

# DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

## CHEMISTRY

# 07

**SYLLABUS :** Valence bond theory, Hybridisation, VSEPR theory, Dipole moment, Hydrogen Bond, Van der Waals forces, Molecular Orbital Theory (MOT), Metallic bond

Max. Marks : 120

Time : 60 min.

### GENERAL INSTRUCTIONS

- The 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.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deducted for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

**DIRECTIONS (Q.1-Q.21) :** There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE choice is correct.

**Q.1** The hybridization and geometry of  $\text{BrF}_3$  molecule is -

- (a)  $\text{sp}^3\text{d}$  and T-shaped
- (b)  $\text{sp}^3\text{d}^2$  and tetragonal
- (c)  $\text{sp}^3\text{d}$  and bent
- (d) None of these

**Q.2** In which of the following, central atom has different hybridisation than others ?

- (a)  $\text{Cl}_2\text{O}$     (b)  $\text{OF}_2$     (c)  $\text{H}_2\text{O}$     (d)  $\text{SO}_2$

**Q.3** In following hydrocarbons, which one has 75% p character and 25% s character -

- (a)  $\text{C}_2\text{H}_4$     (b)  $\text{C}_2\text{H}_2$     (c)  $\text{CH}_4$     (d)  $\text{CH}_2$

**Q.4** Which of the following statement is incorrect?

- (a) Non-bonding pairs occupy more space than bonding pairs
- (b) The bonding orbitals in a trigonal bipyramidal molecule are described as  $\text{sp}^3\text{d}$  hybrid
- (c)  $\text{SnCl}_2$  has linear shape
- (d)  $\text{PCl}_4^+$  and  $\text{AlCl}_4^-$  are isoelectronic

**Q.5** Shape of  $\text{NH}_3$  is very similar to -

- (a)  $\text{CH}_4$     (b)  $\text{CH}_3^-$     (c)  $\text{BH}_3$     (d)  $\text{CH}_3^+$

### RESPONSE GRID

1. (a) (b) (c) (d)

2. (a) (b) (c) (d)

3. (a) (b) (c) (d)

4. (a) (b) (c) (d)

5. (a) (b) (c) (d)

**Q.6** Which of the following has pyramidal shape?

- (a)  $\text{XeO}_3$  (b)  $\text{XeF}_4$   
(c)  $\text{XeF}_2$  (d)  $\text{XeF}_6$

**Q.7** The correct order regarding the electronegativity of hybrid orbitals of carbon is :

- (a)  $sp < sp^2 < sp^3$  (b)  $sp < sp^2 < sp^3$   
(c)  $sp > sp^2 < sp^3$  (d)  $sp > sp^2 > sp^3$

**Q.8** Which of the following bonds is most polar ?

- (a)  $\text{O}-\text{H}$  (b)  $\text{P}-\text{H}$  (c)  $\text{C}-\text{F}$  (d)  $\text{S}-\text{Cl}$

**Q.9** Which of the following does not exist on the basis of molecular orbital theory?

- (a)  $\text{H}_2^+$  (b)  $\text{He}_2^+$  (c)  $\text{He}_2$  (d)  $\text{Li}_2$

**Q.10** The dipole moment of the ammonia molecule is 1.48D. The length of the dipole is -

- (a)  $3.08 \times 10^{-11} \text{ m}$  (b)  $5 \times 10^2 \text{ m}$   
(c) 308m (d) None of these

**Q.11** Which one of the following does not have intermolecular H-bonding ?

- (a)  $\text{H}_2\text{O}$  (b)  $\bullet$ -Nitrophenol  
(c)  $\text{HF}$  (d)  $\text{CH}_3$

**Q.12** Arrange in increasing order of the boiling point-  
 $\text{HF}, \text{HCl}, \text{HBr}, \text{HI}$ .

- (a)  $\text{HCl} < \text{HBr} < \text{HI} < \text{HF}$  (b)  $\text{HCl} > \text{HBr} > \text{HI} > \text{HF}$   
(c)  $\text{HCl} < \text{HBr} > \text{HI} < \text{HF}$  (d) None of these

**Q.13** The hybridization of carbon atoms in  $\text{C}-\text{C}$  single bond in  $\text{H}-\text{C}\equiv\text{C}-\text{CH}=\text{CH}_2$  is -

- (a)  $sp^3-sp^3$  (b)  $sp^2-sp$  (c)  $sp-sp^2$  (d)  $sp^3-sp$

**Q.14**  $\text{C}-\text{C}$  bond in  $\text{C}_2\text{H}_6$  undergoes heterolytic fission, the hybridisation of carbon is/are -

