DPP - Daily Practice Problems

Date : ☐   Start Time : ☐   End Time : ☐

CHEMISTRY CC04

SYLLABUS : Chemical Bonding and Molecular Structure

Max. Marks : 120   **Marking Scheme :** + 4 for correct & (–1) for incorrect   **Time : 60 min.**

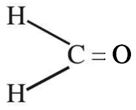
INSTRUCTIONS : This Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

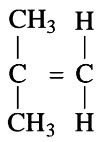
1. Which of the following does not contain coordinate bond ?

(a) BH_4^- (b) NH_4^+

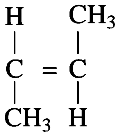
(c) CO_3^{2-} (d) H_3O^+

2. Which of the following has the highest dipole moment?

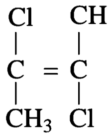
(a) 

(b) 

$\begin{array}{cc} CH_3 & H \\ | & | \\ C & = C \\ | & | \\ CH_3 & H \end{array}$

(c) 

$\begin{array}{cc} H & CH_3 \\ | & | \\ C & = C \\ | & | \\ CH_3 & H \end{array}$

(d) 

$\begin{array}{cc} Cl & CH_3 \\ | & | \\ C & = C \\ | & | \\ CH_3 & Cl \end{array}$

3. Of the following hydrides which one has the lowest boiling point ?

(a) AsH_3 (b) SbH_3 (c) PH_3 (d) NH_3

4. In compounds of type ECl_3, where E = B, P, As or Bi, the angles Cl - E- Cl for different E are in the order.

(a) $B > P = As = Bi$ (b) $B > P > As > Bi$

(c) $B < P = As = Bi$ (d) $B < P < As < Bi$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ

5. The electronegativity difference between N and F is greater than that between N and H yet the dipole moment of NH_3 (1.5 D) is larger than that of NF_3 (0.2D). This is because

(a) in NH_3 the atomic dipole and bond dipole are in the same direction whereas in NF_3 these are in opposite directions

(b) in NH_3 as well as NF_3 the atomic dipole and bond dipole are in opposite directions

(c) in NH_3 the atomic dipole and bond dipole are in the opposite directions whereas in NF_3 these are in the same direction

(d) in NH_3 as well as in NF_3 the atomic dipole and bond dipole are in the same direction

6. KF combines with HF to form KHF_2. The compound contains the species

(a) K^+, F^- and H^+
(b) K^+, F^- and HF
(c) K^+, and $[HF_2]^-$
(b) $[KHF]^+$and F_2

7. On changing N_2 to N_2^+, the dissociation energy of N–N bond ..... and on changing O_2 to O^+_2 the dissociation energy of O–O bond....

(a) increases, decreases
(b) decreases, increases
(c) decreases in both cases
(d) increases in both cases

8. According to MO theory which of the following lists ranks the nitrogen species in terms of increasing bond order?

(a) $N_2^{2-} < N_2^- < N_2$
(b) $N_2 < N_2^{2-} < N_2^-$
(c) $N_2^- < N_2^{2-} < N_2$
(d) $N_2^- < N_2 < N_2^{2-}$

9. Which of the two ions from the list given below have the geometry that is explained by the same hybridization of orbitals, NO_2^-, NO_3^-, NH_2^-, NH_4^+, SCN^-?

(a) NO_2^- and NO_3^-
(b) NH_2^- and NO_3^-
(c) SCN^- and NH_2^-
(d) NO_2^- and NH_2^-

10. The values of electronegativity of atoms A and B are 1.20 and 4.0 respectively. The percentage of ionic character of A - B bond is

