INDEX

MH-SET CHEMISTRY PYQ

SECTION-I

INORGANIC CHEMISTRY

CHAPTER 1

CHEMICAL PERIODICITY

PREVIOUS YEAR EXAM QUESTIONS

(MH-SET 25 Nov. 2011)

1. The number of nodes in a 3s orbital is:
   (A) 0 (B) 1
   (C) 2 (D) 3

(MH-SET 25 Nov. 2011)

2. The three unpaired electrons on the nitrogen atom is ascribed to :
   (A) Pauli's exclusion principle
   (B) Aufbau principle
   (C) Hund's rule
   (D) Uncertainty principle

(MH-SET 25 Nov. 2011)

3. Which of the following specie have distorted octahedral structures?
   (A) SF_6 (B) $[PF_6]^-$
   (C) SbF_5 (D) XeF_6

(MH-SET 25 Nov. 2011)

4. Which one of the following compounds readily forms dimers?
   (A) $AsCl_3$ (B) $AlCl_3$
   (C) PCl_3 (D) BCl_3

(MH-SET 2015)

5. The strength of hydrogen bonds follow the order:
   (A) ClH .... Cl > NH .... N > OH .... O > FH .... F
   (B) ClH .... Cl < NH .... N < OH .... O < FH .... F
   (C) ClH .... Cl < NH .... N > OH .... O > FH .... F
   (D) ClH .... Cl < NH .... N < OH .... O > FH .... F

(MH-SET 2015)

6. First and second ionization energies of Mg are 7.646 and 15.035 eV respectively. The amount of energy in kJ needed to convert all the atoms of magnesium into Mg^{2+} ions present in 12 mg of magnesium vapors is:
   (A) 1.5 (B) 2.0
   (C) 1.1 (D) 0.5

(MH-SET 2015)

7. Which of the following is the correct order of 1^{st} Ionization Potential:
   (A) Ca > Sr > Ba > Mg (B) Ba > Mg > Ca > Sr
   (C) Sr > Ca > Mg > Ba (D) Mg > Ca > Sr > Ba

(MH-SET 2015)

8. The correct order of the basicity of the following oxides:
   (A) $NO_2<CO_2<Na_2O<Al_2O_3$ (B) $CO_2<NO_2<Al_2O_3<Na_2O$
   (C) $NO_2<CO_2<Al_2O_3<Na_2O$ (D) $Al_2O_3<Na_2O<NO_2<CO_2$

(MH-SET 2018)

9. The correct order of First Ionization energy of group 13 elements is:
   (A) B > Tl > Ga > Al > In (B) B > Tl > Al > Ga > In
   (C) B > Al > Ga > In > Tl (D) B > Ga > Tl > In > Al

(MH-SET 2018)

10. The ionophore valinomycin is highly selective for:
    (A) K^+ (B) Na^+
    (C) Mg^{2+} (D) Ca^{2+}

(MH –SET 2019)

11. Size of the d orbitals for Si, P, S and Cl follow the order:
    (A) Si > P > S > Cl (B) Cl > P > S > Si
    (C) Cl > S > P > Si (D) P > S > Si > Cl

(MH – SET 2020)

12. The hydrogen bond strength in
    (i) O—H.....O
    (ii) O—H.....Cl
    (iii) O—H.....N will follow the order:
    (A) (i) > (iii) > (ii) (B) (ii) > (i) > (iii)
    (C) (i) = (ii) > (iii) (D) (i) > (ii) > (iii)

(MH – SET 2020)

13. The strength of hardness of the isoelectronic ions F^-, ^-OH, $^-NH_2$ and $^-CH_3$ follows the order:
    (A) $^-CH_3>^-OH>^-NH_2>F^-$ (B) $^-CH_3>F^->^-OH>^-NH_2$
    (C) $F^->^-OH>^-NH_2>^-CH_3$ (D) $^-CH_3>^-NH_2>^-OH>F^-$

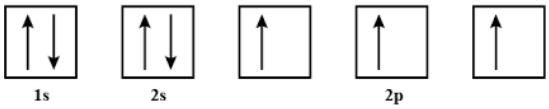
ANSWER KEY									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	C	D	B	B	C	D	B	A	A
11	**12**	**13**							
A	D	C							

:: SOLUTIONS ::

CHEMICAL PERIODICITY

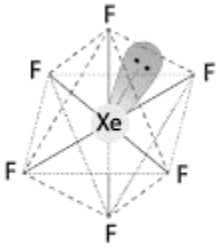
1. **Solution: (C)**
Total number of nodes for any orbital can be given by = n – 1 where n is the principal quantum number. For 3s orbital value of n is 3 so total number of orbitals is = n - 1 =2
Hence, option C is correct.

2. **Solution: (C)**
The presence of three unpaired in Nitrogen can be explained by Hund's rule. According to this rule, *electron pairing in any orbital (s, p, d or f) cannot take place until each orbital of the same sublevel contains 1 electron.* The atomic number of nitrogen is 7, so its electronic configuration will be - $1s^2\ 2s^2\ 2p^3$. 2p orbital has 3 sub-levels each of which will contain one electron. Pairing will occur only if the fourth electron is added. The distribution of electrons on the nitrogen is shown as follows:



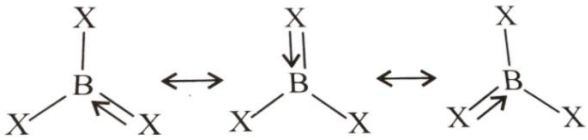
Hence, option C is correct.

3. **Solution: (D)**
H= ½ [V+M−C+A] where,
H= Number of orbitals involved in hybridization.
V=Valence electrons of a central atom.
M- Number of monovalent atoms linked to the central atom.
C= Charge of the cation.
A= Charge of the anion.
By applying the above formula, we get, the structure of XeF_6 is distorted one [sp^3d^3]. Others are perfect octahedral.

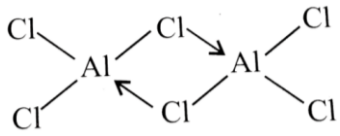


Hence, option D is correct.

4. **Solution: (B)**
Boron atom being small in size is unable to accommodate four large-sized chlorine atoms around it. However, because of its large size, Al can easily accommodate four large-sized Cl atoms around it. Since in both BCl_3 and $AlCl_3$, there are only six electrons present in the valence shell of B and Al, both are electron deficient compound. BCl_3 compounds reduce their electron deficiency by accepting a pair of electrons from the filled np orbital of the halogen atom in the vacant 2p orbital of B, thus forming pπ−pπ back bonding.



However, Al accepts a pair of electrons from 3p orbital of Cl (from another $AlCl_3$ molecule) in its vacant 3p orbital. As a result, $AlCl_3$ exist as a chlorine-bridged dimeric structure.



Hence, option B is correct.

5. **Solution: (B)**
A hydrogen bond is the electrostatic attraction between polar groups that occurs when a hydrogen (H) atom bound to a highly electronegative atom such as nitrogen (N), oxygen (O) or fluorine (F) experiences attraction to some other nearby highly electronegative atom. More electronegative the element, more is the hydrogen bonding.
Hence, the order is Cl < N < O < F
Hence, option B is correct.

6. **Solution: (C)**
The energy required to convert one Mg atom to Mg^{2+} ion is the sum of first and second ionization potentials = 7.646 + 15.035 = 22.681eV = 96.5×22.681=2188.7kJ/mol
The atomic mass of Mg is 24 g/mol and 12 mg of Mg corresponds to 0.5 millimoles.
The amount of energy required to convert 0.5 mmol of Mg atoms to Mg^{2+} ions = $0.5\times10^{-3}\times2188.7=1.1$kJ
Hence, option C is correct.

7. **Solution: (D)**
As we go down group electropositive character increases because of increases in size and hence I.E. decreases. Ba is the most electropositive element in the group and Mg is least.

So, correct order is: Mg > Ca > Sr > Ba.
Hence, option D is correct.

8. **Solution: (B)**
There are certain rules that defines the acidity and the basicity of the oxides.
All metallic oxides are basic in nature hence, Na_2O is more basic in nature. *Metal oxides which react with both acids as well as bases to produce salts and water are known as amphoteric oxides.* Many metals (such as zinc, tin, lead, aluminum, and beryllium) form amphoteric oxides or hydroxides.
All nonmetallic oxides are acidic in nature hence, acidic oxides are NO_2, CO_2.
Deciding between CO_2 and NO_2, we have carried out the hydrolysis reaction of both which produces H_2CO_3 [less acidic] and HNO_3 [more acidic] and hence correct order is $CO_2<NO_2<Al_2O_3<Na_2O$
Hence, option B is correct.

9. **Solution: (A)**
On moving down the group, the ionization enthalpy decreases. This is true for B and Al. The ionization enthalpy of Ga is unexpectedly higher than that of Al. Ga contains 10 d electrons in inner shell which are less penetrating. Their shielding is less effective than that of s and p electrons. The outer electron is held fairly strongly by the nucleus. The ionization enthalpy increases slightly. A similar increase is observed from In to Tl due to presence of 14f electrons in the inner shell of Tl which have poor shielding effect. Hence the order is, B > Tl > Ga > Al > In
Hence, option A is correct.

10. **Solution: (A)**
Valinomycin is a naturally occurring compound in living beings used in the transport of potassium. It is highly selective for potassium ions over sodium ions within the cell membrane. It functions as a potassium-specific transporter and facilitates the movement of potassium ions through lipid membranes down the electrochemical potential gradient.
Hence, option A is correct.

11. **Solution: (A)**
From left to right, Atomic size decreases due to increase in effective nuclear charge and from top to bottom, atomic size increases due to increase in principal quantum number. Hence the order is given as: Si > P > S > Cl
Hence, option A is correct.

12. **Solution: (D)**
A hydrogen bond is the electrostatic attraction between polar groups that occurs when a hydrogen (H) atom bound to a highly electronegative atom such as nitrogen (N), oxygen (O) or fluorine (F) experiences attraction to some other nearby highly electronegative atom. *More electronegative the element, more is the hydrogen bonding.* Also, the chlorine atom is too large. Despite its electronegativity, the size of the atom is such that its electron density is too low to form hydrogen bonds. This is why Chlorine does not display hydrogen bonding while nitrogen does. The correct order of the electronegativity is Cl < N < O and hence, (i) > (iii) > (ii)
Hence, option D is correct.

13. **Solution: (C)**
Hardness of the compound depends upon the size [atomic and ionic radius]. *Smaller is the radius, smaller is the size and harder is the base which shows higher HOMO-LUMO gap.* In the given question, size follows the order as, $CH_3^- > NH_2^- > OH^- > F^-$ and hence, the correct order of the hardness is $CH_3^- < NH_2^- < OH^- < F^-$
Hence, option C is correct.

CHAPTER 2

CHEMICAL BONDING

PREVIOUS YEAR EXAM QUESTIONS

(MH-SET 2011)

1. The bond angles in H_2O are:
   (A) <109° (B) 109°
   (C) 120° (D) 180°

(MH-SET 2011)

2. Which one of the following compounds is practically insoluble in water?
   (A) $CaCl_2$ (B) CaF_2
   (C) MgI_2 (D) $BaCl_2$

(MH-SET 2011)

3. The H-A-H bond angle in the following hydrides with general formula AH_3 follows the order:
   (A) $AsH_3 > PH_3 > NH_3$ (B) $PH_3 > AsH_3 > NH_3$
   (C) $NH_3 > AsH_3 > PH_3$ (D) $NH_3 > PH_3 > AsH_3$

(MH –SET 2013)

4. In which of the following bonds does H carry δ-ve charge?
   (A) F-H (B) O-H
   (C) B-H (D) N-H

(MH – SET 2020)

5. Which of the following statements regarding solubility of LiF and LiI in water at room temperature is correct?
   (A) Both are equally soluble
   (B) Both are insoluble
   (C) LiF is more soluble than LiI
   (D) LiI is more soluble than LiF

(MH – SET 2023)

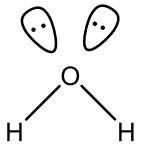
6. The molecular which does not have TD symmetry:
   (A) SiF_4 (B) CH_4
   (C) P_4 (D) XeF_4

ANSWER KEY					
1	**2**	**3**	**4**	**5**	**6**
A	B	D	C	D	D

:: SOLUTIONS ::

Chemical Bonding

1. **Solution: (A)**
   Hybridization of central atom Oxygen in H_2O molecules is sp^3 with tetrahedral geometry with two lone pair of electrons and two bond pairs. lone pair – lone pair repulsion is more as compare to bond-pair-bond pair repulsion in a molecule creating deviation in bong angle from $109.5°$ to $104.5°$.