- (a)  $sp^2$  (b)  $sp^3$  (c)  $sp^2, sp^3$  (d)  $sp, sp^2$

**Q.15** The enolic form of acetone contains  $\sigma$  bond (a),  $\pi$  bond (b) and lone pair of electrons (c) -

- (a) 9a, 1b, 2c (b) 8a, 2b, 2c  
(c) 10a, 1b, 1c (d) 9a, 2b, 1c

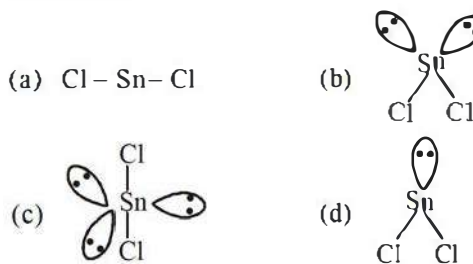
**Q.16** The bond order of  $\text{N}_2^-$  anion is -

- (a) 1 (b) 2 (c) 2.5 (d) 3

**Q.17** Which of the following has maximum bond strength ?

- (a)  $\text{O}_2$  (b)  $\text{O}_2^+$  (c)  $\text{O}_2^-$  (d)  $\text{O}_2^{2-}$

**Q.18** The atomic number of Sn is 50. The shape of gaseous  $\text{SnCl}_2$  molecule is :



**Q.19** The molecular orbital configuration of a diatomic molecule

$$\text{is } \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_x^2 \begin{cases} \pi 2p_y^2 \\ \pi 2p_z^2 \end{cases}$$

Its bond order is

- (a) 3 (b) 2.5 (c) 2 (d) 1

**Q.20** Which is not true according to VBT ?

- (a) A covalent bond is formed by the overlapping of orbitals with unpaired electrons of opposite spins  
(b) A covalent bond is formed by the overlapping of orbitals with unpaired electrons of same spin  
(c) The greater the extent of overlapping the stronger is the bond  
(d) Overlapping takes place only in the direction of maximum electron density of the orbital

**RESPONSE  
GRID**

- |                  |                  |                  |                  |                  |
|------------------|------------------|------------------|------------------|------------------|
| 6. (a)(b)(c)(d)  | 7. (a)(b)(c)(d)  | 8. (a)(b)(c)(d)  | 9. (a)(b)(c)(d)  | 10. (a)(b)(c)(d) |
| 11. (a)(b)(c)(d) | 12. (a)(b)(c)(d) | 13. (a)(b)(c)(d) | 14. (a)(b)(c)(d) | 15. (a)(b)(c)(d) |
| 16. (a)(b)(c)(d) | 17. (a)(b)(c)(d) | 18. (a)(b)(c)(d) | 19. (a)(b)(c)(d) | 20. (a)(b)(c)(d) |

Q.21 Allyl cyanide has -

- (a) 9 sigma bonds and 4 Pi bonds
- (b) 9 sigma bonds, 3 pi bonds and 1 lone pair
- (c) 8 sigma bonds and 5 pi bonds
- (d) 8 sigma bonds, 3 pi bonds and 4 non-bonding electrons

**DIRECTIONS (Q.22-Q.24) :** In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

**Codes :**

- (a) 1, 2 and 3 are correct
- (b) 1 and 2 are correct
- (c) 2 and 4 are correct
- (d) 1 and 3 are correct

Q.22 Which of the following have identical bond order ?

- (1)  $\text{CN}^-$  (2)  $\text{O}_2^-$
- (3)  $\text{NO}^+$  (4)  $\text{CN}^+$

Q.23 The molecules that will have dipole moment are

- (1) *trans*-2-Pentene
- (2) *cis*-3-Hexene
- (3) 2, 2-Dimethylpropane
- (4) 2, 2, 3, 3-Tetramethylbutane

Q.24  $\text{N}_2$  and  $\text{O}_2$  are converted into monoanions  $\text{N}_2^-$  and  $\text{O}_2^-$  respectively, which of the following statements are correct?

- (1) In  $\text{N}_2^-$ , the N – N bond weakens
- (2) In  $\text{O}_2^-$ , bond length increases
- (3)  $\text{N}_2^-$  becomes paramagnetic
- (4) In  $\text{O}_2^-$ , the O – O bond order increases

**DIRECTIONS (Q.25-Q.27) :** Read the passage given below and answer the questions that follow :

The distribution of electrons among various molecular orbitals is called the electronic configuration of the molecule which provides us the following very important information about the molecule.