(a) 50%
(b) 72.24%
(c) 55.3%
(d) 43%

11. In PO_4^{3-} ion the formal charge on the oxygen atom of P–O bond is

(a) $+1$
(b) -1
(c) -0.75
(d) $+0.75$

12. Which molecule/ion out of the following does not contain unpaired electrons?

(a) N_2^+
(b) O_2
(c) O_2^{2-}
(d) B_2

13. Which of the following pairs of ions are isoelectronic and isostructural ?

(a) ClO_3^-, CO_3^{2-}
(b) SO_3^{2-}, NO_3^-
(c) ClO_3^-, SO_3^{2-}
(d) CO_3^{2-}, SO_3^{2-}

14. Which of the following is correct increasing order of lone pair of electrons on the central atom?

(a) $IF_7 < IF_5 < ClF_3 < XeF_2$
(b) $IF_7 < XeF_2 < ClF_2 < IF_5$
(c) $IF_7 < ClF_3 < XeF_2 < IF_5$
(d) $IF_7 < XeF_2 < IF_5 < ClF_3$

RESPONSE	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
GRID	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ

15. Consider the molecules CH_4, NH_3 and H_2O. Which of the given statements is false?

(a) The H–C–H bond angle in CH_4, the H–N–H bond angle in NH_3, and the H–O–H bond angle in H_2O are all greater than 90°

(b) The H–O–H bond angle in H_2O is larger than the H–C–H bond angle in CH_4.

(c) The H–O–H bond angle in H_2O is smaller than the H–N–H bond angle in NH_3.

(d) The H–C–H bond angle in CH_4 is larger than the H–N–H bond angle in NH_3.

16. Predict the correct order among the following :

(a) lone pair- lone pair > lone pair - bond pair > bond pair - bond pair

(b) lone pair - lone pair > bond pair - bond pair > lone pair - bond pair

(c) bond pair - bond pair > lone pair - bond pair > lone pair - lone pair

(d) lone pair - bond pair > bond pair - bond pair > lone pair - lone pair

17. In which of the following species the interatomic bond angle is 109° 28'?

(a) NH_3, BF_4^- (b) NH_4^+, BF_3

(c) NH_3, BF_4 (d) NH_2^-, BF_3.

18. In XeF_2, XeF_4 and XeF_6, the number of lone pairs on Xe are respectively

(a) 2, 3, 1 (b) 1, 2, 3

(c) 4, 1, 2 (d) 3, 2, 1

19. Hybridisation of the underline atom changes in:

(a) $\underline{Al}H_3$ changes to AlH_4^-

(b) $H_2\underline{O}$ changes to H_3O^+

(c) $\underline{N}H_3$ changes to NH_4^+

(d) in all cases

20. The states of hybridization of boron and oxygen atoms in boric acid (H_3BO_3) are respectively

(a) sp^3 and sp^2 (b) sp^2 and sp^3

(c) sp^2 and sp^2 (d) sp^3 and sp^3

21. Among the following ions, the $p\pi - d\pi$ overlap could be present in

(a) NO_3^- (b) PO_4^{3-}

(c) CO_3^{2-} (d) NO_2^-

22. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (101°) down group-15 of the periodic table is due to

(a) decreasing lp-bp repulsion

(b) decreasing electronegativity

(c) increasing bp-bp repulsion

(d) increasing p-orbital character in sp^3

23. Which one of the following pairs of species have the same bond order?

(a) CN^- and NO^+ (b) CN^- and CN^+

(c) O^-_2 and CN^- (d) NO^+ and CN^+

24. N_2 and O_2 are converted into monocations, N_2^+ and O_2^+ respectively. Which of the following statements is wrong?

(a) In N_2^+, N - N bond weakens

(b) In O_2^+, the O - O bond order increases

(c) In O_2^+, paramagnetism decreases

(d) N_2^+ becomes diamagnetic

RESPONSE GRID	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ
	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ

25. The bond dissociation energy of B – F in BF_3 is 646 kJ mol^{-1} whereas that of C – F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B – F bond dissociation energy as compared to that of C – F is

(a) stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4.

(b) significant $p\pi - p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4.

(c) lower degree of $p\pi - p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4.

(d) smaller size of B– atom as compared to that of C– atom.

