Structure & Bonding
Tutorial 5

(1) Which of the following has the highest covalent character?

i. Si-Cl ii. P-Cl iii. S-Cl iv. P-F v. S-F

(2) Which of the following species does not contain lone pairs on the underlined atom.

i. OF_2 ii. PH_3 iii. NF_3 iv. CH_4 v. HCl

(3) Which of the following correctly arranges the species in **increasing** order of bond length?

i. F_2, Cl_2, ICl, BrCl, I_2
ii. F_2, Cl_2, BrCl, ICl, I_2
iii. F_2, BrCl, Cl_2, I_2, ICl
iv. F_2, Cl_2, BrCl, I_2, ICl
v. F_2, ICl, BrCl, Cl_2, I_2

(4) Which covalent compound among the following has the smallest bond length?

i. H-F ii. H-Cl iii. H-Br iv. H-I v. I-I

(5) Among the following, which orbital pair's overlapping results in a powerful bond?

i. s-s ii. sp-sp iii. s-p iv. p-p v. sp^3-sp^3

(6) Which of the following correctly arranges the species in **increasing** order of bond energy?

i. N_2, O_2, F_2 ii. F_2, O_2, N_2 iii. O_2, F_2, N_2

iv. O_2, N_2, F_2 v. F_2, N_2, O_2

(7) Which atom's valence shells can accommodate more than 8 electrons in covalent bonds?

i. H ii. N iii. F iv. Te v. Be

(9) Which of the following correctly arranges the species in **increasing** order of bond polarity?

a) Si-Cl b) S-Cl c) Mg-Cl

i. c < a < b ii. b <a <c iii. b < c < a iv. c < b < a v. a < b < c

(10) Which of the following bonds has the least polarization?

i. O-F ii. P-F iii. Si-N iv. B-Cl v. I-F

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(11) Which covalent bond among the following has the highest ionic characteristics?

i. F-Be-F ii.F-Li iii. F-Br iv. F-F v. F-O-F

(12) Out of the following chlorine atoms, which one has the highest positive partial charge?

i. HCl ii. BrCl iii. OCl_2 iv. SCl_2 v. NCl_3

(13) Which of the following molecule has the highest polarity?

i. NH_3 ii. H_2O iii. H_2S iv. H_2Te v. CF_4

(14) Which of the following bonds has the highest polarization?

i. Br-F ii. Br-Cl iii. Br-Br iv. I-Br v. I-I

(15) Electronegativities of H, C, N, and O are 2.1, 2.5, 3.0 and 3.5 respectively. Which of the following covalent bond is more polarized?

i.C-H ii.N-H iii. O-H iv. O-C v. O-N

(16) Which covalent bond among the following has the highest ionic characteristics?

i.H-H ii.F-F iii. Cl-Br iv. N-H v. O-H

(17) Which of the following substances has covalent characteristics?

i.MgF_2 ii. $MgBr_2$ iii. AlF_3 iv. $AlBr_3$ v. CsF_2

(18) Which of the following sets includes only covalently bound species?

i.NO, HBr, LiOH ii. NH_3, F_2, $AlCl_3$ iii. AlF_3, BF_3, H_2O
iv. NaF, $Al(OH)_2$, CCl_4 v. CO, $BaCl_2$, N_2

(19) Which of the following species only has covalent bonds?

i.H_2SO_4 ii. NH_4NO_3 iii. NaOCl iv. K_2CrO_4 v. Hg_2Cl_2

(20) Which of the following is not a covalent compound?

i.Li_2S ii. MgO iii. Fe_2O_3 iv. Bi_2O_3 v. P_2O_5

(21) Which compound among the following has the highest ionic characteristics?

i. NaF ii. ZnS iii. K_2O iv. $BaCl_2$ v. $RbNO_3$

(22) Which of the following compounds has a dipole moment with a net zero value?

i. $CCl_2=CCl_2$ ii. CH_2Cl_2 iii. C_2Cl_2 iv. BCl_3 v. CCl_4

(23) Which of the following statement is **true** regarding C_2H_2?

i. C_2H_2 molecule contains 1 covalent bond.
ii. C_2H_2 molecule contains 2 covalent bonds.
iii. C_2H_2 molecule contains 3 covalent bonds.
iv. C_2H_2 molecule contains 4 covalent bonds.
v. C_2H_2 molecule contains 5 covalent bonds.