(I) Stability of molecule : The molecule is stable if number of bonding molecular orbital electrons ( $N_b$ ) is greater than the number of antibonding molecular orbital electrons ( $N_a$ ).

(II) Bond order : Bond order =  $\frac{1}{2} (N_b - N_a)$

A positive bond order means a stable molecule while a negative or zero bond order means an unstable molecule.

(III) Nature of the bond : Bond order 1, 2 and 3 corresponds to single, double and triple bonds respectively.

(IV) Bond length : Bond length decreases as bond order increases.

(V) Magnetic nature : If molecular orbitals in a molecule are doubly occupied, the substance is diamagnetic and if one or more molecular orbitals are singly occupied, it is paramagnetic.

Q.25 Which of the following statements is incorrect ?

- (a) Among  $\text{O}_2^+$ ,  $\text{O}_2$  and  $\text{O}_2^-$  the bond length decreases as  $\text{O}_2^- > \text{O}_2 > \text{O}_2^+$
- (b)  $\text{He}_2$  molecule does not exist as the bonding and anti-bonding orbitals cancel each other
- (c)  $\text{C}_2$ ,  $\text{O}_2^{2-}$  and  $\text{Li}_2$  are diamagnetic
- (d) In  $\text{F}_2$  molecule, the energy of  $\sigma 2p_x$  is more than that of  $\pi 2p_y$  and  $\pi 2p_z$

Q.26 The following molecules/species have been arranged in the order of their increasing bond orders. Identify the correct order : (I)  $\text{O}_2$  ; (II)  $\text{O}_2^-$  (III)  $\text{O}_2^{2-}$  ; (IV)  $\text{O}_2^+$

- (a) III < II < I < IV (b) IV < III < II < I
- (c) III < II < IV < I (d) II < III < I < IV

**RESPONSE  
GRID**

21. (a) (b) (c) (d)

22. (a) (b) (c) (d)

23. (a) (b) (c) (d)

24. (a) (b) (c) (d)

25. (a) (b) (c) (d)

26. (a) (b) (c) (d)

**Q.27**  $N_2$  has greater dissociation energy than  $N_2^+$ , whereas  $O_2$  has a lower dissociation energy than  $O_2^+$  because –

- (a) bond order is decreased when  $O_2$  is ionized to  $O_2^+$  and bond order is increased when  $N_2$  is ionized to  $N_2^+$
- (b) bond order is increased when  $O_2$  is ionized to  $O_2^+$  and bond order is decreased when  $N_2$  is ionized to  $N_2^+$
- (c) bond order is decreased when  $O_2$  is ionized to  $O_2^+$  and bond order is decreased when  $N_2$  is ionized to  $N_2^+$
- (d) None of these

**DIRECTIONS (Q. 28-Q.30) :** Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

- (a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

- (b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

- (c) Statement-1 is False, Statement-2 is True.

- (d) Statement-1 is True, Statement-2 is False.

**Q.28 Statement-1 :**  $N_2F_3^+$  is planar at each nitrogen atom.

**Statement-2 :** In  $N_3H$ , the bond angle  $H-N-N$  is  $120^\circ$  and both the  $N-N$  bond lengths are not equal.

**Q.29 Statement-1 :** Geometry of  $SF_4$  molecule can be termed as distorted tetrahedron, a folded square or see saw.

**Statement-2 :** Four fluorine atoms surround or form bond with sulphur atom.

**Q.30 Statement-1 :** The nearly tetrahedral arrangement of the orbitals about the oxygen atom allows each water molecule to form hydrogen bonds with as many as four neighbouring water molecules.

**Statement-2 :** In ice each molecule forms four hydrogen bonds as each molecule is fixed in the space.

**RESPONSE GRID**

27. (a) (b) (c) (d)

28. (a) (b) (c) (d)

29. (a) (b) (c) (d)

30. (a) (b) (c) (d)

**DAILY PRACTICE PROBLEM SHEET 7 - CHEMISTRY**

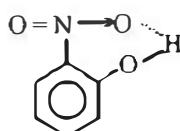
|                                            |    |                  |     |
|--------------------------------------------|----|------------------|-----|
| Total Questions                            | 30 | Total Marks      | 120 |
| Attempted                                  |    | Correct          |     |
| Incorrect                                  |    | Net Score        |     |
| Cut-off Score                              | 36 | Qualifying Score | 60  |
| Success Gap = Net Score – Qualifying Score |    |                  |     |
| Net Score = (Correct 4) – (Incorrect       |    |                  |     |