   Therefore, Option (A) is correct.

2. **Solution: (B)**
   Solubility of compound depend on lattice energy and Hydration energy. decreasing lattice energy favours increasing solubility. AS CaF_2 molecule has extremely high lattice energy. Hence it is insoluble in water.
   Therefore, Option (B) is correct.

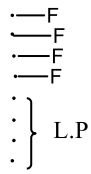
3. **Solution: (D)**
   Electronegativity of central atom decrease, bond angle decrease. As we move down the group electronegativity of atom decreases in order of $N > P >$ As in periodic table. Hence increasing order of bond angle in H-A-H molecule is in order $NH_3 > PH_3 > A_sH_3$
   Therefore, Option (D) is correct.

4. **Solution: (C)**
   If central atom is more electronegative than surrounding atoms then it attracts more negative charge toward itself. In comparison with Boron and Hydrogen, electronegativity of H is 2.1 while that of B is 1.5. Therefore, Hydrogen carries negative charge in B-H bond. In case of F-H, O-H and N-H. Electronegativity of F, O and N is more as compare to H atom resp.
   Therefore, Option (C) is correct.

5. **Solution: (D)**
   In LiF, Fluoride ion have small size and lattice energy of LiF is higher than its hydration energy, therefore it is insoluble in water or other hands In LiI size of Iodide ion is much more larger than fluoride ion. Hence its lattice energy comparatively lower than LiF, therefore LiI is more soluble than LiF.
   Therefore, Option (D) is correct.

6. **Solution: (D)**

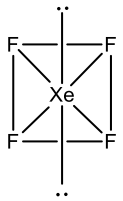
XeF_4



4+2 = 6

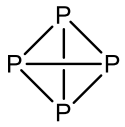
geometry = Oh

shape: square planar



$SiF_4 \longrightarrow 1/2(4+4) = 4 \longrightarrow$ Td

$CH_4 \longrightarrow$ Td

$P_4 \longrightarrow$ 

$XeF_4 \longrightarrow 1/2[8+4] = 12/2 = 6$ (Oh)

PREVIOUS YEAR EXAM QUESTIONS

Valance Shell Electron Pair Repulsion [VSEPR] Theory:

(MH-SET 25 Nov 2011)

1. In PCl_5, the hybridization of the orbitals of the P atom is:
   (A) d^2sp^2 (B) sp^3d
   (C) d^3sp (D) d^3p^3

(MH –SET 2013)

2. The molecule BrF_5, interconverts between:
   (A) trigonal-bipyramidal and tetrahedral structure
   (B) square pyramidal and pentagonal structure
   (C) trigonal-bipyramidal and square planar structure
   (D) square pyramidal and trigonal-bipyramidal structure

(MH –SET 2014)

3. According to VSEPR, the geometry of a AX_7E_0 molecule is:
   (A) Square antiprismatic (B) Pentagonal pyramidal
   (C) Pentagonal bipyramidal (D) Octahedral

(MH –SET 2014)

4. The structure of $[IF6]^-$ is best described as:
   (A) trigonally distorted octahedron
   (B) octahedron
   (C) square pyramid
   (D) trigonal bipyramid

(MH-SET 2015)

5. The species in which the central atom uses sp^2 hybrid orbitals in its bonding is:
   (A) PH_3 (B) NH_3
   (C) BCl_3 (D) SbH_3

(MH-SET 2015)

6. Based on the VSEPR theory, the molecule IF_5 has a shape of:
   (A) Trigonal bipyramid
   (B) Square pyramidal
   (C) Octahedral
   (D) Pentagonal bipyramidal

(MH-SET 2015)

7. The geometry and shape of XeO_3 is, respectively:
   (A) triangular and trigonal pyramidal
   (B) tetrahedral and trigonal pyramidal
   (C) tetrahedral and triangular planar
   (D) trigonal pyramidal and triangular

(MH-SET 2015)

8. Which of the following two are iso structural?
   (A) XeF_2 and IF_2^- (B) NH_3 and BF_3
   (C) CO_3^{2-} and SO_3^{2-} (D) PCl_5 and ICl_5

(MH-SET 2017)

9. According to VSEPR theory, the shape of $[BF_4]^-$ ion is
   (A) Tetrahedral (B) Square planar
   (C) Trigonal bipyramid (D) Octahedral

(MH-SET 2017)

10. In spite of having trigonal bipyramid geometry, XeO_2F_2 and XeO_3F_2 contains ……. Π-bonds respectively.
    (A) 2,3 (B) 3,2
    (C) 2,4 (D) 4,2

(MH-SET 2018)

11. The geometry of the interhalogen compound BrF_3 is:
    (A) Square planar (B) Tetrahedral
    (C) Octahedron (D) Trigonal bipyramid

(MH –SET 2019)

12. The total number of lone pairs for the ion I_3^- is:
    (A) 0 (B) 3
    (C) 6 (D) 9

(MH – SET 2020)

13. The geometry of $N(SiH_3)_3$ will be :
    (A) tetrahedral (B) trigonal pyramidal
    (C) trigonal planar (D) linear

(MH – SET 2020)

14. Geometry of $[IF_7]$ is
    (A) capped octahedron
    (B) cube
    (C) trigonal prismatic
    (D) pentagonal bipyramidal

(MH-SET 2021)

15. The point group of phosphorus pentafluoride is
    (A) C_5h (B) C_3h
    (C) D_3h (D) D_5h

(MH-SET 2021)

16. Molecular geometry of $XeOF_5^-$ is
    (A) trigonal bipyramidal (B) pentagonal pyramid
    (C) octahedral (D) square pyramidal

(MH-SET 2021)

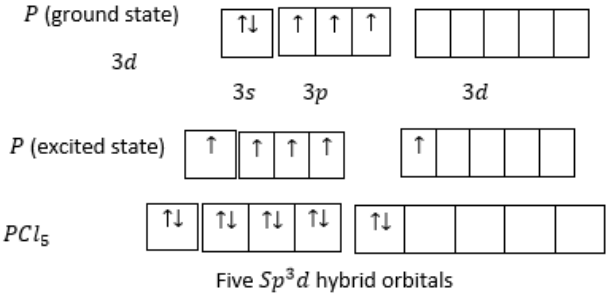
17. The symmetry elements of the compound $SiFClBrI$ are
    (A) $E, 6h, C_5$ (B) E, C_1
    (C) $E, 4C_3, 3C_2, 3S_4, 6\sigma d$ (D) $E, C_\infty, \infty\sigma_v, C_\infty h$

ANSWER KEY									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
B	D	C	A	C	B	B	A	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**			
D	D	C	D	C	B	B			

:: SOLUTIONS ::

Valance Shell Electron Pair Repulsion [VSEPR] Theory:

1. **Solution: (B)**
Electronic configuration of phosphorus is
$P = [Ne]3s^2, 3p^2$



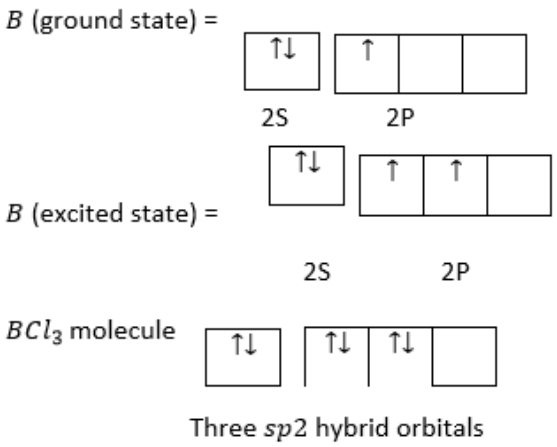
∴ Hybridization of PCl_5 is Sp^3d
Therefore, Option (B) is correct.

2. **Solution: (D)**
The molecule BrF_5, interconverts between square pyramidal and trigonal-bipyramidal structure at high temperature.
Therefore, Option (D) is correct.

3. **Solution: (C)**
For given molecule AX_7E_0, A represent central atom, X represent surrounding atoms and E represent lone pair of electrons.
In X_7E_0 , total bond pairs = 7
Total lone pairs of electrons = 0
Total electrons pairs = 7
When total electron pairs are 7, hybridization molecule is Sp^3d^3 and geometry of compound is pentagonal bipyramidal.
Therefore, Option (C) is correct.

4. **Solution: (A)**
According to VSEPR theory, Total number of valence electrons = total valence electrons of I + total valence electrons of each F + charge of complex $= 7 + (6 \times 7) + 1 = 50$
Now divide valence shell electron by 8 and if obtained value is less than 8 then divide by 2. Therefore, $\frac{50}{8} = 6$ with remainder 2. Now divide remainder by two 2/2 = 1 we get one. ∴ total orbital required = 6+1=7, orbital involved are one S orbital, three p orbital and three d orbitals and hybridization is Sp^3d^2 with geometry trigonal distorted octahedron.
Therefore, Option (A) is correct.

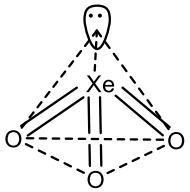
5. **Solution: (C)**
General electronic configuration of $B\ in\ BCl_3$

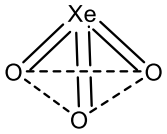


In BCl_3 three $sp2$ hybrid orbitals of boron overlap with three $3p$ orbitals of chlorine to form $B - Cl$ bond with $sp2$ hybridisation.
Therefore, Option (C) is correct.

6. **Solution: (B)**
In IF_5, total valence electron of central atom Iodine are seven out of this seven electron five electron paired with unpaired electron of each fluorine and form five $I - F$ sigma bond. Two remaining electrons of iodine remain as lone pair.
Total bond pairs of electrons in IF_5 = 5
Total lone pairs of electrons in IF_5 = 1
Total electron pairs = 5+1 = 6
When total electron pairs are six, hybridization of molecule is $sp3d^2$ with geometry octahedral and shape square pyramidal.
Therefore, Option (B) is correct.

7. **Solution: (B)**
In XeO_3, total valence electrons of central atom xenon are eight. Out of these 8 electrons, six electrons of xenon paired with six electrons of three oxygen atom and form three double bond with oxygen atoms. Remaining 2 electrons of xenon remain as lone pair.
Total bond pairs of electrons in XeO_3 = 3
Total lone pairs of electrons in XeO_3 = 1
Total electron pairs = 3+1 = 4
When total electron pairs are six, hybridization of molecule is $sp3$ and geometry is tetrahedral by considering lone pair while shape is trigonal pyramidal by ignoring lone pair.





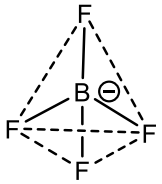
Therefore, Option (B) is correct.

8. **Solution: (A)**

According to VSEPR theory, hybridization of XeF_2 and IF_2^- are $sp3d$ with two bond pairs and three lone pairs each. Geometry of both compounds is same as trigonal bipyramidal. In case of NH_3 geometry is tetrahedral, BF_3 is trigonal planar, CO_3^{2-} is trigonal planar, SO_3^{-2} is tetrahedral, PCl_5 is trigonal bipyramidal and ICl_5 is octahedral. Therefore, IF_2^- and XeF_2 are isostructural.
Therefore, Option (A) is correct.

9. **Solution: (A)**

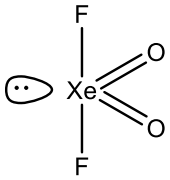
Total valence electrons in boron are three, negative charge on boron contribute one electron for pairing. Total four electron of boron pair with, four electrons of four fluorine atom and form four $sp3$ hybrid orbital with tetrahedral geometry
Hence geometry of $[BF_4]^-$ ion is tetrahedral.

