Periodic Table

EXERCISES

ELEMENTARY

Q.1 (3)

According to triad rule at wt. of $Y = \frac{X+Z}{2}$

$$26 = \frac{10+Z}{2}\ ; \qquad Z = 42$$

Q.2 (3)

According to Aufbau '4s' is lower in energy then 3d.

Q.3 (3)

Q.4 (4)

Q.5 (4)

Q.6 (2)

$15 = [Ne]\ 3s^2\ ,\ 3p^3$
$33 = [Ar]\ 4s^2,\ 3d^{10},\ 4p^3$
$51 = [Kr]\ 5s^2,\ 4d^{10},\ 5p^3$

So all belongs to nitrogen family as outermost configuration is $ns^2\ np^3$ or belongs to 15th group.

Q.7 (3)

Un – 1
Un – 1
Hex – 6 So at no. = 116

Q.8 (1)

F is most electronegative.

Q.9 (4)

Except Li–Na, all have diagonal relationship.

Q.10 (3)

Ionic radii order $N^{3-} > O^{2-} > F^-$

Q.11 (1)

In noble gas vander walls radii is calculated which is normally then double of other type of radii.

Q.12 (1)

As we go from left to right in a period radius decreases.

Q.13 (4)

Q.14 (1)

In isoelectronic anion is bigger in size.

Q.15 (2)

Q.16 (3)

$IE_2(Na) > IE_2(Mg$

because second electron is Na is removed from noble gas configuration.

Q.17 (2)

$Mg \longrightarrow Mg^+ + e^- \qquad 1E_1 = 178$
$Mg^+ \longrightarrow Mg^{2+} + e^- \qquad 1E_2 = 348$

$Mg \longrightarrow Mg^{2+} + e^- \qquad$ so $1E = 1E_1 + 1E_2$
$= 178 + 348 = 526$

Q.18 (4)

1E of anion < 1E of atom.

Q.19 (3)

Q.20 (3)

Since N is having half filled stability of orbital.

Q.21 (3)

EA of chlorine is exothermic.

Q.22 (4)

Due to strong repulsion second EA is endothermic.

Q.23 (2)

Q.24 (1)

Cl has highest E.A.

Q.25 (3)

EN decreases down the group.

Q.26 (2)

Acidic nature increases along the period from left to right..

Q.27 (1)

Basic nature of oxide decreases along the period.

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (2)

Mg	Ca	Sr
24	40	88

$$\frac{88+24}{2} = \frac{112}{2} = 56$$

In this atomic mass of central element was not arithmatic mean of atomic mass of ofter two element so, Mg, Ca, Sr is not a Dobereiner triad.

Q.2 (3)
Be, Mg, Ca obey's newland's octave rule because to it every eight element is similar in property to first one.

Q.3 (4)

Q.4 (4)

Q.5 (1)
EKa aluminium = Ga
EKa manganese = Tc
is not discovered at the time of mendeleef.

Q.6 (2)

Q.7 (2)
Ca and Sr is a pair of element do not follow octave rule because in comparison of Ca is not eight element Sr.

Q.8 (4)

Q.9 (3)

Q.10 (2)
The d-block has 10 columns, because a maximum of 10 electrons can occupy all the (5) orbitals in a d-subshell.

Q.11 (3)

Q.12 (4)
Yes, hydrogen can be placed in 1st group on the basis of its valency +1 (H^+).

Q.13 (3)
Silver belongs to Vth period. So the atomic number of elements placed above and below will be $47 - 18 = 29$ and $47 + 32 = 79$ respectively.

Q.14 (4)
Z = 118 $[Rn]^{86}\, 5f^{14}\, 6d^{10}\, 7s^2\, 7p^6$; as last electron enters in p-subshell, it belongs to p-block. Thus its group number will be 10 + 2 + 6 = 18. Hence the element is a noble gas

Q.15 (2)
Moseley work on X-ray spectrum.

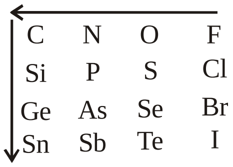
Q.16 (1)

Q.17 (1)
P/e ratio = 7/10 = 0.7
8/10 = 0.8
9/10 = 0.9

Q.18 (4)

Q.19 (1)

Q.20 (1)



Q.21 (3)

Q.22 (4)
$N^{3-} \rightarrow 10$, $S^{2-} \rightarrow$ means not same number of electron.

Q.23 (2)

Q.24 (4)

Q.25 (4)
Second ionisation energy of potassium is greater than that of Ca. In case of potassium ion (i.e. K^+) the electron removal from the stable inert gas configuration ($1s^2\, 2s^2\, 2p^6 3s^2 3p^6$) requires much higher energy.

Q.26 (2)

Q.27 (2)

Q.28 (4)

Q.29 (2)
O has exceptionally smaller value of electron affinity (minimum in family) due to smaller atomic size than sulphur (weaker electron-electron repulsion in larger 3p-subshell).

Q.30 (1)

Q.31 (4)

Q.32 (3)
The addition of extra electron is difficult to the atom having stable configuration and so electron gain enthalpy will be positive. Similarly the removal of

electron is quite difficult from stable configuration and so ionisation enthalpy is higher. However EN remains unaffected because it neither involves gain nor loss of electron.

Q.33 (1)

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OBJECTIVE QUESTIONS

Q.1 (C)

Q.2 (A)
18 Group

Q.3 (A)

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}_{2}^{4}He$$

Uranium element comes in III B & Tr also comes in III B group.

Q.4 (A)

Q.5 (D)
For isoelectronic species, as Z increases, Z_{eff} increases (and vice versa).

Q.6 (A)
For isoelectronic species, as Z increases, Z_{eff} increases (and vice versa).

Q.7 (C)

Q.8 (A)

Q.9 (B)
Atomic radius increases on moving top to bottom in a group due to increasing number of shells. However, it decreasing on moving left to right in a period due to increasing Z_{eff} and addition of electrons in the same shell.
Nb (4d) ≈ Ta (5d) (due to poor shielding of nuclear charge by 4f electrons).
For isoelectronic species, ionic radius $\propto \dfrac{1}{\text{nuclear charge}}$. So correct order is $Y^{3+} < Sr^{2+} < Rb^{+}$.

Q.10 (A)

Q.11 (A)

$$\text{size} \propto \frac{1}{\text{Proton}}$$

Q.12 (C)
$Sc > Ti > V > Cr < Mn > Fe \approx Co \approx Ni < Cu < Zn$

Q.13 (C)

Q.14 (B)

Q.15 (A)
Across the period (i.e. 3rd period) the size of atom decreases and nuclear charge increases. So generally the ionisation energy increases. However the ionisation energy of Mg is greater than Al because of more penetration power of 2s sub-shell electrons of Mg as compared to that of the 2p sub-shell electron of Al. Also, Mg has fully filled configuration.

Q.16 (C)
Removal of Ist electron is easier because of bigger size but 2nd electron is to be removed from $ns^2\ np^6$ configuration i.e. stable noble gas configuration. So $IE_2 >> IE_1$.

Q.17 (C)

Q.18 (C)

Q.19 (B)
$Si - 1s^2, 2s^2\ 2p^6, 3s^2, 3p^2$
$IE_1 < IE_2 < IE_3 < IE_4 < IE_5$ because as the number of electron decreases, the attraction between the nucleus & the remaining electron increases consederably.

Q.20 (B)
As alkali metal IE_1 is less than IE_2.

Q.21 (D)

Q.22 (D)
Because of first hall filled then fullfilled orbital.

Q.23 (C)
$Al(13) \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^1$
$Al^{+}(12) \rightarrow 1s^2, 2s^2, 2p^6, 3s^2$
$Al^{2+} \rightarrow 1s^2, 2s^2\ 2p^6, 3s^1$
$Al^{3+} \rightarrow 1s^2, 2s^2\ 2p^6$
$Al^{2+} < Al^{+} < Al^{3+}$

Q.24 (C)
Because of less E. A.

Q.25 (D)

Q.26 (B)
As size of atom decreases across the period, the attraction between the nucleus and shared pair of electrons increases. So electronegativity increases across the period.

Q.27 (D)
Electronegativity of elements generally increases across the period (less increase) and decreases down the group (more decrease). Si = 1.8, P = 2.1, C = 2.5, N = 3.0. So, the correct increasing order is Si < P < C < N.

Q.28 (D)
There is more interelectronic repulsion in 2p-subshell of fluorine than chlorine (3p). So extra electron will be added easily in 3p-subshell of chlorine as compared to 2p-subshell of fluorine.

Q.29 (B)

Correct order of electron gain enthalpy is O < S < F < CI since F and O have more electron electron density with respect to Cl and S.

Q.30 (D)

The tendency to attract bonded pair of electron in case of hybrid orbitals increases with increase in % s-character and so the order : $sp > sp^2 > sp^3$

The electron affinity values for 2p-series elements is less than that for 3p-series elements on account of small size and high inter electronic repulsions. Statements (B) and (C) are facts. Every cation releases more energy than neutral atom upon gain of an electrons.

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MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (CD)

Group no.	e^- in outermost shell
13th	3
11th	1
9th	2 or 1
18th	2 or 8

Q.2 (BCD)

Q.3 (CD)

1st group elements show 1+ oxidation state and 2nd group elements show 2+ oxidation state.

Q.4 (AD)

Q.5 (BD)

Q.6 (ABD)

Zn have only 2+ or zero oxidation state.

Q.7 (AB)

O^{16}, O^{18} : –2, –1, +1, +2

Na, K : +1

C : +4 to –4 Be :+2

Zn : +2 Rb : +1

Q.8 (ABCD)

Q.9 (CD)

Q.10 (ABD)

(B) Isoelectronic series of ions; all have the xenon electron configuration.

$$\text{Ionic radius} \propto \frac{1}{\text{nuclear charge}}$$

Atomic number : Te = 52; I = 53; Cs = 55; Ba = 56.

(D) Due to poor shielding of nuclear charge by 4f electrons (Lanthanide contraction).

Q.11 (ABCD)

Q.12 (ABD)

(A) As removal of second electron takes place from half filled valence shell electron configuration of S^+ i.e. $3s^2\,3p^3$.

(B) I.E(III) of ${}_{13}Al$ is 2744 kJ mol^{-1} where as that of ${}_{15}P$ is 2910 kJ mol^{-1}. This is because of higher nuclear charge in phosphorus.

(C) I.E(I) of Al is 577 kJ mol^{-1} and that of Ga is 579 kJ mol^{-1}. This may be because of their similar sizes i.e. 1.25 Å in both.

(D) ${}_5B^+ = 1s^2\,2s^2$; ${}_6C^+ = 1s^2\,2s^2\,2p^1$; As s-sub shell electron has high penetration power than p-sub shell electron. In addition B^+ has completely filled 2s sub shell. So I.E (II) of B is 2427 and that of C is 2354 kJ mol^{-1}.

Q.13 (AD)

Q.14 (AB)

Q.15 (AB)

E.A. Order $P > N > N^-$

E.A. Order $S > O > O^-$

Q.16 (BC)

Q.17 (ACD)

Q.18 (BC)

Q.19 (B)

Q.20 (D)

Q.21 (C)

Q.22 (A)

Q.23 (B)

Q.24 (A)

Q.25 (C)

Q.26 (C)

Q.27 (B)

Q.28 (C)

Q.29 (C)

Q.30 (D)

Q.31 (C)

Q.32 (C)

Q.33 (C)

Q.34 (A)
Element just above Z = 43 will be Z = 43 – 18 = 25 and will have electronic configuration
$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$.

Q.35 (B)
All these elements have outermost configuration ns^2 np^5. So they belong to Group (12 + 5 = 17) means halogen family.

Q.36 (C)

Q.37 (B)

Ionic size $\propto \dfrac{1}{\text{Nuclear charge}}$ for isoelectronic species.

Q.38 (D)
Both N^{3-} and Al^{3+} are isoelectronic species, but Al^{3+} has greater nuclear charge. So, it will have smaller size.
Zr(4d) ≈ Hf(5d), because of Lanthanide contraction.
Zn > Cu, their occur greater interelectronic repulsions in completely filled electronic configuration of 12th group elements.

Q.39 (C)
The metallic character of the elements is highest at the extremely left (low ionisation energies) and then decreases across the period from left to right (ionisation energies increases across the period).

Q.40 (C)
The non-metallic character of the elements is highest at the extreme right and then decreases from right to left across the period. Also it decreases more on moving top to bottom.

Q.41 (D)
(A) Ionisation enthalpies of elements generally decrease along a group and increase along a period in Modern periodic table.
(B) In the 3rd period of Modern periodic table, the two most reactive elements are sodium and chlorine.
(C) Iodine has the least negative electron gain enthalpy among all halogens.
(D) Ionisation enthalpy of Pb is greater than that of Sn, because of poor shielding of nuclear charge by 4f-electrons.

Q.42 I → c ; II → d; III → b; IV → a

Q.43 (i) – r, (ii) – s, (iii) – t, (iv) – q, (v) – p
On moving left to right in a period, atomic radii decreases due to increase in Z_{eff} and addition of electrons to the same outermost shell.

Q.44 A → p,r; B → p,s ; C → q,t ; D → p,q,r

Q.45 A → q,r; B → p,s; C → s; D → q,r

Q.46 a → iv; b → iii; c → i ; d → ii

Q.47 a → iii; b → iv; c → ii; d → i

NUMERICAL VALUE BASED

Q.1 [26]
Fe

Q.2 [2]
$8s^1$
x = 1, y = 1
1 + 1 = 2.

Q.3 [7]
N, O, F, P, C, S, Cl

Q.4 [13]
+6, +7
6 + 7 = 13.

Q.5 [6]
$BiF_5, T\ell I_3, PbO_2, SnCl_2, T\ell_2O_3, As_2O_3$

Q.6 [3]
The 4f e⁻ in the antepenultimate shell are very effectivily shielded from their chemical environment outside the atom by 5s and 5pe⁻. Consequently the 4f e⁻ do not take part in bonding.

Q.7 [30]
Zn

Q.8 [8]
$r_A + r_A = 10Å$ ...(i)
$r_B + r_B = 6Å$ ...(ii)
(i) + (ii)
$2(r_A + r_B) = 16Å$

$r_A + r_B = 8Å$

Q.9 [2]
Be, N

Q.10 [5]
H, C, N, O, F

KVPY
PREVIOUS YEAR'S

Q.1 (D)

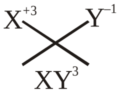
$\xrightarrow{Na_2O>Al_2O_3>SiO_2>P_2O_5}$ Basic Nature ↓

Q.2 (C)
Na^+, Ca^{2+}, F^-, O^{2-} are isoelectronic (10 electron species)

Q.3 (A)
CO and N_2 are isoelectronic because both have 14 electrons.

Q.4 (A)
First ionisation enthalpies for three elements are 1314, 1680 and 2080. These ae in increasing order so elements should be O, F, Ne.

Q.5 (C)
Atomic no. 33 and 17 belongs to 5th & 17th group respectively therefore co-valent bond form between both elements



Atomic no. 33 = As
Atomic no. 17 = Cl $\rightarrow AsCl_3$

Q.6 (C)
Aluminium from amphoteric oxide with oxygen (Al_2O_3)

Q.7 (C)
Mendeleev′s periodic table state that the property of elements are a periodic function of their atomic mass

Q.8 (B)
O^{-2} is isoelectronic with Mg^{+2}
$O^{-2} \rightarrow 8 + 2 = 10e^-$
$Mg^{+2} \rightarrow 12 - 2 = 10e^-$

Q.9 (B)
$Na = 1s^2 2s^2 2p^6 3s^1$
$Na^+ \rightarrow 1s^2 2s^2 2p^6$ [Ne]
[Ne] is inert gas, so, electron removal is very difficult so I.P. is very high.
$Na^{2+} \rightarrow 1s^2 2s^2 2p^5$

Q.10 (A)
as we move left to right in a period atomic radius decrease due to increase in Z_{eff} so. greatest radius is of lithium.

Q.11 (C)

$\xrightarrow{N^{3-} > O^{2-} > F^- > Na^+}$

$\xrightarrow[\text{size decreases}]{\text{effective nuclear charge increases}}$

Q.12 (B)

Highest 3rd I.E. $Eu^{2+} \rightarrow Eu^{3+} e^{\Theta}$ removel of E^{Θ} from half filled E^{Θ} configuration
Lowest 3rd I.E. = Ce ($4f^1 5d^1 6s^2$)

3rd E^{Θ} removel from 5d

Q.13 (C)
Neutral oxide $\Rightarrow N_2O$

Q.14 (C)
The first ionisation potential of K is less than Na.
$\therefore$ The first ionization potential of K is closest to 4.3

JEE-MAIN
PREVIOUS YEAR'S

Q.1 (2)

Oxide	Nature
CaO	Basic
B_2O_3	Acidic
SiO_2	Acidic
ZnO	Amphoteric

Q.2 (3)
The 1st IE order of 3rd period is
Na < Al < Mg < Si < S < P < Cl < Ar
X & Y are Ar & Cl
Z is sodium (Na).

Q.3 (2)
The ionic radii order is
$Na^+ > Mg^{2+} > Al^{3+}$

Q.4 (1)
Cr(Z=24)
[Ar] 4s13d5 Cr shows common oxidation states starting from +2 to +6.

Q.5 (1)
N_2O and NO are neutral oxides of nitrogen
NO_2 and N_2O_3 are acidic oxides.

Q.6 (2)
X = $_{33}As \rightarrow$ Metalloid
Y = $_{53}I \rightarrow$ Nonmetal
Z = $_{83}Bi \rightarrow$ Metal

Q.7 (1)
Na $\rightarrow$ [Ne] $3s^1$ IE is very low but IE_2 is very high due to stable noble gas configuration of Na^+.
Mg $\rightarrow$ [Ne] $3s^2$ IE_1 & $IE_2 \rightarrow$ Low
IE_3 is very high.

Q.8 (3)

Q.9 (2)

Q.10 (10)

Q.11 (2)

Q.12 (3)

Q.13 (12)

Q.14 (2)

Q.15 (4)

Q.16 (3)

Q.17 (1)

Q.18 (18)

Q.19 (2)

Q.20 (3)
Eu $\rightarrow$ [Xe] $4f^7\,6s^2$
$Eu^{2+} \rightarrow$ [Xe] $4f^7$

JEE-ADVANCED PREVIOUS YEAR'S

Q.1 (B)
Due to ineffective shielding of *d* orbitals in Galium, its size will be less than Al.

Q.2 (C,D)
NO $\Rightarrow$ Neutral
$B_2O_3 \Rightarrow$ Acidic
CrO $\Rightarrow$ Basic
All other oxides are amphoteric

Q.3 [9]

Atomic number	**Ionization Enthalpy (kJ/mol)**		
	I_1	**I_2**	**I_3**
n	1681	3374	6050
n+1	2081	3952	6122
n+2	496	4562	6910
n+3	738	1451	7733

By observing the values of I_1, I_2, &I_3 for atomic number (n+2), it is observed that $I_2 >> I_1$.
This indicates that number of valence shell electrons is 1 and atomic number (n+2) should be an alkali metal.
Also for atomic number (n+3), $I_3 >> I_2$.This indicates that it will be an alkaline earth metal which suggests that atomic number (n+1) should be a noble gas & atomic number (n) should belong to Halogen family. Since n < 10; hence n = 9 (F atom)
Note : n = 1 (H atom) cannot be the answer because it does not have I_2 & I_3 values.

Q.4 (2)
Only Na & F will show one non-zero oxidation state. These are Na^+ & F^-.

Chemical Bonding

EXERCISES

ELEMENTARY

Q.1 (4)

Q.2 (3)

Q.3 (3)
In N_2 molecule each Nitrogen atom contribute $3e^-$ so total no. of electron's are 6.

Q.4 (3)
In $CaCl_2$ calcium loose 2 electrons and transfer to Cl atom thus both acquire outermost 8 electron in valence shell.

Q.5 (2)

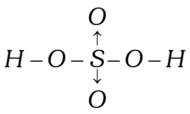
Q.6 (4)

Q.7 (3)
In co-ordinate bond acceptor contain vacant orbital.

Q.8 (2)
Water is a polar solvent while covalent compounds are non-polar so they usually are insoluble in water.

Q.9 (3)
BCl_3 is electron deficient compound because it has only '6' electrons after forming bond.

Q.10 (2)
H_2SO_4 has co-ordinate covalent bond.



$$H-O-\underset{\underset{O}{\downarrow}}{\overset{\overset{O}{\uparrow}}{S}}-O-H$$

Q.11 (3)
NH_3 has lone pair of electron while BF_3 is electron deficient compound so they form a co-ordinate bond $NF_3 \rightarrow BF_3$

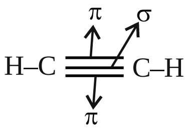
Q.12 (3)

Q.13 (4)
Co-ordinate bond is a special type of covalent bond which is formed by sharing of electrons between two atoms, where both the electrons of the shared pair are contributed by one atom. Since this type of sharing of electrons exits in O_3, SO_3 and H_2SO_4. Therefore all these contains coordinate bond.

Q.14 (3)

Q.15 (1)
In graphite all carbon atoms are sp^2-hybridised and have covalent bond.

Q.16 (3)



Q.17 (2)
π-bond is formed by lateral overlapping of unhybridised p-p orbitals.

Q.18 (4)
CO_2 is sp-hybridised

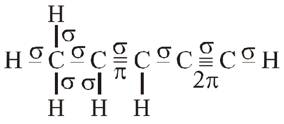
Q.19 (3)
Silica has tendency to form long chain covalent structure such as carbon so it has giant covalent structure.

Q.20 (2)
1σ and 2π

Q.21 (3)
In a double bond connecting two atom sharing of 4 electrons take place as in $H_2C = CH_2$.

Q.22 (3)
$C \equiv C$ is a multiple bond so it is strongest.

Q.23 (1)



σ bond = 10
π bond = 3

Q.24 (1)

Q.25 (1)

Q.26 (4)
H_2O is not linear because oxygen is sp^3 hybridised in H_2O

Q.27 (3)

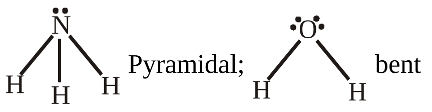
In sp^3 % p character $= \frac{3}{4} \times 100$

Q.28 (4)

Q.29 (3)
CO_2 has sp – hybridization and is linear.

Q.30 (3)

Q.31 (3)



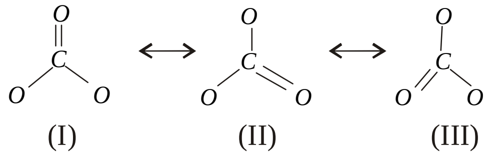
Q.32 (1)

Q.33 (2)
In NH_3 nitrogen has one lone pair of electron.

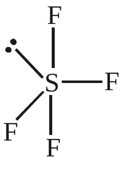
Q.34 (2)

Q.35 (3)

Q.36 (2)
There are three resonance structure of CO_3^{2-} ion.



Q.37 (3)



In TBP axial and equatorial bond length are unequal.

Q.38 (2)
In BF_3 molecule Boron is sp^2 hybridised so its all atoms are co-planar.

Q.39 (3)
Due to *l*p–*l*p repulsions, bond angle in H_2O is lower (104°.5°) than that in NH_3(107°) and CH_4(109°28'). BeF_2 on the other hand, has sp-hybridization and hence has a bond angle of 180°.

Q.40 (3)
C_2H_2 has linear structure because carbons are sp-hybridised and lies at 180°.

Q.41 (1)
CO_2 has bond angle 180°

Q.42 (1)
XeF_2 molecule is Linear because Xe is sp hybridised.

Q.43 (2)
CO_2 is a symmetrical molecule so its dipole moment is zero.

Q.44 (4)
These all have zero dipole moment.

Q.45 (4)
HFhas largest dipole moment because electronegativity difference of both is high so it is highly polar.

Q.46 (2)

Q.47 (1)

Q.48 (3)
Due to distorted tetrahedral geometry SF_4 has permanent dipole moment

Q.49 (1)
In H_2S bond angle is $\approx$ 90º

Q.50 (2)
Ice has hydrogen bonding.

Q.51 (1)

Q.52 (1)

Q.53 (3)
The strongest hydrogen bond is in hydrogen fluoride because the power of hydrogen bond $\propto$

electronegativity of atom and electronegativity

$$\propto \frac{1}{\text{atomic size}}$$

So fluorine has maximum electronegativity and minimum atomic size.

Q.54 (4)
H_2O can form hydrogen bonds rest CH_4 and $CHCl_3$ are organic compound having no oxygen while NaCl has itself intraionic attraction in the molecule.

Q.55 (2)
In electrovalent crystal has cation and anion are attached by electrostatic forces.

Q.56 (4)

Q.57 (3)
Vander waal's forces is the weakest force of attraction.

Q.58 (1)

Q.59 (1)

Q.60 (4)
Boron does not have d-orbital.

Q.61 (3)
Electrovalent compounds are good conductor of heat and electricity in molten state or in aqueous solution.

Q.62 (4)

Q.63 (2)
Due to its small size (fajan's rule)

Q.64 (1)
Ionic compounds are polar.

Q.65 (2)
Li, Na and K are alkali metals with low ionization energy and one electron in their outermost shell so they will form cation easily.

Q.66 (1)
Cs is more electropositive.

Q.67 (2)
When electronegativity difference is more between two joined atoms then covalent bond becomes polar and electron pair forming a bond don't remain in the centre.

Q.68 (3)
Fajan.

Q.69 (4)
Hexane has symmetrical structure so does not have polarity.

Q.70 (3)
HCl is most polar due to high electronegativity of Cl.

Q.71 (2)
Greater the charge of cation more will be its polarising power (according to Fajan's rule).

Q.72 (3)

$$B.O. = \frac{\text{No. of bonding } e^- - \text{No. of antibonding } e^-}{2}$$

$$= \frac{8-3}{2} = \frac{5}{2} = 2.5\ .$$

Q.73 (1)
In N_2^+ number of unpaired electron is 1.

Q.74 (2)
O_2^{2-} is least stable.

Q.75 (4)
Hydride of boron does not exist in BH_3 form. It is stable as its dimer di borane (B_2H_6).

Q.76 (3)

$$\text{B.O. of } N_2 = \frac{1}{2}(10-4) = 3$$

$$N_2^+ = \frac{1}{2}(9-4) = 2.5$$

Q.77 (3)
Oxygen is paramagnetic due to the presence of two unpaired electron :

$$O_2 = \sigma(1s)^2\sigma^*(1s)^2\sigma(2s)^2\sigma^*(2s)^2$$

$$\sigma(2p_x)^2\pi(2p_y)^2\pi(2p_x)^2\pi^*(2p_y)^1\pi^*(2p_z)^1$$

Q.78 (1)

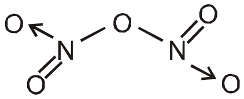
Q.79 (3)
In O_2^{-2} all electron are paired.

JEE-MAIN
OBJECTIVE QUESTIONS

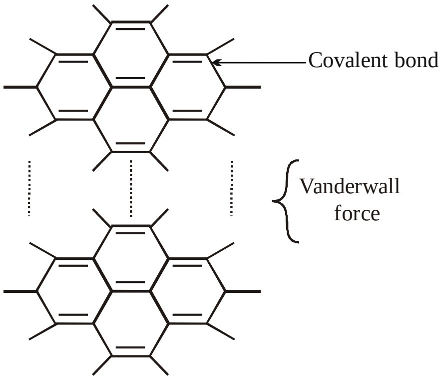
Q.1 (4)

The maximum covalency of representative element is equal to the number of s & p electrons in valence shell.

Q.2 (4)



Q.3 (3)



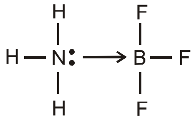
Q.4 (4)

In SF_6, PCl_5 and IF_7 the valence shell has 12, 10 and 14 electrons. As all contain more than 8 electrons in their valence shell they are example of super octet molecules.

Q.5 (4)

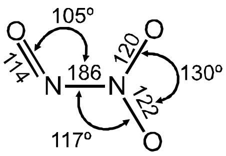
In all species the valence shell contain more than 8 electrons. Thus the octet rule is not applicable to BrF_5, SF_6 and IF_7.

Q.6 (C)

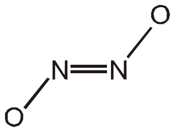


Q.7 (3)

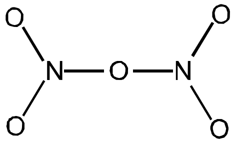
(1) N_2O_3 Dinitrogen trioxide



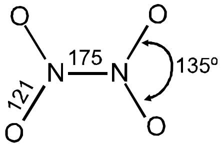
(2) $N_2O_2^{2-}$ Hyponitrite ion



(3) N_2O_5 Dinitrogen pentoxide

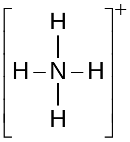


(4) N_2O_4 Dinitrogen tetroxide



Q.8 (3)

The correct Lewis diagram is

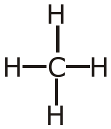


Q.9 (4)

The monothiocarbonate is CSO_2^{2-} and carbon can not have more than 8 electrons in its valence shell.

Q.10 (3)

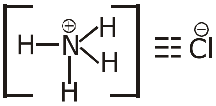
(1)



(only covalent)

(2) H—O—O—H (only covalent)

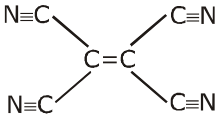
(3)



(covalent and ionic)

(4) H—C≡N (only covalent)

Q.11 (A)



σ–bond = 9

π–bond=9

Q.12 (4)

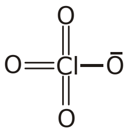
The strength of metallic bonds depends upon the number of mobile electron(s) per atom. Sodium has only one mobile electron per atom where as iron has 8 mobile electrons per atom.

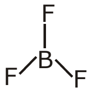
Q.13 (1)

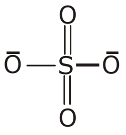
Metallic bond results from the electrical attractions among positively charged metal ions and mobile, delocalised electrons belonging to the crystal as a whole.

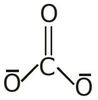
Q.14 (2)

Hyper valent ⇒ voilating octet rule

(1) 

(2) 

(3) 

(4) 

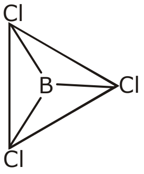
(Hyper) (no)

(Hyper) (no)

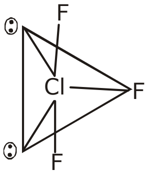
⇒ 1, 3 are Hyper valent

Q.15 (4)

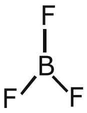
(1) F–Be–F Linear

(2)  Trigonal planar

(3) $\ddot{N}H_3$ Trigonalpyramidal

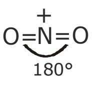
(4)  T-shapal

Q.16 (2)

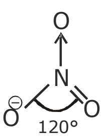


sp², trigonal planar.