# DAILY PRACTICE PROBLEMS

# CHEMISTRY SOLUTIONS

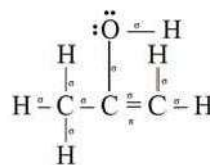
(07)

- (1) (a)  $\text{BrF}_3$  has  $sp^3d$  hybridization and T-shaped.
- (2) (d) Because it has  $sp^2$  hybridisation. Other three have  $sp^3$  hybridisation.
- (3) (c)  $\text{CH}_4$  because it has  $sp^3$  hybridisation.
- (4) (c)  $\text{SnCl}_2$  is a bent shape molecule due to presence of lone pair of electrons.
- (5) (b) Both have the same state of hybridization with one lone pair of  $e^-$  each.
- (6) (a) Due to presence of lone pair of electrons.  
 $\text{XeF}_4$  – Square planar  
 $\text{XeF}_2$  – Linear  
 $\text{XeF}_6$  – Pentagonal pyramidal
- (7) (d) Smaller the size of the hybrid orbital, greater is the electronegativity. Thus, the correct order is :  
 $sp > sp^2 > sp^3$ .
- (8) (c) Due to maximum electronegativity difference between two atoms.
- (9) (c) Helium molecule does not exist as it has bond order of zero.
- (10) (a)  $M = 1.48 \times 3.33 \times 10^{-30} \text{ cm}$   
 $= 4.93 \times 10^{-30} \text{ cm}$   
 $q = 1.6 \times 10^{-19} \text{ C}$   
 $\epsilon = \frac{\mu}{q} = \frac{4.93 \times 10^{-30}}{1.6 \times 10^{-19}} = 3.08 \times 10^{-11} \text{ m} = 0.0308 \text{ nm}$
- (11) (b) *o*-Nitrophenol has intramolecular H bonding as shown below

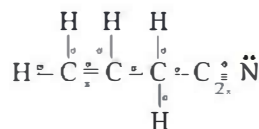


- (12) (a)  $\text{HCl} < \text{HBr} < \text{HI} < \text{HF}$   
 Boiling point depends upon the magnitude of van der Waal's forces operating between the molecules. As the size of the halogen increases from Cl to I, magnitude of attractive forces increases and hence, boiling point increases.  
 $\therefore$  Boiling point of  $\text{HI} > \text{HBr} > \text{HCl}$   
 However, boiling pt of HF is exceptionally high due to strong hydrogen bonding present between the H-F molecules. Thus, the correct order is :  
 $\text{HF} > \text{HI} > \text{HBr} > \text{HCl}$
- (13) (c) As the first carbon has triple bond and second one has double bond with other carbon atoms.
- (14) (c) During heterolytic fission there will be formation of  $\text{CH}_3^+$  and  $\text{CH}_3^-$  which has  $sp^2$  and  $sp^3$  hybridization respectively.

- (15) (a) This is clear from its structure as shown below :



- (16) (c)  $\text{N}_2^- : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \left( \begin{matrix} \pi 2p_x^2 \\ \pi 2p_y^2 \end{matrix} \right) \sigma 2p_z^2 \left( \begin{matrix} \pi^* 2p_x^1 \\ \pi^* 2p_y^0 \end{matrix} \right)$   
 $\text{BO} = \frac{1}{2} (N_b - N_a) = \frac{1}{2} (10 - 5) = \frac{5}{2} = 2.5$   
 $\therefore$  (c) is the correct choice.
- (17) (b) Bond strength (BS) – Bond order (BO)  
 $\text{O}_2 : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \left( \begin{matrix} \pi 2p_x^2 \\ \pi 2p_y^2 \end{matrix} \right) \left( \begin{matrix} \pi^* 2p_x^1 \\ \pi^* 2p_y^1 \end{matrix} \right)$   
 $\text{BO} = \frac{1}{2} (10 - 6) = \frac{4}{2} = 2$   
 $\text{O}_2^+ (15e^-) : \text{BO} = \frac{1}{2} (10 - 5) = \frac{5}{2} = 2.5$   
 $\text{O}_2^- (17e^-) : \text{BO} = \frac{1}{2} (10 - 7) = \frac{3}{2} = 1.5$   
 $\text{O}_2^{2-} (18e^-) : \text{BO} = \frac{1}{2} (10 - 8) = \frac{2}{2} = 1$   
 $\therefore \text{BO is } \text{O}_2^+ > \text{O}_2 > \text{O}_2^- > \text{O}_2^{2-}$   
 Hence, BS is  $\text{O}_2^+ > \text{O}_2 > \text{O}_2^- > \text{O}_2^{2-}$
- (18) (d)  $\text{Sn} [Z = 50], [\text{Kr}] \begin{matrix} 5s & 5p \\ \uparrow\downarrow & \uparrow\downarrow \end{matrix}$   
 $sp^2$  – hybridisation :  $\begin{matrix} \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow \end{matrix}$
- (19) (a)  $\text{B.O.} = \frac{N_b - N_a}{2} = \frac{10 - 4}{2} = 3$ .
- (20) (b) Electrons of same spin never combine to form a bond. Other facts are true or VBT.
- (21) (b) This is clear from structure of allyl cyanide