(24) Which of the following molecule is non-polar?

i. NH_3 ii. HCl iii. CO_2 iv. SO_2 v. H_2S

(25) Which of the following molecule has the highest polarity?

i. PH_3 ii. H_2O iii. CF_4 iv. $SiCl_4$ v. SiH_4

(26) Which of the following central atoms has exactly five pairs of electrons?

i. ClF_5 ii. SF_4 iii. SF_5^- iv. CH_4 v. HCl

(27) Which of the following species has a similar shape to NH_3.

i. SO_3^{2-} ii. $SOCl_2$ iii. $COCl_2$ iv. CO_3^{2-} v. BF_3

(28) Which of the following sets contains species with equal shapes?

i. CO_3^{2-} and SO_3^{2-} ii. ClO_3^- and NO_3^- iii. SF_4 and SO_2Cl_2
iv. ClF_3 and PO_3 v. NO_2^- and Cl_2O

(29) What is the electron pair geometry around the central atom in XeO_3?

i. trigonal planar ii. pyramidal iii. tetrahedral iv. T- shaped v. See-saw

(30) Which couple among the following has an unpaired electron in both species?

i. SO_2 and NO_2 ii. N_2O and NO_2 iii. NO_2 and NO iv. NO and CO v. NO and SO_2

(31) Which of the following statements is **false** regarding CCl_4 molecule?

i. The dipole moment is zero.
ii. This molecule has a tetrahedral shape.
iii. The C atom is sp^3 hybridized.
iv. This molecule only contains σ bonds.
v. There are 3 σ bonds with a 1 π bond.

(32) The number of valence electrons in the Si atom of the $[SiF_6]^{2-}$ molecule is,

i. 2 ii. 4 iii. 6 iv. 10 v. 12

(33) The shape of the POClBrF molecule is,

i. planar ii. tetrahedral iii. octahedral iv. pyramidal v. trigonal bipyramidal

(34) Which of the following molecule is linear?

i. NO_2 ii. SO_2 iii. SiO_2 iv. CO_2 v. NO_3^-

(35) Which of the following is **true** regarding BF_3 molecule?

	Electron pair geometry around B	Hybridization of B
i.	Linear	sp
ii.	Trigonal planar	sp^2
iii.	Tetrahedral	sp^3
iv.	Pyramidal	sp^3
v.	Planar	sp^3

(36) Shape of the H_2S molecule is,

i. linear ii. bent iii. tetrahedral iv. trigonal planar v. None of the above.

(37) Shape of the $ClO3^-$ ion is,

i. tetrahedral ii. planar iii. T-shaped

iv. trigonal bipyramidal v. It is shaped identically to SO_3

(38) Which of the following species differs in shape from SO_4^{2-}?

i. NH_4^+ ii. BCl_4^- iii. SF_4 iv. $S_2O_3^{2-}$ v. CH_4

(39) Which of the following answer is true regarding the shape of PF_4^- ?

i. It is a planar molecule ii. This molecule has a tetrahedral shape

iii. It has an octahedral shape iv. It is T-shaped v. None of the above is true.

(40) Which of the following pairs contains species with similar shapes?

i. NF_3, NO_3^- and BF_3, H_3O^+

ii. NF_3, NH_3 and NO_3^-, BF_3

iii. NF_3, H_3O^+ and NO_3^-, BF_3

iv. NF_3, H_3O+ and NH_3, BF_3

v. NF_3, BF_3 and H_3O^+, NH_3

(41) Which of the following is **true** regarding NH_4^+ ion?