26. Ortho-Nitrophenol is less soluble in water than *p*- and *m*-Nitrophenols because :

(a) *o*-Nitrophenol is more volatile steam than those of *m*- and *p*-isomers.

(b) *o*-Nitrophenol shows intramolecular H-bonding

(c) *o*-Nitrophenol shows intermolecular H-bonding

(d) Melting point of *o*-Nitrophenol is lower than those of *m*- and *p*-isomers.

27. Amongst LiCl, RbCl, $BeCl_2$ and $MgCl_2$ the compounds with the greatest and the least ionic character, respectively are:

(a) LiCl and RbCl
(b) RbCl and $BeCl_2$
(c) $MgCl_2$ and $BeCl_2$
(d) RbCl and $MgCl_2$

28. Bond order normally gives idea of stability of a molecular species. All the molecules viz. H_2, Li_2 and B_2 have the same bond order yet they are not equally stable. Their stability order is

(a) $H_2 > B_2 > Li_2$
(b) $Li_2 > H_2 > B_2$
(c) $Li_2 > B_2 > H_2$
(d) $B_2 > H_2 > Li_2$

29. The shape of IF_6^- is :

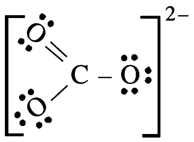
(a) Trigonally distorted octahedron
(b) Pyramidal
(c) Octahedral
(d) Square antiprism

30. Which one of the following molecules is paramagnetic?

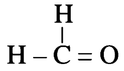
(a) N_2
(b) NO
(c) CO
(d) O_3

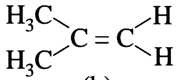
RESPONSE GRID	**25.** ⓐⓑⓒⓓ **26.** ⓐⓑⓒⓓ **27.** ⓐⓑⓒⓓ **28.** ⓐⓑⓒⓓ **29.** ⓐⓑⓒⓓ **30.** ⓐⓑⓒⓓ

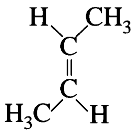
DAILY PRACTICE PROBLEM DPP CHAPTERWISE 4 - CHEMISTRY			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	35	Qualifying Score	50
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

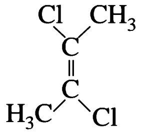
1. **(c)** CO_3^{2-} Its structure is 

2. **(a)** Greater the difference in electronegativity between the two atoms, larger will be polarity and hence dipole moment. Thus (a) has maximum dipole moment.


(a)
(C–O bond is more polar)

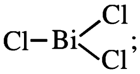

(b)
(very less polar)


(c)

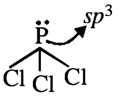

(d)

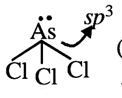
Symmetrical molecules (μ = 0)

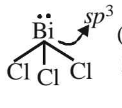
3. **(c)** NH_3 undergoes H-bonding and hence has the highest b.p. Among the remaining hydrides i.e. PH_3, AsH_3 and SbH_3 as we move from PH_3 to BiH_3, the molecular mass increases. As a result the van der waal's forces of attraction increases and the boiling point increases regularly from PH_3 to BiH_3.

4. **(b)** $BiCl_3$: ; sp^2 - Hybridisation

(Trigonal planar geometry); Bond angle = 120°

In PCl_3  (Pyramidal geometry)

In $AsCl_3$  (Pyramidal geometry)

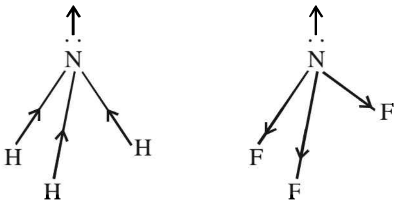
In $BiCl_3$  (Pyramidal geometry)

Bond angle = below 109° 28' and decreases from PCl_3 to $BiCl_3$

In these, order of bond angle :