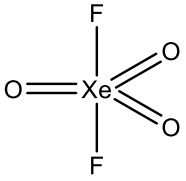


Therefore, Option (A) is correct.

10. **Solution: (A)**

Geometry of XeO_2F_2 and XeO_3F_2 is trigonal bipyramidal





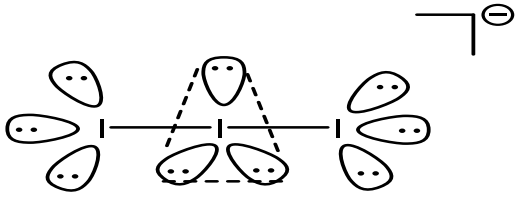
Total π bonds in XeO_2F_2 are 2 and XeO_3F_3 are 3
Therefore, Option (A) is correct.

11. **Solution: (D)**

Total valence electron in bromine are seven. Three electron of bromine pair with 3 unpaired electrons of fluorine and form three single sigma bond, remaining four electrons of bromine remain as lone pairs. Total electron pair in Br are Bond pairs + lone pairs = 2+3 = 5. Hence, hybridization of BrF_3 is $sp3d$ with trigonal bipyramidal geometry.
Therefore, Option (D) is correct.

12. **Solution: (D)**

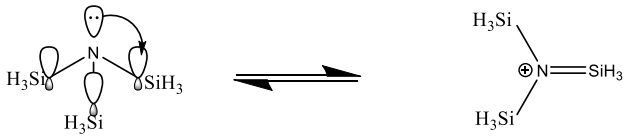
According to VSEPR theory, geometry of I_3^- is trigonal bipyramidal with respect to central iodine atom and geometry of surrounding iodine atoms are tetrahedral. Each iodine atom having three lone pairs, hence total lone pairs are 9.



Therefore, Option (D) is correct.

13. **Solution: (C)**

According to VSEPR theory hybridization of Nitrogen of $N(SiH_3)_3$ should be $sp3$ but actually hybridisation is $sp2$. This is due to presence of empty d-orbital of silicon atom, nitrogen atom possessing lone pair shifted to empty d-orbital of silicon and formation of double bond take place between N and Si. This shifting changes hybridisation of $N(SiH_3)_3$ to sp^2 and shape become a trigonal planar. This phenomenon also called as back bonding.

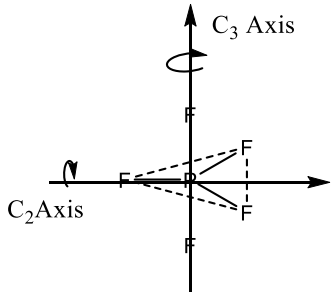


Therefore, Option (C) is correct.

14. **Solution: (D)**

Valence Electron of Iodine
#---------F
#---------F
#---------F
#---------F
#---------F
#---------F
#---------F
Total 7 bond pairs hybridization is sp^3d^3 with Pentagonal Bipyramidal geometry sp^3d^3 Pentagonal bipyramidal
Therefore, Option (D) is correct.

15. **Solution: (C)**

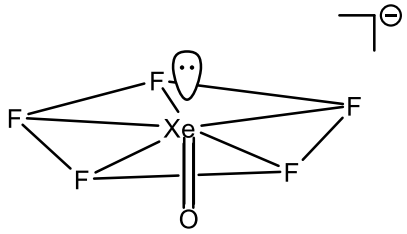


As C_3 and C_2 are perpendicular to each other it gives D_3.

And horizontal plane is present hence point group is = D_3h

Therefore, Option (D) is correct.

16. **Solution: (B)**

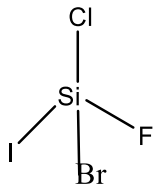


Total lone pairs of electron is one and bond pair of electrons are six, hence hybridization is sp^3d^3 with geometry pentagonal bipyramidal and shape is pentagonal pyramid.

Therefore, Option (B) is correct.

17. **Solution: (B)**

E, C_1 only



Therefore, Option (B) is correct.

PREVIOUS YEAR EXAM QUESTIONS

Molecular Orbital Theory [MOT]:

(MH-SET 7 AUG 2011)

1. When two atoms of chlorine combine to form one molecule of chlorine gas, the energy of the molecule:
   (A) Greater than that of separate atoms
   (B) Equal to that of separate atoms
   (C) Lower than that of separate atoms
   (D) None of the above statement is correct

(MH –SET 2014)

2. The highest occupied molecular orbital of O_2 is (neglecting bonding/ antibonding character):
   (A) σ_g (B) π_g
   (C) σ_u (D) π_u

(MH-SET 2015)

3. The bond order for NO^+ species is:
   (A) 2 (B) 2.5
   (C) 3 (D) 1.5

(MH –SET 2019)

4. Which of the following diatomic molecules is paramagnetic?
   (A) B_2 (B) C_2
   (C) N_2 (D) F_2

(MH –SET 2019)

5. The bond order for O_2 and the hypothetical molecules N_2^- and O_2^+ will follow the trend:
   (A) $O_2 = N_2^- < O_2^+$ (B) $N_2^- = O_2 < O_2^+$
   (C) $N_2^- = O_2^+ < O_2$ (D) $N_2^- = O_2^+ > O_2$

(MH – SET 2020)

6. Carbon monoxide (CO) is isoelectronic with:
   (A) N_2^+ (B) O_2
   (C) NO (D) CN^-

Answer Key					
1	**2**	**3**	**4**	**5**	**6**
C	B	C	A	C	D

SOLUTIONS

Molecular Orbital Theory [MOT]:

1. **Solution: (C)**

Individual chlorine atoms have high energy, they are more reactive and less stable. When two such atom combines together to form Cl_2 molecule, during these reaction some energy release in the form of bond formation energy or bond energy. Therefore Resultant molecule form has energy lower than individual atoms, molecule is more stable and less reactive.

Therefore, option (C) is correct

2. **Solution: (B)**

According to molecular orbital theory electronic configuration of O_2 molecule given as

$(1\sigma_g)^2 < (1\sigma_u)^2 < (2\sigma_g)^2 < (2\sigma_u)^2 < (3\sigma_g)^2 < (1\pi_u)^2 = (1\pi_u)^2 < (1\pi_g)^1 = (1\pi_g)^1$

Therefore, highest occupied molecular orbital of O_2 molecule (HOMO) is π_g

Option (B) is correct

3. **Solution: (C)**

According to molecular orbital theory, total no. of electrons in diatomic molecule and bond order related to each other as follows:

Total no. of electrons	8	9	10	11	12	13	14
Bond orders	0	0.5	1	1.5	2	2.5	3

Total no. of electrons	15	16	17	18	19	20
Bond orders	2.5	2	1.5	1	0.5	0

In NO^+ molecule, total numbers of electron are 14 (7 electron of nitrogen + 8 electrons of oxygen – 1 electron of positive charge). Hence, bond order is three.

Therefore, option (C) is correct

4. **Solution: (A)**
According to MOT, electronic configuration of B_2 molecule is
$(1\sigma_g)^2 < (1\sigma_u)^2 < (2\sigma_g)^2 < (2\sigma_u)^2 < (2\pi_u)^2$
In π_u molecular orbital. Two unpaired electron presents.
Hence B_2 molecule is paramagnetic.
Therefore Option (A) is correct

5. **Solution: (C)**
According to MOT, bond order for O_2 molecule is 2 and that of hypothetical molecule N_2^- and O_2^+ are 2.5 . Hence, trend in bond order given as
$N_2^- \approx O_2^+ > O_2$
Option (C) is correct

6. **Solution: (D)**
Total number of electron in CO molecule are $=6+8=14e^-$
Total number of electron in O_2 molecule are $=8+8=16e^-$
Total number of electrons in NO molecule are $=7+8=15e^-$
Total number of electrons in N_2^+ molecule are $=7+6=13e^-$
Total number of electrons in CN^- molecule are $=6+7+1=14e^-$
Option (D) is correct
$bond\ order \propto energy \propto stability$
Therefore Option (D) is correct.

CHAPTER 3

MAIN GROUP ELEMENTS

PREVIOUS YEAR EXAM QUESTONS

(MH-SET 2011)

1. Both NF_3 and NCl_3 are covalent but they do not undergo hydrolysis similarly because:
   (A) NF_3 is more stable than NCl_3
   (B) Dipole moment of NF_3 is more than NCl_3
   (C) Electronegativity of F is greater than Cl
   (D) Cl can expand its octet by using d-orbitals

(MH-SET 2011)

2. Haber's process for preparation of ammonia is exothermic. It is carried out at a high temperature so as to ensure:
   (A) Faster rate of production of ammonia
   (B) Vaporization of reactants/products
   (C) Declogging of the surface of the catalyst
   (D) Greater yield

(MH –SET 2013)

3. Reducing ability of the oxyanions of sulphur change as:
   (A) $S_2O_3^{2-} > SO_3^{2-} > S_2O_8^{2-}$ (B) $SO_3^{2-} > S_2O_8^{2-} > S_2O_3^{2-}$
   (C) $SO_3^{2-} > S_2O_3^{2-} > S_2O_8^{2-}$ (D) $S_2O_8^{2-} > SO_3^{2-} > S_2O_3^{2-}$

(MH –SET 2013)

4. Match the following class of boranes with their examples:
   (a) Closo (i) B_8H_{14}
   (b) Nido (ii) $(B_{10}H_{10})^{2-}$
   (c) Arachno (iii) B_9H_{13}
   (A) (a)—(iii), (b)—(i), (c)—(ii)
   (B) (a)—(i), (b)—(iii), (c)—(ii)
   (C) (a)—(ii), (b)—(i), (c)—(iii)
   (D) (a)—(ii), (b)—(iii), (c)—(i)

(MH –SET 2013)

5. Among the following statements:
   (a) Sheet silicates have general formula $[Si_2O_5]_n^{2n-}$
   (b) $ZrSiO_4$ is an example for Orthosilicate
   (c) $Si_2O_7^{6-}$ is a Cyclosilicate
   (d) $BaTiSi_3O_9$ is a Pyrosilicate
   (A) Only (a) is correct (B) (a), (c) are correct
   (C) (a), (b) are correct (D) (b), (c) are correct

(MH –SET 2013)

6. The type of hybridization of carbon atoms in graphene sheets is:
   (A) only sp^2 (B) sp^2 and sp^3
   (C) only sp^3 (D) sp and sp^2

(MH –SET 2013)

7. Which of the following statements is correct regarding fullerene C_{60}?
   (A) 12,500 Resonating structures are possible for C_{60}
   (B) Fullerene C_{60} is a super aromatic compound
   (C) Unsubstituted fullerene C_{60} can be acylated using Friedal-Crafts acylation
   (D) Fullerene C_{60} is susceptible to attack by nucleophilic reagents

(MH –SET 2014)

8. The H-B-H bond angle in BH_4^- is:
   (A) 180° (B) 90°
   (C) 120° (D) 109°

(MH –SET 2014)

9. Beryl is a:
   (A) Beryllium containing group like–BeH_3, named in analogy with silyl, alkyl etc.
   (B) Precious stone with diamond like structure
   (C) Cyclic silicate
   (D) Beryllium oxide

(MH –SET 2014)

10. Catena means
    (A) Special type dimeric structure
    (B) A chain structure
    (C) A tetrameric structure
    (D) A trimeric structure

(MH –SET 2014)

11. Identify the following boranes with their class of boranes:
    (a) Closo (i) B_6H_{12}
    (b) Nido (ii) $(B_6H_6)^{2-}$
    (c) Arachno (iii) B_6H_{10}
    (A) (a)-(iii), (b)-(i), (c)-(ii) (B) (a)-(i), (b)-(iii), (c)-(ii)
    (C) (a)-(ii), (b)-(i), (c)-(iii) (D) (a)-(ii), (b)-(iii), (c)-(i)

(MH –SET 2014)