	Electron pair geometry around N	Shape
i.	Pyramidal	Bent
ii.	Trigonal planar	T-shapes
iii.	Tetrahedral	Tetrahedral
iv.	Pyramidal	Pyramidal
v.	Pyramidal	Bent

(42) Which of the following sets contains species with similar shapes?

a) CO_3^{2-} b) NO_3^- c) BO_3^{3-} d) H_2S

i. a,b and d ii. b and c iii. c and d iv. a,b and c v. All

(43) Shape and the electron pair geometry around Xe in XeO4 molecule is,

i. trigonal bipyramidal and octahedral
ii. square pyramidal and trigonal bipyramidal
iii. trigonal bipyramidal and square pyramidal
iv. square pyramidal and octahedral
v. octahedral and square pyramidal

(44) Which of the following sets includes species with similar shapes?

a) NH_3 b) H_3O^+ c) ClF_3 d) BCl_3 e) PCl_3

i. a and c ii. c and d iii. a,b and e iv. c,d and e v. b and c

(45) What is the electron pair geometry around N in NO_2^- ion?

i. linear ii. bent iii. trigonal planar iv. tetrahedral v. See-saw

(46) Which of the following pair contains species with different shapes?

i. CO_2, $BeCl_2$ ii. NO_3^-, SO_3 iii. NCl_3, BCl_3 iv. HOBr, H_2S v. PO_4^{3-}, $S_2O_3^{2-}$

(47) which of the following molecules has 4 atoms in the same plane?

i. BCl_3 ii. SF_3 iii. NH_3 iv. SiH_4 v. PCl_3

(48) Which of the following species has a similar shape to ICl_2^-.

i. SO_2 ii. CO_2 iii. O_3 iv. HOCl v. H_2O

(49) Shape of the BrF_5 molecule is,

i. bent ii. octahedral iii. square pyramidal iv. tetrahedral v. none of the above

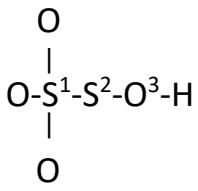
(50) Shape of the XeF_4 molecule is,

i. tetrahedral ii. square planar iii. octahedral iv. trigonal bipyramidal v. see-saw

Structure & Bonding - Tutorial 6

Structured Essay Questions

(1) a) Skeleton of $HS_2O_5^-$ ion is given below.



i) Draw the most acceptable Lewis structure for the above ion.

ii) Draw 3 resonance structures other than the answer in ii).

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iii) Complete the table given below using the structure drawn in i) above.

	Around S1	Around S2	Around O3
Electron pair geometry			
Shape			
Hybridization			
Bond angle			

iv) Name the atomic/hybrid orbitals participating in forming the following σ bonds.

i) S1 – S2 S1 =…….. S2 =……..
ii) S2– O3 S2 =…….. O3=……..
iii) O3 – H O3 =…….. H =……..

b) i) Deduce the shape of the NO_2^{-1} ion using VSEPR theory.

ii) Write the hybridization of N and O atoms in NO_2^- ion.

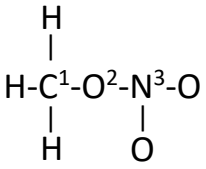
N - ……. O1 - …… O2 - …….

iii) Consider the oxo-anion formed from NO_2-ion and write answers to the following Questions.

Hybridization of N atom - …….

Valency of N atom - ……..

(2) a) Skeleton of methylnitrate (CH_3NO_3) molecule is given below.



i) Draw the most acceptable Lewis structure for the above molecule.

ii) Draw the resonance structures other than the answer in ii) and comment on their stability.

iii) Complete the table given below using the structure drawn in i) above.

	Around C	Around O	Around N
Electron pair geometry			
Hybridization			
Oxidation Number			

iv) Deduce the shapes around following atoms using the VSEPR theory.

a) C

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b) O

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c) N

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……

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b) Complete the following table.

Molecule	Electron pair geometry around central atom	Shape
H_2O		
SiO_2		
HOBr		
BrF_5		
NCl_3		

(3) a) Skeleton of the SCN- ion is given below.

S – C – N

i) Draw the most acceptable Lewis structure for the above molecule.

ii) Draw the resonance structures other than the answer in ii) and comment on their stability.

iii) Complete the table given below using the structure drawn in i) above.

