



## ***Tutorial -1***

- Which statement about resonance structures for  $H_2$  is correct?**
  - Two non-equivalent ionic structures can be drawn.
  - Resonance structures include covalent and ionic forms.
  - All resonance structures are equally likely.
  - Each resonance form exists separately, and the forms are in equilibrium.
- As one goes along the series of diatomics  $Li_2$ ,  $B_2$ ,  $C_2$ ,  $N_2$ ,  $O_2$  and  $F_2$ , the bond dissociation enthalpy:**
  - increases then decreases.
  - increases.
  - decreases then increases.
  - decreases
- Match the hybridization scheme to the carbon atom in each molecule. Which pair is incorrect?**

(a)  $sp^3$ ;  $CH_2Cl_2$       (b)  $sp^3$ ;  $CH_4$     (c)  $sp^2$ ;  $CO_2$     (d)  $sp^2$ ;  $H_2CO$
- Which of the following compositions corresponds to an  $sp^3$  hybrid orbital?**
  - 33% s and 67% p character.
  - 75% s and 25% p character.
  - 25% s and 75% p character
  - 50% s and 50% p character
- Match the shape to an appropriate hybridization scheme for the central atom. Which pair is incorrect?**

(a)  $AlF_3$ ;  $sp^2$       (b)  $PF_3$ ;  $sp^3$     (c)  $ClF_3$ ;  $sp^2$     (d)  $NH_3$ ;  $sp^3$
- For which one of the following molecules or ions would  $sp^3$  hybridization scheme not be appropriate for the central atom?**

(a)  $SiF_4$       (b)  $SF_4$       (c)  $[AlCl_4]^-$     (d)  $GeCl_4$
- Match the shapes to the stated molecule or ion. Which pair is incorrect?**

(a)  $H_2S$ ; non-linear.      (b)  $NH_3$ ; trigonal pyramidal.    (c)  $BH_3$ ; trigonal pyramidal.  
(d)  $H_2O$ ; non-linear



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8. All but one of the following descriptions could apply to a triatomic molecule. Which is the odd one out?  
(a) Linear. (b) Bent (c) Non-linear. (d) Trigonal planar.
9. Apply the VSEPR model to  $\text{AsF}_3$  and to  $\text{AsF}_5$ . Which shapes are consistent with the model?  
(a)  $\text{AsF}_3$ , trigonal pyramidal;  $\text{AsF}_5$ , trigonal bipyramidal.  
(b)  $\text{AsF}_3$ , trigonal pyramidal;  $\text{AsF}_5$ , square-based pyramidal.  
(c)  $\text{AsF}_3$ , trigonal planar;  $\text{AsF}_5$ , trigonal bipyramidal.  
(d)  $\text{AsF}_3$ , trigonal planar;  $\text{AsF}_5$ , trigonal pyramidal.
10. Which of the following combinations of molecular formula and shape is inconsistent with the VSEPR model?  
(a)  $\text{SO}_3$ ; trigonal planar.  
(b)  $\text{SOCl}_2$ ; trigonal pyramidal.  
(c)  $\text{SOF}_4$ ; see-saw.  
(d)  $\text{SO}_2$ ; linear.
11. Consider the molecules  $\text{CH}_4$ ,  $\text{NH}_3$  and  $\text{H}_2\text{O}$ . Which statement below is incorrect?  
(a) The  $\text{H}-\text{O}-\text{H}$  bond angle in  $\text{H}_2\text{O}$  is smaller than the  $\text{H}-\text{N}-\text{H}$  bond angle in  $\text{NH}_3$ .  
(b) The  $\text{H}-\text{C}-\text{H}$  bond angle in  $\text{CH}_4$  is larger than the  $\text{H}-\text{N}-\text{H}$  bond angle in  $\text{NH}_3$ .  
(c) The  $\text{H}-\text{O}-\text{H}$  bond angle in  $\text{H}_2\text{O}$  is larger than the  $\text{H}-\text{C}-\text{H}$  bond angle in  $\text{CH}_4$ .  
(d) The  $\text{H}-\text{C}-\text{H}$  bond angle in  $\text{CH}_4$ , the  $\text{H}-\text{N}-\text{H}$  bond angle in  $\text{NH}_3$ , and the  $\text{H}-\text{O}-\text{H}$  bond angle.
12.  $\text{H}_2\text{O}$  are all greater than  $90^\circ$ . To which of the following species could the VSEPR model not be applied?  
(a)  $[\text{PdCl}_4]^{2-}$   
(b)  $\text{SeCl}_4$   
(c)  $\text{XeCl}_4$   
(d)  $[\text{ICl}_4]^-$