12. Among the following statements:
    (a) Orthosilicates have general formula $(SiO_4)^{4-}$
    (b) $BaTiSi_3O_9$ is an example for Cyclosilicate
    (c) $Si_2O_7^{6-}$ is an Orthosilicate
    (d) $ZrSiO_4$ is a Pyrosilicate
    (A) (a), (b) are correct (B) (a), (c) are correct
    (C) only (a) is correct (D) (c), (d) are correct

(MH –SET 2014)

13. The type of hybridization of carbon in carbon nanotube is:
(A) sp and sp^2 (B) sp^2
(C) sp and sp^3 (D) sp, sp^2 and sp^3

(MH –SET 2014)

14. The oxidation states of chlorine in Cl_2O, Cl_2, $(ClO_3)^-$ are respectively:
(A) +5, 0, +1 (B) +1, –1, +5
(C) –1, 0, +5 (D) +1, 0, +5

(MH –SET 2014)

15. Which of the following will not form clathrates?
(A) Ar (B) He
(C) Kr (D) Xe

(MH –SET 2014)

16. The isotope used for treatment hyperthyroiditis is:
(A) ^{125}I (B) ^{127}I
(C) ^{131}I (D) ^{128}I

(MH –SET 2014)

17. The correct order of the thermal stability of hydrogen halides (H –X) is
(A) HI > HBr > HCl > HF (B) HF > HCl > HBr > HI
(C) HCl < HF < HBr < HI (D) HI > HCl < HF < HBr

(MH-SET 2015)

18. The commercially important ore of lead is:
(A) Bauxite (B) Galena
(C) Haematite (D) Cinnabar

(MH-SET 2015)

19. Aluminothermic reaction is:
(A) Oxidation reaction (B) Reduction reaction
(C) Redox reaction (D) Neutralization reaction

(MH-SET 2015)

20. The hybrid state of carbon C-60 is
(A) sp (B) sp^2
(C) sp^3 (D) dsp^2

(MH-SET 2015)

21. Which one of the following compounds has the smallest (Halogen-S-Halogen) bond angle?
(A) SOF_2 (B) $SOCl_2$
(C) $SOBr_2$ (D) SOI_2

(MH-SET 2015)

22. What is the oxidation state of sulfur atom when thiosulphate acts as a reducing agent forming tetrathionate ($Na_2S_4O_6$) is
(A) +1 (B) +2.5
(C) +4 (D) +5

(MH SET 2016)

23. The correct STYX number for B_5H_9 (nido-pentaborane) is:
(A) 2002 (B) 4120
(C) 3003 (D) 4012

(MH-SET 2016)

24. According to IUPAC nomenclature the ligand O^{2-}, O_2^{2-} and Cl^- are named respectively as:
(A) Peroxido, oxido, chlorido
(B) Oxido, peroxido, chlorido
(C) Oxido, peroxide, chloride
(D) Oxido, superoxo,chloro

(MH-SET 2016)

25. In which of the following pair of molecules the oxidation number of nitrogen is the same?
(A) HNO_2 and HNO_3 (B) NO_2 and N_2O
(C) N_2O_5 and HNO_3 (D) HNO_3 and N_2O

(MH-SET 2017)

26. Which byproduct is obtained during the extraction of Pb from Galena in smelters?
(A) SO_3 (B) SO_4
(C) SO_2 (D) S_3

(MH-SET 2017)

27. The order of ionic radius for M^{3+} cations of group 13 is:
(A) Al < Ga < In < Tl (B) Al < Ga < Tl < In
(C) Al < In < Tl < Ga (D) Al < Tl < In < Ga

(MH-SET 2017)

28. The noble gas which does not form clathrate compound is:
(A) Ne (B) Ar
(C) Kr (D) Xe

(MH-SET 2018)

29. The $F-N-F$ bond angle in NF_3 is:
(A) $109° 28'$ (B) $107° 48'$
(C) $102° 30'$ (D) $104° 27'$

(MH –SET 2019)

30. The molecules P_4 and CH_4 exhibit the same:
(A) Color (B) Geometry
(C) Boiling point (D) Physical state at 300 K

(MH – SET 2020)

31. The bond length of the tetrachlorides for the following Group IV elements follows the order:
(A) $SiCl_4 > CCl_4 > GeCl_4$ (B) $SiCl_4 > GeCl_4 > CCl_4$
(C) $GeCl_4 > SiCl_4 > CCl_4$ (D) $GeCl_4 > CCl_4 > SiCl_4$

(MH-SET 2021)

32. According to wade's rules, the structure of $B_{10}C_2H_{12}$ and $B_{10}H_{12}(SEt_2)_2$ are respectively
(A) nido and closo (B) closo and nido
(C) closo and arachano (D) nido and arachano

(MH-SET 2021)

33. The oxidising tendency of chlorine oxyanions $ClO_4^-, ClO_3^-, ClO_2^-, ClO^-$, follows the order
(A) $ClO_4^- = ClO_3^- < ClO_2^- < ClO^-$
(B) $ClO_4^- > ClO_3^- > ClO_2^- > ClO^-$
(C) $ClO_4^- < ClO_3^- < ClO_2^- \cong CO^-$
(D) $ClO_4^- < ClO_3^- \cong ClO_2^- < ClO^-$

(MH-SET 2021)

34. The only metal which forms nitride N_3 among group 1 element is
(A) K (B) Na
(C) Li (D) Rb

(MH-SET 2023)

35. The Wade's rules can be applied to the naked clusters of p-block elements. According to Wade's rules, the number of skeletal electrons in Pb_5^{2-} cluster is:
(A) 18 (B) 22
(C) 8 (D) 12

(MH-SET 2023)

36. Based on Pauling's electronegativity scale hydrogen can oxidize:
(A) Boron (B) Carbon
(C) Nitrogen (D) Oxygen

(MH-SET 2023)

37. Historically, oxygen was prepared by the decomposition of metal oxides. The correct set of oxides that give dioxygen on heating is:
(A) HgO, CaO, BaO (B) KO_2, BaO_2, Na_2O
(C) Na_2O, CaO, BaO (D) HgO, KO_2, BaO_2

(MH-SET 2023)

38. The set of compounds that show autoionization is:
(A) $Cl_2O_6, POCl_3, HF$ (B) $IF_3, HF, POCl_3$
(C) HF, IF_3, Cl_2O_6 (D) $POCl_3, IF_3, Cl_2O_6$

Answer Key									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	A	D	D	C	A	A	D	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	A	B	D	B	C	B	B	B	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	B	B	C	C	A	A	C	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**		
C	B	C	C	D	A	D	B		

:: SOLUTIONS ::

1. **Solution: (A)**
NF_3 is more stable than NCl_3 and hydrolysis product of NF_3 does not exist.
In contrast to NF_3, NCl_3 and NBr_3 are highly unstable.
Expect NF_3 and PF_3, trihailds are hydrolysed by water and the ease of hydrolysis decreases down the group, i.e., NCl_3 is easily hydrolysed and $SbCl_3$ and $BiCl_3$ are partly hydrolysed.
$NCl_3 + 3\,H_2O \rightarrow 3HOCl + NH_3$
$PCl_3 + 3\,H_2O \rightarrow H_3PO_3 + 3\,HCl$
Hence, option A is correct.

2. **Solution: (A)**
The manufacture of ammonia by Haber's process is an exothermic reaction. According to Le Chatelier's principle maximum yield of an exothermic reaction can be obtained at low temperatures. There are 4 molecules on reactant side and 2 on product side. According to Le Chatelier's principle if you increase the pressure the system will respond by favouring the reaction which produces fewer molecules. So the maximum yield of ammonia will be obtained at high pressure and low temperature
Hence, option A is correct.

3. **Solution: (D)**
$SO_3^{2-} \rightarrow$ $x + (-6) = -2 \Rightarrow x = +4$
$S_2O_3^{2-} \rightarrow$ $2x + (-6) = -2 \Rightarrow x = +2$
$S_2O_8^{2-} \rightarrow$ $2x + (-16) = -2 \Rightarrow x = +7$
Reducing ability of the oxyanions of sulphur change as : $S_2O_8^{2-} > SO_3^{2-} > S_2O_3^{2-}$
Hence, option D is correct.

4. **Solution: (D)**
(a) Closo
Given unit $(B_{10}H_{10})^{2-}$ is same as $(B_nH_n)^{2-}$ unit which is closo.
So, $(B_{10}H_{10})^{2-}$ is closo.
(b) Nido
Given unit $B_9H_{13} = (B_9H_9)^{4-}$ is same as $(B_nH_n)^{4-}$ unit which is nido
So, B_9H_{13} is nido.
(c) Arachno
Given unit $B_8H_{14} = (B_8H_8)^{6-}$ is same as $(B_nH_n)^{6-}$ unit which is arachno
So, B_8H_{14} is arachno.
Hence, option D is correct.

5. Solution: (C)
(a) The general formula of Sheet or Phyllo or two dimensional (2-D) silicates is $(Si_2O_5)_n^{2n-}$. Each SiO_4 tetrahedron shares three oxygen atoms with others and thus by forming two-dimensional sheets. These silicates can be cleaved easily just like graphite. The layers are held together by weak van der Waal's forces.
Sheet silicates have general formula $[Si_2O_5]_n^{2n-}$ (so this statement is correct)
(b) Ortho silicates (or Neso or Island silicates) are the simplest silicates which contain discrete SiO_4^{4-} tetrahedral units. The ortho silicate ion is the strong conjugate base of weak orthosilicic acid as well as it will not persist in aqueous solutions. Hence in nature, ortho silicate minerals are rare and only found with cations which form highly insoluble salts.

Examples of Ortho silicates:

(1) Phenacite (also known as phenakite) - Be_2SiO_4

(2) Willemite - Zn_2SiO_4 - A minor silicate ore of zinc. Highly fluorescent (green) under shortwate UV.

Note: The Be^{2+} and Zn^{2+} ions are tetrahedrally surrounded by the oxygen atoms of silicate.

(3) Olivine - $(Fe/Mg)_2SiO_4$: Typically green in color. The cations are octahedrally coordinated to the oxygen atoms of the silicate.

(4) Zircone - $ZrSiO_4$: The oldest mineral on Earth. The coordination number of Zr^{4+} is 8.

$ZrSiO_4$ is an example for orthosilicate (so this statement is correct)

(c) In cyclosilicates, the tetrahedra form rings of 3, 4, or 6 tetrahedra. However, most cyclosilicates are formed from a framework of six tetrahedra, giving them the formula $(Si_6O_{18})^{-12}$, and examples of this type of mineral includes the gemstones beryl (including the varieties emerald and aquamarine, and tourmaline.

$Si_2O_7^{6-}$ is a cyclosilicate (so this statement is wrong)

(d) Pyro silicate (or Soro silicate or disilicate) contain $Si_2O_7^{6-}$ ions which are formed by joining two tetrahedral SiO_4^{4-} which share one oxygen atom at one corner (one oxygen is removed while joining).

The pyrosilicate ion is less basic than orthosilicate ion. There only one mineral in nature containing pyrosilicate ion.

E.g. 1) Thortveitite - $Sc_2Si_2O_7$, $BaTiSi_3O_9$ is a Pyrosilicate (so this statement is wrong)

Hence, option C is correct.

6. **Solution: (A)**

Graphene is a nanomaterial arranged in a two-dimensional layer of carbon atoms with sp2 hybridization that are connected in a hexagonal lattice structure.

The sp^2 hybridized carbon gives rise to a trigonal structure of graphite. The single layer of graphite named as graphene; is single atom thick layer which has got wide importance due to its high strength, high electrical and thermal conductivity. It is a two dimensional structure of hexagonal rings where carbon atoms are connected with each other by covalent bonds.

Hence, option A is correct.

7. **Solution: (A)**

C-60 has 12,500 resonance structures involving its 60 pi-electrons we may profitably consider the pi-electrons to be particles delocalized over a sphere.

Hence, option A is correct.

8. **Solution: (D)**

H-B-H bond angle in BH_4^- is 109° because it forms the tetrahedral geometry.

Hence, option D is correct.

9. **Solution: (C)**

Beryl is a cyclic silicate.

Cyclic silicates contain $(SiO_3)_n^{2n-}$ ions which are formed by linking three or more tetrahedral SiO_4^{4-} units cyclically. ...