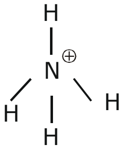
Q.17 (2)



sp

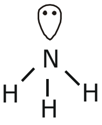


sp²



sp³

Q.18 (2)



sp³

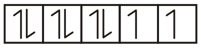
$[PtCl_4]^{2-}$

⇒ Pt is of 3rd transition series

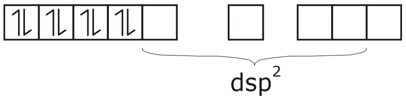
⇒ all ligand will be strong field ligand

⇒ Hybridization ⇒ dsp^2

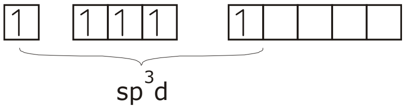
Originally

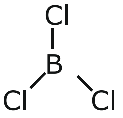


In this compound due to SFL.



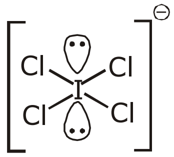
PCl_5 ⇒ sp^3d





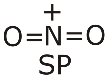
⇒ sp^2

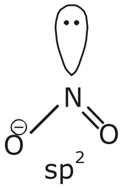
Q.19 (4)

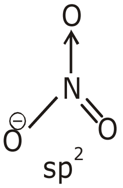


⇒ No of bond pair-lone pair repulsion = 4

Q.20 (3)





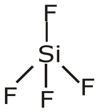


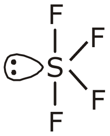
180° = Bent

$(NO_2^+ > NO_3^- > NO_2^-)$

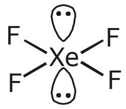
(As L.P. ↑, B.A. ↓)

Q.21 (2)

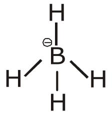
(1)  (equal length)

(2) 

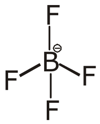
{ axial bonds are longer than equitorial Bonds

(3) 

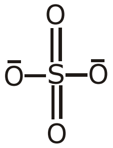
(equal length)

(4) 

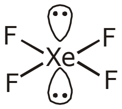
Q.22 (3)

(1) 

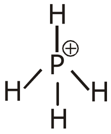
$SP^3 \Rightarrow$ Terahedral

(2) 

$SP^3 \Rightarrow$ Terahedral

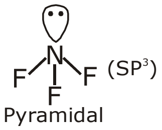
(3) 

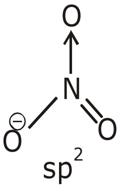
$SP^3d^2 \Rightarrow$ Square Planer

(4) 

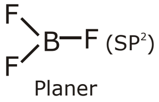
$SP^3 \Rightarrow$ Terahedral

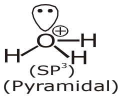
Q.23 (3)

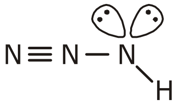




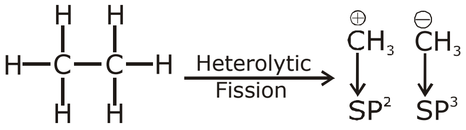
(planar)







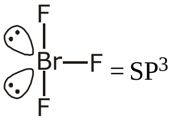
Q.24 (3)



Q.25 (4)

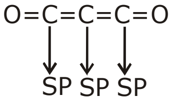
N_3^-, $(CNO)^-$ and $(NCN)^{2-}$ all have same number of electrons i.e., 22 ; so all are isoelectronic with CO_2 which also has 22 electrons.

Q.26 (1)

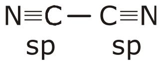


d = T- shaped

Q.27 (1)



Q.28 (A)

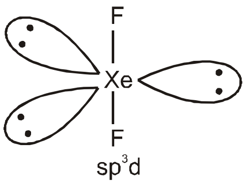


= Linear

Q.29 (1)

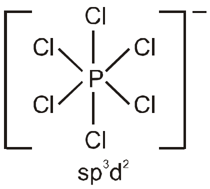
As the p-character in hybrid orbital increases the size of hybrid orbital increases.

Q.30 (4)

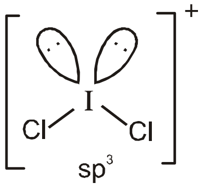
(i) 

(ii) $[N=\overset{+}{\underset{sp}{N}}=N]^{2-}$

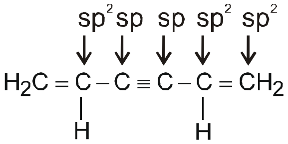
(iii) PCl_5 (s) exists as $[PCl_4]^+$ and $[PCl_6]^-$,



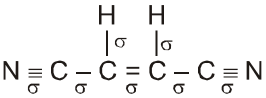
(iv) $I_2Cl_6(\ell) \rightleftharpoons [ICl_2]^+ + [ICl_4]^-$ self ionisation



Q.31 (4)

(1) 

$\overset{}{H_2C}=\overset{sp^2}{C}-\overset{sp}{C}\equiv\overset{sp}{C}-\overset{sp^2}{C}=\overset{sp^2}{CH_2}$

(2) 

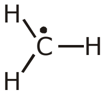
$N \equiv C - C(H) = C(H) - C \equiv N$

(3) In diamond each carbon atom is in sp^3 hybridisation.

(4) O = C = C = C = O

sp sp sp

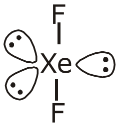
Q.32 (3)



= SP^2

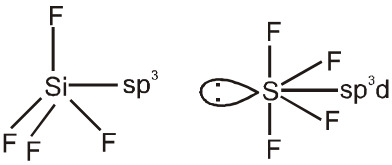
Planer

Q.33 (3)



= SP^{3}d

Q.34 (1)



(1) Tetrahedral and see-saw shaped.

(2) Both are sp^3 hybridised and trigonal pyramid.

(3) Both are sp^3 hybridised and tetrahedral.

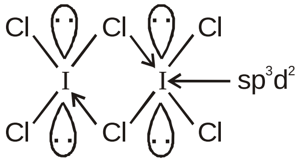
(4) Both are sp^{3}d^2 hybridised and octahedral.

Q.35 (2)

(i) SF_4	Steric no. = 5 Lone pair = 1
(ii) $[PCl_4]^+$	Steric no. = 4 Lone pair = 0
(iii) XeO_2F_2	Steric no. = 5 Lone pair = 1
(iv) $ClOF_3$	Steric no. = 5 Lone pair = 1

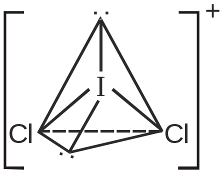
Q.36 (4)

ICl_3 does not exist, but the dimer I_2Cl_6 is a bright yellow solid. Its structure is planar.



Note : $I_2Cl_4Br_2$ will have the same hybridisation as that of iodine in I_2Cl_6. But it exists in 3 different forms.

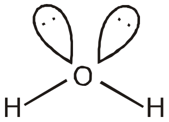
Q.37 (4)

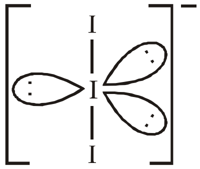


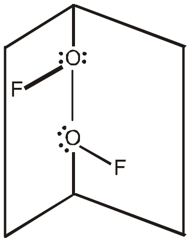
Q.38 (3)

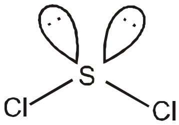
To have minimum repulsions, the two lone pair occupy the trans positions in octahedral geometry.

Q.39 (2)

(1) 

(2)  Number of bond pairs around I = 2. Number of lone pairs around I = 3.

(3) 

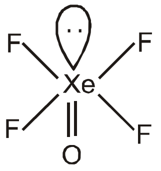
(4) 

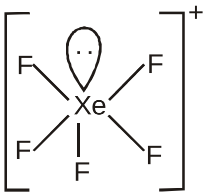
Q.40 (4)

(1) XeO_3 is trigonal pyramid. (2) IOF_4^+ is see-saw.

(3) PCl_5 is trigonal bipyramidal.

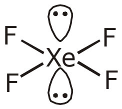
(4)





square pyramidal.

Q.41 (4)



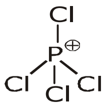
= sp^3d^2

Q.42 (1)

Hybridization is process of mixing of atomic orbital of nearly equal energy

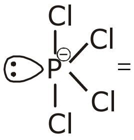
Q.43 (2)

PCl_4^+



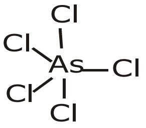
(Tetrahedral)

$P\bar{C}l_4$



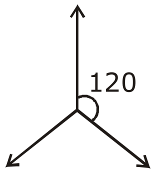
= see saw

sp^3d



sp^3d Trigonal bi pyramidal

Q.44 (3)



$\mu = 0$

Q.45 (2)

P–P>P–S>S–S

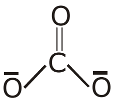
(more directional character)

= more overlap

= more stability

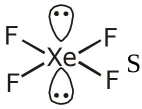
Q.46 (1)

(I)



SP^2=33% S

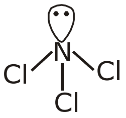
(II)



SP^3d^2 $\% S = \frac{1}{6} \times 100 = 16\%$

(III) $I-\overset{\ominus}{I}-I$ SP^3d $\frac{1}{5} \times 100$ =20%S

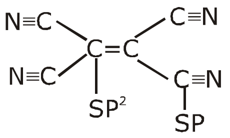
(IV)



$SP^3 = 25\%S$

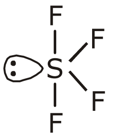
(V) $Cl-\underset{SP}{Be}-Cl$ 50%S

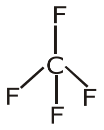
Q.47 (3)

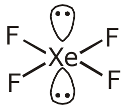


⇒ SP and SP^2 hybridized

Q.48 (4)





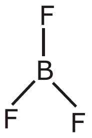


see saw tetrahedral Square planer

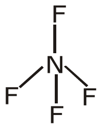
L.P=1 L.P. = 0 L.P.=2

Q.49 (4)

(1)



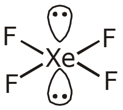
(2)



= all B.L. equal

all B.L. equal

(3)



(4) ClF_3

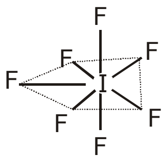
all B.L. equal

SP^3d

= axial bonds are

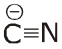
longer than equitorial one

Q.50 (2)



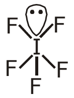
no. of B.P. =7

Q.51 (4)

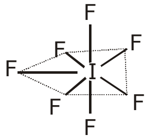


$\overset{\ominus}{C}\equiv N$

Q.52 (1)



SP^{3}d^2 sq. Pyramidal ;



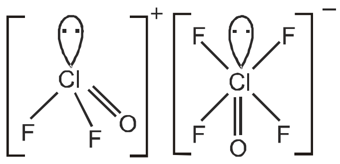
SP^{3}d^3 Pentagonal bipyramidal

Q.53 (3)

(1) both are sp^{3}d

(2) both are sp^{3}d

(3) $[ClF_2O]^+$ is sp^3 but $[ClF_4O]^-$ is sp^{3}d^2



(4) both are sp^{3}d^2

Q.54 (3)

(C–Cl) bond in CH_2=CH–Cl have partial double bond charcter same type partial double bond character present in chloro benzene

Q.55 (2)

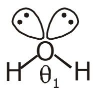
As E.N. of central atom ↑

B.A.↑

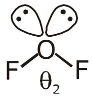
Q.56 (1)

Q.57 (2)

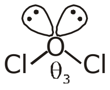
(1)



(2)



(3)



= $Cl_2O > H_2O > F_2O$

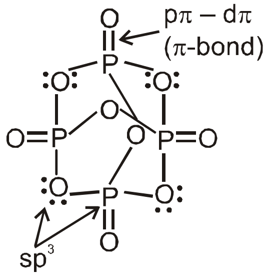
(exception)

As EN of surrounding atom ↑ BA ↓

(VSEPR theory)

Q.58 (4)

P_4O_{10}



The P – O bond lengths shows that the bridging bonds on the edges are 1.60 Å but the P = O bonds on the corners are 1.43 Å and this P = O is formed by pπ – dπ back bonding. A full p-orbital on the oxygen atom overlaps sideway with an empty d-orbital on the phosphorus atom. The bond angle POP is 127º and there is no P – P bonds.

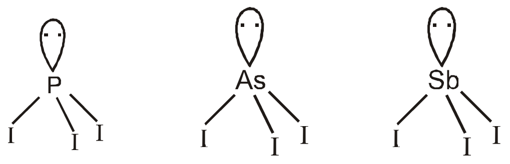
Q.59 (2)

As the electronegativity of central atom increases the bond angle increases due to repulsion between bond pair and bond pair as bond pairs are more close to the central atom.

Q.60 (1)

Atomic size arguments can be used for these species. Larger outer atoms result in larger angles due to steric repulsion.

Q.61 (2)



102º **100º** **99º**

Phosphorus is the most electronegative of the central atoms. Consequently, it exerts the strongest pull on shared electrons, concentrating these electrons near P and increasing bonding pair-bonding pair repulsions– hence, the largest angle in PI_3. Sb, the least electronegative central atoms, has the opposite effect : Shared electrons are attracted away from Sb, reducing repulsions between the Sb–I bonds. The consequence is that the effect of the lone pair is greatest in SbI_3, which has the smallest angle.

Atomic size arguments can also be used for these species. Larger outer atoms result in larger angles ; larger central atoms result in smallest angles.

Q.62 (1)

⇒ more s, more EN of c

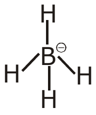
Q.63 (1)

$PH_3 \approx 91^o$

$NH_3 \approx 107^o$

(Drago's rule in PH_3)

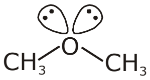
Q.64 (3)



Angle 109°

SP^3

Q.65 (3)

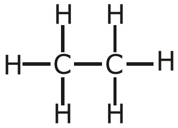


⇒ due presence of bulky group

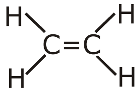
B.A exceeds from 109° also and reaches 110°

⇒ Hyb = SP^3

Q.66 (4)



ethane



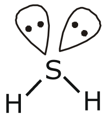
ethene

$H-C\equiv C-H$
acetylene

$CH_3-\overset{o}{C}H_2 > CH_2=\overset{o}{C}H > CH\equiv\overset{o}{C}$

(stability free radical) $\alpha \frac{1}{B.E.}$

Q.67 (1)



angular

⇒ $\mu \neq 0$

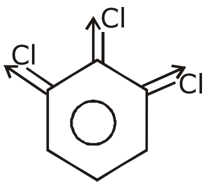
Q.68 (4)

⇒ H_2O is polar molecule

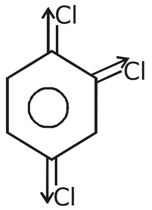
⇒ Hence H_2O has higher critical temp

Q.69 (1)

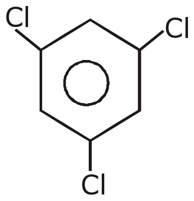
(A)



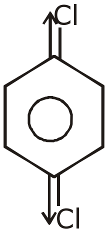
(B)

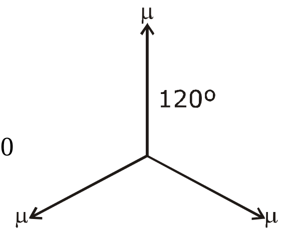


(c)



(D)



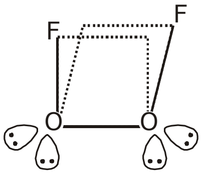


$\mu_{res}=0$ (μ=0)

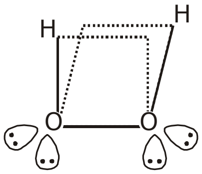
= A has max . μ

Q.70 (4)

(1)

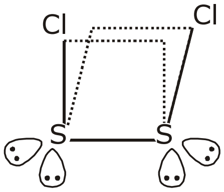


(2)



(open book) (open book)

(3)



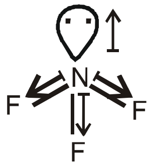
(4) H—C≡C—H

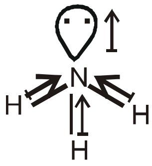
(open book) (Sp) Linear

Q.71 (1)

Dipole moment $\propto \frac{1}{\text{bond angle}}$

Q.72 (2)

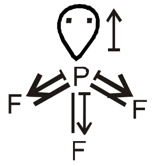




;

So dipole moment of NH_3 is greater than NF_3.

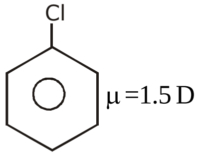
Q.73 (3)



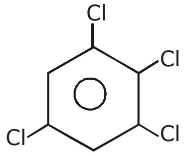
$\mu \neq 0$; SiF_4 , BF_3 and PF_5 are symmetrical molecules thus $\mu = 0$.

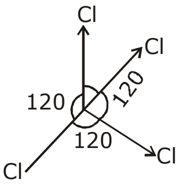
Q.74 (1)
Polarity order
C–F>C–Cl
Distance (Bond) C–Cl > C–F
* Here as exception,distance factor is dominant
CH_3–Cl > CH_3–F >CH_3– or– >CH_3–I
distance factor polarity factor dominant

Q.75 (2)



μ =1.5 D





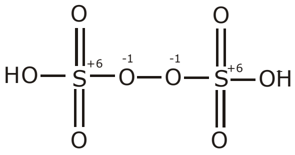
= d.M. of Cl at 120º will cancel each other
$\Rightarrow$ μ = 1.5 D

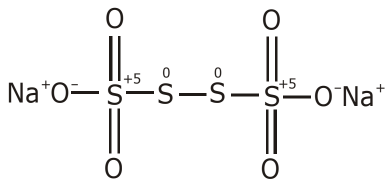
Q.76 (1)

Q.77 (4)
Symmetrical molecules have zero dipole moment.

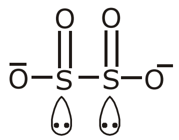
planar, θ = 120º, μ = 0.

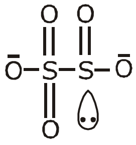
Q.78 (1)

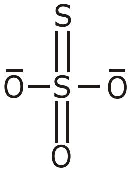


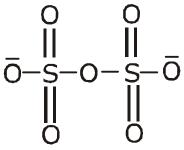


Q.79 (4)

(1)


(2)


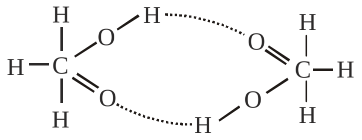
(3)


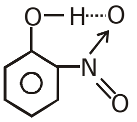
(4)


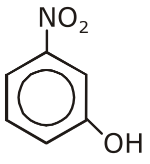
Q.80 (1)
Bases are connected by H-bond

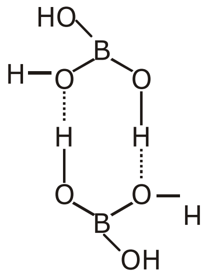
Q.81 (1)
H_2O due to H-bond has highest b.p.

Q.82 (3)

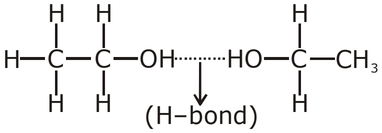
(I)

(Inter H-bond)

(II)

(Intra H-bond)

(III)


(IV)


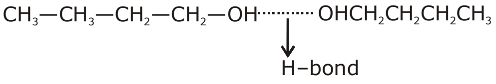
Q.83 (3)



$\Rightarrow$ due to intermolecular H-bond, it has higher b.p. than CH_3OCH_3

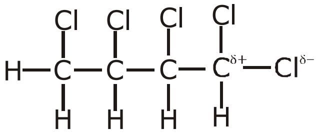
Q.84 (4)
(I) H_3C—CH_2—CH_2—CH_3 n-butane

(II)

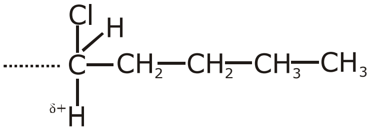


$\underset{\text{H-bond}}{CH_3-CH_3-CH_2-CH_2-OH\cdots\cdots OHCH_2CH_2CH_2CH_3}$

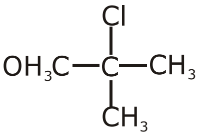
(III)



$H-\underset{H}{\overset{Cl}{C}}-\underset{H}{\overset{Cl}{C}}-\underset{H}{\overset{Cl}{C}}-\underset{H}{\overset{Cl}{C^{\delta+}}}-Cl^{\delta-}$



(IV)



$OH_3C-\underset{CH_3}{\overset{Cl}{C}}-CH_3$

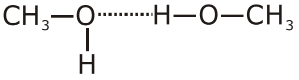
II > III > I > IV

As H-bond>d Interaction

>st. chain>Branch chain

Q.85 (3)

$H-F\cdots\cdots H-F$



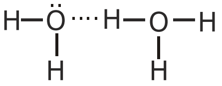
$CH_3-\underset{H}{O}\cdots\cdots H-O-CH_3$

N_2O_4 (no H-bond as no H)

CH_4 (Vanderwaal bond)

Q.86 (4)

$H_2S \rightarrow$ NO H-bond



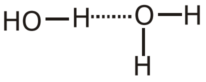
$H-\underset{H}{\ddot{O}}\cdots H-\underset{H}{O}-H$

$H-F — H-F$

$H_2O_2 > H_2O > HF > H_2S$

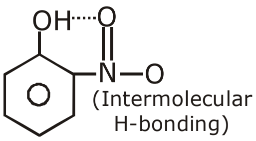
Q.87 (2)

(A)



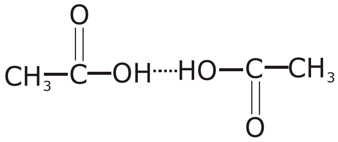
$HO-H\cdots\cdots\underset{H}{O}-H$

(B)



(C) $H-F\cdots\cdots H-F$

(D)



$CH_3-\overset{O}{\overset{\|}{C}}-OH\cdots HO-\underset{O}{\underset{\|}{C}}-CH_3$

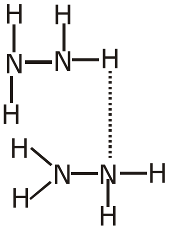
Q.88 (2)

Strength of H-bond

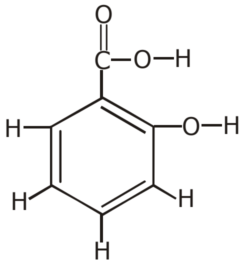
α polarity of H-atom

α EN of central atom attach to the H-atom

Q.89 (3)



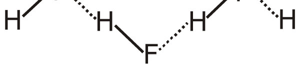
Q.90 (2)



σ bond = 16

π bond = 4

Q.91 (3)



for symmetry

Q.92 (4)

due to H–bond, HF has Low volatility

Q.93 (3)

H–bond holds two ice cubes together

Q.94 (4)

In pure phosphoric acid the PO_4^{3-} groups are bonded together through many hydrogen bonds.

Q.95 (4)

Nitrogen is less electronegative than oxygen so electron pair is easily available for bonding, thus P has stronger H-bonding than Q. As oxygen is more electronegative so H-bond strength of Q is greater than S. The same explanation is given for R and S as that of P and Q.

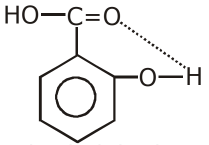
Q.96 (2)

Hydrogen bond acts as a bridge between atoms which holds one atom by covalent bond and the other by hydrogen bond and this increase in the attraction between molecules.

Q.97 (3)

In CH_4, H_2Se and H_2S the central atoms are not more electronegative ; hence do not form hydrogen bonds with itself and other molecule. In N_2H_4 the nitrogen is more electronegative and thus is able to form hydrogen bond with itself and other molecules like water.

Q.98 (1)



salicyladehyde

Q.99 (4)

van der Waal's forces ∝ molecular weight.So AgBr will have maximum van der Waals forces.

Q.100 (4)

London forces are extremely short range in action and the weakest of all attractive forces.

The order of strength of bonds/ forces is ionic bond > covalent bond > hydrogen bond > London force.

Q.101 (4)

All statements are true.

Q.102 (4)

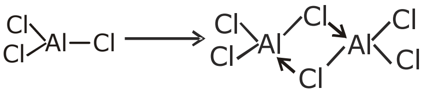
Boiling point of SbH_3 is greater than NH_3. The higher boiling point of SbH_3 is attributed to higher van der Waal forces because of its higher molecular weight.

Q.103 (2)

The boiling points of ICl, H_2S and CO can be explained on the basis of dipole-dipole attraction between their respective molecules. London dispersion force exists among the non-polar molecules like H_2, O_2, Br_2 etc. in solid or liquid states. Even in atoms in molecules which have no permanent dipole, instantaneous dipoles will arise as a result of momentary unbalances in electron distribution.

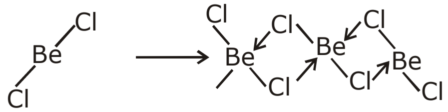
Q.104 (3)

(1)



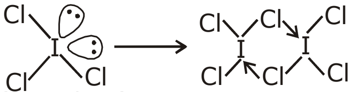
(Incomplete octet) (Complete)

(2)



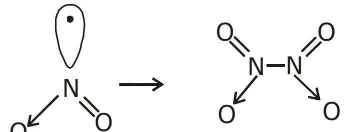
(Incompte octet) Complete octet

(3)



(complete) (complete)

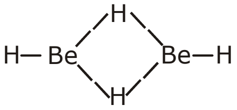
(4)



(incomplete octet) (complete)

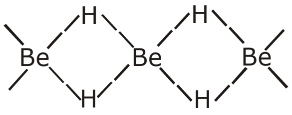
Q.105 (3)

(1)



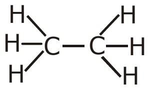
$3C-2e^-$

(2)



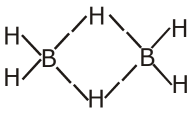
($3C-2e^-$)

(3)



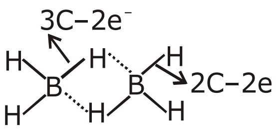
(does not contain $3C-2e^-$)

(4)



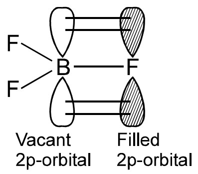
($3C-2e^-$)

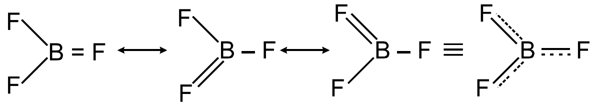
Q.106 (2)



2C–2e Bond = 4 3C–2e Bond = 2

Q.107 (4)



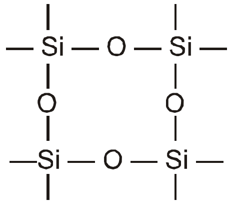


Decrease in B – F bond length is due to delocalised pπ –pπ bonding between filled p-orbital of F atom and vacant p-orbital of B atom.

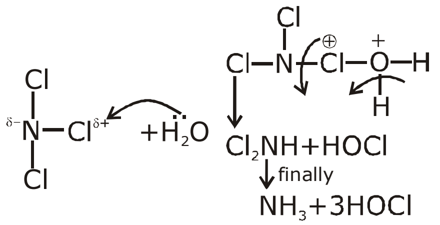
Q.108 (1)

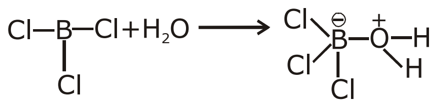
The central atom of PCl_5 have vacant d orbital therefore represent extended covalent bonding while in NCl_5 N have no vacant d orbital

Q.109 (2)



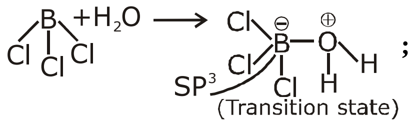
Q.110 (3)



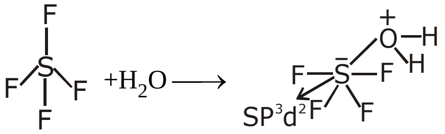


→ HCl+Cl_2BOH $\xrightarrow{\text{finally}}$ $B(OH)_3$+3HCl

Q.111 (3)

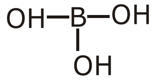


;



Q.112 (1)

(1) $H_3BO_3+H_2O \longrightarrow \overset{\ominus}{B}(OH)_4+H^+$
(no back Bond)



(Back Bond) ⇒ B–O Bond length changes

(2) $H_2SO_4+H_2O \rightarrow 2H^+ + SO_4^{2-}$
(No Change in B.l.)

(3) $HNO_3+H_2O \rightarrow NO_3+H_3O^+$
(No Change in B.L.)

Q.113 (4)

In CH_3Cl carbon does not carry vacant orbital so it can not be hydrolysed.

Q.114 (2)

The conditions required for the formation of an ionic bond.

(i) Ionization enthalpy [M(g) → M^+(g) + e^-] of electropositive element must be low.

(ii) Negative value of electron gain enthalpy [X (g) + e^- → X^-(g)] of electronegative element should be high.

Q.115 (2)

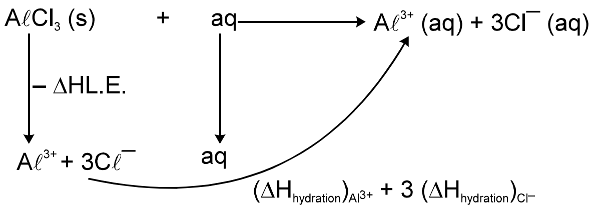
Cs has lowest IE_1 amongst the metals and F has higher electron affinity. So Cs and F form most ionic compound.

Q.116 (4)

(1) Down the group decrease in lattice energy is slightly but decrease in hydration energy is more.

(2) Down the group decrease in lattice energy is more as compared to decrease in hydration energy.

Q.117 (3)



$$\Rightarrow \quad \Delta H_{\text{solution}} = -4665 - 3 \times 381 + 5137 < 0$$

Hence $A\ell Cl_3$ will dissolve and solution consists of hydrated Al^{3+} and Cl^- ions.

Q.118 (1)

As F^- has lowest polarisability amongst O^{2-} and N^{3-}.

Q.119 (1)

Q.120 (1)
As Pb^{2+} has low polarising power. So $PbCl_2$ is ionic.

Q.121 (3)
As charge on cations increases, their polarising power increases and thus covalent character increases.

$$\overset{+}{Li}Cl < \overset{2+}{Be}Cl_2 < \overset{3+}{B}Cl_3 < \overset{4+}{C}\,Cl_4$$

Q.122 (2)
Sn^{4+} has highest polarising power amongst Na^+, Pb^{2+}, Sn^{4+} and Al^{3+} because of smaller size and higher charge. So $SnCl_4$ is most covalent and thus have least melting point.

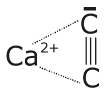
Q.123 (2)
Because of high charge density on Sn^{4+} it has high polarising power and thus leads to greater polarisation of anion i.e., greater distortion of electron clouds of the Cl^- ions. So $SnCl_4$ is most covalent.

Q.124 (2)
Increase in oxidation state (Ni^{4+}) increases the polarising power of cation and thus increases the polarisation of Br^- ion.