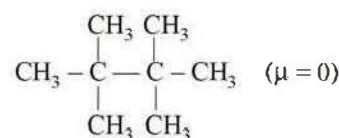
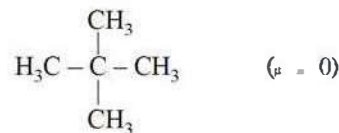
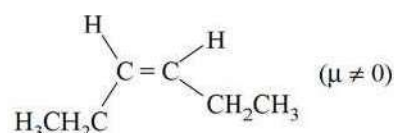
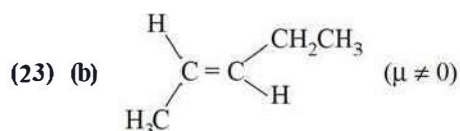
- (22) (d) Bond order =  $\frac{1}{2}$  (number of electrons in bonding molecular orbital – number of electrons in antibonding molecular orbital).

$$\text{Bond order of } \text{O}_2^- = \frac{1}{2} (10 - 7) = 1.5$$

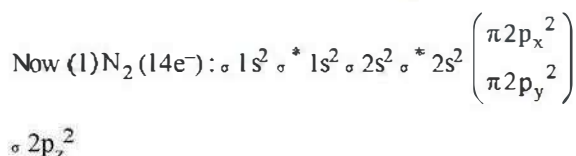
$$\text{Bond order of } \text{NO}^+ = \frac{1}{2} (10 - 4) = 3$$

$$\text{Bond order of } \text{CN}^+ = \frac{1}{2} (8 - 4) = 2$$

$$\text{Bond order of } \text{CN}^- = \frac{1}{2} (10 - 7) = 3$$



- (24) (a) Bond order (BO) ∝ Bond strength (BS)  
and, Bond order (BO) ∝  $\frac{1}{\text{Bond length (BL)}}$



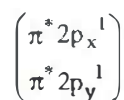
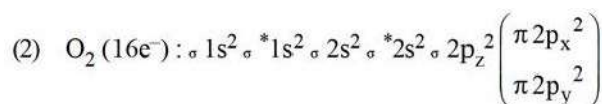
$$\text{BO} = \frac{1}{2} (10 - 4) = \frac{6}{2} = 3$$

$$\text{N}_2^- (15e^-): \text{BO} = \frac{1}{2} (10 - 5) = \frac{5}{2} = 2.5$$

$$\Rightarrow \text{BO}(\text{N}_2) > \text{BO}(\text{N}_2^-)$$

$$\therefore \text{BS}(\text{N}_2) > \text{BS}(\text{N}_2^-)$$

i.e. N–N in  $\text{N}_2^-$  is weaker than that in  $\text{N}_2$

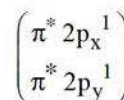
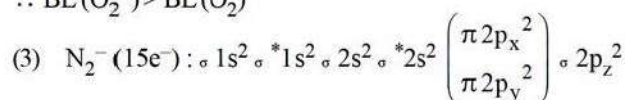


$$\text{BO} = \frac{1}{2} (10 - 6) = \frac{4}{2} = 2$$

$$\text{O}_2^- (17e^-): \text{BO} = \frac{1}{2} (10 - 7) = \frac{3}{2} = 1.5$$

$$\Rightarrow \text{BO}(\text{O}_2^-) < \text{BO}(\text{O}_2)$$

$$\therefore \text{BL}(\text{O}_2^-) > \text{BL}(\text{O}_2)$$



Due to presence of unpaired  $e^-$  in  $(\pi^* 2p_x)$ ,

$\text{N}_2^-$  is paramagnetic

(4) B.O. of  $\text{O}_2^-$  is less than the BO of  $\text{O}_2$ .