(1) Benitoite - $BaTi(SiO_3)_3$: containing three tetrahedra arranged cyclically $[Si_3O_9)^{6-}]$.

2) Beryl - $Be_3Al_2(SiO_3)_6$: containing six-silicate rings $[Si_6O_{18})^{12-}]$. It is an aluminosilicate.

Hence, option C is correct.

10. **Solution: (B)**

Catena: Any compound having two or more rings interconnected like the links of a chain, without a covalent bond.

Catena means chain structure.

Hence, option B is correct.

11. **Solution: (D)**

(a) closo

Given unit $(B_6H_6)^{2-}$ is same as $(B_nH_n)^{2-}$ unit which is closo.

So, $(B_6H_6)^{2-}$ is closo.

(b) nido

Given unit $B_6H_{10} = (B_6H_6)^{4-}$ is same as $(B_nH_n)^{4-}$ unit which is nido

So, B_6H_{10} is nido.

(c) arachno

Given unit $B_6H_{12} = (B_6H_6)^{6-}$ is same as $(B_nH_n)^{6-}$ unit which is arachno

So, B_6H_{12} is arachno.

Hence, option D is correct.

12. **Solution: (A)**

(a) Orthosilicates have general formula $(SiO_4)^{4-}$

Ortho silicates (or Neso or Island silicates) are the simplest silicates which contain discrete SiO_4^{4-} tetrahedral units. The ortho silicate ion is the strong conjugate base of weak orthosilicic acid as well as it will not persist in aqueous solutions. Hence in nature, ortho silicate minerals are rare and only found with cations which form highly insoluble salts.

Examples of Ortho silicates:

(1) Phenacite (also known as phenakite) - Be_2SiO_4

(2) Willemite - Zn_2SiO_4 - A minor silicate ore of zinc. Highly fluorescent (green) under shortwate UV.

Note: The Be^{2+} and Zn^{2+} ions are tetrahedrally surrounded by the oxygen atoms of silicate.

(3) Olivine - $(Fe/Mg)_2SiO_4$: Typically green in color. The cations are octahedrally coordinated to the oxygen atoms of the silicate.

(4) Zircone - $ZrSiO_4$: The oldest mineral on Earth. The coordination number of Zr^{4+} is 8.

(b) $BaTiSi_3O_9$ is an example for cyclosilicate

Beryl is a cyclic silicate.

Cyclic silicates contain $(SiO_3)_n^{2n-}$ ions which are formed by linking three or more tetrahedral SiO_4^{4-} units cyclically. ...

(1) Benitoite - $BaTi(SiO_3)_3$: containing three tetrahedra arranged cyclically $[Si_3O_9)^{6-}]$. 2) Beryl - $Be_3Al_2(SiO_3)_6$: containing six-silicate rings $[Si_6O_{18})^{12-}]$. It is an aluminosilicate.

(c) $Si_2O_7^{6-}$ is an orthosilicate (wrong)

$Si_2O_7^{6-}$ is an Pyrosilicate

(d) $ZrSiO_4$ is a Pyrosilicate (wrong)

$ZrSiO_4$ is a Orthosilicate

Hence, option A is correct.

13. **Solution: (B)**

The chemical bonding of nanotubes is composed entirely of **sp2 hybridized** bonds, similar to those of graphene. These bonds, which are stronger than the sp3 bonds found in diamond, provide nanotubes with their unique strength, and the associated π bonds are the reason for their electrical properties.

Hence, option B is correct.

14. **Solution: (D)**

1. Cl_2O^-

Let X be the oxidation number of chlorine in Cl2O.

$2X-2=0 \implies X=+1$

2. Cl_2

The oxidation number of chlorine is +1, +3, +5, +7 and -1. However for Chlorine gas, the oxidation number (Cl2) is zero.

3. $(ClO_3)^-$

Let x be the oxidation number of chlorine in ClO_3^-.

The oxidation number of oxygen is −2.

The sum of the oxidation numbers of chlorine and oxygen is −1, which is equal to the charge on ion.

Hence, $x+3(-2)=-1$ or, $x=+5$.

Hence, option D is correct.

15. **Solution: (B)**

However, the smaller noble gases He and Ne do not form clathrate compounds because the noble gas atoms are small enough to escape from the cavities.

Clathrates are the compounds formed by inert gases (Argon, Krypton, and Xenon). In which the gas molecules penerate the cavities of the crystal structure composed of H_2O molecules.

Hence, option B is correct.

16. **Solution: (C)**

Radioactive Iodine (I-131) Therapy. Radioiodine therapy is a nuclear medicine treatment for an overactive thyroid, a condition called hyperthyroidism, and also may be used to treat thyroid cancer.

Hence, option C is correct.

17. **Solution: (B)**

As we move down the group in hydrogen halides the thermal stability decreases due to decrease in bond strength. So the correct order of thermal stability is HF > HCl > HBr > HI

Hence, option B is correct.

18. **Solution: (B)**

Ores. Of the more than 60 known lead-containing minerals, by far the most important primary ore of the metal is the lead sulfide galena (PbS). Other commercially significant lead-containing minerals are cerussite (lead carbonate) and anglesite (lead sulfate).

Hence, option B is correct.

19. **Solution: (B)**

During aluminothermic reduction, the ferro-alloys are produced from their oxide ores by reduction with aluminium using the exothermic heat of the reaction.

Aluminothermic reactions are exothermic chemical reactions using aluminium as the reducing agent at high temperature. The process is industrially useful for production of alloys of iron. ... For the production of iron, a cheaper reducing agent, coke, is used instead via the carbothermic reaction.

Hence, option B is correct.

20. **Solution: (B)**

C 60 is the fullerene and in fullerene, the hybrid state of carbon atoms is sp^2 similar to graphite. Fullerenes are stable, but not totally unreactive. The sp^2-hybridized carbon atoms, which are at their energy minimum in planar graphite, must be bent to form the closed sphere or tube, which produces angle strain.

Hence, option B is correct.

21. **Solution: (A)**

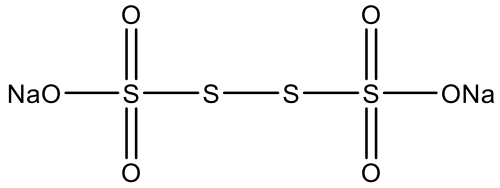
SOF_2 has the smallest bond (X–S–X) in the given molecules.

Fluorine is the most electronegative element on the earth.

It attracts the electrons of S–F bonds towards itself due to which the repulsion between the bond pair electrons decreases. Hence, the SOF_2 bond angle is minimum.

Hence, option A is correct.

22. **Solution: (B)**



From the above structure, we can say that the oxidation numbers of the first sulphur atom are six, the second sulphur atom is two, third sulphur is two, the fourth sulphur atom is six. The sum of the oxidation numbers is zero for an electrically neutral compound and equals the overall charge for anionic species.

Let's take the oxidation number of sulphur as xx, sodium is +1and oxygen is −2, then

The equation to find the unknown oxidation number according to the structure is

$2(+1) + 4x + 6(-2) = 0$

$2 + 4x - 12 = 0$

$4x = 10$

$x = 10/4$

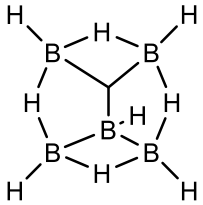
$x = 2.5$

So the oxidation number of S in $Na_2S_4O_6$ is +2.5.

Hence, option B is correct.

23. **Solution: (B)**

It can be clearly seen that there are four B–H–B bridges, one closed or triply bridged B–B–B unit, two B–B bond and no terminal BH_2 groups. Hence, the overall STYX code B_5H_9 molecule is 4120.



Hence, option B is correct.

24. **Solution: (B)**

For anionic ligands end in "-o";

For anions that end in "-ide"(e.g. chloride), "-ate" (e.g. sulfate, nitrate), and "-ite" (e.g. nirite),

Change the endings as follows: -ide ⟶ -o; -ate ⟶ -ato; -ite ⟶ -ito.

The ligand O^{2-}, $O_2^{2-}$and $Cl^-$are named respectively as: Oxido, peroxido, chlorido

Hence, option B is correct.

25. **Solution: (C)**

$HNO_3 \Longrightarrow 1+x+3(-2) = 0$

$\Longrightarrow x = +5$.

$N_2O_5 \Longrightarrow 2x+5(-2) = 0$

$= 2x - 10$

$x = 10/2$

$x = +5$.

Hence, option C is correct.

26. **Solution: (C)**

Galena, the most common mineral of lead, is primarily lead sulfide (PbS). The sulfide is oxidized to a sulfite ($PbSO_3$) which thermally decomposes into lead oxide and sulfur dioxide gas. (PbO and SO_2) The sulfur dioxide is expelled, and the lead oxide is reduced.

Hence, option C is correct.

27. **Solution: (A)**

The size of atom is defined as distance between nucleus and outermost electron. It depends upon the number of shells and screening effect of orbitals. Generally, down the group the atomic size increases because new shells add at each step and effectively nuclear charge decreases.

Order of ionic radius for M^{3+} cations: Al < Ga < In < Tl

Hence, option A is correct.

28. **Solution: (A)**

However, the smaller noble gases He and Ne do not form clathrate compounds because the noble gas atoms are small enough to escape from the cavities.

Clathrates are the compounds formed by inert gases (Argon, Krypton, Xenon). In which the gas molecules penerate the cavities of the crystal structure composed of H_2O molecules.

Hence, option A is correct.

29. **Solution: (C)**

The bond angle in NF_3 (102.3°) is, smaller than NH_3 (107.2°). This is because of. large size of F compared to H. large size of N compared to F.

Hence, option C is correct.

30. **Solution: (B)**

White phosphorus, yellow phosphorus or simply tetraphosphorus (P_4) exists as molecules made up of four atoms in a tetrahedral structure. Methane has 4 regions of electron density around the central carbon atom (4 bonds, no lone pairs). The resulting shape is a regular tetrahedron with H-C-H angles of 109.5°.

Hence, option B is correct.

31. **Solution: (C)**
bond length or bond distance is defined as the average distance between nuclei of two (chemical bond|bonded) atoms in a molecule. It is a transferable property of a bond between atoms of fixed types, relatively independent of the rest of the molecule.
CCl_4 175pm
$SiCl_4$ 190pm
$GeCl_4$ 305 pm
Bond length of the tetrachlorides order:
$GeCl_4 > SiCl_4 > CCl_4$
Hence, option C is correct.

32. **Solutions: (B)**
$B_{10}C_2H_{12} = B_{10}(BH)_2H_{12} = B_{12}H_{14} = B_{12}H_{12}^{2-}$ = Closo
$B_{10}H_{12}(SEt_2)_2 = B_{10}H_{12}(SEt_2)_2 = B_{10}H_{12}H_2 =$
$B_{10}H_{10}^{4-}$ = Nido
Hence, option B is correct.

33. **Solutions: (C)**
$ClO_4^- < ClO_3^- < ClO_2^- \cong CO^-$
The oxidation of many molecules and ions by halogen oxyanions becomes progressively faster as the oxidation no. of the halogen decreases. Thus the rates observed are often I these order.
$ClO_4^- < ClO_3^- < ClO_2^- \cong CO^-$
Hence, option C is correct.

34. **Solutions: (C)**
unlike the other elements of group 1, Li reacts directly with nitrogen to form lithium nitride. This is because Li^+ is very small in size and so its size is the most compatible with the N^{3-} ion
Hence, option C is correct.

35. **Solution: (D)**
Pb_5^{2-}

VEC = 4*5+2 = 22 electron
4n+2 ⟶ closo structure
n = no. of atom

closo 4n+2 n+1 electron pair
5+1 = 6 electron pair
6*2 = 12 electron

36. **Solution: (A)**
B is less electronegative from other so, H can oxidize B easily.

