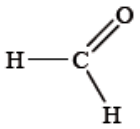
HL Paper 1

What is the hybridization of the carbon atom, and the number of σ and π bonds in the methanal molecule?



	Hybridization	σ bonds	π bonds
A.	sp^2	3	1
B.	sp^3	3	1
C.	sp^3	4	0
D.	sp^2	4	0

Which species has bond angles of 90°?

A. $AlCl_4^-$

B. ICl_4^-

C. NH_4^+

D. $SiCl_4$

Which molecule has an expanded octet?

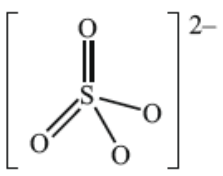
A. CO

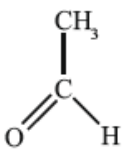
B. CO_2

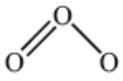
C. SF_2

D. SF_4

Which species contain delocalized electrons?

I. 

II. 

III. 

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which statement is correct?

A. Sigma bonds are formed only by the combination of s atomic orbitals.

B. Pi bonds can be formed in the absence of sigma bonds.

C. Pi bonds are formed parallel to the axis between atoms.

D. Pi bonds are formed only by the combination of hybrid orbitals.

Which of the following best describes the formation of π bonds?

A. They are formed by the sideways overlap of parallel orbitals.

B. They are formed by the axial overlap of orbitals.

C. They are formed by the sideways overlap of an s and p orbital.

D. They are formed by the axial overlap of either s or p orbitals.

Which molecules have at least one sp^2 hybridized atom?

I. CH_3COOH

II. CH_3COCH_3

III. CH_2CHCH_2OH

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which species have delocalized π electrons?

I. $\mathrm{CH_3COCH_3}$

II. $\mathrm{NO_2^-}$

III. $\mathrm{CO_3^{2-}}$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

How many σ and π bonds are present in a molecule of propyne, $\mathrm{CH_3CCH}$?

	σ	π
A.	5	3
B.	6	2
C.	7	1
D.	8	0

How many sigma (σ) and pi (π) bonds are there in $\mathrm{CH_3CH_2CCCH_2COOH}$?

A. 13σ and 5π

B. 15σ and 2π

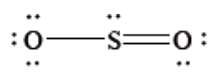
C. 15σ and 3π

D. 15σ only

How many bonding pairs and lone pairs of electrons surround the sulfur atom in the $\mathrm{SF_4}$ molecule?

	Bonding pairs	Lone pairs
A.	4	1
B.	4	0
C.	6	0
D.	8	2

The Lewis structure of $\mathrm{SO_2}$ is given below.



What is the shape of the $\mathrm{SO_2}$ molecule?

A. Bent (V-shaped)

B. Linear

C. T-shaped

D. Triangular planar

Which species have resonance structures?

I. Ozone, O_3
II. Carbon dioxide, CO_2
III. Benzene, C_6H_6

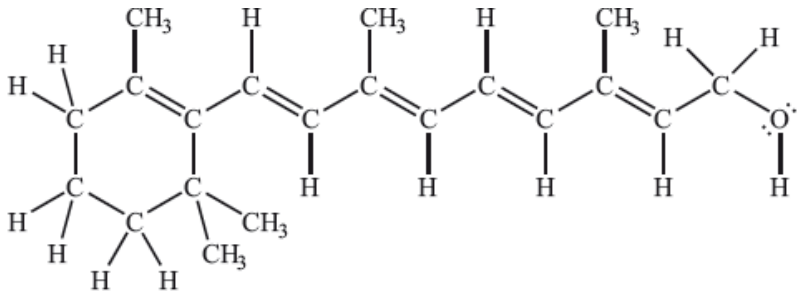
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Retinol (vitamin A) contains a total of **5** double bonds and **46** single bonds.



Which statements are correct?

I. There are 51 σ and 5 π bonds.

II. The oxygen atom is sp^3 hybridized.

III. Retinol is a primary alcohol.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which statements about hybridization are correct?

I. The hybridization of carbon in diamond is sp^3.

II. The hybridization of carbon in graphite is sp^2.

III. The hybridization of carbon in C_{60} fullerene is sp^3.

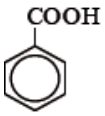
A. I and II only

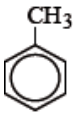
B. I and III only

C. II and III only

D. I, II and III

In which compound are all the carbon atoms sp^2hybridized?

A. 

B. 

C. CH_2CHCH_3

D. $CH_3CH_2CHCHCH_2CH_3$

Which species does **not** have delocalized electrons?

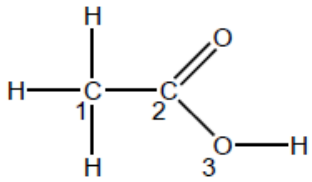
A. NO_3^-

B. NO_2^-

C. O_3

D. C_3H_6

What is the hybridization of the numbered atoms in ethanoic acid?