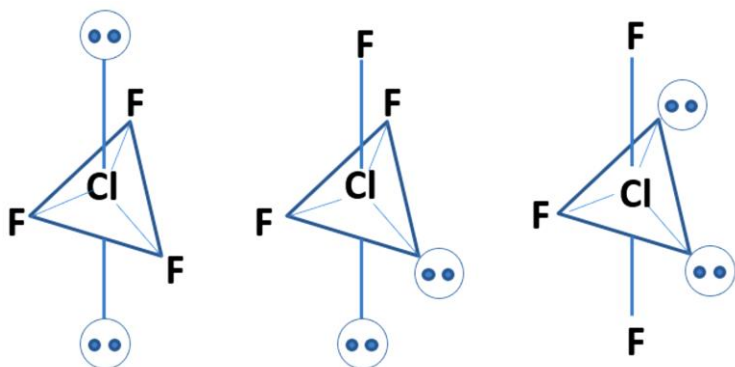
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- 13. For which molecule below is the molecular shape different from the arrangement of the electron-pair domains?**
- (a)  $\text{CF}_4$
  - (b)  $\text{NH}_3$
  - (c)  $\text{SO}_3$
  - (d)  $\text{PCl}_5$
- 14. Which hybridization scheme is most appropriate for the central atom in  $\text{SO}_3$ ?**
- (a)  $\text{sp}^2$
  - (b)  $\text{sp}^3$
  - (c)  $\text{sp}^3\text{d}$
  - (d)  $\text{spd}$
- 15. Apply the VSEPR model to predict a structure for  $\text{OF}_2$ , and then suggest a suitable hybridization scheme for the O atom. Which pair below is the correct combination?**
- (a) Non-linear;  $\text{sp}^2$
  - (b) Linear;  $\text{sp}^2$
  - (c) Non-linear;  $\text{sp}^3$
  - (d) Linear;  $\text{sp}$
- 16. What is orbital? How is it different from orbit?**
- 17. Write down a set of quantum numbers that describes an electron in a 6p atomic orbital. How does this set of quantum numbers differ if you are describing the second electron in the same orbital?**
- 18. The dipole moment of a gas phase HBr molecule is 0.827 D. Determine the charge distribution in this diatomic if the bond distance is 141.5 pm. ( $1\text{D} = 3.336 \times 10^{-30} \text{ Cm}$ )**
- 19. State the demerits of Octet rules?**
- 20. Do  $\text{BeF}_2$ , and  $\text{PF}_5$  follow octet rules?**
- 21. Is it true that any molecule with more than 4 covalent bonds break the Octet rule?**
- 22. Can you explain using Octet rule – the paramagnetism of  $\text{O}_2$ ?**

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**23.** What are the structure of i) gas  $\text{PCl}_5$  and ii) solid  $\text{PCl}_5$  ? which one is more reactive and why ?

**24.** There are three possible structures of  $\text{ClF}_3$ . Which one is correct and why?



**25.** Why does  $\text{PCl}_5$  molecule exist but  $\text{PH}_5$  does not ?

**26.** Draw the Lewis structure of  $\text{POF}_3$  and  $\text{NO}_3^-$

**27.** What are the structure/geometry of  $[\text{BrF}_6]^-$  and  $[\text{TeF}_6]^-$  ?

**28.** Predict the hybridization and geometry with atomic orbital diagram:  $\text{ICl}_4^-$ ,  $\text{TeF}_5$ ,  $\text{POF}_3$  and  $\text{XeF}_6$

**29.** State the electron pair and molecular geometries for:  $\text{SO}_2$ ,  $\text{SF}_4$ ,  $\text{XeF}_4$

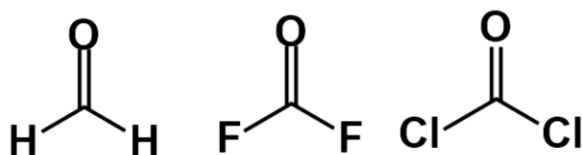
**30.** Predict the Electron-pair geometries and Molecular shapes for the molecules:  $\text{I}^{3-}$ ,  $\text{ClF}_3$ ,  $\text{BrF}_5$

**31.** Draw the possible geometries for the molecule,  $\text{H}_2\text{O}_2$ . Explain their stability using VESPR theory.

**32.** Predict the basic nature of  $\text{NO}^{2+}$ ,  $\text{NO}_2$  and  $\text{NO}_2^-$

**33.** Predict order of bond angle among  $\text{SF}_4$ ,  $\text{SOF}_4$ ,  $\text{CH}_2=\text{SF}_4$

**34.** Predict the bond angle,





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- 35.** In  $\text{BF}_3$ , B–F bond is shorter than expected. Please explain.
- 36.** Why is  $\text{NH}_3$  pyramidal while  $\text{N}(\text{SiMe}_3)_3$  is planar ?
- 37.** Why doesn't  $\text{He}_2$  exist ?
- 38.** Calculate the bond order of  $\text{CO}^+$ ,  $\text{CO}^{2+}$  . Write down the resonating structures of CO.
- 39.** Write the MO electron configuration for  $\text{NO}^-$  ion.
- What is the bond order
  - Will the bond length be shorter or longer than in NO ?
  - How many unpaired electrons will be present ?
  - Will the bonding orbitals be centered more on O or N? please explain
- 40.**  $\text{H}_2\text{O}$  has two lone pairs but it is monodentate. Explain with MO diagram of  $\text{H}_2\text{O}$
- 41.** Draw MO diagram for the valence electrons of BC. (B- Boron and C- Carbon)
- Write the molecular orbital configuration for the valence electrons BC and in  $\text{BC}^-$
  - Which of the molecular orbitals in BC do not have planar mode along internuclear axis ?
  - Which one has the stronger B-C bond, BC or  $\text{BC}^-$  ?
- 42.** What are the differences between hybrid orbital and molecular orbital ?
- 43.** Why does sp mixing happen in MO theory ?