$\therefore$  only (4) is incorrect.

- (25) (d)

(a) Bond order ∝ 1/bond length

$$\text{Bond order } \text{O}_2^+ = 2.5, \text{O}_2 = 2, \text{O}_2^- = 1.5$$

So correct order of bond length is

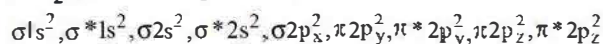
$$\text{O}_2^- > \text{O}_2 > \text{O}_2^+$$

(b) Bond order of  $\text{He}_2 = \frac{2 - 2}{2} = 0$

So  $\text{He}_2$  does not exist

(c) In all these molecules all electrons are paired in molecular orbitals. So they are all diamagnetic.

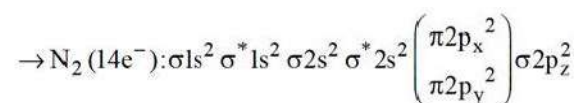
(d)  $\text{F}_2$  (MOT configuration):



Thus  $\sigma 2p_x$  is lower in energy than  $\pi 2p_y$  and  $\pi 2p_z$ .

|            |              |                |                   |                |
|------------|--------------|----------------|-------------------|----------------|
| (26) (a)   | $\text{O}_2$ | $\text{O}_2^-$ | $\text{O}_2^{2-}$ | $\text{O}_2^+$ |
| Bond order | 2            | 1.5            | 1                 | 2.5            |

- (27) (b) Bond order ∝ Dissociation energy (BDE)

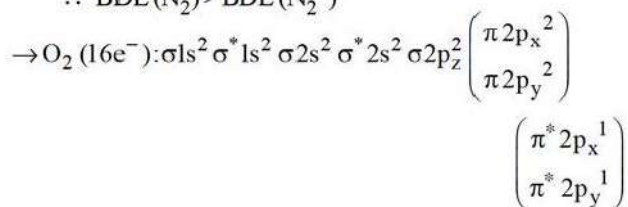


$$\text{BO} = \frac{1}{2} (10 - 4) = \frac{6}{2} = 3$$

$$\text{N}_2^+ (13e^-): \text{BO} = \frac{1}{2}(9-4) = \frac{5}{2} = 2.5$$

$$\text{BO}(\text{N}_2) > \text{BO}(\text{N}_2^+)$$

$$\therefore \text{BDE}(\text{N}_2) > \text{BDE}(\text{N}_2^+)$$

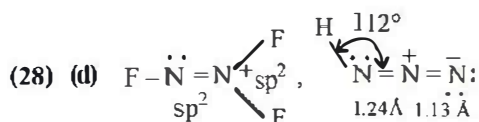


$$\text{BO} = \frac{1}{2}(10-6) = \frac{4}{2} = 2$$

$$\text{O}_2^+ (15e^-): \text{BO} = \frac{1}{2}(10-5) = \frac{5}{2} = 2.5$$

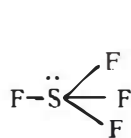
$$\text{BO}(\text{O}_2^+) > \text{BO}(\text{O}_2)$$

$$\therefore \text{BDE}(\text{O}_2^+) > \text{BDE}(\text{O}_2)$$



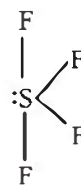
- (i) In  $\text{N}_3\text{H}$ , bond angle is  $112^\circ$  due to  $\ell\text{p}-\text{bp}$  repulsion.  
(ii) Smaller bond length ( $1.13 \text{ \AA}$ ) due to attraction between the opposite poles.

- (29) (b) Sulphur has five pairs of electrons whose arrangement should be trigonal bipyramidal according to VSEPR theory. Two structures are possible.



(a)

Lone pair in the axial position (three  $\ell\text{p}-\text{b.p}$  repulsion at  $90^\circ$ )



(b)

Lone pair in the equatorial position (two  $\ell\text{p}-\text{b.p}$  repulsion)

Accepted structure see-saw geometry

- (30) (a) At any given instant, at room temperature each water molecule forms hydrogen bonds with other water molecules. The water,  $\text{H}_2\text{O}$  molecules are in continuous motion, so hydrogen bonds are constantly & rapidly broken & formed. In ice,  $\text{H}_2\text{O}$  molecules are however fixed in the space lattice.