	Atom 1	Atom 2	Atom 3
A.	sp^3	sp	sp^2
B.	sp^3	sp^2	sp
C.	sp^2	sp^3	sp^2
D.	sp^3	sp^2	sp^3

Which does **not** show resonance?

A. PO_4^{3-}

B. C_6H_6

C. C_6H_{12}

D. O_3

In which group do both compounds contain delocalized electrons?

A. C_6H_{10}, C_5H_{10}
B. Na_2CO_3, NaOH
C. $NaHCO_3$, C_6H_6
D. $NaHCO_3$, C_6H_{12}

Which combination best describes the type of bonding present and the melting point of silicon and silicon dioxide?

	Silicon		Silicon dioxide	
A.	covalent bonding	high melting point	covalent bonding	high melting point
B.	metallic bonding	high melting point	covalent bonding	low melting point
C.	ionic bonding	high melting point	ionic bonding	low melting point
D.	covalent bonding	low melting point	ionic bonding	high melting point

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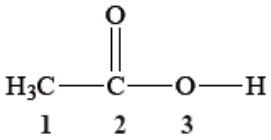
What are the hybridizations of the atoms labelled **1**, **2** and **3** in the molecule below?



	1	2	3
A.	sp^2	sp^2	sp
B.	sp^3	sp^2	sp^3
C.	sp^2	sp	sp^3
D.	sp^3	sp^2	sp

Which allotropes of carbon show sp^2 hybridization?

I. Diamond

II. Graphite

III. C_{60} fullerene

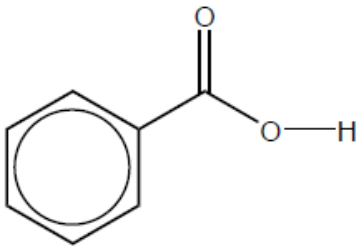
A. I and II only

B. I and III only

C. II and III only

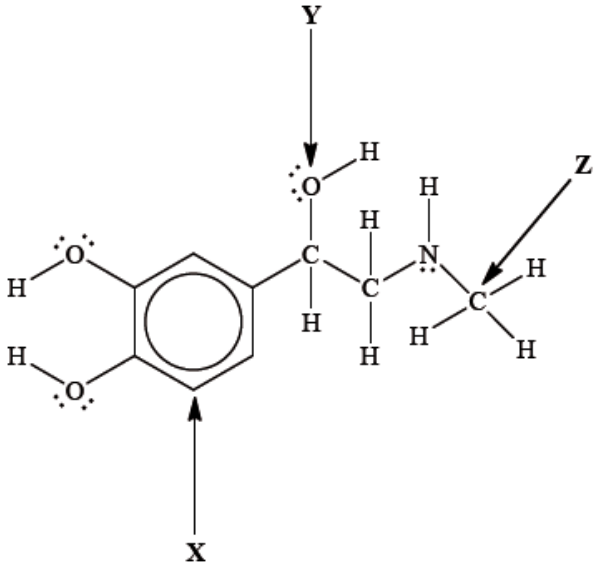
D. I, II and III

Which combination describes the bonding and structure in benzoic acid, C_6H_5COOH?



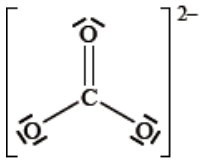
	Number of electron domains per carbon atom	Number of π-electrons	Number of σ-bonds
A.	3	6	6
B.	3	8	15
C.	4	6	6
D.	4	8	10

What is the hybridization of atoms **X**, **Y** and **Z** in epinephrine?

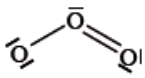


	X	Y	Z
A.	sp^2	sp^3	sp^3
B.	sp^2	sp	sp^3
C.	sp^3	sp^2	sp^2
D.	sp^3	sp^3	sp^3

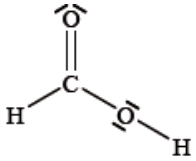
Which species have delocalized electrons?



I



II



III

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which structure has delocalized π electrons?

A. O_3

B. CO

C. HCN

D. CO_2

What is correct for PCl_5?

	Shape	Bond angle(s)
A.	Octahedral	90° and 180°
B.	Trigonal pyramidal	107°
C.	Square pyramidal	90° and 180°
D.	Trigonal bipyramidal	90°, 120° and 180°

Which combination of shape and bond angle is correct for a molecule of xenon tetrafluoride, $\mathrm{XeF_4}$?

	Shape	Bond angle
A.	square pyramid	90°
B.	square planar	90°
C.	tetrahedral	109.5°
D.	octahedral	90°

Which overlap of atomic orbitals leads to the formation of only a sigma (σ) bond?

I. s – p

II. p – p

III. s – s

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

How many sigma and pi bonds are there in propyne, $\mathrm{CH_3CCH}$?

A. 2 sigma and 2 pi

B. 7 sigma and 1 pi

C. 6 sigma and 2 pi

D. 5 sigma and 3 pi

Which can be represented with only one Lewis structure?

A. CH_2O

B. C_6H_6

C. O_3

D. NO_3^-

Which molecules have $\mathrm{sp^2}$ hybridization?