$BCl_3 > PCl_3 > AsCl_3 > BiCl_3$

5. **(a)** In NH_3 the atomic dipole (orbital dipole due to lone pair) and bond dipole are in the same direction whereas in NF_3 these are in opposite direction so in the former case they are added up whereas in the latter case net result is reduction of dipole moment. It has been shown in the following figure :



6. **(c)** Since F form H-bond $[HF_2]^-$ exists. Therefore KHF_2 gives $K^+ + HF_2^-$

7. **(b)** On changing N_2 to N^+_2, B.O. decreases from 3 to 2.5 whereas on changing O_2 to O^+_2, B.O. increases from 2 to 2.5. In former case, the bond dissociation energy decreases and in the latter case, it increases.

8. **(a)** Molecular orbital configuration of

$$N_2^{2-} = \sigma 1s^2\,\sigma^* 1s^2 \sigma 2s^2\,\sigma^* 2s^2 - \begin{cases}\pi 2p_x^2 \\ \pi 2p_y^2\end{cases} \sigma 2p_z^2 \begin{cases}\pi^* 2p_x^1 \\ \pi^* 2p_y^1\end{cases}$$

$$\text{Bond order} = \frac{10-6}{2} = 2$$

$$N_2^- = \sigma 1s^2\,\sigma^* 1s^2\,\sigma 2s^2 \sigma^* 2s^2 \begin{cases}\pi 2p_x^2 \\ \pi 2p_y^2\end{cases} \sigma 2p_z^2 \begin{cases}\pi^* 2p_x^1 \\ \pi^* 2p_y^0\end{cases}$$

$$\text{Bond order} = \frac{10-5}{2} = 2.5$$

$$N_2 = \sigma 1s^2\,\sigma^* 1s^2\,\sigma 2s^2 \sigma^* 2s^2 \begin{cases}\pi 2p_x^2 \\ \pi 2p_y^2\end{cases}, \sigma 2p_z^2$$

$$\text{Bond order} = \frac{10-4}{2} = 3$$

∴ The correct order is $= N_2^{2-} < N_2^- < N_2$

9. **(a)** Hybridisation $= \frac{1}{2}$ [No. of valence electrons of central atom + No. of monovalent atoms attached to it + Negative charge if any – Positive charge if any]

NO_2^- $H = \frac{1}{2}[5+0+1-0] = 3 = sp^2$

NO_3^- $H = \frac{1}{2}[5+0+1-0] = 3 = sp^2$

NH_2^- $H = \frac{1}{2}[5+2+1+0] = 4 = sp^3$

NH_4^+, $H = \frac{1}{2}[5+4+0-1] = 4 = sp^3$

$SCN^- = sp$

i.e., NO_2^- and NO_3^- have same hybridisation.

10. **(b)** Electronegativity difference is 4.0 - 1.20 = 2.8 percentage ionic character is 72.24% when the electronegativity difference is 1.7, the % ionic character is approx 51%.

11. **(c)** In PO_4^{3-} ion, formal charge on each O-atom of P – O

$$\text{bond} = \frac{\text{Total charge}}{\text{Number of O atom}} = -\frac{3}{4} = -0.75$$

12. **(c)** The electronic configuration of the given molecules are :

$$N_2^+ = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi p_y^2, \sigma 2p_z^1 ;$$

1 unpaired e^-

$$O_2 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 \approx \pi 2p_y^2,$$

$\pi^* 2p_x^1 \approx \pi^* 2p_y^1$; 2 unpaired e^-s

$$O_2^{2-} = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 \approx \pi 2p_y^2,$$

$\pi^* 2p_x^2 \approx \pi^* 2p_y^2$; no unpaired e^-s

$$B_2 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^1 \approx \pi_2 p_y^1;$$

2 unpaired e^-s

13. **(c)** ClO_3^- and SO_3^{-2} both have same number of electrons (42) and central atom in each being sp^3 hybridised. Both are having one lone pair on central atom hence they are pyramidal.