37. **Solution: (D)**
Generally metal oxides are stable even at 1000^0C. but many oxides decomposes on heating. Peroxides generally decomposes on heating.

$$HgO, KO_2, BaO_2 \xrightarrow{\Delta} O_2$$

38. **Solution: (B)**

$2HF \rightleftharpoons H_2F + HF_2^-$
$2POCl_3 \rightleftharpoons POCl_2 + POCl_4^-$
$2IF_3 \rightleftharpoons IF_4^- + IF_2^+$
} These all shows autoionization

COORDINATION CHEMISTRY

CHAPTER 4

PREVIOUS YEAR EXAM QUESTIONS

(MH - SET 2004)

1. The lowest energy d-d transition of $[Cr(NH_3)_6]^{3+}$ originates from
   (A) $^4T_{2g}$ to $^4A_{2g}$ (B) $^4A_{2g}$ to $^4T_{1g}$
   (C) $^4T_{2g}$ to $^4T_{2g}$ (D) $_4T_{2g}$ to $^4T_{1g}$

(MH - SET 2011)

2. Compound X, which is soluble water in informs a white precipitate Y on reaction with aqueous $AgNO_3$. Y is soluble in ammonia but insoluble in dilute nitric acid. On addition of K_2CrO_4 to X, a brown precipitate is formed. Compounds X and Y are:
   (A) K_3PO_4, AgCl (B) KCl, AgCl
   (C) $BaCl_2$, AgCl (D) $BaCO_3$, AgCl

(MH - SET 2011)

3. Identify the series with correct order of stability of the complexes:
   (A) $[Ni(CN)_4]^{2-} < [Mn(CN)_6]^{3-} < [Cr(CN)_6]^{3-}$
   (B) $[Ni(CN)_4]^{2-} > [Mn(CN)_6]^{3-} > [Cr(CN)_6]^{3-}$
   (C) $[Ni(CN)_4]^{2-} < [Mn(CN)_6]^{3-} > [Cr(CN)_6]^{3-}$
   (D) $[Ni(CN)_4]^{2-} > [Mn(CN)_6]^{3-} < [Cr(CN)_6]^{3-}$

(MH - SET 2011)

4. $[(NH_3)_4Rh(\mu\text{-}OH)_2Rh(NO_2)_4]$ and $[(NH_3)_2(NO_2)_2Rh(\mu\text{-}OH)_2(NH_3)_2(NO_2)_2]$ are examples of:
   (A) ionization isomers
   (B) coordination isomers
   (C) linkage isomers
   (D) hydrate isomers

(MH - SET 2011)

5. Among the following ions which one has the highest magnetic moment?
   (A) $[Cr(H_2O)]^{3+}$ (B) $[Fe(H_2O)]^{3+}$
   (C) $[Cu(H_2O)]^{3+}$ (D) $[Zn(H_2O)]^{3+}$

(MH - SET 2011)

6. The type(s) of isomerism possible in a molecule with the formula, $[Os(acac)_2(SCN)_2]$? (acac=acetylacetonate)
   (A) geometrical, optical
   (B) linkage, geometrical
   (C) geometrical, optical, coordination
   (D) linkage, geometrical, optical

(MH - SET 2011)

7. Which of the following metal ions will form a low spin octahedral complex with the highest magnetic moment value?
   (A) Fe^{3+} (B) Co^{3+}
   (C) Co^{2+} (D) Cr^{3+}

(MH - SET 2011)

8. The ground state value of J for ^3F term for V^{3+} is:
   (A) 0 (B) 1
   (C) 2 (D) 4

(MH - SET 2011)

9. For $M_L = 3$ and $M_S = 1$ system, the ground term symbol is:
   (A) $^4D_3$ (B) $^3F_2$
   (C) $^4F_2$ (D) $^3F_3$

(MH - SET 2011)

10. A blood red colour is obtained when aqueous ferric ion solution reacts with:
    (A) $[Fe(CN)_6]^{3-}$ (B) KCN
    (C) $[Fe(CN)_6]^{4-}$ (D) KSCN

(MH - SET 2013)

11. Magnetic measurements indicate that $[Co(H_2O)_6]^{2+}$ has 3 unpaired electrons. Therefore, the hybridization of the metal orbitals in $[Co(H_2O)_6]^{2+}$is:
    (A) d^2sp^3 (B) sp^3d^2
    (C) dsp^2 (D) sp^2d

(MH - SET 2013)

12. Find the crystal field stabilization energy (CFSE) (in kJ/mol) for complex, $[Ti(H_2O)_6]^{3+}$. According to CFT, the first absorption maximum is obtained at 20, 3000 cm^{-1} for the transition:
    (A) 0.4 ΔE (B) 0.8 ΔE
    (C) 1.2 ΔE (D) 1.6 ΔE

(MH - SET 2013)

13. Coordinated water molecules of Cd (II) complex can be successively replaced by Br^- finally to result in $[CdBr_4]^{2-}$. In this process, the fourth equilibrium constant (K_4) is observed to be higher than the third one, because:
    (A) Equilibrium constant for the last step is always the highest
    (B) Three molecules of H_2O are released during the fourth step
    (C) The aqua Cd^{2+} complex is octahedral
    (D) A Br^- anion replaces a neutral (H_2O) molecule from the coordination sphere

(MH - SET 2013)

14. Which statement most correctly describes crystal field theory for a d-block complex of unspecified geometry?
    (A) The theory considers covalent interaction between a metal centre and the surrounding ligands.
    (B) The theory considers electrostatic interaction between a metal ion and the surrounding ligand which are taken to be point charges.
    (C) The theory rationalizes the non-degeneracy of the metal-orbitals by considering the electrostatic repulsions between point charge ligands and electrons in the metal d-orbitals.
    (D) The theory rationalizes the metal d-orbitals are split into two levels.

(MH - SET 2013)

15. The reaction: $[Co(H_2O)_5Cl]^{2+}$+ $[Cr(H_2O)_6]^{2+}$ ⟶ $[Co(H_2O)_6]^{2+}$+ $[Cr(H_2O)_5Cl]^{2+}$ is an example of:
    (A) isomerization
    (B) nucleophilic substitution
    (C) inner-sphere electron transfer
    (D) outer-sphere electron transfer

(MH - SET 2013)

16. Which of the statements is false?
    (A) In an octahedral crystal field, the electrons fill the e_g level first, followed by t_{2g} level.
    (B) Diamagnetic metal ions cannot have an odd number of electrons.
    (C) Low-spin complexes can be paramagnetic.
    (D) In high-spin octahedral complexes Δ_{oct} is less than the electron pairing energy, and is relatively every small.

(MH - SET 2013)

17. The first excited state configuration of low-spin octahedral d^4 system is:
    (A) ^2E_g (B) $^5T_{2g}$
    (C) ^5E_g (D) $^3T_{2g}$

(MH - SET 2014)

18. The oxidation numbers of Cr in K_2CrO_4 and $K_2Cr_2O_7$ are, respectively:
    (A) 3 and 6 (B) 6 and 3
    (C) 6 and 6 (D) 3 and 3

(MH - SET 2014)

19. Which of the following complex ion has a magnetic moment value same as $[Cr(H_2O)_6]^{3+}$:
    (A) $[Cu(NH_3)_4]^{2+}$ (B) $[Mn(H_2O)_6]^{3+}$
    (C) $[Fe(H_2O)_6]^{3+}$ (D) $[Mn(H_2O)_6]^{4+}$

(MH - SET 2014)

20. The visible spectra of salts of following complexes are measured in aqueous solutions.
    For which complex would the spectrum contain absorptions with the highest ε_{max} values?
    (A) $[MnO_4]^-$ (B) $[CoCl_4]^{2-}$
    (C) $[Co(H_2O)_6]^{2+}$ (D) $[Mn(H_2O)_6]^{2+}$

(MH - SET 2014)

21. $[Cr(CN)_6]^{3-}$ is expected to be:
    (A) Diamagnetic
    (B) Paramagnetic with $\mu_{eff} < 3.87$ BM
    (C) Paramagnetic with $\mu_{eff} > 3.87$ BM
    (D) Paramagnetic with μeff ≈ 3.87 BM

(MH - SET 2014)

22. Which of the following complexes has the maximum number of unpaired electrons?
    (A) $[FeCl_4]^-$ (B) $[VO(H_2O)_5]^{2+}$
    (C) $Hg[Co(NCS)_4]$ (D) $[Co(NH_3)_6]^{3+}$

(MH - SET 2014)

23. The bright yellow colour of $[Cu(phen)_2]^+$ (phen = 1, 10-phenanthroline) is due to:
    (A) d-d transitions
    (B) intraligand charge transfer transition
    (C) LMCT transition
    (D) MLCT transition

(MH –SET 2014)

24. Mention the correct statement about electron transfer reactions:
    (A) Electron transfer reaction occurring through inner sphere mechanism are faster that outersphere mechanism.
    (B) Electron transfer reaction occurring through outer sphere mechanism are faster if Ligands are pi-acceptor.
    (C) Electron transfer reaction occurring through outer sphere mechanism are faster if the conductivity of ligand is high.
    (D) All are correct.

(MH - SET 2014)

25. For which pair of the complexes is the order of values of Δ_{oct} correct?
    (A) $[Rh(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+}$
    (B) $[Fe(CN)_6]^{4-} > [Fe(CN_6)]^{3-}$
    (C) $[Rh(NH_3)_6]^{3+} < [Co(NH_3)_6]^{3+}$
    (D) $[Rh(NH_3)_6]^{3+} = [Co(NH_3)_6]^{3+}$

(MH - SET 2015)

26. On treatment of $[Ni(NH_3)_4]2+$ with concentrated HCl, two compounds X and Y having the same formula, $[NiCl_2(NH_3)_2]$ are obtained, X can be converted into Y by boiling with dilute HCl. A solution of X reacts with oxalic acid to form $[Ni(C_2O_4)(NH_3)_2]$ whereas Y does not react. Point out the correct statement of the following.
    (A) X is cis isomer and Y is trans isomer
    (B) X and Y are two optical isomers in cis geometry
    (C) X is trans isomer and Y is cis isomer
    (D) X and Y are two optical isomers in trans geometry

(MH - SET 2015)

27. For a d^3 tetrahedral configuration (assuming high spin), the Crystal Field Stabilization Energy is
(A) - 0.4 Δ_{tet} (B) - 1.2 Δ_{tet}
(C) - 0.8 Δ_{tet} (D) 0.8 Δ_{tet}

(MH - SET 2015)

28. Which of the following complex will not show optical isomerism?
(A) $[Ni(NH_2CH_2CH_2NH_2)_3]^{2+}$ (B) $[Ru(en)_3]^{2+}$
(C) $[Pt(diene)Cl_2]^+$ (D) $[Co(EDTA)]^{4-}$

(MH - SET 2015)

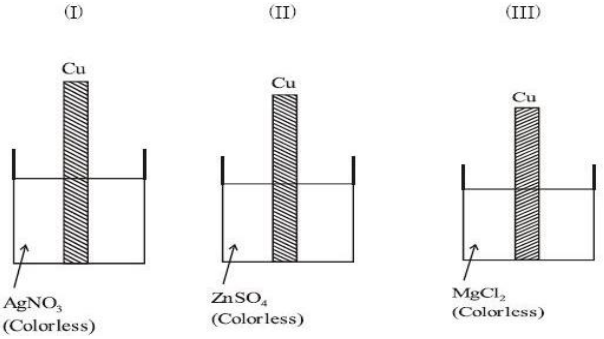
29. Which of the following statements is not true for CFSE?
(A) CFSE increase with increase in oxidation state of d-block metal.
(B) CFSE decrease with increase in oxidation state of d-block metal.
(C) CFSE indifferent with change in oxidation state.
(D) CFSE increase with decrease in oxidation state.