Q.125 (2)
for maximum ionic character,
* IE of cation must be less
* EA of anion must be larger
⇒ CS and F
⇒ (B)

Q.126 (1)
$C_3^{4-} \Rightarrow {}^{3-}C-C\equiv C^-$
$= \sigma -$ bond = 2
$\pi -$ bond = 2

Q.127 (B)

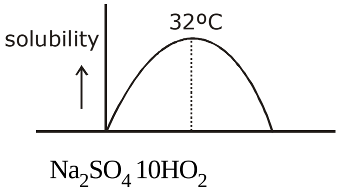


$\sigma -$ bond = 1
$\pi -$ bond = 2

Q.128 (4)
$MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$
most stable least stable
$= BaCO_3 \rightarrow BaO + CO_2$
= as ϕ of cation ↑ T.S. ↓ K_P ↑ .

Q.129 (1)
Polarizibility size of anions
$I^- > Br^- > Cl^- > F^-$

Q.130 (2)



Q.131 (2)
Na has lower IE_1 and Cl has higher electron affinity and thus form Na^+ and Cl^- which are held together by electrostatic force of attraction.

Q.132 (2)

Q.133 (2)
$Cl_2 > Br_2 > F_2 > I_2$
very less due to interelectronic repulsion
due to small 2p orbital.

Q.134 (1)
Across the period the size of anion decrease and thus the degree of hydration increases.
hydration enegy ∝ 1/ size of anion.

Q.135 (2)
According fajan's rule

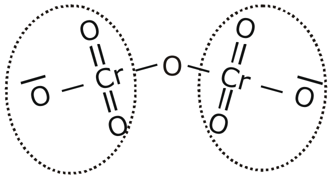
Q.136 (4)

Q.137 (4)

bond length $\propto \dfrac{1}{\text{bond order}}$

$CO < CO_2 < CO_3^{2-}$

Q.138 (2)



⇒ 6 Cr — O Bond equal due to resonance effect.

Q.139 (3)
As the size of anions decrease the distance of valence shell electrons from nucleus decreases and so polarizability decreases.

Q.140 (3)
Solubility $BaCO_3$ and $MgCO_3$ can be explained on the basis of their hydration and lattice energies.

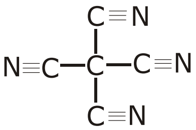
Q.141 (1)

$\oplus\ddot{N}\overset{\leftarrow}{\equiv}\ddot{O}$ $\qquad$ $\ddot{C}\overset{\leftarrow}{\equiv}\ddot{O}$

$\ddot{C}\overset{\leftarrow}{\equiv}\ddot{N}^{\ominus}$

Q.142 (1)

(1) Tetra cyanomethane

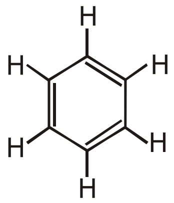


$N\equiv C-\overset{C\equiv N}{\underset{C\equiv N}{C}}-C\equiv N$

$$\frac{\sigma}{\pi} = \frac{8}{8} = 1$$

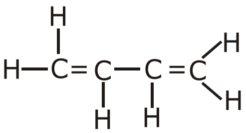
(2) O=C=O $\qquad \frac{\sigma}{\pi} = \frac{2}{2} = 1$

(3)



$$\frac{\sigma}{\pi} = \frac{12}{3} = 4$$

(4)



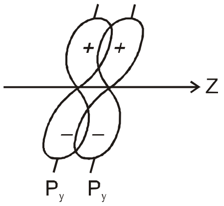
$H-\overset{H}{C}=\underset{H}{C}-\underset{H}{C}=C\!<^{H}_{H}$

$$\frac{\sigma}{\pi} = \frac{9}{2} = 4.5$$

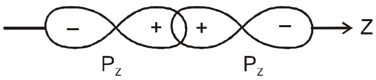
$\Rightarrow A = B < C < D$

Q.143 (3)

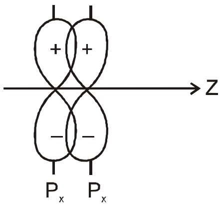
(1)



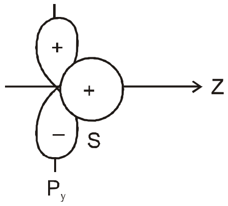
(2)



(3)



(4)



Zero overlap

Q.144 (3)
(1) and (B) have negative overlap while (C) has positive overlap. Thus (C) will show effective overlapping.

Q.145 (2)
(OF)

$$B.0 = \frac{1}{2}\begin{vmatrix} 2 & 2 \\ 2 & 2 \\ 6 & 3 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} 6-3 \\ =1.5 \end{vmatrix} = \frac{3}{2}$$

Q.146 (1)

(1) $N\bar{O}$ $(16\bar{e})$ = paramagnetic

(2) O_2^{2-} $(18\bar{e})$ = diamagnetic

(3) $(C\bar{N})$ $(14\bar{e})$ = diamagnetic

(4) CO $(14\bar{e})$ = diamagnetic

Q.147 (1)

$$B.O \propto \frac{1}{\text{bond length}} \propto \text{bond energy}$$

Q.148 (4)

(1)$NO \longrightarrow NO^+$
3.0=2.5 $\qquad$ B.O.=3
(Para) $\qquad$ (dia)

(2) $O_2^+ \rightarrow O_2$ $\qquad$ (unpaired=2)
unpaired e =1
B.O = 2.5 $\qquad$ B.O = 2
(Para) $\qquad$ (Para)

(3) $N_2 \rightarrow \overset{\ominus}{N}_2$
(dia) $\qquad$ (para)

Q.149 (2)
B_2 bond order = 1 ; C_2 bond order = 2 ; F_2 bond order = 1 ; O_2^- bond order = 1.5
bond order $\propto$ 1/bond length.

Q.150 (1)

$(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\pi 2p^2_x = \pi 2p^2_y)$ $(\sigma 2p_z)^2$; number of anti bonding electrons in N_2 is 4.

* represents antibonding molecular orbitals.

Q.151 (3)

(3) $O_2 : (\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p^2_x = \pi 2p^2_y)$ $(\pi^*2p_x{}^1 = \pi^*2p^1_y)$

$O_2^- : (\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p^2_x = \pi 2p^2_y)$ $(\pi^*2p_x{}^2 = \pi^*2p^1_y)$

Q.152 (4)

M.O for $C_2 = \sigma_1 s^2 < \sigma_1{}^* s^2 < \sigma_2 s^2 < \sigma_2{}^* s^2 <$

$$\underbrace{\pi_2 p^2{}_x = \pi_2 p^2{}_y}_{\text{HOMO}} < \underbrace{\sigma_2 p_z}_{\text{LUMO}}$$

It is important to note that double bond in C_2 consists of both pi bonds because of the presence of four electrons in two pi molecular orbitals $C_2^{2-}\left[C \overset{\pi}{\underset{\sigma}{\equiv}} C\right]^{2-}$.

Q.153 (1)

(A) Bond order of $N_2^+ = 2.5$; The bond order of O_2^+ $1/2(10-5) = 2.5$.

(B) Bond order of $F_2 = 1$; The bond order of $Ne_2 = 0$.

(C) Bond order of $O_2 = 2$; The bond order of $B_2 = 1$.

(D) Bond order of $C_2 = 2$; The bond order of $N_2 = 3$.

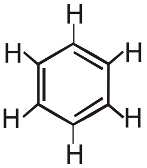
Q.154 (3)

The electron density is zero in the nodal plane during the formation of a molecular orbital from atomic orbitals of the same atom.

Q.155 (4)

O_2^{2+}	O_2^{2-}	F_2^{2-}	H_2^-
B.O. =3	B.O. =1	B.O. =0	B.O.=0.5

Q.156 (3)



$$\frac{\sigma}{\pi} = \frac{12}{6} = 4$$

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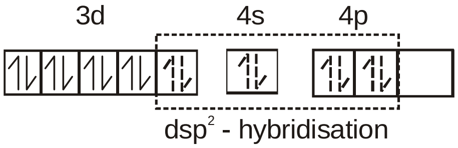
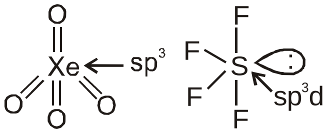
OBJECTIVE QUESTIONS

Q.1 (B)

Ni is in + 2 oxidation state and CN^- is strong field ligand and so,

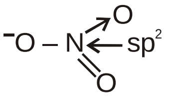
$[Ni(CN)_4]^{2-}$



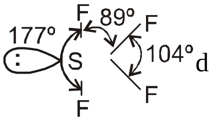


Q.2 (C)

(A) in S_8 hybridisation of each S-atom is sp^3 , in P_4 hybridisation of each P-atom is sp^3



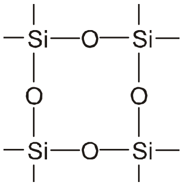
(B)



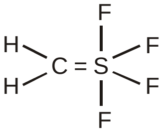
due to bp-lp repulsions

(C) Inter molecular H-bonding (PO_4^{3-} groups are bonded by many H-bonds)

(D)



Q.3 (A)



Hydrogen atoms are in a vertical plane with axial fluorine atoms, π-bond involving a p-orbital of carbon atom must lie in equatorial plane of the molecule.

Six atoms, i.e. 2 H-atoms, C,S. and both axial F-atoms lie in one plane.

Q.4 (C)

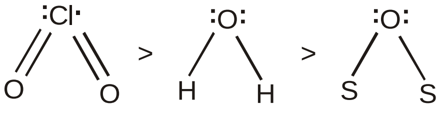
(a) According to VSEPR as electonegativity of central atom decreases, bond angle decreases. So bond angle of $H_2O > H_2S > H_2\,Se > H_2Te$

(b) $C_2H_2 > C_2H_4 > CH_4 > NH_3$ with bond pair- lone pair
sp sp^2 sp^3 sp^3 repulsion

(c) $SF_6 < NH_3 < H_2O < OF_2$ in this case bond angle of NH_3 is highest because lp - lp repulsion is absent in. it.

(d) $ClO_2 > H_2O > H_2S > SF_6$

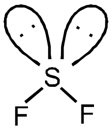
ClO_2 bond angle is highest due to its sp^2 hybridisation, rest all are sp^3 or sp^3d^2 hybridised more repulsion in double bond electrons.



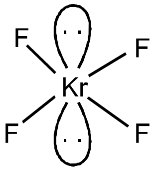
> SF_6 (Octahedral)

Q.5 (D)

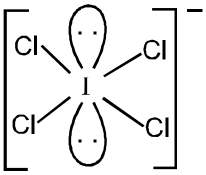
(A)



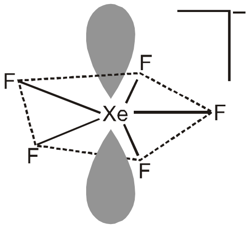
(B)



(C)



Q.6 (C)

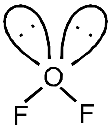


Hybridisation sp^3d^3, pentagonal planar ; two non-bonding electron pairs one above the plane and the other below the plane.

Q.7 (B)

(I) $[PCl_4]^+ \rightarrow sp^3$

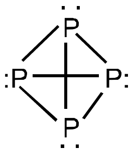
(II)



has ≈ 102° bond angle due to lp – lp repulsion, as bond pairs are closer to F-atoms.

(III) All have sp^3 hybridisation and one lone pair.

(IV)



Q.8 (B)

Fluorine is more electronegative but dipole moment is the product of charge and distance between combining atoms (covalently bonded) ; due to more charge separation in CH_3Cl, it has higher dipole moment.

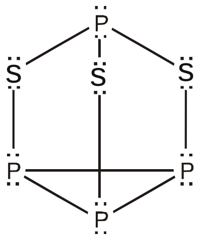
Q.9 (A)

(A) Boiling point of ICl > Br_2 as ICI is polar and Br_2 is non-polar in nature.

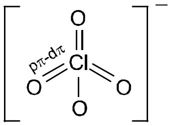
(B)

pyramidal about each N-atom.

(C)

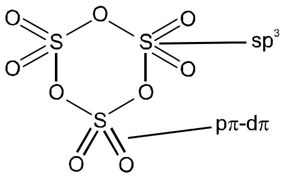


(D)



identical due to resonance.

Q.10 (A)



Q.11 (B)

Strength of H-bond depends on following factors.

(i) Electronegativity of element covalently bonded to hydrogen atom.

(ii) Size of electronegative element.

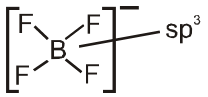
(iii) Ease of donation of lone pair of electrons by electronegative element.

Q.12 (B)

As molecular weight increases, magnitude of Van der Waal's force of attraction increases.

Therefore, boiling point increases. Though NH_3 has strong H-bonding but boiling point of SbH_3 is highest due to highest molecular weight. Boiling point NH_3 = 238.5 K and SbH_3 = 254.6 K.

Q.13 (D)

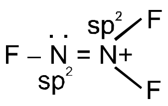


(with one empty sp^3 hybrid orbital)

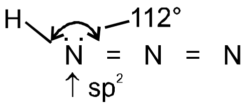
All bond lengths are identical.

Q.14 (D)

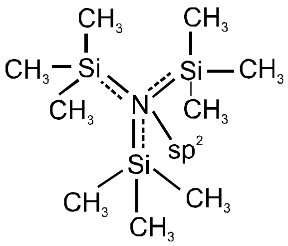
(A)



(B)



(C)



Q.15 (B)

BF_4^- is much bigger than F^-. So $NaBF_4$ is more soluble than NaF in water.

Q.16 (D)

(A) H_2O_2 = 1.48 Å due to repulsions between non-bonded pairs of electron on O-atoms and O_2F_2 = 1.217 Å.

(B) In O_2^{2-} very slightly increases due to charge (–ve) on two O atoms.

(C)

	Bond Order	Internuclear Distance (pm)	Number of unpaired(s) Electrons
O_2^+ (dioxygenyl)	2.5	112.3	1
O_2 (dioxygen)	2.0	120.07	2
O_2^- (superoxide)	1.5	128	1
O_2^{2-} (peroxide)	1.0	149	0

Q.17 (B)

N_2^{2-}: $\sigma 1s^2\ \sigma^*1s^2\ \sigma\ 2s^2\ \sigma^*2s^2\ \pi 2p_x^{\ 2}\ \pi\ 2p_y^{\ 2}\ \sigma 2p_z^{\ 2}\ \pi\ 2p_x^{\ 1}\ \pi^*2p_y^{\ 1}$.

$$\text{B.O. } N_2^{2-} = \frac{10-6}{2} = 2.; \quad \text{B.O. } O_2 = \frac{10-6}{2} = 2.$$

NO^- isoelectronic with O_2 so B.O. = $\frac{10-6}{2}$ = 2.

All have same number of electrons (i.e. 16) so isoelectronic.

Q.18 (D)

(A) Stability $O_2^+ > O_2 > O_2^-$

Bond order 2.5 2 1.5

(C) In all these molecules all electrons are paired in molecular orbitals.

Q.19 (A)

	O_2	O_2^-	O_2^{2-}	O_2^+
Bond Order	2	1.5	1	2.5

Q.20 (C)

	Bond order	**Unpaired electron**
O_2^+	2.5	1
NO	2.5	1
N_2^+	2.5	1

Q.21 (A)

	NO^- >	NO >	NO^+	(bond length)
Bond order	2.0	2.5	3	
	H_2 >	H_2^+ >	He_2^+	(bond energy)
Bond order	1	0.5	0.5	

(In He_2^+ more electron in antibonding MO's)

	NO_2^+ >	NO_2 >	NO_2^-	(bond angle)
Bond angle	180°	133°	115°	
	O_2^{2-} <	O_2^+ <	O_2	
			(paramagnetic moment)	
No. of unpaired e^-				
	0	1	2	

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MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (BC)

Breaking of bond requires energy.

Q.2 (ABC)

(A) BrF_5 contains 10 electrons inplace of eight.

(B) SF_6 contains 12 electrons inplace of eight.

(C) IF_7 contains 14 electrons inplace of eight.

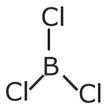
Q.3 (ABD)

(C) In NO_3^- molecule, nitrogen can not expand its octet due to non availability of vacant d-orbital. In (A), (B), (D) central atom expand octet by exciting electron in outermost vacant d-orbital.

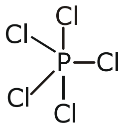
Q.4 (BC)

(A) O = C = O

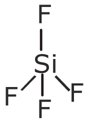
(octet only obeyed)

(B) 

does not follow octet rule

(C) 

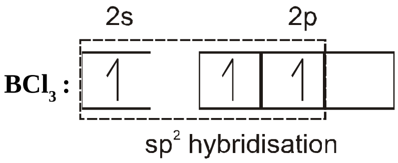
does not follow octet rule

(D) 

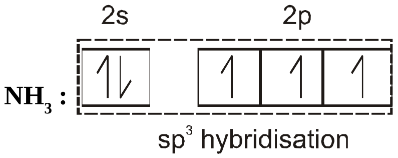
follow octet rule

Q.5 (BC)

(a) Electronic configuration of boron in ground state is $1s^22s^22p^1$.

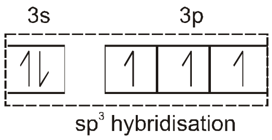


(b) Electronic configuration of nitrogen in ground state is $1s^22s^22p^3$.



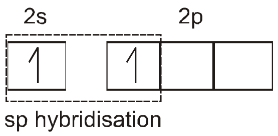
(c) Electronic configuration of phosphorus in ground state is $1s^22s^22p^63s^23p^3$.

PCl$_3$:



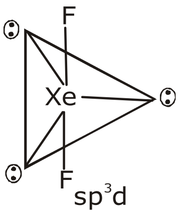
(d) Electronic configuration of boron in ground state is $1s^2 2s^2$.

BeF$_2$:



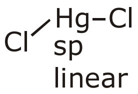
Q.6 (ABCD)

(A)

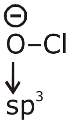


O=C=O
sp

(B) $\overset{\ominus}{I-I-I}$,
sp^{2}d
linear

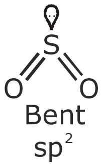


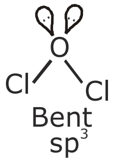
(C)



$\overset{-}{C}\equiv\overset{+}{O}$
Linear
sp

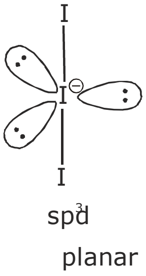
(D)



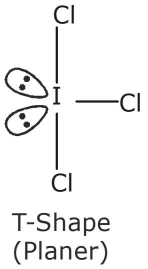


Q.7 (ABD)

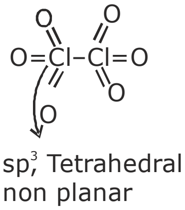
(A)



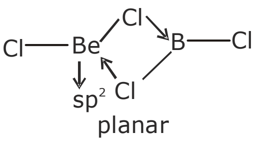
(B)



(C)



(D)



Q.8 (B)

$XeF_6 \longrightarrow Xe\overset{\oplus}{F_5} + \overset{\ominus}{F}$

sp^{3}d^2

⇒ Ans. → (B)

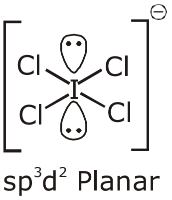
Q.9 (AC)

It is the orbital that undergo hybridisation and not the electrons. For example , for orbitals of nitrogen atom ($2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$) belonging to valency shell when hybridise to form four hybrid orbitals , one of which has two electrons (as before) and other three have one electron each. It is not necessary that only half filled orbitals participate in hybridisation. In some cases, even filled orbitals of valence shell take part in hybridisation.

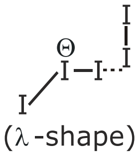
Q.10 (AC)

XeF$_4$ ⇒ Square planer

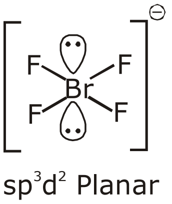
(A)



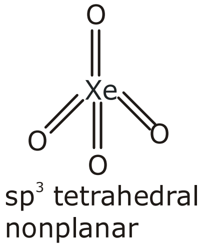
(B)



(C)

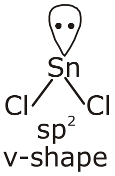


(D)



Q.11 (BCD)

(A)



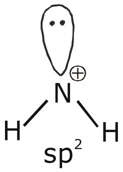
(B) $\overset{\ominus}{N}=\overset{\oplus}{C}-\bar{O}$
(sp linear)

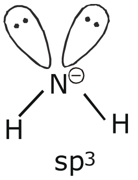
(C) S=C=S
(sp) linear

(D) $O=\overset{+}{N}=O$
sp
(linear)

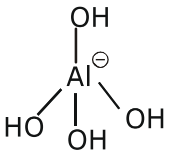
Q.12 (ABD)

(A)





(B)



sp^3

(C) sp^2

% = 1/3 × 100 = 33.33 %

% p = 2/3 × 100 = 66.66 %

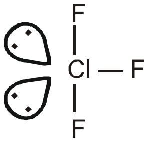
⇒ unequal P-cnarater

(D) consider VBT theory

Q.13 (ABCD)

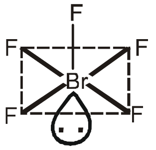
(A) I – Cl, linear and polar because of the difference in the electronegativities of iodine and chlorine.

(B)



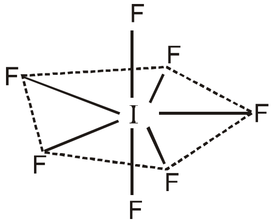
$\mu \neq 0.$

(C)



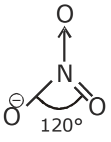
$\mu \neq 0.$

(D)

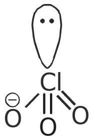


$\mu = 0.$

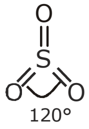
Q.14 (A)



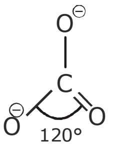
sp^2
planar
32e



sp^3
pyramidal
42e

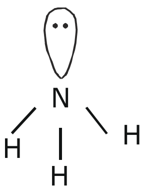


sp^2
planar
40e



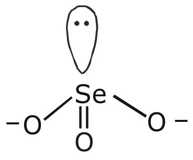
sp^2
planar
32e

Q.15 (AB)



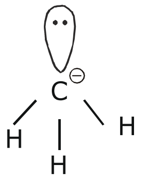
sp_3
(pyramidal)

(A)



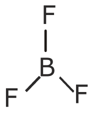
sp^3
Pyramidal

(B)



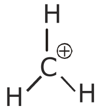
sp^3
(pyramidal)

(C)



sp^2
planar

(D)



sp^2
planar

Q.16 (BD)

$NH_3 \xrightarrow{H^+} \overset{\oplus}{N}H_4$

(A) sp^3 sp^3

⇒ No change in hybridisation

(B) $AlH_3 + \overset{\ominus}{H} \rightarrow \overset{\ominus}{Al}H_4$

sp^2 sp^3

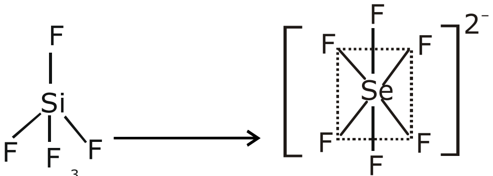
⇒ Hydridisation charge

(C) $NH_3 \longrightarrow \overset{\ominus}{N}H_2$

sp^3 sp^3

⇒ no charge in hybridisation

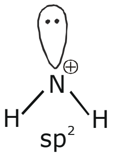
(D)



sp^3 sp^3d^2

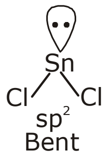
⇒ Hybridisation is changing.

Q.17 (BC)

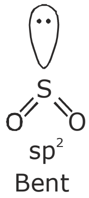


sp^2
Bent

(A) O = C = O
linear, sp

(B) 

sp^2
Bent

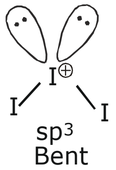
(C) 

sp^2
Bent

(D) Cl – Be – Cl ⇒ sp ⇒ linear

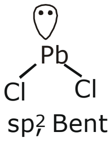
Q.18 (AD)

(A) $I - \overset{\ominus}{I} - I$

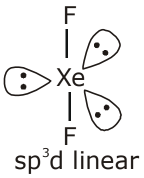
(B) 

sp^3
Bent

sp^3d, linear

(C) 

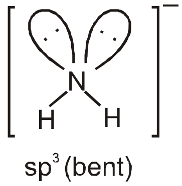
sp^2, Bent

(d) 

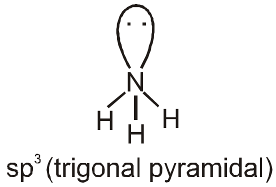
sp^3d linear

Q.19 (ABD)
(Consider VBT theory)

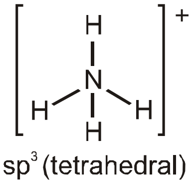
Q.20 (AC)

(A) 

sp^3 (bent)

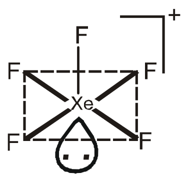


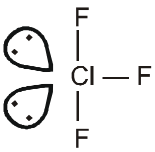
sp^3 (trigonal pyramidal)

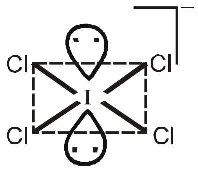

$$\left[\begin{matrix} & H & \\ H- & N & -H \\ & H & \end{matrix}\right]^+$$
sp^3 (tetrahedral)

Q.21 (ABCD)

(A) Cl — Hg — Cl.

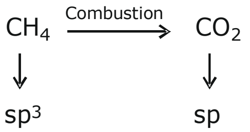
(B) 

(C) 

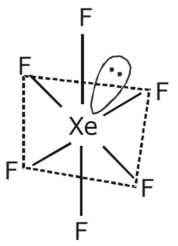
(D) 

Q.22 (AB)

Q.23 (A)

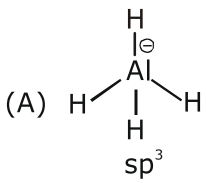

$$\begin{tikzcd} CH_4 \arrow[r, "\text{Combustion}"] \arrow[d] & CO_2 \arrow[d] \\ sp^3 & sp \end{tikzcd}$$

Q.24 (BC)

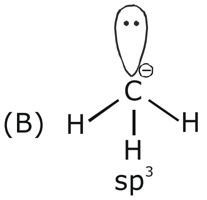


capped octahedral or distorted octahedral

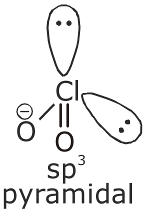
Q.25 (ABCD)



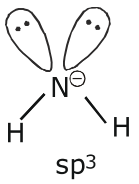
sp^3



sp^3

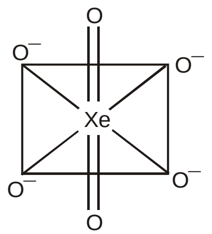
(C) 

sp^3
pyramidal

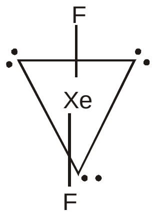
(D) 

sp^3

Q.26 (AB)

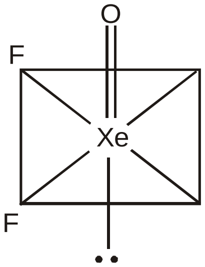
(A) 

Perxenate ion $[XeO_6]^{4-}$

(B) 

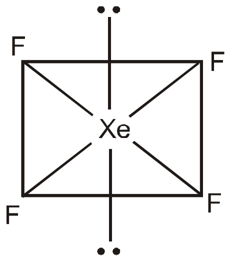
XeF_2 (Linear)

(C)

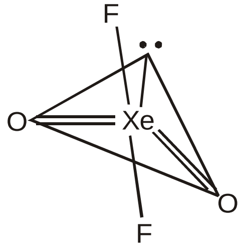


XeOF$_4$ (one l.p.)

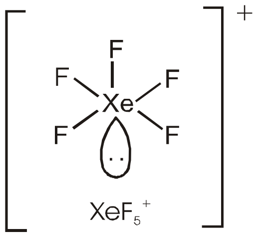
(D)



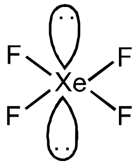
XeOF$_4$ (two l.p.)



XeO$_2$F$_2$(one l.p.)

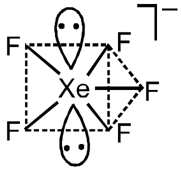


(square pyramidal)



(square planar)

XeF$_4$



(pentagonal planar)

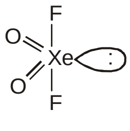
Q.27 (ACD)

(A) see – saw and square pyramidal with one lone pair of electrons.

(B) XeO$_2$F$_2$ is see-saw and XeO$_3$F$_2$ is trigonal bipyramidal and XeO$_2$F$_2$ has one and XeO$_3$F$_2$ has zero lone pair of electrons.

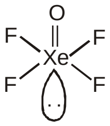
(C) Both square pyramidal and has one lone pair of electrons.

(D) XeF$_4$ is square planar having two lone pairs of electrons whereas XeF$_5^-$ is pentagonal planar having two lone pairs of electrons.



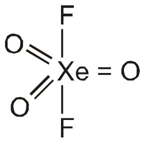
(see-saw)

XeO$_2$F$_2$



(square pyramidal)

XeOF$_4$



(trigonal bipyramidal)

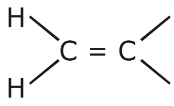
XeO$_3$F$_2$

Q.28 (ACD)

Hybridisation	**Atomic orbitals**	**Bond angle(s)**	**Geometry**
sp	s + arbitrary p^n	180°	Linear
sp^2	s + arbitrary p^n	120°	Trigonal
sp^3	s + arbitrary p^n	109.5°	Tetrahedral
sp^{3}d	d_{z^2}+	s + p_x + p_y + p_z	90°, 120°
Trigonal bipyramidal			
dsp^3	$d_{x^2-y^2}$+	s + p_x + p_y + p_z	> 90°, < 90°
Square pyramidal			
d^{2}sp^3d_{z^2}+$d_{x^2-y^2}$+	s + p_x + p_y + p_z	90°	Octahedral

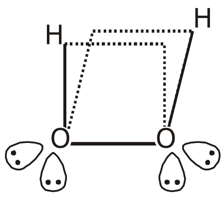
Q.29 (ABC)

(A)



no rotation

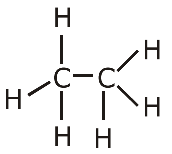
(B)



(no rotation)

(C) H – C ≡ C – H (no rotation)

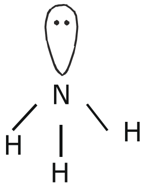
(D)



(Rotation possible)

Q.30 (BD)

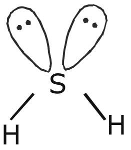
(A)



107°

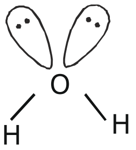
sp^3

(B)



no hybridisation (drago's Rule)

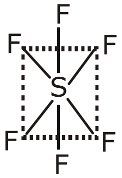
(C)



sp^3

104°

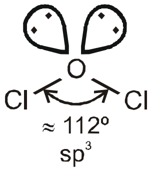
(D)



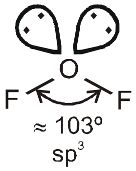
sp^3d^2

(all angle 90°)

Q.31 (ABC)



Bond angle increases on account of bp - bp repulsion because of more electronegativity of oxygen and steric repulsion between bigger Cl atoms.



