VSEPR Theory

21. **(a) BCl_3 has no lone pair of electrons but NCl_3 has a lone pair of electrons**

Explanation:

In BCl_3, boron has only three valence electrons and forms three bonds — no lone pairs — leading to a **trigonal planar** shape.

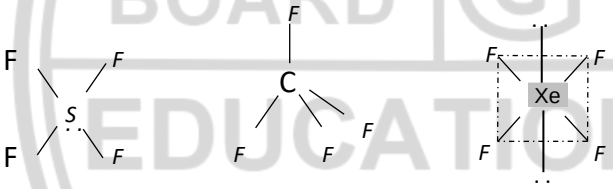
In NCl_3, nitrogen has one lone pair and three bond pairs, giving a **pyramidal** shape due to lone pair–bond pair repulsion.

22. (d) Number of electrons in ClO_2^-

$= 7 + 6 + 6 + 1 = 20$

Number of electrons in $ClF_2^+ = 7+7+7 - 1=20$.

23. (b) Central atom having four electron pairs will be of tetrahedral shape.



24. (d)

25. **(a) CO_3^{2-}**

Explanation (Word-friendly format):

The carbonate ion (CO_3^{2-}) has **three equivalent resonance structures** with delocalized π-electrons.

The central carbon atom is **sp^2 hybridized**, resulting in **three sigma bonds** arranged at **120°** angles in one plane.

Therefore, **CO_3^{2-} is a planar species**.

- NH_2^- → has a bent shape (sp^3 hybridization with lone pairs).
- PCl_3 → has a pyramidal shape (sp^3 hybridization with one lone pair).

26. (c) It shows sp^2 – hybridization and show trigonal planar structure.

27. **(c) $NH_3 > H_2O > CH_4 < C_2H_2$**

Explanation (Word-friendly format):
Let's compare based on hybridization and lone pairs:

- **C_2H_2 (sp)** → linear → bond angle **180°**
- **CH_4 (sp^3)** → tetrahedral → bond angle **109.5°**
- **NH_3 (sp^3 with one lone pair)** → bond angle **107°**
- **H_2O (sp^3 with two lone pairs)** → bond angle **104.5°**

Thus, the **decreasing order of bond angle** is:
C_2H_2 (180°) > CH_4 (109.5°) > NH_3 (107°) > H_2O (104.5°)

Hence, the **reducing order** (in question form) is:
$NH_3 > H_2O > CH_4 < C_2H_2$

28. (b) H_2S show bond angle nearly 90^o.

29. **(a) A pair of valence electrons not involved in bonding**

Explanation (Word-friendly format):
A **lone pair** refers to a **pair of valence electrons** that **does not take part in chemical bonding**.
These electrons belong exclusively to one atom and influence the molecule's **shape and polarity** due to **lone pair–bond pair repulsion**.

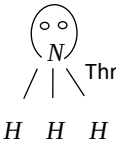
30. **(a) Repulsion between lone pair and bond pair**

Explanation (Word-friendly format):
In a water molecule (H_2O), the oxygen atom is **sp^3 hybridized** with **two lone pairs** and **two bond pairs**.
According to the **VSEPR theory**, lone pair–bond pair repulsion is **greater** than bond pair–bond

pair repulsion.

This stronger repulsion **pushes the hydrogen atoms closer**, reducing the bond angle from the tetrahedral value of 109.5° to **104.5°** .

31. (a) Bond angle of hydrides is decreases top to bottom in the group. $NH_3 > PH_3 > AsH_3 > SbH_3$

32. (c) 

Three bond pair and one lone pair of electron.

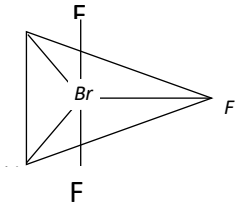
33. (c) Unpaired electrons are present in KO_2 while others have paired electron

$NO_2^+ = 22$ electrons ; $BaO_2 = 72$ electrons

$AlO_2 = 30$ electrons ; $KO_2 = 35$ electrons

34. (a) Bond angle decreases from H_2O to H_2Te .

35. (c) BF_3 does not contain lone pair of electron.

36. (b) 

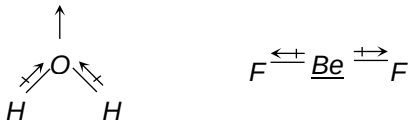
Bent *T*-shaped geometry in which both lone pairs occupy the equatorial position of the trigonal bipyramidal here

$(l_p - l_p)$ repulsion = 0

$(l_p - b_p)$ repulsion = 4 and

$(b_p - b_p)$ repulsion =2

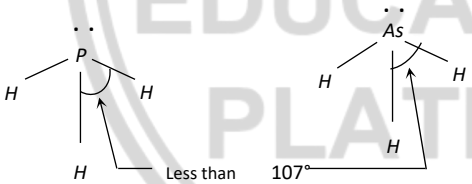
37. (b) The overall value of the dipole moment of a polar molecule depends on its geometry and shape *i.e.*, vectorial addition of dipole moment of the constituent bonds water has angular structure with bond angle 105° as it has dipole moment. However BeF_2 is a linear molecule since dipole moment summation of all the bonds present in the molecule cancel each other.



38. (d) BCl_3, BBr_3 and BF_3, all of these have same structure *i.e.* trigonal planar (sp^2 hybridization) Hence bond angle is same for all of them (*i.e.*, equal to 120°)

39. (d) We know that molecule of (NH_3) has maximum repulsion due to lone pair of electron. Its shape is pyramidal and is sp^3 hybridization.

40. (b)



As the electronegativity of central atom decreases bond angle is decreases

$\therefore$ NH_3 has largest bond angle.

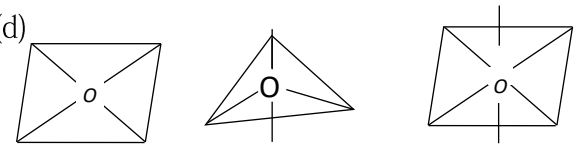
41. (c) In NH_3, sp^3-hybridization is present but bond angle is $106^{\circ}45'$ because Nitrogen has lone pair of electron according to VSEPR theory due to *bp-lp* repulsion bond angle decreases from $109^{\circ}45'$ to $106^{\circ}45'$.

42. (a) Bond strength decreases as the size of the halogen increases from *F* to *I*.

43. (b) NH_3 has pyramidal structure, yet nitrogen is sp^3 hybridised. This is due to the presence of lone pair of electron.

44. (c) SiF_4 has symmetrical tetrahedral shape which is due to sp^3 hybridization of the central sulphur atom in its excited state configuration. SF_4 has distorted tetrahedral or Sea- Saw geometry which arise due to sp^3d hybridization of central sulphur atom and due to the presence of lone pair of electron in one of the equatorial hybrid orbital.

45. (d)



dsp^2 hybridization (Four 90°) | sp^3d hybridization (Six 90° angle) | sp^3d^2 hybridization (Twelve 90°