C=C bond.

6. A student states: “A double bond contains two sigma bonds.” Explain why this statement is incorrect.

7. Describe how sigma and pi bonds are formed when two nitrogen atoms bond together to form N_2.

8. Explain why a carbon–carbon single bond is longer and weaker than a carbon–carbon double bond.

Answers

1. Which statement about sigma (σ) and pi (π) bonds is correct?

A. Pi bonds are formed by head-on overlap of orbitals
B. Sigma bonds are weaker than pi bonds
C. Every covalent bond contains at least one sigma bond
D. Pi bonds allow free rotation about a C=C bond

Answer:C

Every covalent bond contains a sigma bond. Pi bonds are formed by sideways overlap and restrict rotation.

2. Explain what is meant by a sigma (σ) bond.

Answer:
A sigma bond is a covalent bond formed by head-on overlap of atomic orbitals along the internuclear axis, with electron density concentrated between the nuclei.

3. Explain why pi (π) bonds are generally weaker than sigma (σ) bonds.

Answer:
Pi bonds are weaker because they are formed by sideways overlap of p orbitals, resulting in a smaller area of orbital overlap compared to sigma bonds.

4. State the number of sigma (σ) and pi (π) bonds present in each molecule:

a) H_2 b) O_2 c) N_2

Answer:
a) H_2: 1 σ, 0 π
b) O_2: 1 σ, 1 π
c) N_2: 1 σ, 2 π

5. Ethene (C_2H_4) contains a carbon–carbon double bond.

a) State how many sigma and pi bonds are present in an ethene molecule.
b) Explain why ethene does not freely rotate about the C=C bond.

Answer:
a) Ethene contains 5 σ bonds and 1 π bond.
b) The pi bond restricts rotation because breaking the sideways overlap would be required for rotation to occur.

6. A student states: “A double bond contains two sigma bonds.” Explain why this statement is incorrect.

Answer:
The statement is incorrect because a double bond contains one sigma bond and one pi bond, not two sigma bonds.

7. Describe how sigma and pi bonds are formed when two nitrogen atoms bond together to form N_2.

Answer:
In nitrogen, one sigma bond is formed by head-on overlap of p orbitals along the internuclear axis. Two pi bonds are formed by sideways overlap of the remaining p orbitals above and below the axis, resulting in a triple bond.

8. Explain why a carbon–carbon single bond is longer and weaker than a carbon–carbon double bond.

Answer:
A carbon–carbon single bond contains only one sigma bond. A double bond contains one sigma bond and one pi bond, resulting in greater electron density between the nuclei, making the bond stronger and shorter.