Bond angle decreases on account of ℓp - ℓp repulsion because of more electronegativity of fluorine (bond pairs are closer to F-atoms).

Q.32 (A)

$$\%\text{ S-character} \propto \text{B.A} \propto \frac{1}{\text{BN}} \propto \text{ Bond strength} \propto \text{Size of orbital}$$

Q.33 (BCD)

Q.34 (ABCD)

Q.35 (ABD)

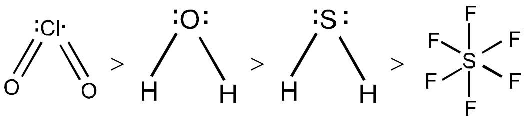
(A) According to VSEPR theory as electronegativity of central atom decreases, bond angle decreases. So bond angle of $H_2O > H_2S > H_2Se > H_2Te$

(B) $C_2H_2 > C_2H_4 > CH_4 > NH_3$. In NH_3 there is bp-lp repulsion so bond angle decreases to 107° from 109.5°.

sp	sp^2	sp^3	sp^3
180°	120°	109.5°	107°

(C) $SF_6 < NH_3 < H_2O < OF_2$ in this case bond angle of NH_3 is highest because lp - lp repulsion is absent in. it.

(D) $ClO_2 > H_2O > H_2S > SF_6$



sp^2 (≈117°) sp^3 (104.5°) sp^3 (92°) sp^3d^2 (90°)

Note : It is supposed that in H_2S the hybrid orbitals do not participate in bonding but pure p-atomic orbitals participate in bonding.

Q.36 (BE)

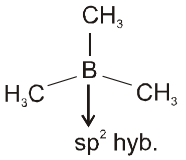
Q.37 (ABC)

(A), (B) and (C) are correct statements according to the VSEPR theory but (D) is false. Bigger atoms occupy equatorial position to minimize the repulsions.

Q.38 (AB)

(A) Due to the presence of lone pair bond angle decreases.

(B)

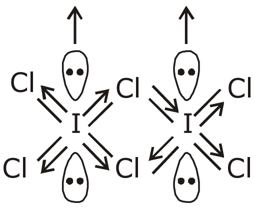


(C) NH_4Cl is an ionic compound and 'N' is in sp^3 hybridisation.

(D) S_8 molecule has 16 electron pairs left behind after the bonding.

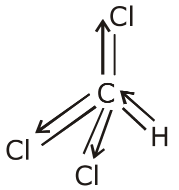
Q.39 (ACD)

(A)



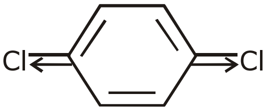
Square plane

$\mu = 0$

(B) 

$\mu \neq 0$

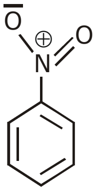
(C) $O = C = O$
$\mu = O$

(D) 

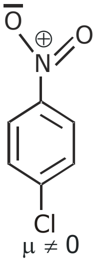
$\mu = O$

⇒ Ans. : A, C, D

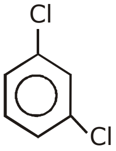
Q.40 (ABCD)

(A) 

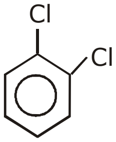
$\mu \neq 0$

(B) 

$\mu \neq 0$

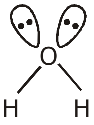
(C) 

$\mu \neq 0$

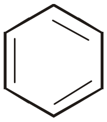
(D) 

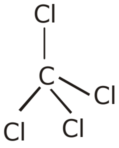
$\mu \neq 0$

Q.41 (BCD)

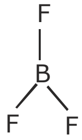
(A) 

$\mu \neq 0$

(B) 
$\mu = 0$

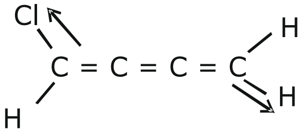
(C) 

$\mu = 0$

(D) 

$\mu = 0$

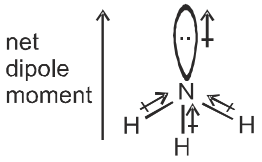
Q.42 (D)



$\mu = 0$

⇒ odd no. of double bonds
⇒ Planar
⇒ Ans - D

Q.43 (ABD)

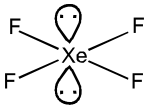
(A) 

(B) Dipole moment is a vector quantity as it depends on the magnitude and the direction.

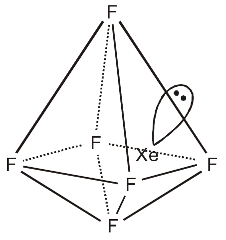
(C) $O \overset{\leftarrow\!+}{=} C \overset{+\!\rightarrow}{=} O$ $\mu = 0.$

(D) As a result of polarisation in covalent bond which arises due to the difference in the electronegativities of combining atoms, the molecule possesses the **dipole moment.**

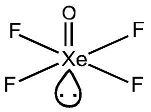
Q.44 (BC)
Polarity depend on net dipole moment. If diple moment $\mu = 0$ it is nonpolar.

(A) 

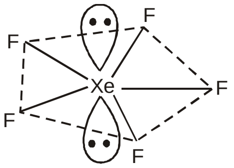
XeF_4 $\mu = 0$ non polar

(B) 

XeF_6 $\mu \neq 0$ polar

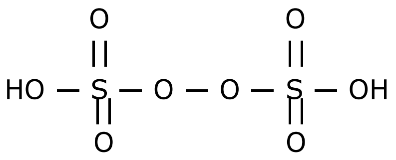
(C) 

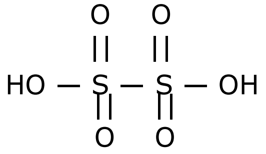
$XeOF_4$ $\mu \neq 0$ polar

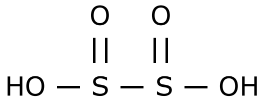
(D) 

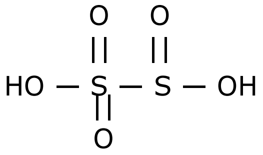
XeF_5^- $\mu = 0$ non polar

Q.45 (BCD)

(A)


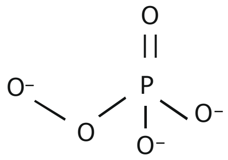
(B)


(C)


(D)


⇒ B,C,D

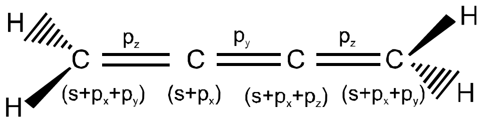
Q.46 (ACD)



⇒ H$^+$ will add it self where
O$^-$ is Resonance stabilised only

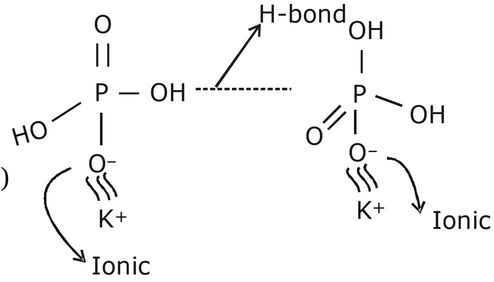
⇒ Ans. A,C,D

Q.47 (ACD)
(A) Ethyne being non-polar is more soluble in acetone.
(B) CD_3F is more polar than CH_3F. In CD_3F, C–D bond is more polar as deuterium is more electropositive than hydrogen.
(C) Silyl isocyanate (SiH_3NCO) is linear in shape because of pπ-dπ delocalisation of lone pair of electrons on nitrogen. While in methyl isocyanate (CH_3NCO) there is no pπ-dπ delocalisation of electron as carbon does not have empty d-orbital and thus is bent in shape.

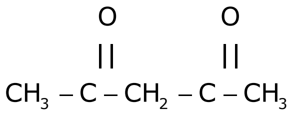
(D)


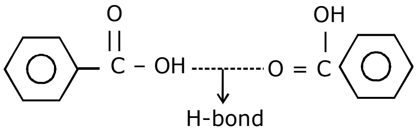
In $CH_2=C=C=C=CH_2$, the 2H–atoms on one C–atom lie in a plane perpendicular to the plane in which 2H–atoms on other C–atom lie.

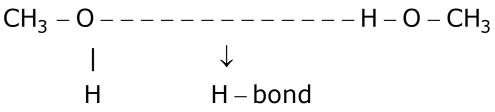
Q.48 (ABCD)

(A)


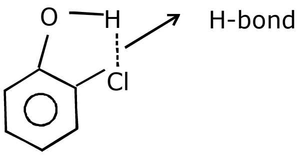
(b) In solid state, Baric acid Individual units Blonl$_3$ hydrogen Bonded together in to two dimensional sheet.

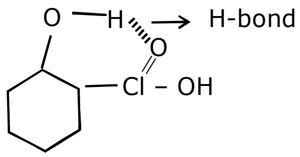
(c)

$CH_3-\overset{O}{\overset{||}{C}}-CH_2-\overset{O}{\overset{||}{C}}-CH_3$

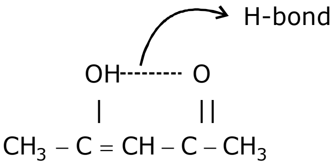



$CH_3-\underset{H}{\underset{|}{O}}-------------H-O-CH_3$

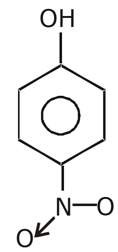
Q.49 (ABC)

(A)


(B)


(C)

$CH_3-\overset{OH}{\overset{|}{C}}=CH-\overset{O}{\overset{||}{C}}-CH_3$

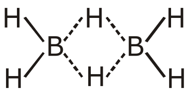
(D)



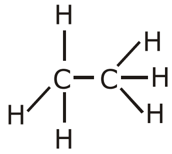
no Intra H-bond

Q.50 (AC)

(A)



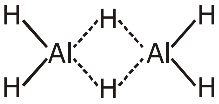
(B)



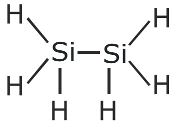
(x–x bond exist)

no x–x Bond

(C)



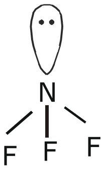
(D)



(x–x bond)

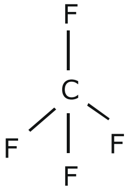
Q.51 (C)
Partial double will occur due to Back Bonding

(A)



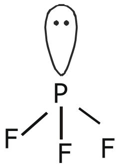
(no Back Bond)

(B)



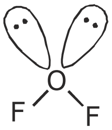
(no Back Bond)

(C)



(Back bond from L.P. of F to vacant orbital of P)
⇒ has double bond character

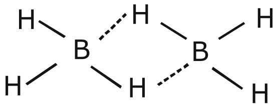
(D)



no back bond

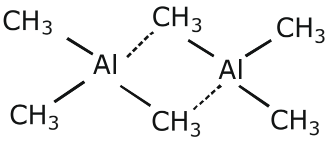
Q.52 (ABC)

(A)



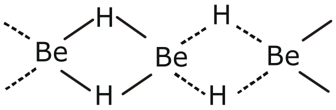
(3c - 2e bond exist)

(B)



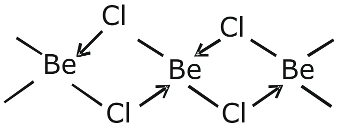
(3c - 2e$^-$bond exist)

(C)



(3c - 2e bond exist)

(D)



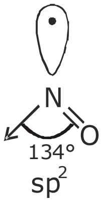
(3c - 2e bond absent)

Q.53 (A)

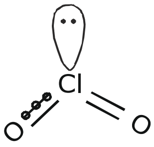
Q.54 (ABC)

(A)

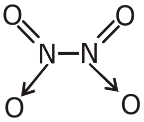
(B)



(C)



(D)

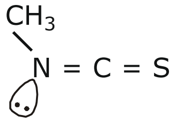


Q.55 (AC)
Inert pair effect is shown by Bi an pb

Q.56 (AD)
$Pb^{2+} = [Xe]\ 4f^{14}, \quad 5d^{10}, \quad 6s^2, \quad 6p^2$
$\Rightarrow (18 + 2)\ e^-$ system
Similarly Cd^{2+} will have the same system

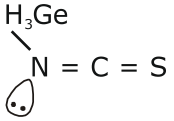
Q.57 (BC)
(B) B_2H_6 is a electron deficient compound as boron has only six electron in its valence shell.
(C) $AlCl_3$ is a electron deficient compound as aluminium has only six electron in its valence shell.

Q.58 (BCD)

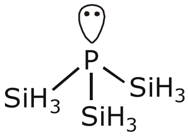
(A) 

Bent

(B) $H_3Si \overset{\rule{1em}{0.4pt}}{\longleftarrow} N = C = S$
Linear due to Back bond

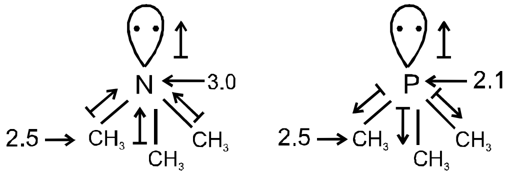
(C) 

Bent as no effective Back Band
due to large size of Ge

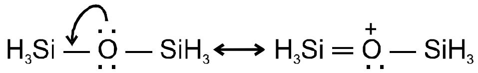
(D) 

pyramidal

Q.59 (ACD)
(A) Nitrogen is more electronegative than phosphorus.

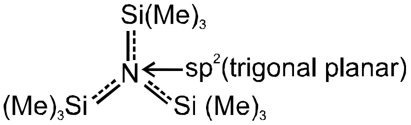


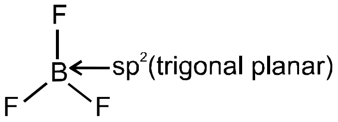
So, dipole moment of trimethylamine is greater than trimethy phosphine.

(B) 
$H_3Si-\ddot{O}-SiH_3 \longleftrightarrow H_3Si=\overset{+}{O}-SiH_3$

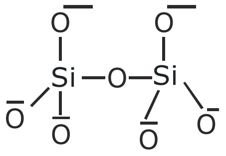
In trisilyl ether the lone pair of electron on oxygen atom is less easily available for donation because of pπ-dπ delocalisation due to presence of the vacant d-orbital with Si. This however is not possible with carbon in CH_3-O-CH_3 due to the absence of d-orbital making it more basic.

(C) Bond order of C_2 and O_2 are same i.e., 2. In C_2 molecules both bonds are π-bonds whereas, there is one σ and one π-bond in O_2 molecule
$C_2 = 131$ pm ; $O_2 = 121$ pm.

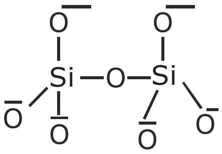
(D) 

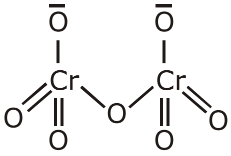


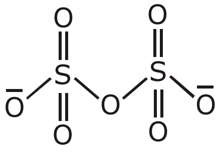
Q.60 (B)

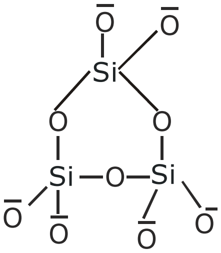


Q.61 (ABC)

(A) 

(B) 

(C) 

(D) 

Q.62 (ABC)
(A) With hydrogen sulphur does not undergo sp^3d^2 hybridisation because of larger difference in energies between s, p and d-orbitals. Sulphur show +6 oxidation state with highly electronegative elements like O and F.
(B) As fluorine is smaller and more electronegative than oxygen.
(C) I^- being stronger reducing agent reduces Fe^{3+} to Fe^{2+}.

Q.63 (AD)
(A & B) Ba^{2+} is larger than Mg^{2+}. According to Fajan's rule smaller cation has higher polarising power and therefore, MgO is more covalent than BaO (i.e. BaO is more ionic).

Melting Points : BeO = 2500ºC; MgO = 2800ºC ; CaO = 2572ºC ; BaO = 1923ºC

Q.64 (BCD)

(A) is incorrect, as ionic compounds have higher melting points as well as higher boiling points due to strong electrostatic force of attraction between the ions.

(B), (C) and (D) are properties of ionic compounds.

Q.65 (ABD)

Q.66 (BD)

(B) and (D) favour the covalent bond formation according to Fajan's rule.

Q.67 (AC)

Consider Fajan rule

Q.68 (ABCD)

Factual according to Fajan's Rule.

Q.69 (BCD)

∵ A does not conduct electricity in aq. molten or solid

⇒ it must be non polar covalent comp.

⇒ B only conduct electricity on fused form or in aq. solution hence it must be ionic.

⇒ C only conduct electricity in aq. solution hence

Q.70 (ABCD)

(A) O_2^+ B.O.=2.5

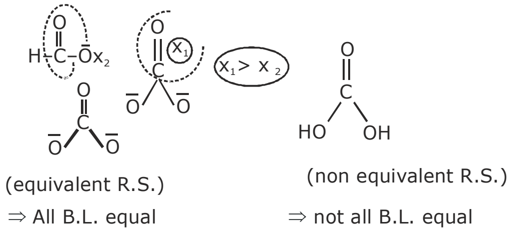
(B) O_2^- B.O.=1.5

(C) NO B.O = 2.5

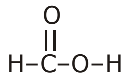
(D) H_2^+ B.O.=0.5

Q.71 (CD)

(A)

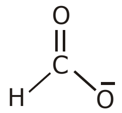


(B)



non equivalent R.S.

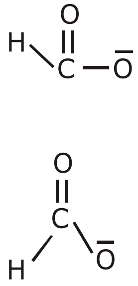
⇒ all B.L. not equal



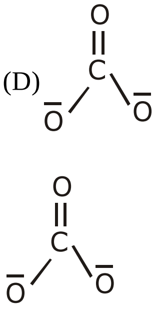
equivalent of R.S.

⇒ all B.L. equal

(C)



(D)



Q.72 (ABC)

(A) $O_2^{2+}(14\bar{e})$ B.O. = 3

(B) $NO^+(14e)$ B.O. = 3

(C) $C\bar{N}(14e)$ B.O. = 3

(D) $\overset{\oplus}{CN}(12\bar{e})$ B.O. = 2

⇒ Ans. A, B, C

Q.73 (ABD)

(A) Perioxide ion (O_2^{2-}) ↓ B.O. = 1 Oxygen(O_2) ↓ B.O. = 2

(B) $B.O. \propto \frac{1}{B.L.}$

⇒ Peroxide has weaker bond compound to O_2

(C) O_2^{2-} $(18\bar{e})$ diamagnetic $O_2(16\bar{e})$ ↓ Paramagnetic

(D) correct

Q.74 (BD)

N_2	CO
$C\bar{N}$	NO^+
$(14\bar{e})$	(14e)
(14e)	(14e)
↓	↓
↓ ↓	
Diamagnetic	Diamagnetic
Diamagnetic	Diamagnetic
$N \equiv N$	$\bar{C} \equiv O^+$
$\bar{C} \equiv N$	$N \equiv O^+$
$(\mu \equiv O)$	$\mu \neq O$
$\mu \neq O$	$\mu \neq O$
Linear	Linear
Linear	Linear

Q.75 (AD)

Q.76 (ABC)

(A) $O_2^+ : (\sigma 1s)^2\ (\sigma^*1s)^2\ (\sigma 2s)^2\ (\sigma^*2s)^2\ (\sigma 2p_z)^2\ (\pi 2p^2_x = \pi 2p^2_y)\ (\pi^*2p_x^1 = \pi^*2p_y)$

(B) NO is derivative of O_2: $NO(O_2^+)\ (\sigma 1s)^2\ (\sigma^*1s)^2\ (\sigma 2s)^2\ (\sigma^*2s)^2\ (\sigma 2p_z)^2\ (\pi 2p^2_x = \pi 2p^2_y)\ (\pi^*2p_x^1 = \pi^*2p_y)$

(C) $O_2^- : (\sigma 1s)^2\ (\sigma^*1s)^2\ (\sigma 2s)^2\ (\sigma^*2s)^2\ (\sigma 2p_z)^2\ (\pi 2p^2_x = \pi 2p^2_y)\ (\pi^*2p_x^{\ 2} = \pi^*2p^1_y)$

(D) $B_2 : (\sigma 1s)^2\ (\sigma^*1s)^2\ (\sigma 2s)^2\ (\sigma^*2s)^2\ (\pi 2p^1_x = \pi 2p^1_y)\ (\sigma p_z)^0$

Q.77 (ABCD)

(A) He – H (3e$^-$) H_2^- (3e$^-$)

(B) $O_2^{\ +}$ (15 e$^-$)   NO (15 e$^-$)

(C) He_2^+ (3e-) Li_2^+ (5e-)

$1s^2, \sigma^*, 1s^1$ $\sigma 1s^2, \sigma^*1s^2, \sigma 2s^1$

⇒ same unpair e$^-$ ⇒ same magnetic moment

(d) N_2^+ (13e-) N_2^- B.O=2.5

B.O. 2.5   (15 e$^-$)

$e^2_{1s}, \sigma^*1s^2, \sigma 2s^2, \sigma^*2s^2, \pi 2py^2, \pi 2pz^2, \sigma 2px^1$

⇒ umpaired e$^-$ = 1

unpaired e$^-$ = 1

Q.78 (ABC)

(A)	C_2 12 e$^-$	⇒ diamagnetic
(B)	O_2^{2-} (18 e$^-$)	⇒ Diamagnetic
(C)	Li_2 (6e)	⇒ Diamagnetic
(D)	N_2^+ 13 e$^-$	⇒ paramagnetic

Q.79 (AB)

(A)	B_2 (10 e$^-$)	⇒	paramagnetic
(B)	O_2 (16 e$^-$)	⇒	Paramagnetic
(C)	N_2 (14 e$^-$)	⇒	Diamagnetic
(D)	He_2 (4 e$^-$)	⇒	Diamagnetic

Q.80 (AC)

Q.81 (ABC)

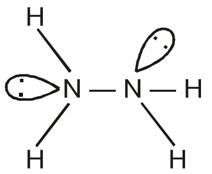
O_2^{2+} bond order = 3, NO^+ bond order = 3, CN^- bond order = 3, CN^+ bond order = 2

Q.82 (AC)

Q.83 (AB)

Q.84 (BCD)

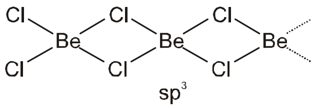
(A) Structure is similar to that of ethane. Each N atom is tetrahedrally surrounded by one N, two H and a lone pair. The two halves of the molecules are rotated 95° about N – N bond and occupy a gauche (non-eclipsed) conformation. The bond length is 1.45 Å.



(B) Has partial double bond character due to pπ-dπ delocalisation.

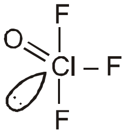
(C) OF_2=103° (approximate) and OCl_2 = 112° (approximate).

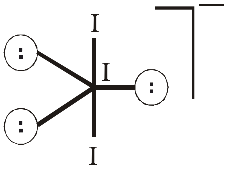
(D) Exist in polymeric structure as



in solid state.

Q.85 (C)

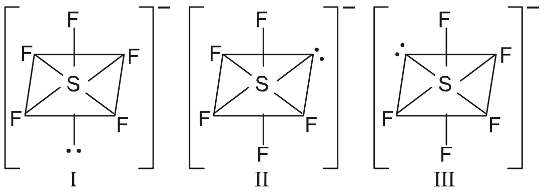




Cl-atom is in sp^3d hybridisation state. Hence geometry is trigonal bi-pyramidal which is similar to I_3^-

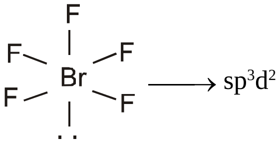
Q.86 (D)

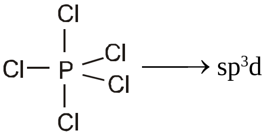
Number of electrons pairs = 6 ; number of bond pairs = 5 ; number of lone pairs =1. According to VSEPR theory geometry of the molecule is trigonal bipyramidal. As all positions are equivalent the lone pair of electrons can occupy any position in octahedral geometry as given below.

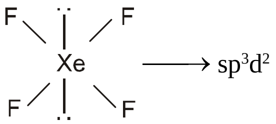


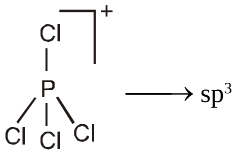
I II III

Q.87 (D)

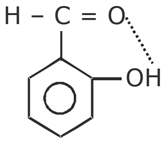


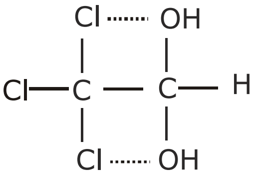
(A)


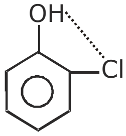
(B)


(C)


Q.88 (A)

(C)


(B)


(D)


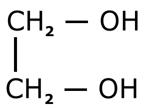
(A) CCl_3 CHO (chloral)

Q.89 (A)

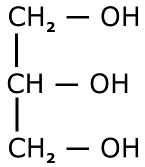
density up to 4°C then decreases sharply

Q.90 (D)

(A) H_2O (B.P. order) — H_2O (A6 greater no. of H - bond occuring in H_2O

(B)


CH_2-OH | CH_2-OH

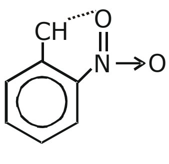


CH_2-OH | $CH-OH$ | CH_2-OH

Ethylene glycol — more no. of H-bond

Less no of H- bond

⇒ Hence glycerol is more viscous than ethylene glycol.

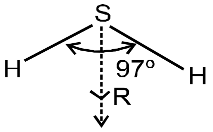
(C)


⇒ due to Intramolecular H-bond exist

⇒ discrete form steam volatile

(D) Not equi distant

Q.91 (B)



$$\mu_R = \sqrt{2\mu_{S-H}^2 + 2\mu_{S-H}^2 \times \cos 97^\circ}$$

$$\mu_R = \sqrt{2} \times \mu_{S-H} \times \sqrt{1-0.12}\,, \quad \mu_R = \sqrt{2} \times \mu_{S-H} \times \sqrt{0.88}$$

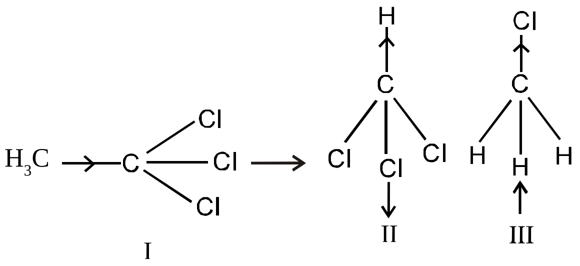
$$\mu_{S-H} = \frac{1.5}{\sqrt{2} \times 0.94}\ D$$

$$(\mu_{S-H})_{Cal} = \frac{0.15 \times 10^{-9} \times 1.6 \times 10^{-19}}{\frac{10}{3} \times 10^{-30}}$$

$$(\mu_{S-H})_{Cal} = 3 \times 0.15 \times 1.6 \times 10\ D$$

$$\text{So \% Ionic character} = \frac{1.5}{\sqrt{2} \times 0.94} \times \left[\frac{1}{0.15 \times 16 \times 3}\right] \times 100 = 16\,\%$$

Q.92 (D)



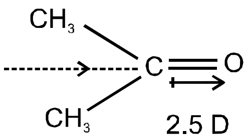
$\mu = 3\ \mu_{C-Cl} \times \cos 70.5 + \mu_{CH_3} = 1.5 + 0.4 = 1.9$ D

$\mu = 3\ \mu_{C-Cl} \times \cos 70.5 - \mu_{C-H} = 1.5 - 0.4 = 1.1$ D

$\mu = 3\ \mu_{C-H} \times \cos 70.5 + \mu_{C-Cl} = 1.9$ D

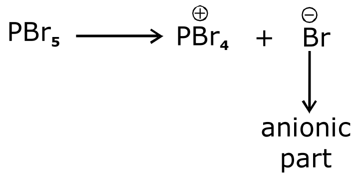
Q.93 (A)

$2\mu_{CH_3}$ cos 60



$\mu_{net} = 2.5 + \mu_{CH_3}$ $= 2.5 + 0.4 = 2.9$ D.

Q.94 (D)



$PBr_5 \longrightarrow \overset{\oplus}{PBr_4} + \overset{\ominus}{Br}$

anionic part

Q.95 (C)

$$PCl_5 \longrightarrow \overset{\oplus}{PCl_6} + \overset{\ominus}{PCl_4}$$

$$\overset{\oplus}{PCl_4} + \overset{\ominus}{PCl_6}$$

$$PBr_5 \longrightarrow \overset{\oplus}{PBr_4} + \overset{\ominus}{Br}$$

109º 28º

109º 28º

⇒ difference in B.A. = 0

Q.96 (B)

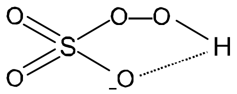
$$PCl_5 \rightleftharpoons \overset{\oplus}{PCl_4} + \overset{\ominus}{PCl_6}$$

sp^3d^2

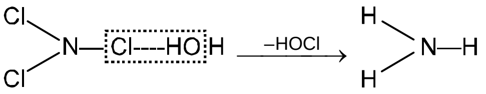
90º, 180º

Q.97 (C)

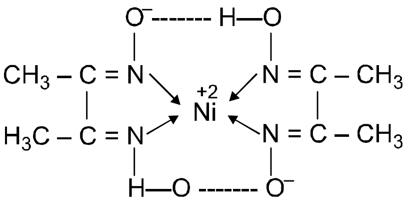
(A), (B) and (D) have intermolecular H-bonding (Y) while anion of Caro's acid (i.e. HSO_5^-) has intramolecular H-bonding (X) as shown below.



Q.98 (C)

(A)


(B) Association of molecules leads to a high melting solid because of inter molecular H-boning(Y).

(C)


rosy red ppt

(D) Ionic peroxides form well crystallized hydrates such as $Na_2O_2.8H_2O$ and $M''O_2.8H_2O$. These compounds contain discrete O_2^{2-} ions to which water molecules are hydrogen bonded, giving chains of the type shown in structure ----- O_2^{2-} ----- $(H_2O)_8$ ----- O_2^{2-} ----- $(H_2O)_8$ -----

The formation of such stable hydrates, accounts for the extreme hygroscopic nature of crystalline peroxide.

Q.99 (B)

(B) In the solid state, the $B(OH)_3$ units are intermolecular H-bonded together into two dimensional sheets with almost hexagonal symmetry the layers are quite a large distance apart (3.18Å) and thus crystal break quite easily into very fine particles.