	Around S	Around C	Around N
Electron pair geometry			
Hybridization			
Oxidation Number			

iv) Deduce the shapes around following atoms using the VSEPR theory.

a) C

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b) S

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c) N

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……

b) i) Draw the most acceptable lewis structure for $Cr_2O_7^{2-}$ ion.

ii) Write the hybridization and oxidation number of Cr atoms in $Cr_2O_7^{2-}$ ion.

Hybridization - ……..

Oxidation number - ……..

(4) a) i) Draw the most acceptable Lewis structure for $S_2O_3^{2-}$ ion.

ii) Write the oxidation numbers of S atoms in the above ion.

S1 - ……

S2 - ……

iii) Draw the Lewis dot and cross diagram for the above ion.

iv) Draw the resonance structures for the above ion.

b) Complete the table using the species in the given list.

$POCl_3$, OCl_2, XeF_2, SF_4, SO_3, SF_6

Property I	Property II	Species
Non polar	i. There are 5 atoms in the same plane. ii. There are 3 lone pairs around the central atom. iii. All the atoms are placed in a single plane	…… …… ……
Polar	iv. Most electronegative atom is the central atom. v. There are 3 different bond angles within the molecule. vi. All the bond angles are around 109°	…… …… ……

Resonance Structures

(01) Draw the resonance structures of the following molecules and state their stability.

1. CO

2. NO

3. NO_2

4. NO^+

5. N_2O

6. N_2O_3

7. N_2O_5

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8. NO_2^-

9. NO_3^-

10. CO_3^{2-}

11. HCO_3^-

12. $C_2O_4^{2-}$

13. NOCl

14. CH_3COO^-

15. SCN^-

16. CN^-

17. N_3^-

18. O_3

19. H_2O_2

20. NH_4^+

21. NH_2^-

22. SO_3^{2-}

23. SO_4^{2-}

24. $S_2O_3^{2-}$

25. $SOCl_2$

26. Cl_20

27. ClO_3^-

28. HOCl

29. SO_2

30. PO_4^{3-}

32. $H_2PO_4^-$

33. HPO_4^{2-}

34. ClO_2

35. IO_3^-

36. BrO_3^-

37. MnO_4^-

38. CrO_4^{2-}

39. $Cr_2O_7^{2-}$

40. MnO_4^{2-}

41. ClO_4^-

42. I_3^-

43. NO_2F

44. N_2O_4

45. HN_3

(02) Draw the resonance hybrid of the following molecules.

1. NO_2^-
2. NO_3^-
3. NO_2
4. NO^+
5. N_2O_3
6. N_2O

7. N_2O_4 8. N_2O_5 9. N_3^-

10. SO_3^{2-} 11. SO_4^{2-} 12. $S_2O_3^{2-}$

13. CO_3^{2-} 14. $C_2O_4^{2-}$ 15. MnO_4^-

16. MnO_4^{2-} 17. CrO_4^{2-} 18. $Cr_2O_7^{2-}$

19. SCN^- 20. O_3 21. I_3^-

22. Cl_2O 23. ClO_3^- 24. ClO_4^-

25. PO_4^{3-} 26. IO_3^- 27. HPO_3^{2-}

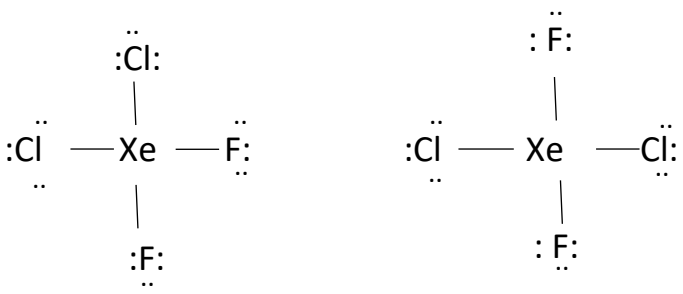
28. HCO_3^- 29. CHO_2^- 30. CH_3COO^-

31. NO_2F 32. H_3PO_3 33. $SOCl_2$

34. ClO_2 35. NCO^- 36. CNS^-

(03) State whether the given structures are resonance structures. Explain the reason.

1.



(a) (b)

……

……