(MH –SET 2015)

30. The reaction of $[Pt(NH_3)_4]^{2+}$ with two equivalent of Cl^- produces
(A) cis- $[Pt(NH_3)_2Cl_2]$ (B) trans-$[Pt(NH_3)_2Cl_2]$
(C) cis-$[Pt(NH_3)_2Cl_2]^{2-}$ (D) trans-$[Pt(NH_3)_2Cl_2]^{-2}$

(MH - SET 2015)

31. Consider the following three set of experiments:



Colorless solution changes to blue colored solution in:
(A) II (B) III
(C) I (D) II and III

(MH-SET 2015)

32. When acidic $K_2Cr_2O_7$ solution is added to Na_2S solution, green Cr^{3+} ions and free S are formed. When same acidic $K_2Cr_2O_7$ solution is added to NaCl solution, no change is noted. Among the substances involved in these reactions which one is the best reducing agent?
(A) $K_2Cr_2O_7$ (B) Na_2S
(C) Cr^{3+} (D) S

(MH-SET 2015)

33. The effective magnetic moment of an octahedral Co(II) complex was found to be μ_{eff} = 4.0 μB. What is the electron configuration of this complex?
(A) high-spin complex, $t_{2g}^3e_g^4$
(B) high-spin complex, $t_{2g}^5e_g^2$
(C) low-spin complex, $t_{2g}^5e_g^2$
(D) low-spin complex, $t_{2g}^3e_g^4$

(MH-SET 2015)

34. The lowest energy d-d transition in Cr(III) complexes varies in the order
(A) $[CrCl_6]^{3-} < [Cr(H_2O)_6]^{3+} < [Cr(en)_3]^{3+} < [Cr(CN)_6]^{3-}$
(B) $[CrCl_6]^{3-} < [Cr(en)_3]^{3+} < [Cr(H_2O)_6]^{3+} < [Cr(CN)_6]^{3-}$
(C) $[Cr(en)_3]^{3+} < [CrCl_6]^{3-} < [Cr(H_2O)_6]^{3+} < [Cr(CN)_6]^{3-}$
(D) $[Cr(H_2O)_6]^{3+} < [Cr(en)_3]^{3+} < [CrCl_6]^{3-} < [Cr(CN)_6]^{3-}$

(MH-SET 2015)

35. The redox indicator methylene blue at the transition potential show a color change
(A) blue to red (B) blue to red violet
(C) red to colorless (D) blue to colorless

(MH - SET 2016)

36. Which of the following species contains an element in an oxidation states that is not a whole numbers?
(A) VO_4^{3-} (B) Mn_2O_3
(C) $S_4O_6^{2-}$ (D) $Cr_2O_7^{2-}$

(MH-SET 2016)

37. During a ligand substitution reaction, if an intermediate with higher coordination is formed, the possible mechanism of the reaction is:
(A) A (B) I_a
(C) D (D) I_d

(MH-SET 2016)

38. Which of the following is expected to undergoes the fastest inner sphere reduction by $[Cr(H_2O)_6]^{2+}$?
(A) $[Co(PY)_6]^{3+}$ (B) $[Co(PY)_5(ampy)]^{3+}$
(C) $[Fe(PY)_5(dampy)]^{3+}$ (D) $[Co(PY)_5(dampy)]^{3+}$
[PY = pyridine; ampy = 4-aminopyridine; dampy = 3,5-diaminopyridine]

(MH-SET 2016)

39. The reaction:

$$[Pt(en)_2Cl_2]_2^+(aq) + [Pt(NH_3)_4]_2^+(aq) \underset{Cl^-}{\overset{Cl^-}{\rightleftharpoons}} [Pt(en)_2]_2^+(aq) + [Pt(NH_3)_4Cl_2]_2^+(aq)$$

Is an example of:
(A) Isomerization reaction
(B) Ligand substitution reaction
(C) Electron transfer process
(D) Reproportionation reaction

(MH-SET 2016)

40. The term symbol not possible for the nd^2 electronic configuration is:
(A) ^3F (B) ^1D
(C) ^1G (D) ^1F

(MH SET 2016)

41. Which of the following complexes has zero orbital moment?

(A) $[Mn(CN)_6]^{4-}$ (B) $[Mn(CN)_6]^{3-}$
(C) $[Mn(H_2O)_6]^{5+}$ (D) $[FeF_6]^{3-}$

(MH SET 2016)

42. The π-acidic ligands stabilize the metal ions in lower oxidation states because of:
(A) L → M π- interaction
(B) Stronger L → M σ- interaction
(C) Synergic effect
(D) Neutralization of the positive charge over the metal ion.

(MH - SET 2016)

43. Which of the following has the lowest nephelauxetic effect
(A) $[RuF_6]^{3-}$ (B) $[Fe(Py)_6]$
(C) $[Ru(NH_3)_6]^{2+}$ (D) $[Ru(bipy)_3]^{2+}$
[PY = pyridine]

(MH-SET 2016)

44. The electronic transition responsible for the color of transition metal ions is:
(A) $d_\pi \rightarrow d_\sigma$ (B) $d_\pi \rightarrow d_{\sigma*}$
(C) $d_\pi \rightarrow d_{\pi*}$ (D) $d_\sigma \rightarrow d_{\pi*}$

(MH - SET 2017)

45. For transition metal (M) spinels, M(II) $[M'III]_2O_4$ is considered a normal spinel, while M'(III) [M(II) M'(III)]O_4 is considered an inverse spinel. Based on these considerations which one of the following is true?
(A) Fe_3O_4 is a normal spinel
(B) $NiFe_2O_4$ is a normal spinel
(C) Co_3O_4 is an inverse spinel
(D) Mn_3O_4 is a normal spinel

(MH - SET 2017)

46. Which of the following metal ions should from a more stable octahedral complex with pyridine:
(A) Fe^{2+} (B) Fe^{3+}
(C) Ru^{3+} (D) V^{3+}

(MH - SET 2017)

47. Tetrahedral complex are always:
(A) high spin complexes
(B) Low spin complexes
(C) Intermediate spin
(D) High spin-low spin equilibria

(MH - SET 2017)

48. The hybridization in $[PtCl_4]^{2-}$ is:
(A) dsp^2 (B) dsp^3
(C) d^2sp^3 (D) sp^3

(MH - SET 2017)

49. The complexes $[Co(NH_3)_6]$ $[Cr(CN)_6]$ and $[Cr(NH_3)_6]$ $[Co(CN)_6]$ are examples of:
(A) Polymerization isomerism
(B) Linkage isomerism
(C) Coordination isomerism
(D) Ionization isomerism

(MH - SET 2017)

50. Jahn-Teller distortion in octahedral is shown by:
(A) Low spin d^6, d^8 and d^9 complexes
(B) High spin d^4, low spin d^7 and d^9 complexes
(C) High spin d^5, low spin d^6 and d^9 complexes
(D) High spin d^3, high spin d^6 and d^9 complexes

(MH - SET 2017)

51. The strongest π acceptor ligand is:
(A) CN^- (B) PCl_3
(C) PF_3 (D) PMe_3

(MH - SET 2017)

52. Cis and trans $[PtA_2X_2]$ type of complexes are distinguished by interacting with:
(A) Chromyl chloride
(B) Thiourea
(C) Potassium dichromate
(D) Iron sulphateheptahydrate

(MH-SET 2017)

53. Which statement about the trans effect and trans influence is correct?
(A) The trans influence is a ground state effect, whereas the trans effect has trans effect has a kinetic origin.
(B) The trans effect is a ground state effect, whereas the trans influence has a kinetic Origin
(C) Both trans effect and trans influence are ground state effects.
(D) Rates of substitution are affected by the trans effect but not by trans influence

(MH-SET 2017)

54. Which of the following pairs of coordination complexes undergo inner sphere electron transfer reaction?
(A) $[Co(NH_3)_5Cl]^{2+}/[Cr(H_2O)_6]^{2+}$
(B) $[Co(NH_3)_5SCN]^{2+}/[Cr(H_2O)_6]^{2+}$
(C) $[Co(NH_3)_5H_2O]^{3+}/[Cr(H_2O)_6]^{2+}$
(D) $[Co(NH_3)_6]^{3+}/[Cr(H_2O)_6]^{2+}$

(MH-SET 2017)

55. Racemization of octahedral complexes containing three bidentate chelate rings by the Bailer twist mechanism forms a intermediate of point group
(A) D_{3h} (B) C_2v
(C) C_3v (D) D_{2h}

(MH-SET 2017)

56. The number of electronic transitions observed in octahedral V(III) complexes are:
(A) Two (B) Three
(C) One (D) Four

(MH-SET 2017)

57. The room temperature (26 ^{0}C) magnetic moment per copper (II) ion in copper acetate monohydrate is 1.4 B.M. The magnetic behavior can be best explained by (At. No. Cu = 29)

(A) Ferromagnetic coupling of two copper (II) spins.
(B) Antiferromagnetic coupling of two copper (II) spins.
(C) Ferrimagnetic coupling of two copper (II) spins.
(D) This is the normal magnetic behavior of this compound

(MH-SET 2017)

58. $[Ni(en)_3]^{2+}$ has three absorption bands in electronic spectra: 11,200, 18350 and 29000 cm^{-1}.The 10 Dq value of the complex:
(A) 8,960 cm^{-1} (B) 13,440 cm^{-1}
(C) 18,350 cm^{-1} (D) 11,200 cm^{-1}

(MH-SET 2017)

59. Quenching of the orbital contribution to the ligand field in electronic configuration:
(A) $e^2t_2^1$ (B) $e^4t_2^4$
(C) $e^4t_2^5$ (D) $e^4t_2^3$

(MH-SET 2017)

60. The compound trans-Fe (o-phen)$_2$(NCS)$_2$ has a magnetic moment of 0.65 B.M. at 80 K, increasing with temperature to 5.2 B.M. at 300 K. This phenomenon is known as:
(A) Spin pairing (B) Spin canting
(C) Spin crossover (D) Spin flip

(MH-SET 2017)

61. The spin multiplicity of an atom in its ground state and having the outer shell configuration $4s^23d^7$ is:
(A) 19 (B) 15
(C) 7 (D) 4

(MH-SET 2018)

62. The spin only magnetic moment for a first-row transition metal ion with $^3F_4$ ground state term is:
(A) 3.87 B.M. (B) 4.90 B.M.
(C) 2.83 B.M. (D) 5.92 B.M

(MH-SET 2018)

63. Crystal Field Stabilization Energy for a d^3 ion in tetrahedral geometry is:
(A) -1.2 (B) -0.8
(C) -0.4 (D) 0.0

(MH-SET 2018)

64. The ^{1}G term of nd^2 configuration can be assigned to:
(A) 45 microstates (B) 9 microstates
(C) 21 microstates (D) 15 microstates

(MH-SET 2018)

65. The correct order of Nephelauxetic parameter (β) of the ligands is:
(A) $CN^- > NCS^- > en > NH_3 > H_2O$
(B) $H_2O > NH_3 > en > NCS^- > CN^-$
(C) $en > CN^- > NCS^- > NH_3 > H_2O$
(D) $H_2O > NH_3 > NCS^- > CN > en$

(MH-SET 2018)

66. $[Ni(dipyridyl)_3]SO_4$ records three transitions in electronic spectra at 12,650 cm^{-1}, 19,200 cm^1 and 26,000 cm^{-1}. The 10 Dq of the complex is:
(A) 12650 cm^{-1} (B) 15180 cm^{-1}
(C) 10120 cm^{-1} (D) 26000 cm^{-1}

(MH-SET 2018)

67. 'A' type of ground Mulliken symbol in complex having O_h symmetry is:
(A) $t_{2g}^3eg^2$ (B) $t_{2g}^1eg^0$
(C) $t_{2g}^3eg^1$ (D) $t_{2g}^6eg^3$

(MH-SET 2018)

68. The d^n electron configuration of the first row transition metal ions that show 'high-spin'—'low-spin' transition are:
(A) d^4 and d^5 (B) d^5 and d^6
(C) d^4, d^5, d^6 and d^7 (D) d^4, d^5 and d^6

(MH-SET 2018)

69. The measurement of the intensity of the scattered light as a function of the concentration of the dispersed phase form is the principle of:
(A) Colorimetry (B) Turbidimetry
(C) Nephelometry (D) Phosphorimetry

(MH-SET 2018)

70. In the base-catalyzed substitution of Cl^- by OH^- in $[Co(NH_3)_5Cl]^{2+}$ under strongly basic conditions, the first step in the mechanism is:
(A) Conversion of an ammine to amido ligand
(B) Substitution of Cl^- by OH^-
(C) Dissociation of Cl^- to give 5-coordinate intermediate
(D) Association of OH^- to give 7 coordinate intermediates