Q.100 (B)

Q.101 (B)

Q.102 (C)

sp^3d^2 ($d_{x^2-y^2}$ and d_{z^2})

Q.103 (A) - p ; (B) - q ; (C) - p ; (D) - s

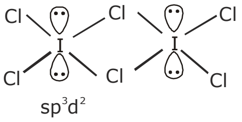
Steric no. of $IO_2F_2^-$ = 4 + 1 = 5, sp^3d;

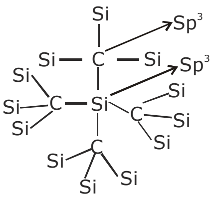
Steric no. of F_2SeO = 3 + 1 = 4, sp^3;

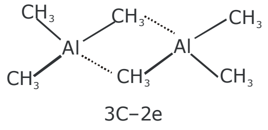
Steric no. of $ClOF_3$ = 4 + 1 = 5, sp^3d ;

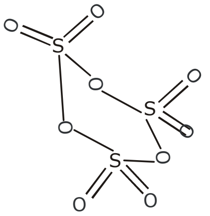
Steric no. of XeF_5^+ = 5 + 1 = 6, sp^3d^2

Q.104 (A) - r ; (B) - q,p ; (C) - S ; (D) - pq

(A)


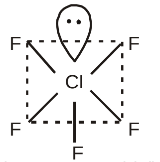
(B)


(C)


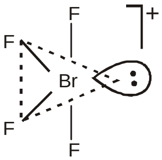
(D)


Q.105 (A) – p, r ; (B) – r ; (C) – q, s ; (D) – p,r, s

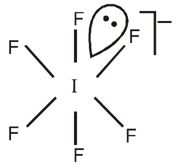
(A) ClF_5, BrF_4^+ , IF_6^- ; all have same oxidation state (+5)



(square pyramidal)



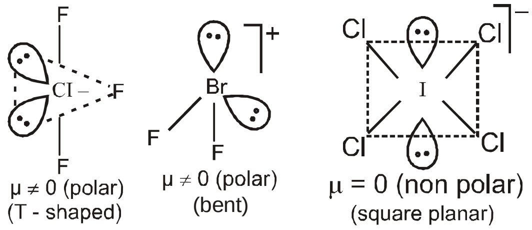
(see-saw)



(distorted octahedral)

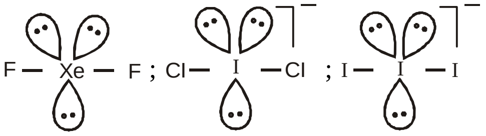
All have one lone pair of electrons each ; but different shapes ; μ ≠ 0 so polar,

(B) ClF_3 , BrF_2^+ , ICl_4^- ;all have same oxidation state (+3) ;



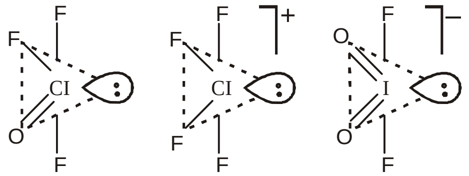
μ ≠ 0 (polar) (T - shaped) μ ≠ 0 (polar) (bent) μ = 0 (non polar) (square planar)

(C) $XeF_2 = +2$; $ICl_2^- = +1$; $I_3^- = +1$;



All have three lone pairs each and same shape but different oxidation state. In all μ = 0 ; so non - polar

(D) $ClOF_3$, ClF_4^+, $IO_2F_2^-$; All have same oxidation number (+5)

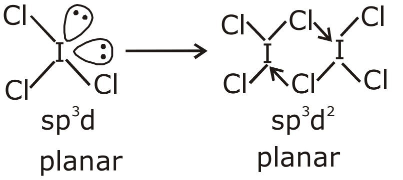


seesaw see - saw see - saw

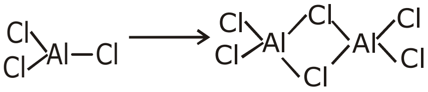
In all μ ≠ 0 , so all polar.

Q.106 (A) - q (B) - r (C) - s (D) - p,q

(A)



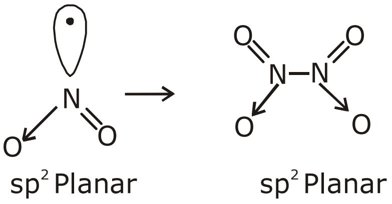
(B)



sp^2 planar sp^3 nonplanar

(C) AlF_3 no dimer form

(D)



Q.107 (A) – p, s ; (B) – q, r, t ; (C) – p, r, ; (D) – q, r, s, t

(A) B_2 $\sigma1s^2\ \sigma1s^{*2}\ \sigma2s^2\ \sigma2s^{*2}\ \pi2p_x^1 = \pi2p_y^1\ \sigma2p_z^0$
Bond order = 1/2 (6 – 4) = 1 : Paramagnetic

(B) N_2 $\sigma1s^2\ \sigma1s^{*2}\ \sigma2s^2\ \sigma2s^{*2}\ \pi2p_x^2 = \pi2p_y^2\ \sigma2p_z^2$
Bond order = 1/2 (10 – 4) = 3 (N ≡ N) : Diamagnetic
Bond order of O_2 = 1/2 (10 – 6) = 2.

(C) O_2^+ $\sigma1s^2\ \sigma1s^{*2}\ \sigma2s^2\ \sigma2s^{*2}\ \sigma2p_z^2\ \sigma2p_x^2 = \pi2p_x^{*2}\ \pi2p_x^{*1} = \pi2p_y^{*0}$
Bond order of O_2 = 1/2 (10 – 5) = 2.5 : Paramagnetic

(D) C_2 $\sigma1s^2\ \sigma1s^{*2}\ \sigma2s^2\ \sigma2s^{*2}\ \pi2p_x^2 = \pi2p_y^2\ \sigma2p_z^0$
Bond order = 1/2 (8 – 4) = 2 : Diamagnetic
Both bond are π bonds,
Bond energy of C_2 is 620 KJ/mole whereas bond energy of O_2 is 498 KJ/mole

Q.108 (A) - q, r ; (B) - p,q,r,s ; (C) - q,s ; (D) - p,q,r,s

sp^3d^2 ($d_{x^2-y^2}$ and d_{z^2})

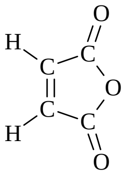
sp^3d (TBP then d_{z^2})

dsp^2 ($d_{x^2-y^2}$)

NUMERICAL VALUE BASED

Q.1 [4]
N_2^+, N_2^-, O_2^+, C_2^+ have fractional bond order.

Q.2 [9]

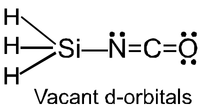


No. of sigma bonds = 9

Q.3 [4]
(a) PCl_6^- (Coordinate Bond = 1)
(b) $NH_3 \cdot BF_3$ (Coordinate Bond = 1)
(c) HNO_3 (Coordinate Bond = 1)
(D) CO (Coordinate Bond = 1)

Q.4 [5]

Q.5 [18]



LP of N can be delocalised back bonding (pπ – dπ). SN of N = 2 sp

Q.6 [4]

Q.7 [4]

No. of resonating structure in hyper conjunction

= n + 1

where n = no. of α Hydrogen

$CH_3 - CH = CH_3$, 3 (α) H

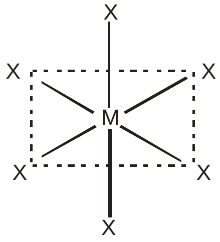
Ans. = 3 + 1 = 4

Q.8 [6]

Q.9 [3]

(iv, vi, vii)

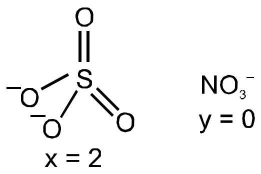
Q.10 [3]

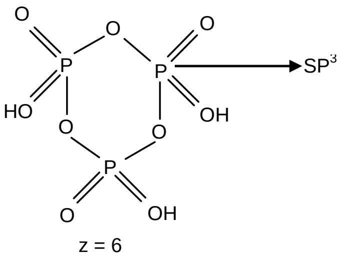


Q.11 [9]

(NO_3^-, CO_3^{2-}, F_2, Cl_2, Br_2, O_2^{2-}, O_2^-, Li_2^+, He_2^+)

Q.12 [8]





Q.13 [0]

Because CCl_4 symmetrical molecule.

Q.14 [4]

Q.15 [0]

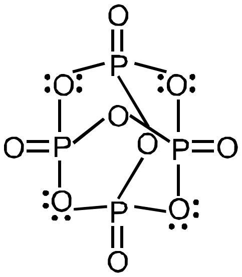
S-Being very low electro negativity can not form H-bonding.

Q.16 [2]

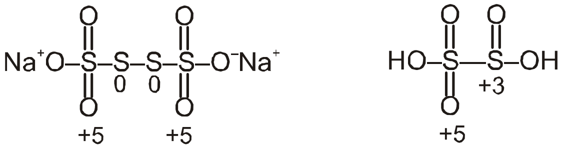
Q.17 [3]

Q.18 [4]

P_4O_{10}



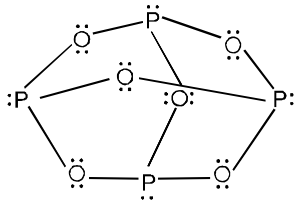
Q.19 [10]



x = 5 y = 2

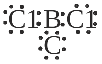
value of x × y is = 5 × 2 = 10

Q.20 [6]

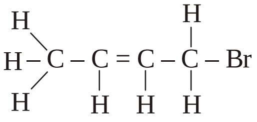


KVPY
PREVIOUS YEAR'S

Q.1 (B)

 Clearly B has only 6 e^-, Octet is not complete

Q.2 (A)



$\mathrm{H_3C-CH=CH-CH_2-Br}$

bonds = 10 single + 1 double

Q.3 (D)

Bond order of O_2^{2-}

Total electron = 18

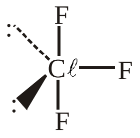
Configuration = KK $\sigma(2s)^2\,\sigma^*(2s)^2\,\sigma^*(2p_z)^2\;\pi(2p_z)^2$

$\pi(2p_y)^2\ \pi^*(2p_x)^2\ \pi^*(2p_y)^2$

Bond order $= \dfrac{N_b - N_a}{2} = \dfrac{8-6}{2} = 1.0$

Q.4 (C)

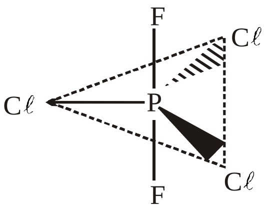
Three bond pair & two lone pair present in ClF_3 molecule



T-shape

Q.5 (A)

Correct structure of PCl_2F_2 is



Trigonal biprymidal

for minimum repulsion between atoms.

Q.6 (B)

$\underline{XeF_6} + 3H_2O \rightarrow \underline{XeF_3} + 6HF$

$\downarrow$ $\qquad\qquad\qquad \downarrow$

Sp^3d^3Hybridisation (distorted octahedral) $\qquad$ Sp^3 Hybridisation (Pyramidal)

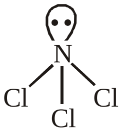
Q.7 (C)

Q.8 (C)

(A) O_2, B.O = 2 $\qquad$ (B) F_2, B.O = 1

(C) O_2^+ B.O = 2.5 $\qquad$ (D) F_2^- B.O = 0.5

Q.9 (D)



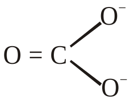
$\mu_R \neq 0$

Q.10 (A)

Bond length $\propto \dfrac{1}{\text{Bond Order}}$

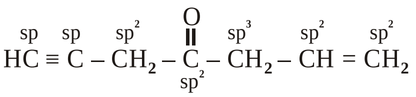
CO, B.O. = 3

O = C = O, B.O. = 2



B.O. = 1.33

Q.11 (A)



$$\overset{sp}{HC} \equiv \overset{sp}{C} - \overset{sp^2}{CH_2} - \underset{sp^2}{\overset{O}{\overset{\|}{C}}} - \overset{sp^3}{CH_2} - \overset{sp^2}{CH} = \overset{sp^2}{CH_2}$$

Q.12 (D)

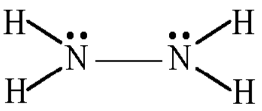
CCl_4 has zero dipole moment due to its tetrahedral shape, all C- Cl bond moment cancel each other.

Q.13 (C)

XeF_2; no. of lp on Xe = 3

XeF_4; no. of lp on Xe = 2

Q.14 (C)

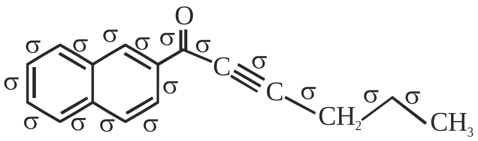


2 lone pair on nitrogen

4 N – H bond pair

1 N – N bond pair

Q.15 (B)



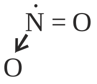
17, C – C sigma bond present in this structure.

Q.16 (D)

Species having unpaired electron are paramagnetic & without unpaired are diamagnetic

$:\dot{N} = O$ 1 unpaired electron

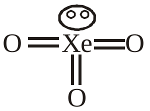
O_2 2 unpaired e^- (MOT)



unpaired electron

CO_2 no unpaired electron

Q.17 (C)



sp^3/ Pyramidal geometry

$XeF_6 + 3H-OH \rightarrow 6HF + XeO_3$

Q.18 (D)

Alkali Metals has highest tendency to form ionic bond readily

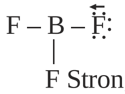
$1s^2\ 2s^2\ 2p^6\ 3s^1$ [Na metal]

Q.19 (C)

Lewis acid strength of BBr_3, BCl_3 and BF_3 is in the order of

$BF_3 < BCl_3 < BBr_3$

Due to back bonding



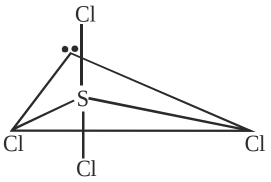
Strong 2p – 2p Back bonding

Q.20 (B)

	H–C–H CH_4	H–$\ddot{N}$–H NH_3	H–$\ddot{O}$–H H_2O
	B.P. = 4 L.P. = 0	B.P. = 3 L.P. = 1	B.P. = 2 L.P. = 1
Hybridization	sp^3	sp^3	sp^3
Bond angle	109°, 28'	107°.1	104.5°

Q.21 (D)

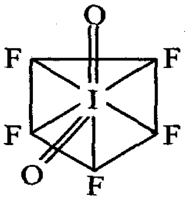
$SCl_4 \Rightarrow 4b.p + 1\lambda.p.$



Q.22 (D)

$[IO_2F_5^-]$ ion

Hybridisation is sp^3d^3 shape is pentagonal bipyramidal Double bond cause more repulsion so they would be on Axial position 180° angle to each other so shape is



Q.23 (D)

$\mu \propto \Delta EN$

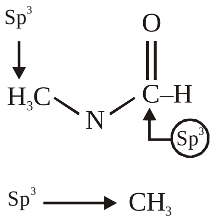
So HF has highest value of dipole moment

Q.24 (C)

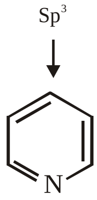
Greater is the tendency to donate ℓ.p more stable will be the lewis. acid-acid-base adduct.

Q.25 (B)

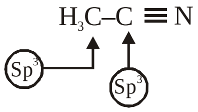
(I)



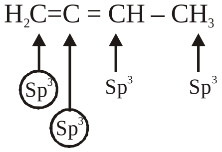
(II)



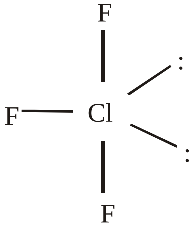
(III)



(iv)

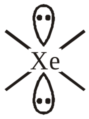


Q.26 (A)



T-Shape, sp^3d hybridisation

Q.27 (C)



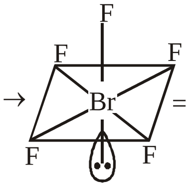
$\Rightarrow$ 4 bond pair + 2 lone pair. $\Rightarrow$ Steric Number = 6 = sp^3d^2

Q.28 (C)

	Number of electron	Bond order
O_2^{2-}	18	$BO = \frac{10-8}{2} = 1$
B_2	10	$BO = \frac{6-4}{2}$

Q.29 (D)

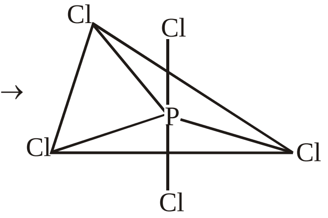
$BrF_5 \rightarrow$



=Square pyramidal

The lone pair occupy more space around the central atom and push away the four planar F atom. Here the axial Br–F bond length is 170 pm but equatorial Br-F bond length is 177 pm

$PCl_5 \rightarrow$



= Triangular peramidal
Two type of P–Cl bond
P–Cl axial > P–Cl equatorial

Q.30 (A)

$$\underset{120^\circ}{BF_3} > \underset{109^\circ 28}{NH_4^+} > \underset{107^\circ}{NH_3} > \underset{92^\circ}{PH_3}$$

Q.31 (A)
Reason: Better extent of back bonding, Note –Cl can't donate 3p electron pair to boron as fluorine because of larger size 3p orbital.

Q.32 (D)
Configuration of C_2

$$\sigma_{1s}^2\sigma^{*2}_{1s}\ \sigma_{2s}^2\sigma^{*2}_{2s}\ \pi^2_{2px} = \pi^2_{2py}\sigma_{2pz}$$

an extra electron added to the s2p of the above configuration.

Q.33 (B)
$MgCl_2$ $CaCl_2$ $SrCl_2$ $BaCl_2$

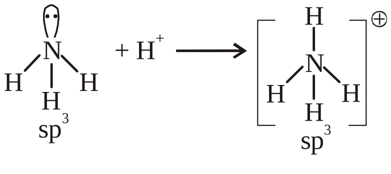
$\xrightarrow{\hspace{6cm}}$ $\phi_{M^{2+}}\downarrow$ Covalent Character$\downarrow$
$\xrightarrow{\hspace{6cm}}$
$BaCl_2 < SrCl_2 < CaCl_2 < MgCl_2$ (Covalent character)

Q.34 (D)
Ans is option (D)

$AlCl_3$	non - polar
CCl_4	non - polar
$SeCl_6$	non - polar
$AsCl_3$	polar

Q.35 (B)
Large size of anion $\propto$ polarisation
Size of anion $\downarrow \Rightarrow$ Polarization $\uparrow$

Q.36 (C)



Q.37 (D)
O_2^{2-} $\Rightarrow$ diamagnetic due to absence of unpaired electrons.

JEE-MAIN
PREVIOUS YEAR'S

Q.1 (1)

Species	Bond order
Ne_2	0
N_2	3
O_2	2
F_2	1

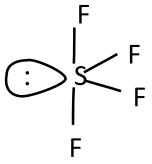
Q.2 (1)

Species	→	Bond order
Be_2	→	0 (zero) (not possible)
O_2^{2-}	→	1 (one)
He_2^-	→	$\frac{1}{2}$ (Half)
He_2^+	→	$\frac{1}{2}$ (Half)

Q.3 1 (SF_6)
$SiCl_4 + 4H_2O \rightarrow H_4SiO_4 + 4HCl$
$PCl_5 + 2H_2O \rightarrow POCl_3 + 2HCl$
$BF_3 + 3H_2O \rightarrow H_3BO_3 + 3HF$
$SF_6 + H_2O \rightarrow$ No reaction

Q.4 (1)
Theory

Q.5 (4)

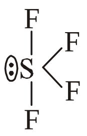


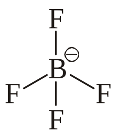
SF_4 see-saw structure Axial bond length is more than equitorial bond length

Q.6 (2)

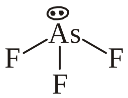
Q.7 (1)

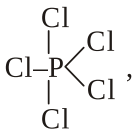
Q.8 (2)

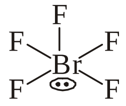
SF_4 =


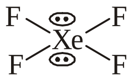
, $BF_4^{\ominus}$ =


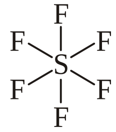
ClF_3 =


, AsF_3 =


PCl_5 = 

, BrF_5 = 

XeF_4 = 

, SF_6 = 

Two l.p. on central atom is = ClF3, XeF4

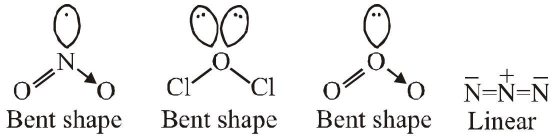
Q.9 (15)

AX is a covalent diatomic molecule.

The molecule is NO.

Total no. of electrons is 15.

Q.10 (4)



Q.11 (2)

Lewis base : Chemical species which has capability to donate electron pair.

In NF_3, SF_4, ClF_3 central atom (i.e. N, S, Cl) having lone pair therefore act as lewis base.

In PCl_5 central atom (P) does not have lone pair therefore does not act as lewis base.

Q.12 (4)
Q.13 (10)
Q.14 (0)
Q.15 (4)
Q.16 (3)
Q.17 (4)
Q.18 (0)

JEE-ADVANCED PREVIOUS YEAR'S

Q.1 (B,C)

Lone pairs on the central atom in $BrF_5 = 1$

Lone pairs on the central atom in $ClF_3 = 2$

Lone pairs on the central atom in $XeF_4 = 2$

Lone pairs on the central atom in $SF_4 = 1$

Q.2 (A,C)

O_2^{2+} (B.O. = 3) have shorter bond length than

O_2 (B.O. = 2)

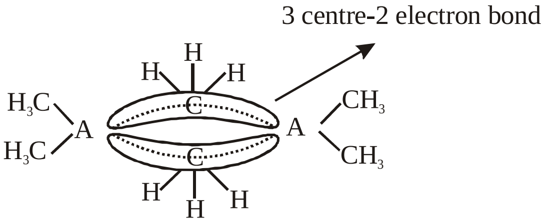
Q.3 (B)

Correct order :

$$\underset{(+5)}{H_3PO_4} > \underset{(+4)}{H_4P_2O_6} > \underset{(+3)}{H_3PO_3} > \underset{(+1)}{H_3PO_2}$$

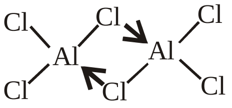
Q.4 (A,B,D)

Structure of $Al_2(CH_3)_6$

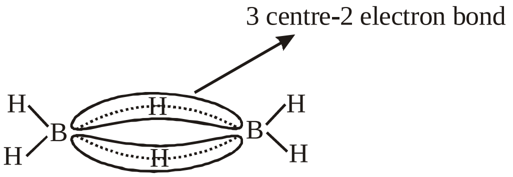


⇒ BCl_3 is stronger lewis acid due to small size of boron.

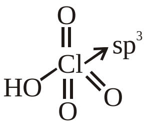
⇒ Structure of Al_2Cl_6

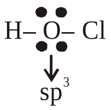


Structure of B_2H_6



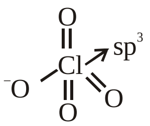
Q.5 (ACD)

(A) 



(B) $Cl_2 + H_2O \rightarrow HCl + HOCl$

(C)	Acidic :	$HClO_4$	>	H_3O^+
		Acid-1		Acid-2
	Basic	ClO_4^-	<	H_2O
		C.B -1		C. B. - 2

(D) 

Resonance stabilization

Q.6 (AD)

$$X_2 : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2,$$

$$\pi 2p_x^2 = \pi 2p_y^2, \frac{\pi^* 2p_x^2 = \pi^* 2p_y^2}{(\text{HOMO})}, \underset{(\text{LUMO})}{\sigma^* 2p_z^0}$$

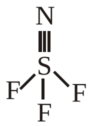
(F_2)
Down the group π^* to σ^* excitation become easy.

Q.7 [6]

Species		Ione pair on central atom
$TeBr^{2-}$	:	1
BrF_2^+	:	2
SNF_3	:	0
XeF_3^-	:	3

Total Number of lone of pair = 6

SNF_3 :



Q.8 [6]

(H_2, Cl_2, Be_2, C_2, N_2, F_2)

H_2 : $\sigma 1s^2$

He_2^+ : $\sigma 1s^2, \sigma^* 1s^2$

Li_2 : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2$

Be_2 : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2$

B_2 : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^1 = \pi 2p_y^1$

C_2 : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2$

N_2 : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2 = \pi 2p_z^2$

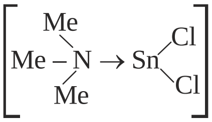
O_2^- : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2 = \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^1$

F_2 : $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_z^2 = \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$

Q.9 (A,D)

$$\underset{(Q)}{SnCl_2} + Cl^- \rightarrow \underset{(X)}{SnCl_3^-}$$

$SnCl_2 + Me_3N \rightarrow SnCl_2 . NMe_3$



$$\underset{(Q)}{SnCl_2} + 2CuCl_2 \rightarrow \underset{(Z)}{SnCl_4} + 2CuCl$$

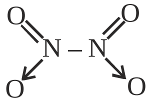
Q.10 (B,D)

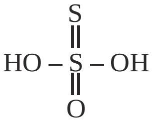
Polar molecule	Non-polar molecule
$CHCl_3$, SO_2, C_6H_5Cl, H_2Se, BeF_5, O_3, XeF_6, NO_2, NH_3, $POCl_3$, CH_3Cl	$BeCl_2$, CO_2, BCl_3, SF_6

So correct answer is option (B) and (D)

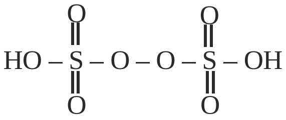
Q.11 [4.00]

$N \equiv N \rightarrow O$





$N \equiv N \rightarrow O$



Q.12 (19.00)

$$XeF_4 + O_2F_2 \rightarrow \underset{Y}{XeF_6} + O_2$$

Y has 3 lone pair of electron in each fluorine and one lone pair of electron in xenon. Hence total lone pair of electrons is 19.

Q.13 [6]

Here polar molecules in the liquid form will be attracted/deflected near charged comb.

Polar molecules : HF, H_2O, NH_3, H_2O_2, $CHCl_3$, C_6H_5Cl
(6-polar molecules)

Nonpolar molecules : O_2, CCl_4, C_6H_6

Hydrogen and It's Compound

EXERCISES

ELEMENTARY

Q.1 (1)
$^3_1H \Rightarrow n + p = 3.$

Q.2 (3)

Q.3 (4)

Q.4 (3)
⇒ Alkali metals because of valency e⁻ one
⇒ Halogen due to forming salts like halogens NaCl, NaH.

Q.5 (3)

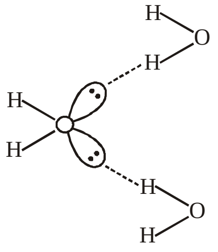
Q.6 (4)

Q.7 (4)

Q.8 (4)

Q.9 (2)

Q.10 (2)



Q.11 (1)
Due to open cage like structure.

Q.12 (1)

Q.13 (2)
By boiling temporary hardness of water can be removed. $Ca(HCO_3)_2 \xrightarrow{\text{Boil}} \underset{\text{(insoluble)}}{CaCO_3} + H_2O + CO_2$

Q.14 (1)
Chlorides and sulphates of *Mg* and *Ca* produces permanent hardness and bicarbonates of *Mg* and *Ca* produces temporary hardness.

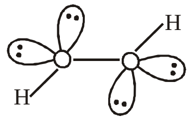
Q.15 (4)

Q.16 (4)
The density of water is $1 gcm^{-3}$ at 4°*C*

so molarity = $\frac{1000}{18}$ = 55.5 M.

Q.17 (4)
Water containing Ca^{+2}, Mg^{+2} and H^+ (> 10^{-7} m) is a hard water.
$H^+(aq) + CH_3COONa(aq) \rightleftharpoons CH_3COOH(s) + Na^+(aq)$

Q.18 (4)



Q.19 (2)

Q.20 (3)
$Na_2O_2 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O_2$

Q.21 (3)
$\underset{-2}{H_2S} + H_2O_2 \rightarrow \underset{0}{S} + 2H_2O$

In this reaction H_2O_2 shows oxidising nature

Q.22 (2)

Q.23 (3)
Reactivity of H_2 is least among then due to bond dissociation.

JEE-MAIN

OBJECTIVE QUESTIONS

Q.1 (4)
Hydrogen does not has lone pair of electron so it can not form coordinate bond with other atoms or molecules.

Q.2 (4)
Hydrogen and alkali metals are electropositive their electronegativity is very less i.e. H – 2.1, Li 1.0, Na 0.9, k = 0.8, Rb = 0.8

Q.3 (3)
In electronegativity of hydrogen is in between metals and non metals so it behaves as both electro +ve and electro – ve. It can lose electron to form H^+ ion and it can also gain electron to form H^- ion.

Q.4 (4)
Hydrogen is colourless gas.

Q.5 (1)
Ionisation energy of hydrogen is (1312 kJ mol^{-1}) which is too high than that of alkali metals and low than that of halogens.

Q.6 (1)

Hydrogen accepts electron to form anion and get inert gas configuration like halogens.

$H + e^- \longrightarrow H^+$ (hydride ion)

$X + e^- \longrightarrow X^-$

halogen halide ion

Q.7 (3)

The ratio of protium, deuterium and tritium in nature is not certains.

Q.8 (3)

Hydrogen does not combine with helium.

Q.9 (4)

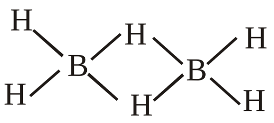
$$Zn + NaOH \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2\uparrow$$

Q.10 (3)

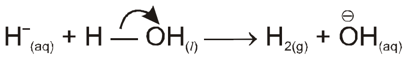
Occlusion.

Q.11 (3)

H–Be– H



Q.12 (2)



$$H^-_{(aq)} + H - OH_{(l)} \longrightarrow H_{2(g)} + \overset{\ominus}{O}H_{(aq)}$$

$CaH_2 + 2H_2O \longrightarrow 2H_2 + Ca(OH)_2$

Q.13 (3)

Ortho hydrogen is not the isotop of hydrogen but it is isomer of hydrogen.

Q.14 (3)

Oxidation number of hydrogen in hydrogen molecule and hydrogen atom is zero. Oxidation number of hydrogen in all compound containing hydrogen is + 1. except hydrides.

oxidation no. of hydrogen in hydrides is – 1.

Q.15 (3)

Cation exchange resin exchanges Ca^{2+}, Mg^{2+} ions from water, and water becomes soft.

Q.16 (B)

Hydrated silicates of Al and Na is called permutit $Na_2Al_2Si_2O_8 . x.H_2O$

Q.17 (1)

$CaCl_2$, $CaSO_4$, $MgCl_2$, $MgSO_4$, When dissolve in water it becomes permanently hard.

Q.18 (2)

$Na_2Al_2Si_2O_8 . xH_2O + Ca^{2+} \rightarrow CaAl_2Si_2O_8.xH_2O + 2Na^+$

Q.19 (2)

In bosch process water gas is used for production of H_2.

Q.20 (4)

H_2

Q.21 (D)

Clark's process involve addition of slaked lime for removing temp. hardness.

Q.22 (3)

At Anode

$2H^- \longrightarrow H_2 + 2e^-$

Q.23 (1)

Due to Ca and Mg salts

Q.24 (2)

D_2O Heavy water

Q.25 (2)

Slowing down the speed of high energy neutrons.

Q.26 (2)

$Ma_3N_2 + 6H_2O \rightarrow 3Mg(OD)_2 + 2ND_3$

Q.27 (4)

Each oxygen atom attached with four hydrogen, two by covalent bonds and two hydrogen bonds in ice.

