JEE Mains 2019 Chapter wise Question Bank

Chemical Bonding - Questions

Q1

According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^-?

(1) Li_2^+ is unstable and Li_2^- is stable
(2) Li_2^+ is stable and Li_2^- is unstable
(3) Both are stable
(4) Both are unstable

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Q2

In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic?

(1) $NO \rightarrow NO^+$ (2) $N_2 \rightarrow N_2^+$
(3) $O_2 \rightarrow O_2^+$ (4) $O_2 \rightarrow O_2^{2-}$

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Q3

Two pi and half sigma bonds are present in:

(1) O_2^+ (2) N_2
(3) O_2 (4) N_2^+

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Q4

Among the following molecules/ions,

$C_2^{2-}, N_2^{2-}, O_2^{2-}, O_2$

Which one is diamagnetic and has the shortest bond length?

(1) O_2 (2) N_2^{2-} (3) O_2^{2-} (4) C_2^{2-}

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Q5

Among the following, the molecule expected to be stabilized by anion formation is:

C_2, O_2, NO, F_2

(1) C_2 (2) F_2 (3) NO (4) O_2

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Q6

Among the following species, the diamagnetic molecule is:

(1) NO (2) CO (3) B_2 (4) O_2

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Q7

During the change of O_2 to O_2^-, the incoming electron goes to the orbital :

(1) $\pi 2p_y$ (2) $\sigma^* 2p_z$ (3) $\pi^* 2p_x$ (4) $\pi 2p_x$

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Q8

The correct statement among the following is :

(1) $(SiH_3)_3N$ is planar and less basic than $(CH_3)_3N$.
(2) $(SiH_3)_3N$ is pyramidal and more basic than $(CH_3)_3N$.
(3) $(SiH_3)_3N$ is pyramidal and less basic than $(CH_3)_3N$.
(4) $(SiH_3)_3N$ is planar and more basic than $(CH_3)_3N$.

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Chemical Bonding - Solutions

Q1

(3) Electronic configuratios of Li_2^+ and Li_2^-:

Li_2^+: $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^1$

Li_2^-: $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^1$

Now,

Bond order of $Li_2^+ = \frac{1}{2}(3-2) = \frac{1}{2}$

Bond order of $Li_2^- = \frac{1}{2}(4-3) = \frac{1}{2}$

Here, both Li_2^+ and Li_2^- have positive bond order, thus both are stable.

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Q2

(1) In case of NO (paramagnetic) $\rightarrow$ NO^+ (diamagnetic) the bond order has increased from 2.5 to 3.

For other cases:

N_2 (Diamagnetic) $\rightarrow$	N_2^+ (Paramagnetic)
O_2 (Paramagnetic) $\rightarrow$	O_2^+ (Paramagnetic)
O_2 (Paramagnetic) $\rightarrow$	O_2^{2-} (Diamagnetic)
B.O = 2	B.O = 1

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Q3

(4) $N_2^+ = 13e^-$

$= \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2$

$= \pi 2p_y^2 \sigma 2p_z^1$

$$\text{B.O.} = \frac{\text{Bonding electrons} - \text{Antibonding electrons}}{2}$$

$$\text{B.O.} = \frac{9-4}{2} = 2.5 = 2\pi \text{ bond} + 0.5\ \sigma \text{ bond}$$

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Q4

(4) Bond length $\propto \frac{1}{\text{Bond order}}$

and diamagnetic species has no unpaired electron in their molecular orbitals.

	No. of unpaired electrons	Bond order	Magnetic character
C_2^{2-}	0	3	diamagnetic
N_2^{2-}	2	2	paramagnetic
O_2^{2-}	0	1	diamagnetic
O_2	1	2	paramagnetic

$\therefore$ C_2^{2-} has least bond length and is diamagnetic.

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Q5

(1) Configuration of C_2

$= \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2$

Configuration of C_2^-

$= \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2\ \sigma 2p_z^1$

Bond order

$$= \frac{\text{No. of bonding } e^- - \text{No. of antibonding } e^-}{2}$$

C_2 has *s-p* mixing and the HOMO is $\pi 2p_x = \pi 2p_y$ and LUMO is $\sigma 2p_z$. So, the extra electron will occupy bonding molecular orbital and this will lead to an increase in bond order.

C_2^- has more bond order than C_2.

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Q6

(2) The molecules with no unpaired electrons are diamagnetic.

Molecule	No. of unpaired electrons
NO	1
CO	Zero
O_2	2
B_2	2

Since CO has no unpaired electron. Hence CO is diamagnetic.

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Q7

(3) Electronic configuration of O_2 is

$$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2$$
$$= \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^1$$

When an electron is added in O_2 to form O_2^-, the incoming electron goes to $\pi^* 2p_x$ or $\pi^* 2p_y$ orbital.

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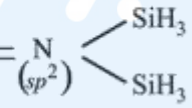
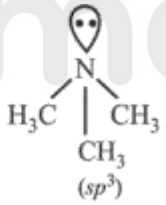
Q8

(1) 



Due to backbonding of lone pair electrons of nitrogen into vacant *d*-orbitals of Si, trisilylamine $(SiH_3)_3N$ is planar. In trimethylamine $(CH_3)_3N$, there is no backbonding and hence it is more basic.

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