14. **(a)** The number of lone pairs of electrons on central atom in various given species are

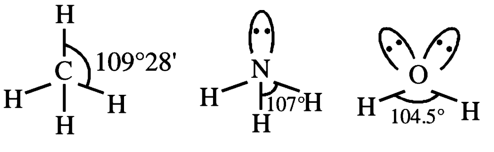
Species	**Number of lone pairs on central atom**
IF_7	0
IF_5	1
ClF_3	2
XeF_2	3

Thus the correct increasing order is

$IF_7 < IF_5 < ClF_3 < XeF_2$

0 1 2 3

15. **(b)** CH_4 NH_3 H_2O



Tetrahedral; Trigonal pyramidal Bent

Note: The geometry of H_2O should have been tetrahedral if there are all bond pairs. But due to presence of two lone pairs the shape is distorted tetrahedral. Hence bond angle reduced to 104.5° from 109.5°.

16. **(a)** According to VSEPR theory order of repulsion in between lp – lp, lp – bp and bp – bp is as under

lp – lp > lp – bp > bp – bp

17. **(a)** In NH_3 and BF_4^- the hybridisation is sp^3 and the bond angle is almost 109° 28'.

18. **(d)** In XeF_2 Total number of valence electrons of Xe = 8, two electrons shared with 2F atoms, 6 electrons left hence 3 lone pairs, in XeF_4 4 shared with 4 F atoms 4 left hence 2 lone pairs; in XeF_6 6 shared with 6 F atoms 2 left hence 1 lone pair.

19. **(a)** $$\text{Hybridisation} = \frac{1}{2}\left[\begin{pmatrix}\text{No. of electrons}\\ \text{in valence}\\ \text{shell of atom}\end{pmatrix} + \begin{pmatrix}\text{No.of monovalent}\\ \text{atoms around it}\end{pmatrix} - \begin{pmatrix}\text{charge on}\\ \text{cation}\end{pmatrix} + \begin{pmatrix}\text{charge on}\\ \text{anion}\end{pmatrix}\right]$$

(a) For AlH_3,

Hybridisation of Al atom $= \frac{1}{2}[3+3-0+0]$

$= 3 = sp^2$

For AlH_4^-,

Hybridisation of Al atom $= \frac{1}{2}[3+4-0+1]$

$= 4 = sp^3$

(b) For H_2O,

Hybridisation of O atom

$= \frac{1}{2}[6+2-0+0] = 4 = sp^3$

For H_3O^+, Hybridisation of O atom

$= \frac{1}{2}[6+3-1+0] = 4 = sp^3$

(c) For NH_3

Hybridisation of N atom

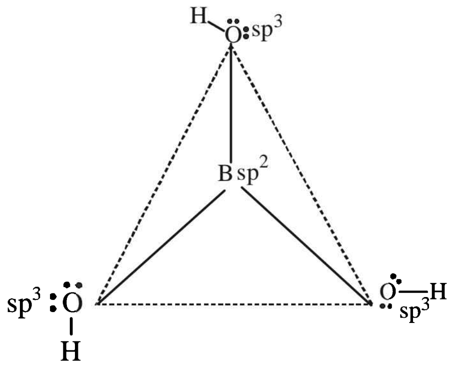
$= \frac{1}{2}[5+3-0+0] = 4 = sp^3$

For NH_4^+, Hybridisation of N atom

$= \frac{1}{2}[5+4-1+0] = 4 = sp^3$

Thus hybridisation changes only in option (a).

20. **(b)**



21. **(b)** Hybridisation in PO_4^{3-} = ½ [5 + 0 + 3 –0] = 4 sp³. In π bonding only d orbital of P, p orbital of O can be involved. Since hybrid atomic orbitals do not form π bond.

22. **(b)** The bond angle decreases on moving down the group due to decrease in bond pair-bond pair repulsion.