Q.28 (3)

Q.29 (3)

Q.30 (2)

$Na_2O_2 + 2HCl \longrightarrow 2NaCl + H_2O_2$

$Na_2O_2 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O_2$

Q.31 (3)

Q.32 (4)

H_2O_2 when oxidised in acidic or basic medium it produces O_2

$2MnO_4^- + 6H^+ + 5H_2O_2 \longrightarrow 2 Mn^{2+} + 8H_2O + 5O_2$ (acidic medium)

$2MnO^-_4 + 3H_2O_2 \longrightarrow 2MnO_2 + 3O_2 + 2H_2O$ (basic medium)

Q.33 (4)

Hydrogen peroxide can be used as an oxidant, reductant and an acid. It oxidise Fe^{2+} into Fe^{3+} solwly in acidic medium but in basic medium it oxidises very fast.

$2Fe^{2+} + 2H^+_{(aq)} + H_2O_2 \longrightarrow 2Fe^{3+}_{(aq)} + 2H_2O_{(l)}$ acidic medium (SRP = + 1.77 V)

$2Fe^{2+} + H_2O_2 \longrightarrow 2Fe^{3+} + 2OH^-$ basic median (SRP = + 0.87 V)

Hydrogen peroxide is also acidic in nature.

$H_2O_2 \rightleftharpoons H^+ + HO_2^-$

Ka = 1.5×10^{-12}

$Na_2CO_3 + H_2O_2 \longrightarrow Na_2O_2 + H_2O + CO_2$

Q.34 (3)

H_2O_2 can not be dried over conc. H_2SO_4 because it oxidises by H_2SO_4

$H_2SO_4 \longrightarrow H_2O + SO_2 + O$

$H_2O_2 + O \longrightarrow H_2O + O_2$

$H_2SO_4 + H_2O_2 \longrightarrow 2H_2O + SO_2 + O_2$

Q.35 (2)

10 V means 3.035% H_2O_2, hence 20 V means 6.070% H_2O_2

Q.36 (4)

H_2O_2 can be used as antiseptic, bleaching agent and propellent.

Q.37 (3)

It undergoes autoxidation on prolonged standing.

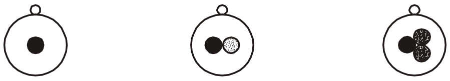
Q.38 (2)

Q.39 (3)

JEE ADVANCED
OBJECTIVE QUESTIONS

Q.1 (B)

Hydrogen has three isotopes and two isomers.



		Protium	Deuterium	Tritium
O	Electron-		1	1
●	Proton-		1	1
◍	Neutron-		Nil	1

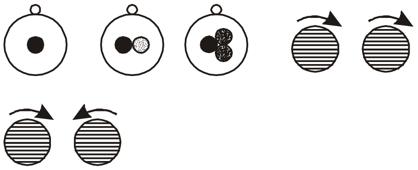
Orthohydrogen Parahydrogen

1

1 (Isomers of hydrogen)

2 (Isotopes of hydrogen)

Ortho hydrogen-two protons in hydrogen molecule when spins in the same direction the form is termed as orthohydrogen, and when proton spins are in opposite direction the form is known as para hydrogen.



Q.2 (B)

Electronic configuration of hydrogen and deuterium is the same i.e. $1s^1$

Q.3 (B)

The number of possible diatomic molecules of three isotopes of hydrogen are six

i.e.

1. H – H	4. D – D	H – Protium
2. H – D	5. D – T	D – Deuterium
3. H – T	6. T – T	T – Tritium

Q.4 (B)

First ionizatition potential of H is 1312 kJ mol^{-1}

Q.5 (A)

(A) $Cu + HCl \longrightarrow$ No reaction

(B) $3Fe + 4H_2O\ (g) \longrightarrow Fe_3O_4 + 4H_2 \uparrow$

(C) $Mg + 2H_2O\ (hot) \longrightarrow Mg(OH)_2 + H_2$

(D) $Na + C_2H_5OH \longrightarrow C_2H_5ONa + H$

Q.6 (B)

(A) $4Fe + 10\ HNO_3 \longrightarrow 4Fe\ (NO_3)_2 + NH_4NO_3 + 3H_2O$
very dil.

$4Fe + 10\ HNO_3 \longrightarrow 4Fe(NO_3)_2 + N_2O + 5H_2O$
dil.

(B) $Mn + 2HNO_3 \longrightarrow Mn(NO_3)_2 + H_2$
dil.

(C) $3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
dil.

(D) $2Al + 8HNO_3 \longrightarrow 2Al(NO_3)_3 + 2NO + 4H_2O$

Q.7 (A)

Hydrogen atoms at the moment of formation is known as nascent hydrogen. It is believed that part of energy liberated in the reaction producing hydrogen become associated with hydrogen molecules and thus make them hyperactive.

Q.8 (C)

Hydrogen can act both as oxidising and reducing agent. It acts as oxidising agent when reacts with metal and form metal hydrides which are electrovalent compounds.

$2Na + H_2 \longrightarrow 2Na\,H$

$Ca + H_2 \longrightarrow CaH_2$

Hydrogen also acts as reducing agent when its reacts with oxides

$PbO + H_2 \longrightarrow Pb + H_2O$

$CuO + H_2 \longrightarrow Cu + H_2O$

$Fe_3O_4 + H_2 \longrightarrow 3Fe + 4H_2O$

Q.9 (A)

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

1 mole excess 1 mole

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

1 mole excess 1 mole

Ration of volume of hydrogen in both cases is 1 : 1.

Q.10 (B)

In the reaction with calcium hydrogen acts as an oxidising agent.

$Ca + H_2 \longrightarrow CaH_2$ $(Ca^{2+}\ 2H^-)$

Q.11 (C)

Hard water contains soluble salts $CaCl_2$ $MgCl_2$, $CaSO_4$ $MgSO_4$ $Ca(HCO_3)_2Mg(HCO_3)_2$

Q.12 (B)

Temporary hardness of water is due to the presence of $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ in water

Q.13 (A)

$Ca(OH)_2$ reacts with $Ca(HCO_3)_2$ to precipitate $CaCO_3$

$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3\downarrow + 2H_2O$

$Mg(HCO_3)_2 + 2Ca(OH)_2 \longrightarrow 2CaCO_3\downarrow + Mg(OH)_2\downarrow + 2H_2O$

Q.14 (B)

$CaSO_4$

Q.15 (D)

Hard water passed through cation exchange resin which releases H^+ and then passed through anion exchanges resin which releases OH^-

$2RH_{(s)} + M^{2+}_{(aq)} \rightleftharpoons MR_{2(s)} + 2H^+_{(aq)}$ .... (i) $[M^{2+} = Ca^{2+}/Mg^{2+}]$

$RNH_{2(s)} + H_2O_{(l)} \rightleftharpoons RNH^+_3 + OH^-_{(s)}$

$RNH^+_3.\ OH^-_{(s)} + X^-_{(aq)} \rightleftharpoons RNH_3X^- + OH^-$ ... (ii) $[X^- = Cl^-, HCO^-_3, SO^{2-}_4$ etc.]

OH^- neutralise the H^+ released in the cation exchange in (eq i)

$H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O_{(l)}$

Q.16 (D)

Hard water when passed through resin containing R–COOH groups it becomes free from Ca^+ ions.

Q.17 (A)

Permanent hardness can not be removed by boiling water.

Q.18 (C)

Temporary hardness is because of the presence of bicarbonates of Mg^{2+} and Ca^{2+}. The methods used for their removal are

(A) boiling method

(B) Clark's method , $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$

Permanent hardness is because of the presence of SO_4^{2-}, Cl^- etc of Mg^{2+} and Ca^{2+}. The methods used for their removal are

(A) Washing soda method, $MCl_2 + Na_2CO_3 \rightarrow MCO_3 + 2NaCl$

(B) Calgon's method $M^+ + Na_4\,P_6O^{2-}_{18} \rightarrow Na_2MP_6O^{2-}_{18}$

Q.19 (A)

Q.20 (C)

Calgon is sodium hexametaphosphate $Na_2[Na_4(PO_3)_6]$

Q.21 (C)

Ortho H_2 have spin of protons para H_2 have same different spin of protons.

Q.22 (C)

Ortho and para H_2 has similar chemical properties.

Q.23 (B)

Deuterium is prepared from ordinary hydrogen by fractionation.

Q.24 (A)

Saline hydride means salt like hydride. Alkali metals and alkaline earth metals and some highly + ve members of lanthanide series can transfer electron easily to hydrogen atoms. Ex. NaH, KH, CaH_2 | (Si, B, and Al do not form salt like hydride).

Q.25 (A)
Ti $H_{1.5-1.8}$ is a interstitial hydride.

Q.26 (D)
In CaH_2 H has oxidation state (–1) [+ 2 + 2x = 0, x = – 1]

Q.27 (C)
Gaseous H_2O_2 has dihedral angle equal to 111.5°.

Q.28 (B)
H_2O_2 acts as reducing agent and reduces $KMnO_4$ solution in acidic medium.

$2KMnO_4 + 6H^+ + 5H_2O_2 \longrightarrow 2K^+ + 2Mn^2 + 8H_2O + 5O_2$

Q.29 (A)
In basic medium H_2O_2 oxidises $Cr_2(SO_4)_3$

$\underset{\text{Cr – Oxi. No. = + 3}}{2Cr^{3+}} + 10H^- + 3H_2O_2 \longrightarrow \underset{\text{Cr – Oxi. No. = + 6}}{2CrO^{2-}{}_4} + 8H_2O$

Q.30 (C)
Ionic compounds are more soluble in soft water than heavy water. Soft water has high dielectric constant (78.39), while that of heavy water in 78.06. Due to higher polar character of solf water it is an excellent solvant for ionic compounds. Distillations ionic compouds takes place because of ion-dipole interactions solubility of covalent compounds is due to the formation of hydrogen bonds with water molecules.

Q.31 (C)

Q.32 (D)
CaH_2 is ionic hydride

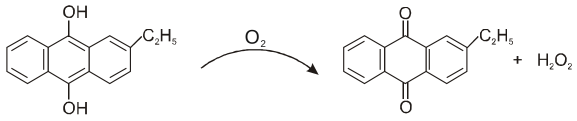
Q.33 (C)
Acetanilide

Q.34 (A)
H_2O_2 slowly decomposes to give nascent oxygen, which decolourises the coloured substances

$H_2O_2 \longrightarrow H_2O + \underset{\text{nascent oxygen}}{[O]}$

Coloured substances + $\underset{\text{nascent oxygen}}{[O]}$ ⟶ Colourless substance.

Q.35 (A)
On industrial scale H_2O_2 is prepared by auto oxidation of 2-ethylanthraquinol.



2-ethylanthraquinol

Q.36 (C)
A solution of $K_2Cr_2O_7$ in H_2SO_4 is oxidised to blue cromic acid by H_2O_2 and dissolve in ether to give blue coloured solution.

$K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + H_2Cr_2O_7$
$H_2Cr_2O_7 + 4H_2O_2 \longrightarrow 2CrO_5 + 5H_2O$

$K_2Cr_2O_7 + H_2SO_4 + 4H_2O_2 \longrightarrow K_2SO_4 + 2CrO_5 + 5H_2O$

Percromic acid (blue)

Q.37 (D)
Hint : H_2 = 50 volumes, CO = 40 volumes, N_2 and CO_2 = 5 volumes etc.

Q.38 (C)
Oxidation number of Mn in MnO^-_4 is + 7 and oxidation number in Mn^{2+} is + 2.
The oxidation number decreases from + 7 to + 2, hence MnO^-_4. is reduced.

Q.39 (A)

Q.40 (D)
$H_2O_2 \rightleftharpoons H^+ + HO_2^-$; $H_2O_2 \rightleftharpoons 2H^+ + O_2^{2-}$

$2NaOH + H_2O_2 \longrightarrow Na_2O_2 + 2H_2O$.

JEE-ADVANCED
MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (A)

Q.2 (B)

Q.3 (D)

$\underset{(A)}{C + H_2O} \xrightarrow{1270\ K} \underset{(B)}{H_2 + CO}$

$\underset{(B)}{CO + H_2} + \underset{(A)}{H_2O} \xrightarrow[673\ K]{FeCrO_4} \underset{(A)}{H_2} + \underset{(C)}{CO_2}$

Q.4 (C)
Bosch process.

Q.5 (B)
Both A and X are H_2O.

Q.6 (B)
$Z = H_2$

Q.7 (B)
Syngas = $[CO + H_2]$

Q.8 (A)
H_2O_2 is also known is oxidane.

Q.9 (C)

Q.10 (B)

Q.11 (D)
Interstitial hydrides are non-stochiometric hydrides and thus deficient in hydrogen. Transition and innertransition elements at elevated temp. absorb hydrogen into the interstices of their lettices to yield metal like hydrides.

Q.12 (A) – r, (B) – p, (C) – q, (D) – s

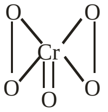
NUMERICAL VALUE BASED

Q.1 [6]

Q.2 [2]

Q.3 [2]

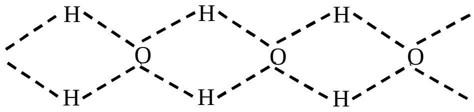
X = CrO_5



two peroxide linkage

Q.4 [1]
Acid is

Q.5 [2]
H-bonded structure of $H_2O(s)$ is



Q.6 [750 ml of O_2 at NTP.]
According to definition,
1 ml of '30 volume' H_2O_2 gives 30 ml of O_2 at NTP
$\therefore$ 25 ml of '30 volume' H_2O_2 gives 30 × 25 ml of O_2 at NTP = 750 ml of O_2 at NTP.

Q.7 [4]
No. of Peroxy linkage in $H_2S_2O_8$, CrO_5 & H_2TiO_4 are 1, 2 and 1 respectively.

Q.8 [3]
$H_2S_2O_8$ on completely hydrolysis gives ....2..... mole of H_2SO_4 & ....1....... mole of H_2O_2.

KVPY
PREVIOUS YEAR'S

Q.1 (C)
H_2 is reducing agent

Q.2 (C)
Clark method

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 \downarrow + 2H_2O$$

Q.3 (C)

$$CO(g) + H_2O(g) \xrightarrow[\text{catalyst}]{673K} CO_2(g) + H_2(g)$$

Q.4 (D)
Permanent hardness can be removed by – sodium hexametaphosphate.
Calgon process
$Na_2[Na_4(PO_3)_6] + Ca^{2+} \longrightarrow Na_2[Ca_2(PO_3)_6] + 4Na^+$

JEE-MAIN
PREVIOUS YEAR’S

Q.1 (1)
Calgon $\rightarrow$ $Na_2[Na_4(PO_3)_6] \xrightarrow{\text{Water Soluble}} 2Na+$

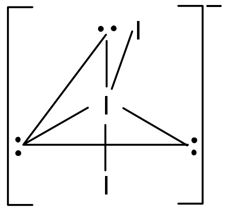
$[Na_4(PO_3)_6]^{2-} \xrightarrow{Ca^{2+}} 2Na^+ \underset{\text{Soluble}}{[Na_2Ca(PO_3)_6]^{2-}}$

Q.2 (1)

Q.3 (1)
Since extent of intermolecular forces are more in D_2O as compared to H_2O, therefore D_2O has more viscosity as well as Boiling point as compared to H_2O.

Q.4 (2)

Q.5 (1)



sp^{3}d hybridisation

Linear shape ∠I–I–I = 180°

Q.6 (4)
In basic medium, oxidising action of H_2O_2.
$Mn^{2+} + H_2O_2 \rightarrow Mn^{+4} + 2OH^-$
In basic medium, reducing action of H_2O_2
$I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
In acidic medium, oxidising action of H_2O_2.
$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$
Hence correct option (4)

Q.7 (4)

For temporary hardness,

$Mg(HCO_3)_2 \xrightarrow{heating} Mg(OH)_2\downarrow + 2CO_2\uparrow$

Assertion is false.

$MgCO_3$ has high solubility product than $Mg(OH)_2$.

According to data of NCERT table 7.9 (Equilibrium chapter), the solubility product of magnesium carbonate is 3.5×10^{-8} and solubility product of $Mg(OH)_2$ is 1.8×10^{-11}.

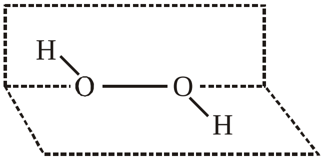
Hence Reason is incorrect.

The question should be Bonus.

Q.8 (3)

The dielectric constant of H_2O is greater than heavy water.

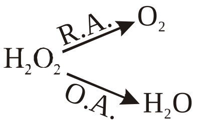
Q.9 (2)



Structure of H_2O_2

(Open book type) → Non planar

H_2O_2 is used in the treatment of effluents.



act as both O.A & R.A.

H_2O_2 is miscible in water due to hydrogen bonding.

Q.10 (2)

(a) H_2O_2 can acts as both oxidising and reducing agent in basic medium.

(i) $2Fe^{2+} + H_2O_2 \rightarrow 2Fe^{3+} + 2OH^-$

In this reaction, H_2O_2 acts as oxiding agent.

(ii) $2\overset{+7}{M}nO^- + 3H\ O \rightarrow 2\overset{+4}{M}nO\ + 3O\ + 2H\ O + 2OH^-$

In this reaction, H_2O_2 acts as reducing agent.

(b) The basic principle of hydrogen economy is the transportation and storage of energy in the form of liquids or gaseous dihydrogen.

Advantage of hydrogen economy is that energy is transmitted in the form of dihydrogen and not as electric power.

Q.11 (3)

Q.12 (2)

Q.13 (3)

Q.14 (2)

Q.15 (4)

Q.16 (3)

Q.17 (4)

Q.18 (1)

Q.19 (2)

Q.20 (1)

Q.21 (3)

Q.22 (2)

Q.23 (1)

Q.24 (4)

Q.25 (1)

Q.26 (0)

Q.27 (173)

Q.28 (3)

JEE-ADVANCED PREVIOUS YEAR'S

Q.1 (A)

s-Block Elements

EXERCISES

Elementary

Q.1 (4)

$M + O_2 \rightarrow M_2O \xrightarrow{+O_2} M_2O_2 \xrightarrow{+O_2} MO_2$

M = K, Rb, Cs

Q.2 (1)

Valency shell $e^- = 1$

Q.3 (3)

Alkali metals are highly reactive metals. They react with

Alcohol – $2C_2H_5OH + 2K \rightarrow 2C_2H_5OK + H_2$

Water – $2K + 2H_2O \rightarrow 2KOH + H_2$

Ammonia – $K + (x + y)NH_3 \rightarrow$

$$\underset{\text{Ammoniated cation}}{\left[K(NH_3)_x\right]^+} + \underset{\text{Ammoniated electron}}{\left[e(NH_3)_y\right]^-}$$

But they do not react with kerosene.

Q.4 (2)

Full filled configuration, polarisation.

Q.5 (4)

Smaller size ion in gas form have greater size ion in aq. medium.

Q.6 (1)

Low IE.

Q.7 (4)

Q.8 (2)

Alkalimetal oxides are basic in nature.

Q.9 (4)

Element –	Li	Na	K	Rb
Atomic radius (pm) –	152	186	227	248

Q.10 (1)

For IInd IE Alkali metal have inertgas configuration.

Q.11 (2)

Q.12 (2)

Q.13 (1)

LiOH < NaOH < KOH < RbOH

Down the group basic character increases

Q.14 (3)

$Fe(OH)_3$ is soluble in sodium hydroxide solution.

Q.15 (4)

Ionic mobility $\propto \frac{1}{\text{size}}$.

Q.16 (2)

Q.17 (2)

$O_2^- \rightarrow$ Super oxide

Q.18 (3)

Q.19 (2)

Q.20 (2)

Q.21 (1)

Q.22 (4)

Element –	Mg	Al	Si	P
Atomic radii (Å)–	1.60	1.43	1.32	1.28

as we move across the period nuclear charge increases, hence, size decreases.

Q.23 (2)

Q.24 (1)

Q.25 (2)

Q.26 (4)

Due to small size of Be^{+2}, high covalent character.

Q.27 (3)

Zn, Be, Al, Sn, Pb oxides are amphoteric in nature.

Q.28 (1)

$Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2$

Solubility decreasing order.

Q.29 (4)

Q.30 (4)

Q.31 (4)
$BaSO_4$ is sparingly soluble in water because the solubility of second group sulphates decreases with increasing atomic size. Because of hydration energy decreases.

Q.32 (2)

Basic strength of oxides $\propto \frac{1}{EN}$

Q.33 (2)

$Ca + \frac{1}{2} O_2 \rightarrow CaO.$

Q.34 (4)

Q.35 (1)
Chlorophyl is complex of Mg.

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (2)
The block of an element depends on the type of sub-shell which receives the last electron. As last electron enters in p-subshell of outer most shell according to Aufbau rule, the element of option (2) belongs to p-block.

Q.2 (3)
They have weak metallic bond because of one valence electron per atom. So they have low melting points.

Q.3 (3)
(1) Down the group, the atomic size increases with increasing atomic number and so attraction for shared pair of electrons decreases. Hence electronegativity decreases.
(2) Down the group, the atomic size increases with increasing atomic number and so attraction between valence electron and nuclear decreases. Hence ionization energy decreases.
(3) Down the group atomic size increases with increase in number of atomic shells while effective nuclear charge remains constant.
(4) Down the group atomic size increases with increase in number of atomic shells and therefore, the strength of metallic bond decreases. So melting point decreases.

Q.4 (2)
For (A), (C) and (D) refer above question.
(D) Sodium is smaller than potassium in size. The valence shell electron is tightly bound with nucleus and therefore, more energy is required to eject out the electron. So sodium has higher ionisation energy than that of potassium.

Q.5 (2)
They easily lose valence shell electron because of their low ionisation energies, on account of their bigger atomic sizes. So they behave as strong reducing agents.

Q.6 (2)
Alkali metals have one mobile electron per atom, those may undergo oscillation producing metallic lustre.

Q.7 (1)
Emmited wavelength lies in visible region

$$\underset{\text{violet blue}}{(390\ \text{nm} - 760\ \text{nm})} \quad \Delta E = h\mu = \frac{hc}{\underset{\text{Red}}{\lambda}}$$

Blue has high frequency low wavelength - high energy

Q.8 (4)
The metallic bond is purely the electric attraction between the mobile electrons and positive part of the atom, the kernel. This electrical attraction depends upon the (i) number of mobile electrons per atom and (ii) the size of the atom.
The strength of metallic bond is weakest in Cs metallic lattice amongst these elements because of largest atomic radius.

Q.9 (2)
Sodium is reactive because of it's low ionization energy and so reacts with benzene, alcohol and water but does not react at all with kerosene.

Q.10 (1)
It has highest polarising power among the alkali metals because of small size and thus show different properties than that of other elements of the group.

Q.11 (4)
Li reacts with N_2 and O_2 of air forming Li_3N and Li_2O but Na reacts with only O_2 forming Na_2O not with N_2 forming Na_3N (it requires high temperature.)

Q.12 (1)
Down's process involves the electrolysis of fused sodium chloride containing $CaCl_2$ & KF using Fe as cathode & graphite as anode at about 600ºC. $CaCl_2$ & KF are added to decrease fusion temperature (1600ºC).

Q.13 (3)

Salt of KCl gives lilac or pale violet colour to the flame. NaCl and LiCl give golden yellow and crimson colour to the flame respectively.

Q.14 (4)

Along the period, atomic size decreases and nuclear charge increases and thus lattice energy increases,

$$\text{Lattice energy} \propto \frac{\text{Charge on cation}}{\text{Size of cation}}.$$

Q.15 (1)

Down the group Z_{eff} decrease & complex farmation tendeny decrease

Q.16 (4)

$M + (x + y)\,NH_3 \longrightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$; solution contains unpaired solvated electrons which are responsible for their strongly reducing and highly conducting nature.

Q.17 (4)

Electropositive character is the measure of ease of formation of cation by losing electron. With increasing atomic size, the ionization energy decreases and, therefore, the ease of formation of cation by losing the electron increases resulting into more electropositive character of the metal. Down the group, metallic character increases due to decreases in ionisation energy and so electropositive character increase.

Q.18 (1)

$Na + H_2O \rightarrow NaOH + H_2$

A C B (Combustible)

$Zn + NaOH \rightarrow Na_2ZnO_2 + H_2$

Amphoteric

$Zn + \text{dil } H_2SO_4 \rightarrow ZnSO_4 + H_2$

Q.19 (1)

T.S ∝ Ionic character (for polyatomic anion)

Li_2CO_3 is least ionic or most covalent

Q.20 (4)

K_2O, KO_2, K_2O_2

Rb_2O, RbO_2, Rb_2O_2

Na, Li from normal oxide

Q.21 (1)

$NaHCO_3 + NaOH \xrightarrow{\text{Neutralisation}} Na_2CO_3 + H_2O$

Acidic hydrogen Base

Q.22 (2)

According to Fajan's rule NaF has highest ionic character because of smaller size of anion F^-. So NaF has highest melting point. The order of melting point is generally fluoride > chloride > bromide > iodide.

Q.23 (2)

(1) $2LiNO_3 \xrightarrow{\Delta} Li_2O + 2NO_2\uparrow (\text{brown}) + \frac{1}{2}O_2\uparrow$

(2) $KNO_3 \xrightarrow{\Delta} KNO_2 + \frac{1}{2}O_2\uparrow$

(3) $Pb(NO_3)_2 \xrightarrow{\Delta} PbO + 2NO_2\uparrow (\text{brown}) + \frac{1}{2}O_2\uparrow$

(4) $2AgNO_3 \xrightarrow{\Delta} 2Ag + 2NO_2\uparrow (\text{brown}) + O_2\uparrow$

Q.24 (2)

Alkali metal carbonates except Li_2CO_3 are stable towards heat because they are most basic in nature and basic character increases down the group and thermal stability increases down the group.

Bigger HCO_3^- anion is polarised by smaller Li^+ and thus readily decomposes to give CO_2 gas.

$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$

Q.25 (3)

Bigger HCO_3^- anion is polarised by smaller Li^+ and thus readily decomposes to give CO_2 gas. $LiHCO_3$ does not exist in solid state this exist only in solution.

Q.26 (2)

$2Na + O_2 \longrightarrow Na_2O_2$

Q.27 (1)

In frame test thermal excitation deexcitation takes place in cation with low Ionisation potential

Q.28 (4)

$$Na_{(s)} + (x + y)_{(g)}NH_3 \rightarrow \underset{\substack{\text{solvated}\\\text{sodium}\\\text{ion}}}{Na^+(NH_3)_x} + \underset{\substack{\text{solvated}\\\text{or}\\\text{Ammoniated}\\\text{electron}}}{e(NH_3)_y}$$

Q.29 (1)

Fajan rule

solubility inpolar solvent ∝ Ionic character

solubility in non polar ∝ cavalent character solvent

Q.30 (1)

Thermal stability of alkali metal oxy-acid salts increases with increasing metallic character so Li_2CO_3 has lowest stability.

Q.31 (3)

$KHCO_3$ is soluble in water so it can not be separated as intermediate product.

Q.32 (3)

$Na_2CO_3 + SO_2 \text{ (excess)} + H_2O \longrightarrow NaHSO_3 + CO_2$

Q.33 (3)

$NaOH + I_2 \longrightarrow NaIO_3 + NaI$, with dilute NaOH, NaI and NaOI are formed.

Q.34 (4)

Washing soda is decahydrated sodium carbonate.

Q.35 (4)

Sodium carbonate does not decompose on heating as it is stable towards heat.

Q.36 (3)

Microcosinic salt is used in microcosmicbed test

Q.37 (2)

$NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + \underset{\text{extingusher fire}}{CO_2}$

Q.38 (3)

Cs is highly electropositive & forms ionic bond with Cs^+ cation.

Q.39 (1)

It is prepared by Solvay's ammonia process using sodium chloride as raw material.

Q.40 (3)

Glauber's salt is decahydrated sodium sulphate.

Q.41 (2)

$Na_2O_2 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O_2$

Q.42 (2)

Fluorides of alkaline earth metals except BeF_2 are insoluble in water. The solubility of BeF_2 in water is due to higher hydration energy on account of small size of Be^{2+} ion and F^- ion and high charge density of Be^{2+} ion.

Q.43 (3)

$Na + Al_2O_3 \rightarrow Na_2O + Al$ (Position in electrochemical series)

$Na_2O + CO_2 \rightarrow Na_2CO_3$

Q.44 (2)

According to Fajan's rule, smaller size of cation and higher charge density on cation favours covalent character.

Q.45 (1,4)

BaO_2 exists as Ba^{2+} and O_2^{2-} and K_2O_2 exists as K^+ and O_2^{2-}, therefore, O_2^{2-} is peroxide ion.

Q.46 (1)

A compound dissolves in water when its hydration energy exceeds lattice energy. $BaSO_4$ is sparingly soluble in water because lattice energy of $BaSO_4$ is greater than it's hydration energy while Na_2SO_4 is soluble in water because it's hydration energy is greater than the lattice energy.

Q.47 (1)

$P_4 + NaOH \xrightarrow{\text{dispropartionation}} PH_3 + \underset{\text{Sodium Hypophosphite}}{NaH_2PO_2}$

Q.48 (4)

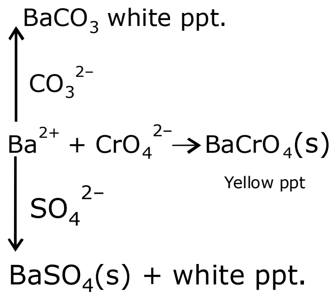
$MgCl_2$ being covalent in nature, gets hydrolysed by the water of crystallisation present, into MgO.

$MgCl_2 . 6H_2O \longrightarrow MgO + 2HCl + 5H_2O$

Q.49 (3)

$K_2O + H_2O \rightarrow KOH$

Q.50 (3)



Q.51 (2)

$A \longrightarrow \underset{\text{Lime water}}{Ca(OH)_2}$

$\underset{\text{Lime water}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\substack{\text{White ppt}\\(C)}}{CaCO_3} + H_2O$

$C \rightarrow CaCO_3$

$Ca(OH)_2 + Na_2CO_3 \rightarrow \underset{C}{CaCO_3} + \underset{B}{NaOH}$

Q.52 (2)

(1) Ca salt imparts brick red colour to the flame.

(2) Sr salt imparts bright crimson colour to the flame.

(3) Ba salt imparts apple green colour to the flame.

(4) Mg salt does not impart any colour to the flame because of high ionization energy.

Q.53 (2)

General electronic configuration of second group metals is [Noble gas] ns^2. As all electrons are paired, so the alkaline earth metal salts are diamagnetic.

Q.54 (1)

Along the period from left to right, atomic number increases and, therefore, nuclear charge also increases. So first ionization energy of alkaline earth metals are higher than those of the alkali metals of the same period because of higher nuclear charge.

Q.55 (4)

Be has higher ionisation energy than boron because of stable completely filled valence shell, $2s^2$ as compared to less stable partially filled valence shell, $2s^2\ 2p^1$.