I. $\mathrm{C_2H_4}$

II. C_4H_{10}

III. C_6H_6

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Which of the following is correct?

	Atom	Number of electron domains	Molecular geometry	Hybridization
A.	C in C_2H_2	2	linear	sp
B.	C in C_2H_6	4	square planar	sp^3
C.	N in NH_3	3	trigonal pyramidal	sp^3
D.	O in H_2O	4	bent	sp^2

Which species does **not** contain delocalized electrons?

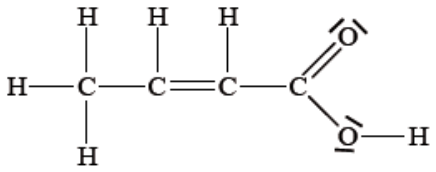
A. $CH_3CH_2O^-$

B. $CH_3CO_2^-$

C. O_3

D. NO_3^-

How many sigma (σ) and pi (π) bonds are there in the following molecule?

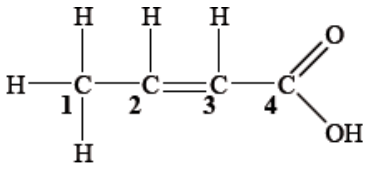


	σ bonds	π bonds
A.	9	2
B.	9	4
C.	11	2
D.	11	4

Which species breaks the octet rule?

A. PCl_3
B. BF_4^-
C. SCl_4
D. NH_4^+

Identify the hybridization of carbon atoms in this molecule

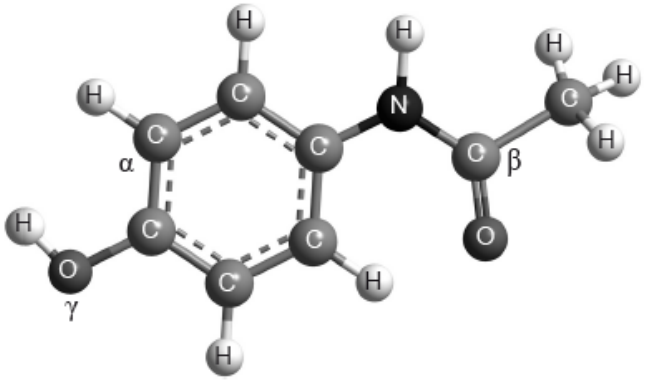


	1	2	3	4
A.	sp^3	sp^2	sp^2	sp^2
B.	sp^2	sp^2	sp^2	sp
C.	sp^3	sp	sp^2	sp
D.	sp	sp^2	sp	sp^2

What is the type of hybridization of the silicon and oxygen atoms in silicon dioxide?

	Silicon	Oxygen
A.	sp^3	sp^3
B.	sp^3	sp^2
C.	sp^2	sp^3
D.	sp^2	sp^2

Which combination correctly describes the types of hybridization shown by the two carbon atoms labelled α and β and the oxygen atom labelled γ in the molecule of paracetamol shown below?



Paracetamol

	α	β	γ
A.	sp^2	sp^2	sp^3
B.	sp^3	sp^2	sp^2
C.	sp^2	sp^2	sp^2
D.	sp^2	sp^3	sp^3

Which molecule is trigonal bipyramidal in shape?

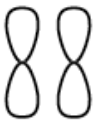
A. PCl_3

B. $SiCl_4$

C. PCl_5

D. SF_6

The diagrams below show s and p orbitals in different positions. Which combinations can form a σ-bond?

I. 

II. 

III. 

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

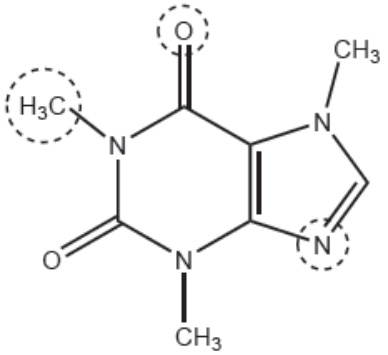
What is the correct number of sigma (σ) and pi (π) bonds in prop-2-enenitrile, CH_2CHCN?

	σ bonds	π bonds
A.	7	2
B.	4	5
C.	6	3
D.	3	3

How many sigma (σ) and pi (π) bonds are present in this molecule?

	σ	π
A.	12	6
B.	14	5
C.	16	6
D.	17	5

What is the hybridization state and electron domain geometry around the circled C, N and O atoms?



	C	O	N
A.	sp^3 and tetrahedral	sp^2 and trigonal planar	sp^2 and trigonal planar
B.	sp^2 and trigonal planar	sp and linear	sp^3 and tetrahedral
C.	sp^3 and tetrahedral	sp and linear	sp^2 and trigonal planar
D.	sp^3 and trigonal pyramidal	sp^2 and trigonal planar	sp^3 and trigonal pyramidal

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Which combination describes the PH_4^+ ion?

	Molecular geometry	Central atom hybridization
A.	Tetrahedral	sp^3
B.	Square planar	sp^3
C.	Tetrahedral	sp^2
D.	Square planar	sp^2