NH_3	PH_3	ASH_3	SbH_3	BiH_3
107°	94°	92°	91°	90°

This can also be explained by the fact that as the size of central atom increases sp³ hybrid orbital becomes more distinct with increasing size of central atom i.e. pure p- orbitals are utilized in M–H bonding

23. **(a)** For any species to have same bond order we can expect them to have same number of electrons. Calculating the number of electrons in various species.

$O_2^-(8+8+1=17)$; $CN^-(6+7+1=14)$

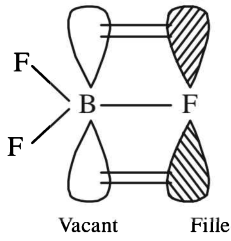
$NO^+(7+8-1=14)$; $CN^+(6+7-1=12)$

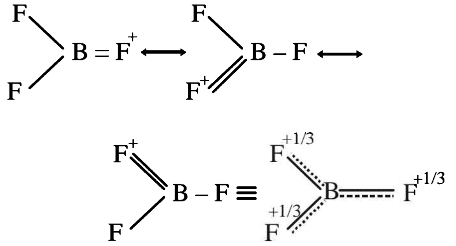
We find CN^- and NO^+ both have 14 electrons so they have same bond order. Correct answer is (a).

24. **(d)** $\sigma_b^2\,\sigma{*}_a^2\,\sigma_b^2\,\sigma_a^{*2}\,(\pi_b^2=\pi_b^2)\,\sigma_b^1(N_2^+=13\,\text{electrons})$

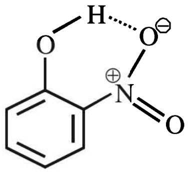
it contains one unpaired electron hence paramagnetic

25. **(b)** The delocalised $p\pi-p\pi$ bonding between filled *p*-orbital of F and vacant *p*-orbital of B leads to shortening of B–F bond length which results in higher bond dissociation energy of the B–F bond.





26. **(b)** Compounds involved in chelation become non-polar. Consequently such compounds are soluble in non-polar solvents like ether, benzene etc. and are only sparingly soluble in water whereas meta and para isomers are more soluble in water & less soluble in non-polar solvents.



intra-molecular H-bonding

27. **(b)** According to Fajan’s rules smaller, highly charged cation has greatest covalent character while large cation with smaller charge has greatest ionic character.

28. None of the given option is correct.

The molecular orbital configuration of the given molecules is

$H_2 = \sigma 1s^2$ (no electron anti-bonding)

$Li_2 = \sigma 1s^2\,\sigma^* 1s^2\,\sigma 2s^2$(two anti-bonding electrons)

$B_2 = \sigma 1s^2\,\sigma^* 1s^2\,\sigma 2s^2\,\sigma^* 2s^2\,\left\{\pi 2p_y^1 = \pi 2p_z^1\right\}$

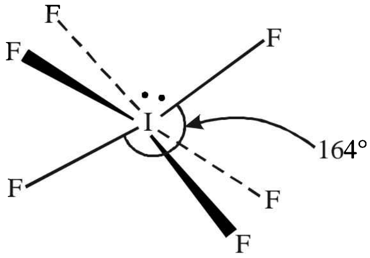
(4 anti-bonding electrons)

Though the bond order of all the species are same (B.O = 1) but stability is different. This is due to difference in the presence of no. of anti-bonding electron.

Higher the no. of anti-bonding electron lower is the stability hence the correct order is $H_2 > Li_2 > B_2$

29. **(a)** The structure of IF_6^- is distorted octahedral

This is due to presence of a “weak” lone pair.



30. **(b)** The molecular orbital configuration of the molecules given is

Total no. of electrons in NO = 7(N) + 8(O) = 15

$$\text{Hence E.C. of NO} = KK[\sigma(2s)]^2[\sigma^*(2s)]^2[\sigma 2p_z]^2[\pi(2p_x)]^2[\pi(2p_y)]^2[\pi^*(2p_x)]^1$$

Due to presence of one unpaired electron NO is paramagnetic.

Except NO all are diamagnetic due to absence of unpaired electrons.