Q.56 (4)

Down the group size increases and, therefore, attraction between valence shell electron and nucleus decreases and thus ionisation energy decrease.

Along the period the atomic size decreases and nuclear charge increases. So generally the ionization energy increases. However, half-filled and completely filled valence shell electron also affect the ionization energy along the period.

Q.57 (4)

Down the group size increases and therefore, attraction between valence shell electron and nucleus decreases and thus ionisation energy decreases.

Q.58 (4)

The oxide and other compounds of beryllium is more covalent than those formed by the heavier and large sized member (Ca, Sr, Ba) because of higher ionization energy on account of it's small atomic size.

Q.59 (1)

$Mg + 3N_2 \longrightarrow Mg_3N_2$;

$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$.

Q.60 (2,3)

Mg^{2+} ion has higher hydration energy than that of Na^+ and Ca^{2+} ions because Na^+ ion has small charge and bigger size of atom than that of Mg^{2+}.

Ca^{2+} ion has bigger size then that of Mg^{2+}.

Q.61 (2)

Hydration energy $\propto$ polarising power

$Na^+ < Mg^{2+} < Mg^{3+} < Al^{3+} < Be^{3+}$

Q.62 (3)

The solubility of sulphates of alkaline earth metal salts decreases down the group from Be to Ba. This is because of the fact that down the group with increasing size of cation the lattice energy as well as hydration energy also decreases but the change in hydration energy is more as compare to that of lattice energy.

Q.63 (1)

K [Ar] $4s^1 \rightarrow$ second ionisation is extremely difficult.

Ca [Ar] $4s^2$

Ba [Xe] $5S^2$

Q.64 (3)

Ca^{2+} or Mg^{2+} + $EDTA^{4-} \rightleftharpoons$ $[Ca(EPTA)]^{2-}$

Hardness or $[MgEDTA]^{2-}$ causing ion

Q.65 (1)

Be & Mg due to small size does not impart colour to the flame as excitation & deexcitation is not possible.

Q.66 (1)

Q.67 (3)

Lithopane is ($BaSO_4$ + ZnS)

white pigment

$BaSO_4$ is insoluble in water

Q.68 (4)

$Be(OH)_2$ down the group solubility increase

$Mg(OH)_2$

$CO(OH)_2$ $K_{sp} = 4s^3$

$Sr(OH)_2$

Q.69 (2)

Green flame is given by Ba^{2+}

$BaS_2O_3 + HCl \rightarrow BaCl_2 + H_2O + \underset{\text{pungent gas}}{SO_2\uparrow} + \underset{\text{yellow ppt}}{S_8}$

$BaS_2O_3 + K_2CrO_4 \rightarrow \underset{\text{yellow ppt}}{BaCrO_4} + K_2S_2O_3$

Q.70 (1)

$Mg(OH)_2$

Base or Antacid which distroys

and as per neutralisation reaction

Q.71 (1)

$3Mg + N_2 \longrightarrow Mg_3N_2$; $2Mg + O_2 \longrightarrow 2MgO$

Q.72 (3)

Mg_2C_3 or $(Mg^{2+})_2 = -C_3^{4}$

& C_3^{4-} or $C^{3-} - C \equiv C^{\ominus}$

Q.73 (3)

Basic nature of hydroxides increases down the group. The strength of a base depends on ionisation of the hydroxide which depends on polarity of bond and internuclear distance between the oxygen of the hydroxide and metal atom.

Q.74 (1)

$Ba(NO_3)_2 \xrightarrow{\Delta} BaO + 2NO_2 + \frac{1}{2}O_2$; Alkali metal nitrates gives only O_2 gas.

Alkali metal nitrates give only O_2 on heating below 500ºC according to following reaction,

$MNO_3 \longrightarrow MNO_2 + \frac{1}{2}O_2$

Q.75 (4)

The solubility of hydroxides of alkaline earth metal salts increases down the group from Be to Ba. This is because of the fact that down the group with increasing size of cation the hydration energy as well as lattice energy also decrease but the change in lattice energy is more as compare to that of hydration energy.

Q.76 (4)

Evident from Fajan rule

Q.77 (2)

$MgCO_3 \longrightarrow MgO + CO_2$

Alkali metal carbonates except Li_2CO_3 are thermally stable.

Q.78 (3)

Plaster of Paris is hemihydrate of calcium sulphate.

Q.79 (2)

$$\underset{\text{Plaster of Paris}}{2CaSO_4.H_2O} \xrightarrow[H_2O]{\text{Setting}} \underset{\text{Orthorhombic}}{CaSO_4.2H_2O} \xrightarrow{\text{Hardening}} \underset{\text{Monoclinic}}{CaSO_4.2H_2O}$$

Q.80 (1)

$\underset{X}{CaCO_3} \longrightarrow CaO + CO_2, CaO + H_2O \longrightarrow \underset{Y}{Ca(OH)_2}$

$Ca(OH)_2 + 2CO_2 \longrightarrow \underset{Z}{Ca(HCO_3)_2}$, $Ca(HCO_3)_2 \longrightarrow CaCO_3 + H_2O + CO_2$

Q.81 (1)

$2[CaSO_4.2H_2O] \longrightarrow 2CaSO_4.H_2O$ (calcium sulphate hemihydrate) + $3H_2O$

Gypsum Plaster of Paris

Q.82 (2)

Desiccator is a covered glass vessel in which material is placed for drying along with dehydrating agent. $CaCl_2$ is deliquescent in nature and, therefore, it absorbs water. So it is used as a dehydrating agent.

$CaCl_2 + 6H_2O \longrightarrow CaCl_2.6H_2O$

Q.83 (2)

BeO is amphoteric due to its diogional similarly with Al

Q.84 (1)

$MgHCO_3\,(aq) \longrightarrow MgCO_3\downarrow + CO_2\uparrow + H_2O.$

Q.85 (1)

$MgCl_2 . 6H_2O \longrightarrow MgO + 2HCl + 5H_2O.$

Q.86 (1)

Magnesium oxide when mixed with a saturated solution of magnesium chloride sets to a hard mass like cement known as magnesia cement or **Sorrel's cement**. The composition is $MgCl_2.5MgO.xH_2O$.

JEE-ADVANCED OBJECTIVE QUESTIONS

Q.1 (C)

The alkali metal atoms have the largest size in a particular period of the periodic table and thus they contain loosely bound electrons which absorb the photons and then re-emit it and producing metallic lustre.

Q.2 (D)

Aq. radius α polarising power

Q.3 (C)

$Na + R-OH \rightarrow R-O^- Na^+ + H_2$

Rest does not contain acidic hydrogen in faet sodium in strored in kerocene oil.

Q.4 (D)

(A) Along the period, the nuclear charge increases and, therefore, atomic size decreases. So Na has larger atomic radius than Mg.

(B) Mg is smaller than Na and Mg has two valence electrons per atom while Na has only one valence electron per atom. So Mg has stronger metallic bond than that of Na (Na is a soft metal).

(C) Because of stronger metallic bond in Mg than Ca, boiling and melting points of Mg are greater than Ca.

(D) Mg does not impart characteristic colour to the flame because the electrons in Mg are too strongly bound to get excited by flame. Ca imparts brick red colour to the flame because of its low ionisation enthalpy.

Q.5 (C)

Degress of hydration α polarising power of cation

$$\alpha \frac{1}{\text{radius of cation}}$$

Q.6 (B)

Q.7 (C)

$2KNO_3 + 10K \longrightarrow 6K_2O + N_2$

Q.8 (C)

$Ca(OH)_2 + Na_2O_2 \xrightarrow{\text{compressed}} CaO_2 + 2NaOH.$

Q.9 (B)

$2NaNO_3 + 10Na \longrightarrow 6Na_2O + N_2.$

Q.10 (A)

$$Na_2SO_4 + CaCO_3 + 4C \xrightarrow[\text{furnace}]{\Delta} \underbrace{Na_2CO_3 + CaS}_{\text{black ash}} + CO$$

Q.11 (C)

$$KI + I_2 \longrightarrow \underset{\text{Brown}}{\overset{+}{K}\,\overset{-}{I_3}}$$

Q.12 (C)

From Fajan rule

M.P. α thermal stability α Lattice energy of dissociation

$$\alpha \frac{1}{r^+ + r^-}$$

Q.13 (C)

Q.14 (A,D)

$K^+O_2^-$	$Rb^+\ O_2^-$
$(K^+)_2\ O_2^{2-}$	Apply MOT on
$(Na^+)_2\ O_2^{2-}$	O_2^- & O_2^{2-}

Q.15 (D)

$Zn(OH)_2$ is amphoteric

Q.16 (A)

(A) $KHCO_3$ obtained as intermediate is water soluble. So it cannot be separated for obtaing K_2CO_3 by calcination in Solvay process.

(B) **Le-Blanc** process :

$KCl + H_2SO_4 \longrightarrow KHSO_4 + HCl$;

$KHSO_4 + KCl \longrightarrow K_2SO_4 + HCl$

$K_2SO_4 + CaCO_3 + 2C \longrightarrow K_2CO_3 + CaS + 2CO_2$

(C) Prechts process :

(a) $2KCl + 3(MgCO_3 . 3H_2O) + CO_2 \longrightarrow 2(MgCO_3 . KHCO_3 . 4H_2O) + MgCl_2$

(b) $2(MgCO_3 . KHCO_3 . 4H_2O) \xrightarrow{140°C} 2MgCO_3 \downarrow + K_2CO_3 + 9H_2O + CO_2.$

Q.17 (A)

$Al^{3+} + 4OH^-$ (from NaOH) $\longrightarrow [Al(OH)_4]^-$

So aluminium exists in the anionic part.

Q.18 (C)

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2.$

Q.19 (C)

$2KOH + 4NO \longrightarrow 2KNO_2 + N_2O + H_2O.$

Q.20 (D)

Hargreaves process.

$4NaCl\,(s) + 2SO_2\,(g) + 2H_2O\,(g) + O_2\,(g) \longrightarrow 2Na_2SO_4 + 4HCl.$

Q.21 (A)

$KNO_3 \rightarrow KNO_2 + O_2$

$Cu(NO_3)_2 \rightarrow CuO + NO_2 + O_2$

$AgNO_3 \rightarrow Ag + NO_2 + O_2$

$Pb(NO_3)_2 \rightarrow PbO + NO_2 + O_2$

Q.22 (A)

$$\overset{\oplus}{Li} \cdots \overset{\ominus}{AlH_4}$$

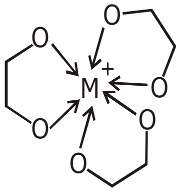
Q.23 (C)

Q.24 (A)

Q.25 (A)

Lattice energy $\alpha \dfrac{1}{r^+ + r^-}$

Q.26 (A)



Crown ether M^+ Li^+ .....Cs^+

Q.27 (D)

Q.28 (A)

$MgCl_2$, $BaCl_2$ and $CaCl_2$ appreciably dissolve in cold water because their hydration energies exceed the lattice energies. Ba^{2+} and Ca^{2+} impart apple green and brick red colour to the flame respectively.

The electrons in magnesium are too strongly bound to get excited by flame. Hence this element does not impart any colour to the flame.

Note : $PbCl_2$ does not impart any colour to the flame but it is insoluble in cold water.

Q.29 (C)

(A), (B) and (D) are correct statements.

(C) In chlorophyll (a complex) central metal is Mg and Mg also forms complex with $[EDTA]^{4-}$

Q.30 (C)

$Li^{+} \searrow Mg^{2+}$ Diagional relationship Li^+ is harder than rest alkalimetal which are soft & can be easily cut with knife.

Q.31 (D)

Be, Al amphoteric

Na, K are strongly Basic

Ca Mg Sr Ba are moderately basic

Q.32 (B)

from Fajan's rule

Basic Nature α Ionic character

Q.33 (D)

$X \rightarrow Mg \qquad Y \rightarrow Mg_3N_2 \qquad Z — NH_3$

$T \rightarrow [Cu(NH_3)_4]SO_4$

$Mg + N_2 \rightarrow Mg_3N_2$; $Mg_3N_2 + H_2O \rightarrow Mg(OH)_2 + NH_3$

$NH_3 + CuSO_4 \rightarrow [Cu(NH)_4]SO_4$

Q.34 (A)

$Ca(OCl)_2 + CaCl_2 \rightarrow Cl_2 + Ca(OH)_2$

Q.35 (D)

(A) The thermal stability of oxy-acid salts of alkaline earth metals generally increases down the group with increasing metallic character, i.e. electropositive character.

(B) The soublility of the alkaline earth metal hydroxides increases down the group from Be to Ba. This is because of the fact that down the group with increasing size of cation the lattice energy as well as hydration energy also decrease but the change in lattice energy is more as compare to that of hydration energy.

(C) Down the group atomic size increases and, therefore, attraction between the valence shell electron and nucleus decreases ; so ionisation enthalpy decreases. Hence, they react with water with increasing vigour even in cold to form hydroxides from Be to Ba.

(D) The alkaline earth metals have low ionization enthalpies due to fairly large size of the atoms. Since the atomic size increases down the group, their first ionization enthalpy decreases.

Q.36 (A)

SnO, ZnO and PbO are amphoteric oxides and, therefore, react with acids as well as bases forming salts whereas MgO is a basic oxide.

Q.37 (A)

The stability of carbonates increases with increasing metallic character i.e. electropositive character. Down the group, ionisation energies decreases and thus electropositive character increases.

Q.38 (C)

$BaSO_4$ is insoluble in HCl

but $BaCO_3$ & $BaCl_2$ dissoluble in HCl

Q.39 (D)

$Mg_2C_3 + H_2O \rightarrow Mg(OH)_2 + CH_3C^+CH_2$.

Q.40 (C)

Chlorophyll contain Mg^{+2} ion.

Q.41 (B)

As per fajan's rule

% Ionic chalater α $\dfrac{1}{\text{Polarising power of cation}}$

Q.42 (B)

$BeO + C + Cl_2 \longrightarrow (BeCl_2) + CO$

$BeCl_2 + H_2O \xrightarrow{\text{Hydrolysis}} Be(OH)_2 + HCl$

Q.43 (B)

$BeCl_2 + LiAlH_4 \longrightarrow BeH_2 + LiCl + AlCl_3$

Q.44 (B)

Thermal stability α Ianic characler
for salt having
polyatomic anion

Q.45 (C)

$Ca + H_2O \rightarrow Ca(OH)_2 + H_2O$
$CaH_2 + H_2O \rightarrow Ca(OH)_2 + H_2$
hydroith

Q.46 (A)

Lithopone is a mixture of barium sulphate and zinc sulphide which is used in printing and paints.

Q.47 (A)

$Mn(OH)_2 + 2O_2^{2-} \longrightarrow MnO_4^{2-}$ (green) $+ 2OH^-$.

Q.48 (B)

$CaC_2 + N_2 \longrightarrow CaCN_2 + C$.

Q.49 (B)

(A) Liquid sodium metal is used as coolant in nuclear reaction.
(B) Steric acid is $CH_3(CH_2)_{16}$ COOH and potassium stearate is $CH_3(CH_2)_{16}$ COOK which is used in the preparation of soft soaps.
(C) Potassium nitrate is used in gun powder as explosive.
(D) Potassium superoxide absorbs CO and CO_2 and liberates oxygen gas. Therefore it is used in breathing apparatus in submarine.

Q.50 (C)

$Be_2C + H_2O \longrightarrow Be(OH)_2 + CH_4$
$(Be^{2+})_2...C^4$

$Ca^{2+}\,(\bar{C}\equiv\bar{C}) + H_2O \longrightarrow Ca(OH)_2 + H-C\equiv C-H$
acetylene

Q.51 (D)

Like dissolves like as acetone
has high covalent character dissolves relatively covalent compound.

Q.52 (A)

It is not photoelectric radius show
β-emmison due to its radiactive nature.

JEE-ADVANCED

MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (AB)

Configurations given in options (A) and (B) are of d-block elements as last electron enters in d-subshell.

Q.2 (ACD)

(A) They readily form cations by losing valence shell electron on account of their bigger atomic sizes.
(B) They readily form cations by losing valence shell electron because of low ionization energies on account of their bigger atomic sizes. Hence they have high oxidation potentials.
(C) Metallic bonds are weaker because of bigger atomic size and one valence electron per atoms. Hence they have low melting point due to weak metallic bonds.
(D) They readily dissolve in liquid ammonia at –33ºC (boiling point of ammonia) forming blue colour solutions.

$$M + (x + y)\,NH_3 \longrightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$$

Q.3 (ABC)

(A) In alkali metals, the metallic bonds are weaker on account of large size and one valence electron per atom. So they are soft and can be cut with knife.
(B) The alkali metals are highly reactive due to their large size and low ionisation enthalpy. So alkali metals do not occur in free state in nature.
(C) The alkali metals are highly electropositive due to their large size and low ionisation enthalpy.
(D) All alkali metal hydrides are ionic solids with high melting points.

Q.4 (ABD)

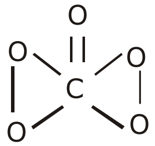
(A) The solubility of the alkali metal carbonates increases down the group from Li to Cs. This is because of the fact that down the group with increasing size of cation the lattice energy as well as hydration energy also decrease but the change in lattice energy is more as compare to that of hydration energy. Lithium hydrogencarbonate is not obtained in the solid form while all other elements form solid hydrogencarbonates.
(B) K_2CO_3 can not be prepared by Solvey process because intermediate formed, $KHCO_3$ is appreciably soluble in water.
(C) Li_2CO_3 and $MgCO_3$ both are not thermally stable.
(D) $Na_2CO_3.NaHCO_3.2H_2O$ is a mineral called trona.

Q.5 (AC)

$$KO_2 \xrightarrow{\Delta} K_2O + \frac{1}{2}O_2$$

$$KO_2 + H_2O \xrightarrow{0°C} KOH + O_2$$

Q.6 (ABC)



$Na^+......\overline{O} - \overline{O}.....Na^+$

Ba^{2+} .... $(O^- — O^-)$

Q.7 (AD)

Sodium when dissolved in liquid ammonia produces solvated electron which imparts blue colour to the sol. refer (ques. 15)

Q.8 (ABC)

(A) The increasing stability of the peroxide or superoxide, as the size of the metal ion increases, is due to the stabilisation of large anions by larger cation through lattice energy effects.

(B) Bigger cation stabilises bigger anion and similarly smaller cation stabilises smaller anion through lattice energy effects.

(C) The low solubility of LiF is due to its high lattice energy whereas low solubility of CsI is due to smaller hydration energy .

(D) NaOH is deliquescent in nature. So, NaOH absorbs moisture.

Q.9 (BCD)

(A) Sodium bicarbonate is sparingly soluble while sodium carbonate is fairly soluble in water.

(B) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2$ (soluble) $+ H_2O$. (Bayer's process).

(C) $NaHCO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$ – reduces acidity.

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$ – CO_2 liberated produces porosity and thus makes bread soft.

(D) One of the uses of potassium hydroxide is in making the soft soaps

Q.10 (CD)

(C) NaOH & NaH_2PO_4 produces Na_2HPO_4 and Na_3PO_4

(D) $NaHCO_3$ & NaOH produces Na_2CO_3

Q.11 (AC)

Q.12 (AB)

Q.13 (AB)

Zn^{+2} & Cr^{+3} soluble in excess NaOH

Q.14 (AC)

As size ↑ stability of hydride ↓

Q.15 (AC)

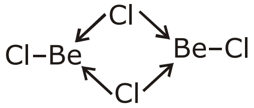
(A) $4LiNO_3 \longrightarrow 2Li_2O + 5O_2 + 2N_2$.

(B) $NaNO_3 \longrightarrow NaNO_2 + \frac{1}{2}O_2$.

(C) $Mg(NO_3)_2 \longrightarrow MgO + 2NO_2 + \frac{1}{2}O_2$.

Q.16 (ABC)

4 valence shell electron (electron defficient)



Q.17 (AC)

$P_2O_5 + H_2O \rightarrow H_3PO_4$

$CaCl_2 + H_2O \rightarrow CaCl_2.2H_2O$

P_2O_5 & $CaCl_2$ are dehydrating agent.

Q.18 (CD)

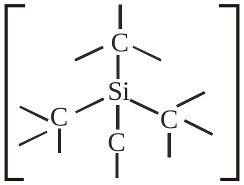
For solubility

Hydration energy should be greater then lattice energy.

Q.19 (CD)

Oxide of Ca is basci in nature

Q.20 (ABD)



Q.21 (ABC)

The hydration enthalpies of alkaline earth metal ions decrease with increase in ionic size down the group.

$Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$

The hydration enthalpies of alkaline earth metal ions are larger than those of alkali metal ions, because of their much larger charge to radius ratio, exert a much stronger electrostatic attraction on the oxygen of water molecule surrounding them. Thus, compounds of alkaline earth metals are more extensively hydrated than those of alkali metals, e.g., $MgCl_2$ and $CaCl_2$ exist as $MgCl_2.6H_2O$ and $CaCl_2.6H_2O$ while NaCl and KCl do not form such hydrates. So all statements are correct.

Q.22 (ABC)

(A), (B) and (C) are correct statements.

Q.23 (ABCD)

(A) $Na_2CO_3 + Ca(OH)_2 \longrightarrow CaCO_3 \downarrow$ (white) + 2NaOH.

(B) $3Ca(OH)_2 + 2Cl_2 \longrightarrow Ca(OCl)_2.Ca(OH)_2.CaCl_2.2H_2O$.

(C) $2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + 2H_2O$.

(D) $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 \downarrow$ (milkiness).

Q.24 (ABCD)

(A) Because of diagonal relationship both have same electronegativity (Be = 1.5 & Al = 1.5).

(B) Beryllium hydroxide dissolves in excess of alkali to give a beryllate ion, $[Be(OH)_4]^{2-}$ just as aluminium hydroxide gives aluminate ion, $[Al(OH)_4]^-$ and salt with acids.

(C) The ionic radius of Be^{2+} is estimated to be 45 pm; the charge/radius ratio is nearly the same as that of the Al^{3+} ion (the charge per unit area is nearly similar, Be^{2+} = 2.36 and Al^{3+} = 2.50).

(D) The chlorides of both beryllium and aluminium have Cl^- bridged chloride structure in vapour phase.

Q.25 (ABCD)

Beryllium the first member of the Group 2 metals, shows anomalous behavior as compared to magnesium and rest of the members. Further, it shows diagonal relationship to aluminium. All statements are correct because they show diagonal relationship.

Q.26 (A)

$2\,Na + O_2$ (zero) $\longrightarrow Na_2O_2$ (– 1 per atom).

Q.27 (A)

$KO_2 + 2\,H_2O$ (from moisture of the breath) $\longrightarrow 4\,KOH + 3\,O_2$;

$KOH + CO_2 \longrightarrow KHCO_3$; $2KO_2 + CO_2 \longrightarrow K_2CO_3 + 3/2O_2$.

Q.28 (B)

Smaller cation stabilises smaller anion and bigger cation stabilises bigger anion through lattice energy effect.

Q.29 (B)

$2\,Na_2O \xrightarrow{\Delta} Na_2O_2 + 2\,Na$.

Q.30 (C)

(A) O_2^- and O_3^- having unpaired electron are attracted by weak magnetic field ; so paramagnetic in nature.

(B) $2KO_2 + 2H_2O \longrightarrow 2KOH + H_2O_2 + O_2$.

(C) $K_2O_2 + CO \longrightarrow K_2CO_3$; but does not liberate dioxygen.

(D) 4K (dissolved in liquid NH_3) $\xrightarrow{3O_2} 2K_2O_3$.

Q.31 (B)

Very dilute solutions of the metals are paramagnetic, with approximately one unpaired electron per metal atom (corresponding to one solvated electron per metal atom) ; this paramagnetism decreases at higher concentration. As the concentration of metal increases, metal ion clusters are formed and above 3M concentration the solutions are diamagnetic.

Q.32 (D)

(A) The dilute solutions conduct electricity better than any salt in any liquid and the conductivity is similar to that of the pure metals. Conduction is due mainly to the presence of solvated electrons.

(B) The dilute solutions are paramagnetic but this paramagnetism decreases at higher concentration. As the concentration of metal increases, metal ion clusters are formed and above 3M concentration the solutions are diamagnetic.

(C) Ammoniated electrons are responsible for the blue colour of the solution.

Q.33 (B)

The dilute solutions have strong reducing properties on account of the presence of solvated unpaired electrons.

Q.34 (B)

$$CaOCl_2 + H_2O \longrightarrow Ca(OH)_2 + Cl_2$$

$$CH_3COCH_3 + 3Cl_2 \longrightarrow CCl_3 - CO - CH_3$$

$$2CCl_3COCH_3 + Ca(OH)_2 \longrightarrow (CH_3COO)_2Ca + 2CHCl_3$$

Q.35 (D)

$$\underset{145}{CaOCl_2.H_2O} \longrightarrow \underset{71}{Cl_2}$$

$$\% \quad \frac{71 \times 100}{145} = 49$$

Q.36 (B)

$$6CaOCl_2 \longrightarrow Ca(ClO_3)_2 + 5CaCl_2$$

Q.37 (A) – r, s (B) – r (C) – p,q,r,s (D) – q

(A) Solvay process is used for the manufacture of $NaHCO_3$ and Na_2CO_3 ; the raw material is NaCl.

(B) $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2\uparrow + H_2O\uparrow$.

(C) $Na_2O + H_2O \longrightarrow 2NaOH$; NaOH being basic turns red litmus blue.

$Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O_2$; NaOH being basic turns red litmus blue but H_2O_2 being oxidising agent bleaches coloured litmus.

$NaHCO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$; solution is alkaline and turns red litmus blue.

$Na_2CO_3 + 2H_2O \rightleftharpoons 2NaOH + H_2CO_3$; solution is alkaline and turns red litmus blue.

(D) $Na_2O_2 + CO \longrightarrow Na_2CO_3$; $2Na_2O_2 + 2CO \longrightarrow 2Na_2CO_3 + O_2$. Hence, it absorbs CO and CO_2 and liberates oxygen.

Q.38 (A) – r (B) – s (C) – q (D) – p

(A) $\underset{\text{(slaked lime)}}{3Ca(OH)_2} + 2Cl_2 \xrightarrow[35^oC]{\text{below}} \underset{\text{bleaching powder}}{Ca(OCl)_2.\,CaCl_2.\,Ca(OH)_2.\,H_2O} + H_2O$

(B) $\underset{\text{(milk of lime)}}{2Ca(OH)_2} + 2Cl_2 \xrightarrow{\text{cold (below 25}^oC)} CaCl_2 + \underset{\text{calcium hypochlorite}}{Ca(OCl)_2} + 2H_2O.$

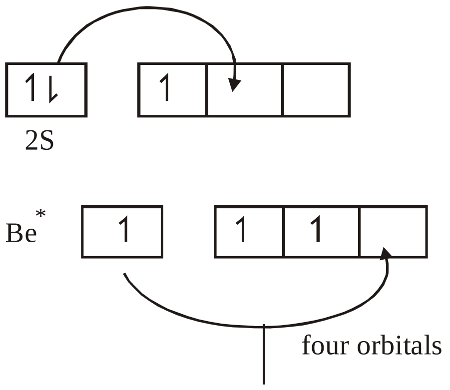
(C) $\underset{\text{(slaked lime)}}{6Ca(OH)_2} + 2Cl_2 \xrightarrow{\text{heat (above 35}^oC)} 5CaCl_2 + \underset{\text{calcium chlorate}}{Ca(OCl_3)_2} + 6H_2O$

(D) $2Ca(OH)_2 + 2Cl_2 \xrightarrow{\text{red heat}} \underset{\text{calcium chloride}}{2CaCl_2} + 2H_2O + O_2\uparrow$

NUMERICAL VALUE BASED

Q.1 [4]

Be = [He] $2S^2\,2P^0$



Q.2 [2]

$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3$

depends upon ionic character.

Q.3 [2]

Li_2O

Na_2O_2

$\left.\begin{matrix}Rb\\Cs\end{matrix}\right\}MO_2$

Q.4 [6]

$MgCl_2.6H_2O$ & $CaCl_2.6H_2O$ can exist.

Q.5 [6]

Mg has a high charge density and also has empty d orbitals. This allows it to accommodate 6 water molecules in its hydration sphere.

Q.6 [9]

$$\underset{(s)}{CaSO_4}\,.\,2H_2O \xrightarrow{\Delta} \underset{(s)}{CaSO_4\,.\frac{1}{2}\,H_2O} + \frac{3}{2}\,\underset{(g)}{H_2O}$$

Q.7 [4]

Q.8 [2]

Gypsum: $CaSO_4\,.\,2H_2O$

KVPY
PREVIOUS YEAR'S

Q.1 (C)

$Pb_3O_4 + 4HNO_3(\text{die}) \longrightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

Q.2 (A)

Mg do not give flame test

Q.3 (D)

Fullerene contain both single & double bond with 2 type of bond length C – C BL = 143.5 pm ; C=C BL = 138.3 pm.

Q.4 (C)

Alkalimetal give deep blue solution on dissolving in liquid ammonia.

$$M + (x+y)NH_3 \longrightarrow \underset{\text{ammoniated metal cation}}{[M(NH_3)_x]^{\oplus}} + \underset{\text{ammoniated electron}}{[e(NH_3)_y]^{\Theta}}$$

JEE-MAIN
PREVIOUS YEAR'S

Q.1 (2) (rb,Cs)

Q.2 (1)

Theory based

Q.3 (2)

$Be(OH)_2$, BeO

Q.4 (3)

Lattice energy $\propto |Z^+||Z^-|$

$$\propto \frac{1}{r^+ + r^-}$$

	LiF	LiCl
Size	$F^- < Cl^-$	[charge are same]
Lattice energy	LiF > LiCl	

NaCl $\longrightarrow$ $Na^{\oplus} + Cl^-$ $|Z^+||Z^-| = 1 \times |1| = 1$

MgO $\longrightarrow$ $Mg^{+2} + O^{-2}$ $|2||-2| = 4$

Lattice energy MgO > NaCl

Charge dominate over size

Q.5 (2)

(a) Be → it is used in the Windows of X-ray tubes

(b) Mg → it is used in the Incendiary bombs and signals

(c) Ca → it is used in the Extraction of metals

(d) Ra → it is used in the Treatment of cancer

Q.6 (3)

$Ca(OCl)_2$ is Bleach.

$CaSO_4 \cdot \frac{1}{2} H_2O$ is plaster of paris.

$CaCO_3$ is used as an antacid.

CaO is major component of cement.

Q.7 (4)

Li–Mg, B–Si, Be–Al show diagonal relationship but Li and Na do not show diagonal relationship as both belongs to same group and not placed diagonally.

Q.8 (3)

Q.9 (2)

Li^+ Na^+ K^+ Rb^+ Cs^+

$\longrightarrow$ Hydration energy ↑

$\longrightarrow$ Ionic mobility ↓

$\longrightarrow$ Conductivity ↓

$\therefore$ Correct option is $Na^+ > K^+ > Rb^+ > Cs^+$.

OR

As the size of gaseous ion decreases, it get more hydrated in water and hence, the size of aqueous ion increases. When this bulky ion move in solution, it experience greater resistance and hence lower conductivity.