(MH-SET 2018)

71. Which of the following pairs of coordination complexes do not undergo inner sphere electron transfer reaction?
(A) $[Co(NH_3)_5NO_3]^{2+}/[V(OH_2)_6]^{2+}$
(B) $[Co(NH_3)_5I]^{2+}/[V(OH_2)_6]^{2+}$
(C) $[Co(en)_3]^{3+}/[V(OH_2)_6]^{2+}$
(D) $[Co(NH_3)_5Br]^{2+}/[V(OH_2)_6]^{2+}$

(MH-SET 2018)

72. Racemization of octahedral complexes containing three bidentate rings by the Ray-Dutt twist mechanism forms intermediates of ..... point group.
(A) D_3h (B) C_2v
(C) C_3v (D) D_2h

(MH-SET 2018)

73. Which of the following statements with respect to 'trans effect' is true?
(A) Ammonia > Chloride (B) Water > Chloride
(C) Pyridine > Chloride (D) Chloride > Ammonia

(MH - SET 2018)

74. The structure of $(NH_3)_3CrO_4$ is:
(A) Trigonal bipyramid (B) Pentagonal bipyramid
(C) Square Pyramid (D) Pentagonal Pyramid

(MH - SET 2018)

75. The IUPAC nomenclature of $[CoCl(CN)(NO_2)(NH_3)_3]$ is:
(A) Triamminechloridocyanidonitrocobalt (III)
(B) Chloridocyanidonitrotriamminecobalt (III)
(C) Cyanidochloridonitrotriamminecobalt (III)
(D) Triamminechloridonitrocyanidocobalt (III)

(MH - SET 2018)

76. The cation of dichloro bis (ethylenediamine) cobalt (III) belongs to D_3 symmetry is an example of:
(A) Coordination isomerism
(B) Optical isomerism
(C) Linkage isomerism
(D) Ionization isomerism

(MH - SET 2018)

77. Common feature of CO, CN^- and NO^+ ligands is:
(A) They have empty π orbitals
(B) They act as π donor ligands
(C) They are all weak field ligands
(D) They decrease the value of Δ_0

(MH - SET 2018)

78. Jahn-Teller distortion will be exhibited by:
(A) $[Mn(H_2O)_6]^{2+}$ (B) $[Cr(H_2O)_6]^{3+}$
(C) $[Ni(H_2O)_6]^{2+}$ (D) $[Cu(H_2O)_6]^{2+}$

(MH - SET 2018)

79. Tetragonal distorted complexes will be exhibited by:
(A) Low spin Fe^{2+} (B) High spin Cr^{2+}
(C) High spin Mn^{2+} (D) Ni^{2+}

(MH –SET 2019)

80. The reaction $[Co(NH_3)_5Cl]^{2+} + [Cr(H_2O)_6]^{2+} + 5H^+ \rightarrow [Co(H_2O)_6]^{2+} + [Cr(H_2O)_5Cl]^{2+} + 5NH_4^+$ is an example of:
(A) Ligand transfer process only
(B) Ligand exchange process only
(C) Outer sphere electron transfer process
(D) Inner sphere electron transfer process

(MH –SET 2019)

81. The product of the reaction between 2 Cl^- and cis-$(Pt(NH_3)_2(Py)_2]^{2+}$ will be:
(A) cis-$[PtCl_2(NH_3)(PY)]$ (B) cis-$[Pt(NH_3)_2Cl_2]$
(C) trans-$[PtCl_2(Py)(NH_3)]$ (D) cis-$[PtCl_2(Py)_2]$

(MH –SET 2019)

82. Among the following alkaline earth metal ions the exchange rates for the water molecules from the first coordination sphere at 25°C will be:
(A) $Be^{2+} > Mg^{2+} > Ca^{2+}$ (B) $Mg^{2+} > Be^{2+} > Ca^{2+}$
(C) $Ca^{2+} > Mg^{2+} > Be^{2+}$ (D) $Mg^{2+} > Ca^{2+}$ Be^{2+}

(MH - SET 2019)

83. According to CFT, Ni^{2+} can have two unpaired electrons in:
(A) Octahedral geometry
(B) Tetrahedral geometry
(C) Both octahedral and tetrahedral geometry
(D) Square planar geometry

(MH - SET 2019)

84. Which of the following complexes will not exhibit ideal octahedral geometry?
(A) $[Ti(H_2O)_6]^{3+}$ (B) $[Ni(H_2O)_6]^{2+}$
(C) $[Mn(H_2O)_6]^{2+}$ (D) $[Cr(H_2O)_6]^{3+}$

(MH - SET 2019)

85. The hybridization for the complex ion $[FeF_6]^{3-}$ and $[Fe(CN)_6]^{3-}$is:
(A) d^2sp^3 and sp^3d^2 (B) d^2sp^3 and d^2sp^3
(C) sp^3d^2 and sp^3d^2 (D) sp^3d^2 and d^2 sp^3

(MH –SET 2019)

86. The spin only magnetic moment for the complex $Hg[Co(SCN)_4]$ is:
(A) $\sqrt{3}$ (B) $\sqrt{15}$
(C) $\sqrt{8}$ (D) $\sqrt{24}$

(MH –SET 2019)

87. The molecular formula for sodium b is (thiosulphato) argentate (I) is:
(A) $Na_2[Ag(S_2O_3)_2]$ (B) $Na_3[Ag(S_2O_3)_2]$
(C) $Na[Ag(S_2O_3)_2]$ (D) $Na_3[Ag(S_2O_3)]$

(MH –SET 2019)

88. $MnO_4^-$is coloured in aqueous medium while ReO_4^- is colorless because:
(A) The energy required for LMCT is higher for ReO_4^- than MnO_4^-
(B) MnO_4^- is colored due to MLCT
(C) d – d transition are forbidden in ReO_4^-
(D) The energy of d – d transition in ReO_4^- is much higher than MnO_4^-

(MH –SET 2019)

89. The ion $[Ni(Pyridine)_4(H_2O)_2]^{2+}$ has d – d absorption bands at 27000, 16500 and 10150 cm^{-1}. The 10 Dq value of Ni^{2+} ion is:
(A) 10150 cm^{-1} (B) 10500 cm^{-1}
(C) 16500 cm^{-1} (D) 6350 cm^{-1}

(MH –SET 2019)

90. The electric dipole allowed transition in a d^3 atomic system is:
(A) $^4F \rightarrow {}^2D$ (B) $^3F \rightarrow {}^3P$
(C) $^4F \rightarrow {}^4D$ (D) $^4F \rightarrow {}^2G$

(MH –SET 2019)

91. Which of the following complexes will have the highest spin only magnetic moment?
(A) $[VCl_6]^{4-}$ (B) $[Ni(CN)_4]^{2-}$
(C) $[Co(NH_3)_6]^{3+}$ (D) [η^5-$(C_5H_5)_2Cr$]

(MH – SET 2020)

92. The only electronic transition that occurs in Cu^{2+} tetrahedral complexes is
(A) $^2E_g \leftarrow {}^2T_{2g}$ (B) $^2E \leftarrow {}^2T_2$
(C) $^2T_{2g} \leftarrow {}^2E_g$ (D) $^2T_2 \leftarrow {}^2E$

(MH – SET 2020)

93. The first absorption level of $[VF_6]^{3-}$ complex is observed at 14,800 cm^{-1}. The 10 Dq value for the complex is
(A) 14,800 cm^{-1} (B) 18,500 cm^{-1}
(C) 12,916 cm^{-1} (D) 8,700 cm^{-1}

(MH – SET 2020)

94. The reaction of $NiBr_2$ and Ph_2EtP results in two products with composition $[Ni(P(Ph)_2Et)_2\ Br_2]$. The first product is green in colour with magnetic moment 3.20 B.M. The second product is red in colour and is diamagnetic. The geometry of the green and red product respectively is:
(A) square planar and tetrahedral
(B) trigonal pyramidal and octahedral
(C) octahedral and trigonal bipyramidal
(D) tetrahedral and square planar

(MH – SET 2020)

95. The total orbital angular momentum quantum number L and spin quantum S of the term symbol ^4G is
(A) 2, ½ (B) 3, 3/2
(C) 4, 3/2 (D) 5, 1/2

(MH – SET 2020)

96. Which of the following can be classified as labile complexes?
(i) $[Cr(H_2O)_6]^{3+}$
(ii) $[Ti(H_2O)_6]^{3+}$
(iii) $[V(H_2O)_6]^{3+}$
(A) (i) and (ii) (B) (ii) and (iii)
(C) (iii) and (i) (D) Only (iii)

97. The magnetic moment of potassium salt of $[Fe(CN)_6]^{3-}$ is $2.3\mu\beta$. Choose the correct statement from the following
(A) it is spin only value of one unpaired electron
(B) it is spin only value of one and two unpaired electrons
(C) the increase in magnetic moment because of ferromagnetic coupling
(D) the increase in magnetic moment because of spin orbital coupling

(MH - SET 2020)

98. The driving force for complexation of Mg^{2+} by EDTA in aqueous medium is:
(A) change in oxidation state of magnesium
(B) increase in entropy
(C) change in coordination geometry
(D) decrease in entropy

(MH - SET 2020)

99. Trans-tetraamminedichloridocobalt (III) cation belongs to .. point group.
(A) D_6h (B) D_3h
(C) D_4h (D) $D_\infty h$

(MH-SET 2021)

100. A complex that possess ^5D ground term symbol from its metal ion is
(A) $[Mn(CN)_6]^{3-}$ (B) $[Cr(H_2O)_6]^{2+}$
(C) $[Fe(CN)_6]^{4-}$ (D) $[CO(H_2O)_6]^{2+}$

(MH-SET 2021)

101. The magnetic moment of the complex $[MnCN(S)_6]^{4-}$ is $6.06\ \mu B$. its electronic configuration is
(A) $t_{2g}^5\ e_g^0$ (B) $t_{2g}^3\ e_g^2$
(C) $t_2^3\ e^2$ (D) $t_{2g}^2\ e_g^3$

102. Mullikan symbol (S) possible for 'G' tem in octahedral ligand field is/are
(A) A_{1g} (B) T_{2g}, E_g
(C) $A_{1g}, E_g, T_{1g}, T_{2g}$ (D) A_{2g}, T_{2g}, T_{19}

(MH-SET 2021)

103. N type of semiconductor (S) among $Fe_2O_3, FeO, FeS,, CuI\ and\ Cu_2O$ is/are:
(A) $FeO, FeS\ and\ Fe_2O_3$ (B) $CuI\ and\ Cu_2O$
(C) $Fe_2O_3, FeO\ and\ Cu_2O$ (D) Fe_2O_3 only

(MH-SET 2021)

104. In a base catalysed substitution of Cl^- by OH^- in $[CO(NH_3)_5Cl]^{2+}$ under strongly basic conditions the first step in the mechanism will be
(A) substitution Cl^- by OH^-
(B) dissociation of Cl^- to give five coordinate intermediate
(C) association of OH^- to give seven coordinate intermediate
(D) conversion of an ammine liquid to amido ligand

(MH-SET 2021)

105. The crystal field stabilisation energy (CFSE) of an octahedral Ti^{3+} complex is $20100cm^{-1}$ CFSE of its tetrahedral complex will be:
(A) 10050 cm^{-1} (B) 20100 cm^{-1}
(C) 8933 cm^{-1} (D) 11187 cm^{-1}

(MH-SET 2021)

106. The reactions of $[PtCl_4]^{2-}$ with NH_3 reaction (I) and $[PtCl_4]^{2-}$ with $[NO_2]^-$ followed by NH_3 reaction (II) are ways of forming
(A) (I): $Cis - [PtCl_2(NH_3)_2]$;
(II): $Cis - [PtCl_2(NH_3)(NO_2)^-]$
(B) (I): $trans - [PtCl_2(NH_3)_2]$;
(II): $trans - [PtCl_2(NH_3)(NO_2)^-]$
(C) (I): $Cis - [PtCl_2(NH_3)_2]$;
(II): $trans - [PtCl_2(NH_3)(NO_2)^-]$