Size of gasesous ion : $Cs^+ > Rb^+ > K^+ > Na^+$

Size of aqueous ion : $Cs^+ < Rb^+ < K^+ < Na^+$

Conductivity : $Cs^+ > Rb^+ > K^+ > Na^+$

Q.10 (2)

(a) $CaCl_2.6H_2O \longrightarrow CaCl_2 + 6H_2O$

(b) $MgCl_2.8H_2O \longrightarrow MgO + 2HCl + 6H_2O$

The dehydration of hydrated chloride of calcium can be achieved. The corresponding hydrated chloride of magnesium on heating suffer hydrolysis.

(c) BeO → Amphoteric

MgO

CaO

SrO

BaO

Q.11 (4)

Q.12 (1)

Q.13 (2)

Q.14 (1)

Q.15 (4)

Q.16 (2)

Q.17 (2)

Q.18 (2)

Q.19 (1)

p-Block Elements (Boron and Carbon Family)

EXERCISES

ELEMENTARY

Q.1 (1)

Q.2 (3)

Q.3 (4)

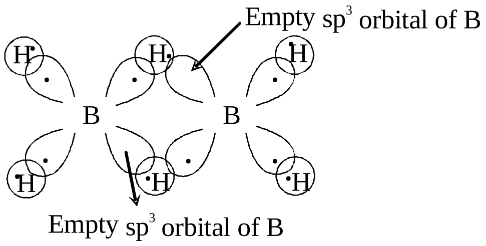
Q.4 (3)

Q.5 (1)
B_2O_3 oxides of non metals are acidic & of metals are basic boron is non metal.

Q.6 (3)
$2H_3BO_3 \rightarrow B_2O_3 + 3H_2O$

Q.7 (4)
Boron form different hydride of general formula B_nH_{n+4} and B_nH_{n+6} but BH_3 is unknown.

Q.8 (1)
B_2H_6



Q.9 (4)

Q.10 (1)
Liquified Ga expand on solidification Ga is less electropositive in nature, It has the weak metallic bond so it expand on solidification.

Q.11 (4)
Aluminium is used as reducing agent in metallurgy.

Q.12 (1)
Al is used as reducing agent in thermite process.

Q.13 (3)

Q.14 (3)
Alumina is amphoteric oxide, which reacts acid as well as base.

Q.15 (1)

Q.16 (1)

Q.17 (3)
Boron (2), Si, Ge, As, Sb, and At are the metalloid elements. Bismuth (Bi) and tin (Sn) are metals while carbon (3) is non-metal.

Q.18 (3)

Q.19 (2)
CaC_2 have one sigma and two π bond.

Q.20 (1)

Q.21 (3)
Solid CO_2 is knows as dry ice because it evaporates at –78°C without changing in the liquid state.

Q.22 (1)
Carbon suboxide has linear structure with C – C bond length equal to 130 Å and C – O bond length equal to 120 Å.
$O = C = C = C = O \leftrightarrow O^- - C \equiv C - C \equiv O^+$

Q.23 (1)
Among all the central atoms of all the ions only C does not has vaccont d orbital of suitable energy so it can't have six coordination.

Q.24 (1)

Q.25 (2)
Glass being a mixture of sodium and calcium silicates reacts with hydrofluoric acid forming sodium and calcium fluorosilicates respectively.
$Na_2SiO_3 + 3H_2F_2 \rightarrow Na_2SiF_6 + 3H_2O$
$CaSiO_3 + 3H_2F_2 \rightarrow CaSiF_6 + 3H_2O$
The etching of glass is based on these reactions.

Q.26 (2)
When hydrogen peroxide react with PbS then they form $PbSO_4$

Q.27 (1)

Q.28 (1)

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (2)

Down the group the inert pair effect is more pronounced on account of enhanced increase in effective nuclear charge.

Q.2 (4)

Q.3 (1)

Q.4 (4)

$CuO + B_2O_3 \longrightarrow Cu(BO_2)_2$ (blue bead) -
Copper (II) metaborate

Q.5 (2)

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$$

Q.6 (3)

$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$$

Q.7 (4)

$$Al_2S_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2S$$

Q.8 (1)

There is least van der Waal's force of attraction in BF_3 on account of less number of polarisable electrons among the boron halides. So BF_3 is gas at 0°C.

Q.9 (3)

Sol. $B(OH)_3 + 2HOH \rightleftharpoons [B(OH)_4]^- + H_3O^+$.

In aqueous solution the boron completes its octet by accepting OH^- from water molecules. It therefore function as a weak monobasic lewis acid.

Q.10 (3)

$BF_3 + 3H_2O \longrightarrow B(OH)_3 + 3HF$ (Partial hydrolysis)

$BF_3 + HF \longrightarrow HBF_4$.

Q.11 (4)

As it becomes passive by the action of conc. HNO_3 forming a protective oxide layer on the surface.

Q.12 (4)

$$2Al + 2NaOH + 6H_2O \longrightarrow 2NaAl(OH)_4 + 3H_2.$$

Q.13 (2)

It is acidic because of the hydrolysis of $Al_2(SO_4)_3$ according to the following reaction.

$$Al_2(SO_4)_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2SO_4.$$

Q.14 (3)

According to Fajan's rule it is a covalent compound and thus easily hydrolysed. It is also a electron deficient compound containing only six electrons around Al atom and therefore is a Lewis acid.

Q.15 (2)

They have valence shell electron configuration $ns^2\ np^2$; so two electrons of p sub shell or four electrons of s and p sub shells can participate in chemical bonding.

Q.16 (3)

As differ in their crystal structures and physical properties.

Q.17 (2)

Because graphite has π-electrons which are delocalised over the whole sheet. The electrons are mobile and thus it conducts electricity along the sheet.

Q.18 (1)

It is chemically inert towards concentrated acids as well as bases.

Q.19 (4)

Methanides give CH_4 on reaction with H_2O.

$$Al_4C_3 + 12H_2O \longrightarrow 4Al(OH)_3 + 3CH_4$$
$$Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$$

Q.20 (3)

$$2NaHCO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2CO_2\uparrow + 2H_2O$$

Q.21 (1)

CO_2 can not act as reducing agent because carbon is in its highest oxidation state, i.e., +4.

Q.22 (1)

Q.23 (2)

$$CO + Cl_2 \xrightarrow{h\nu} COCl_2$$

Q.24 (1)

$CO_2\ (g) + H_2O\ (l) \longrightarrow H_2CO_3\ (aq)$; $H_2CO_3 \rightleftharpoons H^+(aq) + HCO_3^-(aq)$; $HCO_3^- \rightleftharpoons H^+(aq) + CO_3^{2-}(aq)$.

Q.25 (2)

Coal gas contains H_2, saturated and unsaturated hydrocarbons, CO, CO_2, N_2 and O_2.

Q.26 (1)

All compound are ionic carbides.

Al_4C_3 exists as Al^{3+} and C^{4-} ; CaC_2 exist as Ca^{2+} and C_2^{2-} ; similarly Mg_2C_3 exist as Mg^{2+} and C_3^{4-}.

Q.27 (1)

(1) Interstitial carbides are formed by transition elements and lanthanides.

(2) SiC is a covalent carbide known by the name carborundum.

(3) CO is toxic, because it forms a complex with haemoglobin in the blood and this complex is more stable than oxy-haemoglobin. This prevents the haemoglobin in the red blood corpuscles from carrying oxygen round the body. This causes oxygen deficiency, leading to unconsciousness and then death.

$$Hb—O_2 + CO \longrightarrow Hb—CO + O_2$$

(4) $2Ca_3(PO_4)_2 + 6SiO_2 + 10C \longrightarrow P_4 + 6CaSiO_3 + 10CO$.

Q.28 (3)

$Sn(OH)_2 + 4OH^- + H_2O \longrightarrow [Sn(OH)_6]^{4-}$ (soluble complex)

Q.29 (3)

Pb^{4+} has higher polarising power and Br^- and I^- being larger in size can easily give the electrons to Pb^{4+} i.e. as compared to Cl^-, Br^- and I^- are good reducing agents.

Q.30 (4)

Pb^{+4} acts as an oxidising agent due to inert pair effect. In larger I^-, valence shell electrons are loosely held by nucleus so acts as reducing agent. As a result Pb^{+4} oxidises I^- to I_2 and itself reduced to Pb or Pb^{2+}.

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OBJECTIVE QUESTIONS

Q.1 (C)

On account of higher charge density i.e. charge/size ratio it gets hydrolysed forming H_3BO_3.

$$2B^{3+} + 6H_2O \longrightarrow 2H_3BO_3 + 6H^+$$

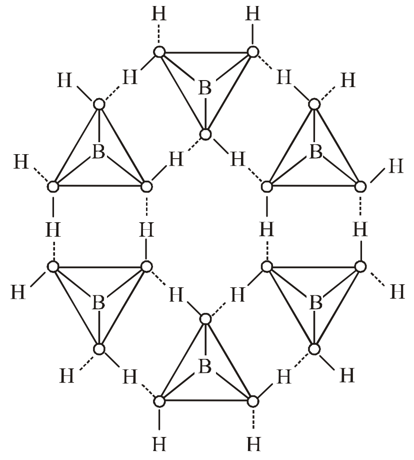
$$2B^{3+} + 6H_2O \longrightarrow 2H_3BO_3 + 6H^+$$

Q.2 (C)

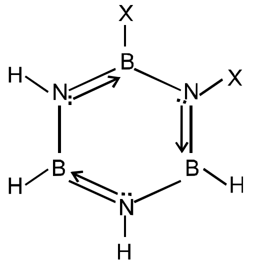
CH_3 group being larger can not form a bridge between two small sized boron atoms.

Q.3 (B)

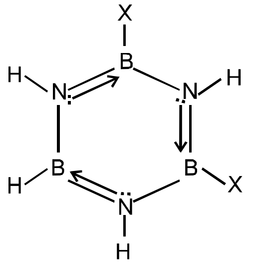
In the solid state, the $B(OH)_3$ units are hydrogen bonded together in to two dimensional sheet with almost hexagonal symmetry.



Q.4 (B)



1, 2–



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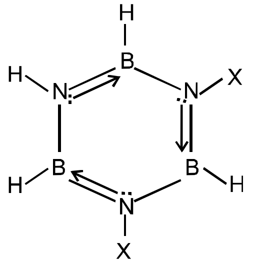
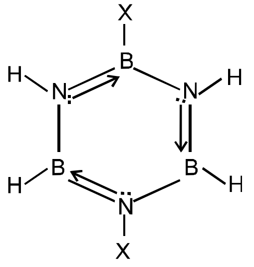


1, 3–



1, 4–

Q.5 (B)

$$B_2O_3 + 3Mg \text{ or } Na \xrightarrow[\Delta]{\text{High temperature}} 2B + 3MgO / Na_2O$$

Q.6 (C)

$$[B_4O_5(OH)_4]^{2-} + 5H_2O \rightleftharpoons 2B(OH)_3 + 2[B(OH)_4]^-$$

or

$$[B_4O_7]^{2-} + 7H_2O \longrightarrow 2B(OH)_3 + 2[B(OH)_4]^-$$

Q.7 (D)

$$Na_2B_4O_7 . 10H_2O \xrightarrow[-10H_2O]{740^\circ C} 2NaBO_2 + B_2O_3$$

(glassy bead)

Q.8 (C)

$Na_2B_4O_7 + 7H_2O \xrightarrow{\text{Hydrolysis}} 4H_3BO_3 + 2NaOH$;

Hence basic due to formation of NaOH which is a stronger base.

Q.9 (A)

$CoO + B_2O_3 \longrightarrow Co(BO_2)_2$ (blue bead)

Q.10 (C)

$Ca_2B_6O_{11} + Na_2CO_3 \longrightarrow 2CaCO_3\downarrow + Na_2B_4O_7 + 2NaBO_2$

Q.11 (C)

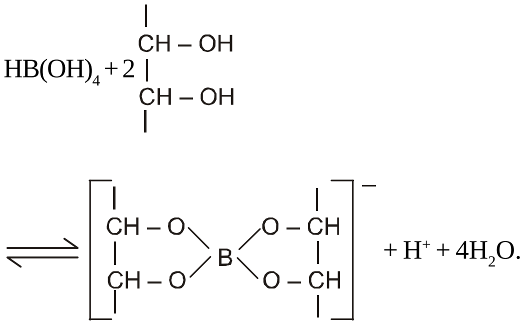
Q.12 (B)

$B_2H_6 + NH_3 \xrightarrow[\text{low temperature}]{\text{Excess } NH_3} B_2H_6 . 2NH_3$ or

$[H_2B(NH_3)_2]^+ [BH_4]^-$ (ionic compound).

Q.13 (ABC)

cis-diols form very stable complex with $[B(OH)_4]^-$, Thus removing it from solution



Q.14 (A)

Peroxoborate in solution provides H_2O_2 according to following chemical reaction

$[B(OH)_3(O_2H)]^- + H_2O \rightleftharpoons [B(OH)_4]^- + H_2O_2$

Q.15 (D)

$[B_4O_5(OH)_4]^{2-} + 5H_2O \rightleftharpoons 2B(OH)_3$ (weak acid) + $2[B(OH_4)]^-$ (salt)

Q.16 (A)

$[B_4O_5(OH)_4]^{2-} + 5H_2O \rightleftharpoons 2B(OH)_3$ (weak acid) + $2[B(OH_4)]^-$ (salt)

Q.17 (D)

$B_2H_6 + 2NH_3 \longrightarrow [H_2B(NH_3)_2]^+ + [BH_4]^-$

$B_2H_6 + 2N(CH_3)_3 \longrightarrow [2H_3B \longleftarrow N(CH_3)_3]$

Q.18 (B)

B_4C is chemically inert.

Q.19 (B)

$2Al + 3H_2O \longrightarrow Al_2O_3 + 3H_2O$ (slow reaction)

Al_2O_3 forms protecting oxide layer on Al surface

Q.20 (B)

$CO_2 + H_2O \longrightarrow H_2CO_3 \rightleftharpoons CO_3^{2-} + 2H^+$

$3CO_3^{2-} + 3H_2O + 2Al^{3+} \longrightarrow 2Al(OH)_3\downarrow$ (as weakly acidic) + $3CO_2$.

Q.21 (C)

$Na_2CO_3 + H_2O \longrightarrow 2NaOH + CO_2$; $4OH^- + Al \longrightarrow [Al(OH)_4]^-$ (soluble complex)

Q.22 (D)

Formula of alums contain the ions $[M(H_2O)_6]^+$, $[M'(H_2O)_6]^{3+}$ and SO_4^{2-} in the ratio 1 : 1 : 2.

Example : (i) Potash alum $K_2SO_4 . Al_2(SO_4)_3 . 24H_2O$; (ii) Chrome alum $K_2SO_4 . Cr_2(SO_4)_3 . 24H_2O$

Q.23 (B)

As $Al(OH)_3$ is amphoteric in nature and thus form $[Al(H_2O)_2(OH)_4]^-$.

Q.24 (A)

$AlCl_3.6H_2O \xrightarrow[\text{hydrolysis}]{\Delta} Al_2O_3 + 6HCl + 3H_2O$.

Q.25 (C)

$Al(OH)_3$ (amphoteric hydroxide) + $OH^- \longrightarrow [Al(OH)_4]^-$ (soluble complex)

Q.26 (A)

$CO_2 + H_2O \rightleftharpoons CO_3^{2-} + 2H^+$

$2Al^{3+} + 3CO_3^{2-} + 3H_2O \longrightarrow 2Al(OH)_3 + 3CO_2$

Q.27 (B)

$\Delta_f H^{(-)} = 0$

Q.28 (A)

Mixture of CO and N_2 obtained by passing air over red hot coke is called producer gas.

Q.29 (A)

$\mathrm{Ni + 4CO \xrightarrow{28°C} [Ni(CO)_4]}$ volatile compound.

Q.30 (D)

$\mathrm{CuCl + NH_3 + CO \longrightarrow [Cu(CO)NH_3]^+ Cl^-}$ (soluble complex).

Q.31 (B)

Q.32 (D)

(A) $\mathrm{Al_4C_3 + 12\,H_2O \longrightarrow 4Al(OH)_3 + 3CH_4}$

(B) $\mathrm{CaC_2 + 2\,H_2O \longrightarrow Ca(OH)_2 + C_2H_2}$

(C) Does not give any gas.

(D) $\mathrm{Mg_2C_3 + 4H_2O \longrightarrow 2Mg(OH)_2 + CH_3{-}C{\equiv}CH}$.

Q.33 (D)

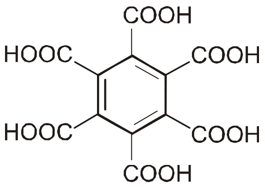
Allylides gives 1-propyne on hydrolysis with water, e.g.,

$\mathrm{Mg_2C_3 + 4H_2O \longrightarrow 2Mg\,(OH)_2 + CH_3{-}C \equiv CH}$

Such compounds contain C_3^{4-} $[:\overset{\cdot\cdot}{\underset{\cdot\cdot}{C}}-C\equiv C:]^{4-}$ ions.

Q.34 (B)

Graphite changes to Mellitic acid also called benzene hexa-carboxylic acid with hot concentrated HNO_3.



(Mellitic acid)

Q.35 (B)

CO burns with blue flame and also acts as reducing agent ; used in the extraction of various metal from their oxide ores.

Q.36 (B)

$\mathrm{K_4\,[Fe(CN)_6] + 6H_2SO_4\ (conc) + 6H_2O \xrightarrow{\Delta} 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO}$

Q.37 (D)

Both have same number of electrons i.e. 22, so isoelectronic and are linear so also isostructural.

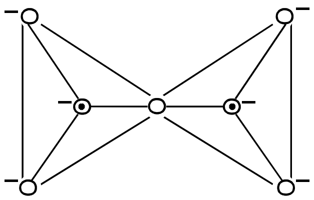
Q.38 (A)

$\mathrm{SiO_2 + 6HF \longrightarrow H_2SiF_6 + 2H_2O}$.

Q.39 (D)

$\mathrm{Si + NaOH\ (hot) \longrightarrow Na_4[SiO_4]}$ (silicate)

Q.40 (C)

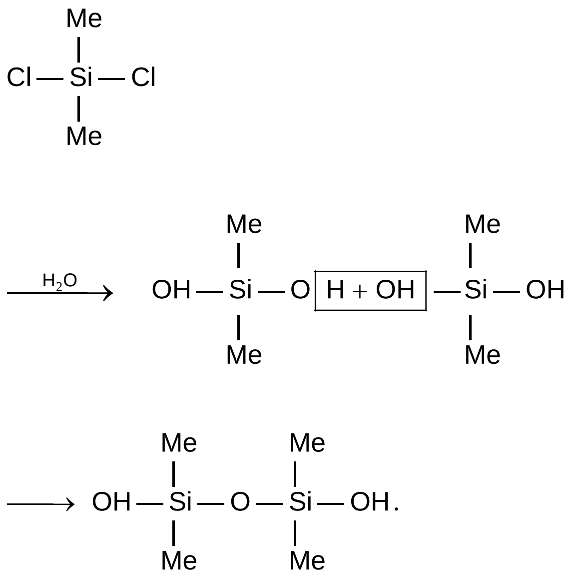


, $Si_2O_7^{6-}$

Q.41 (A)

CCl_4 is not readily hydrolysed due to non-availability of d-orbital in carbon.

Q.42 (A)



$$\mathrm{Cl-\overset{Me}{\underset{Me}{Si}}-Cl}$$

$$\xrightarrow{H_2O} \mathrm{OH-\overset{Me}{\underset{Me}{Si}}-O}\boxed{\mathrm{H+OH}}\mathrm{-\overset{Me}{\underset{Me}{Si}}-OH}$$

$$\longrightarrow \mathrm{OH-\overset{Me}{\underset{Me}{Si}}-O-\overset{Me}{\underset{Me}{Si}}-OH.}$$

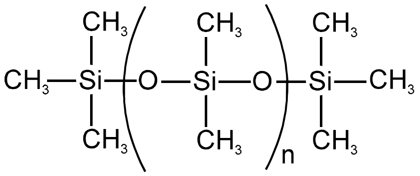
In this manner several molecules may combine to form a long chain polymer i.e. linear polymer.

Q.43 (A)

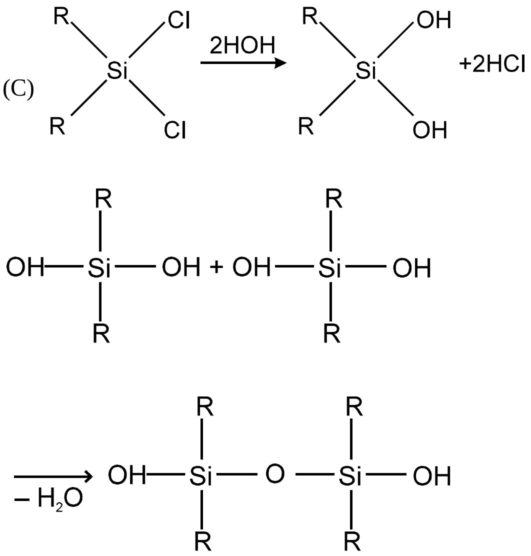
(A) When a mixture of $PhSiCl_3$ and $(Ph)_2SiCl_2$ is dissolved in toluene and then hydrolysed with water silicon resins are obtained.

(B) Silicones from the hydrolysis of a mixture of $(CH_3)_3$ SiCl & $(CH_3)_2$ $SiCl_2$

The dichloro derivative will form a long chain polymer as usual. But the growth of this polymer can be blocked at any stage by the hydrolysis product of mono-chloro derivative.



(C)



In this manner several molecules may combine to form a long chain polymer whose both the ends will be occupied by –OH groups. Such compounds are generally represented from the following formula.

Q.44 (C)

(A) Zeolite is a three dimensional sheet silicate.

(B) Asbestos is double change silicate.

(C) Emerald is a cyclic silicate having $Si_6O_{18}^{12-}$ units containing 1 – 2% Cr giving green colour.

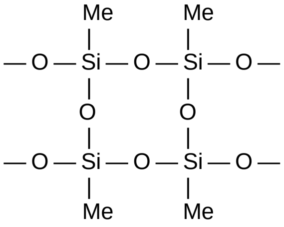
(D) Talc is two dimensional sheet silicate.

Q.45 (B)

Si atoms in silicones are surrounded by non-polar alkyl or aryl groups, which repel water molecules.

Q.46 (B)

When a compound like CH_3SiCl_3 undergoes hydrolysis, a complex cross-linked polymer is obtained as chain can grow in three places as



Q.47 (A)

Q.48 (A)

Carbon does not expand its covalence beyond four as it does not contain d-orbitals.

Q.49 (D)

$$Pb_3O_4 \xrightarrow{> 550^\circ C} 6PbO + O_2\uparrow$$

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MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (ACD)

$$BCl_3 + 3H_2O \xrightarrow{\text{Hydrolysis}} H_3BO_3 + 3HCl;$$

$$SiCl_4 + 3H_2O \xrightarrow{\text{Hydrolysis}} H_2SiO_3 + 4HCl$$

Q.2 (BCD)

Boron does not increase its covalence beyond four as it does not have d-orbital.

Q.3 (BCD)

Borax bead test generally given by coloured salt of transition metals.

Q.4 (ABCD)

(A) It is a acidic oxide and is anhydride of boric acid and it reacts with alkalies or bases to form borates.

$3Na_2O + B_2O_3 \rightarrow 2Na_3BO_3$ (sodium orthoborate)

It is a weak monobasic acid soluble in water and in aqueous solution the boron atom completes its octet by accepting OH^- from water molecules:

$B(OH)_3(aq) + 2H_2O(\ell) \rightleftharpoons [B(OH)_4]^-(aq) + H_3O^+(aq)$. $pK = 9.25$.

(B) BX_3 (except BF_3) get hydrolysed due to presence of vacant p-orbital and SiX_4 get hydrolysed due to presence of vacant d-orbital.

(C) Controlled pyrolysis of diborane leads to most of the higher boranes. It catches fire spontaneously in air and explodes with O_2. Reaction with oxygen is extremely exothermic.

$$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O \quad \Delta H = -2160 \text{ kJ mol}^{-1}$$

$$Si_2H_6 + (4 + n)\, H_2O \xrightarrow{\text{trace of alkali}} 2SiO_2 + nH_2O + 7H_2$$

(D) Aluminium hydride is a polymer due to formation of electron defecient bond (Al —— H – – – Al).

Q.5 (ACD)

(B) Borax is used as flux in soldering not H_3BO_3.

Q.6 (BCD)

(A) BF_3 is gas at room temperature.

Q.7 (ABC)

(D) Only hydrated salts of aluminium are generally ionic but anhydrous salts are covalent in nature e.g. anhydrous $AlCl_3$ is covalent whereas hydrated $AlCl_3$ is ionic.

Q.8 (AC)

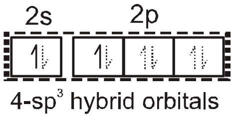
Compounds containing C_2^{2-} gives ethyne on reaction with H_2O.

$$\overset{2+}{Sr}\,C_2^{2-} + 2H_2O \longrightarrow Sr(OH)_2 + CH \equiv CH$$

Similary $Al_2(C_2)_3$ gives ethyne.

Q.9 (ABCD)

(A) $[BeF_4]^{2-}$



Four electron pairs

- two form covalent and two form coordinate bonds. Two F^- ions each donate an electron pair in to an empty sp^3 hybrid orbital forming two coordinate bonds.

(B) $[B_4O_5(OH)_4]^{2-} + 5H_2O \rightleftharpoons 2B(OH)_3 + 2\,[B(OH)_4]$

$^-\,2[B(OH)_4] + 2H_3O^+ \longrightarrow 2B(OH)_3 + 4H_2O$

Only $[B(OH)_4]^-$ formed in water reacts with HCl.

(C) $HCOONa + H_2SO_4 \longrightarrow CO\uparrow + Na^+ + HSO_4^- + H_2O$.

$K_3[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \longrightarrow 6CO + Fe^{3+} + 3\,K^+ + 6NH_4^+ + 6SO_4^{2-}$

Solid potassium ferrocyanide also liberates CO (g) on heating with concentrated H_2SO_4.

(D) $2I_2O_5 + 5CO \longrightarrow 5CO_2 + 2I_2$

Q.10 (ABD)

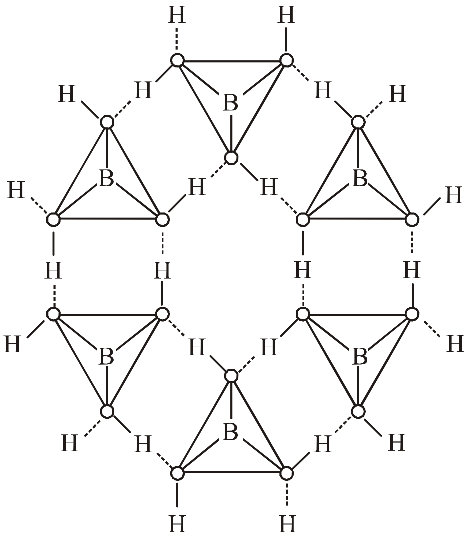
Exists as dimer, Al_2Cl_6 and being covalent easily hydrolysed. $AlCl_3$ is electron deficient, thus acts as Lewis acid.

Q.11 (C)

Orthoboric acid acts as lewis-acid in water not as proton donor (as it does not liberater H^+ ion) because it completes its octet by accepting the OH^- from water.

$B(OH)_3 + H_2O \longrightarrow [B(OH)_4]^- + H^+$.

In the solid state, the $B(OH)_3$ units are hydrogen bonded together in to two dimensional sheets with almost hexagonal symmetry. The layered are quite a large distance apart (3.18 Å) and thus the crystal breaks quite easily into very fine particles.

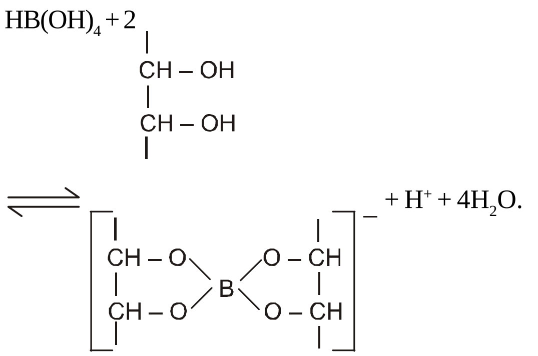


Q.12 (A)

If certain organic polyhydroxy compounds such as glycerol, manitol or sugars are added to the titration mixture, then $B(OH)_3$ behaves as a strong monobasic acid and it can be now titrated with NaOH and the end point is detected using phenolphthalein as indicator (pH = 8.3 - 10.0).

The added compound must be a cis-diol, to enhance the acid properties. The cis-diol forms very stable complex with the $[B(OH)_4]^-$, thus removing it from solution. The reaction is reversible and thus removal of one of the products shifts the equilibrium in the forward direction and thus all the $B(OH)_3$ reacts with NaOH; in effect it acts as a strong acid in the presence of the cis-diol.

$B(OH)_3 + NaOH \longrightarrow Na[B(OH)_4] + NaBO_2 + 2H_2O$.



Q.13 (B)

(A) $B_2H_6 + HCl \rightarrow B_2H_5Cl + H_2$

(B) $B_2H_6 + NH_3 \xrightarrow[\text{low temperature}]{\text{excess } NH_3} B_2H_6.2NH_3$

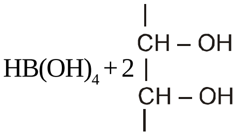
$B_2H_6.2NH_3$ is ionic compound and comprises $[H_3N \rightarrow BH_2 \leftarrow NH_3]^+$ and $[BH_4]^-$ ions.

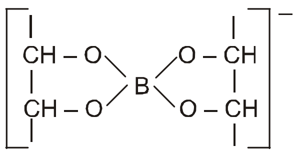
(C) $B_2H_6 + 2(Me)_3N \rightarrow 2[Me_3N.BH_3]$
(D) $B_2H_6 + 6H_2O \rightarrow 2B(OMe)_3 + 6H_2$
Reactions involved

$$(A)\ 2Na[BH_4](A) + I_2 \xrightarrow[\text{solution}]{\text{in diglyme}} B_2H_6(B) + H_2 + 2NaI$$

$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3(C) + 3H_2$$

$$B(OH)_3 + 2H_2O \rightleftharpoons H_3O^+ + [B(OH)_4]^- \ ; pK = 9.25$$



$\longrightarrow$  $+ H^+ + 4H_2O.$

$$B_2H_6(B) + 3O_2 \longrightarrow B_2O_3 + 3H_2O$$

$CoO + B_2O_3 \longrightarrow Co(BO_2)_2$ (cobalt metaborate - blue colour bead).

Q.14 (A – q) ; (B – p) ; (C – r, s) ; (D – q).

$$(A)\ 3H_2 + 2BBr_3 \xrightarrow[\text{Titanium metal filament}]{\text{heated}} 2B + 6HBr$$

$$(B)\ Na_2B_4O_7.10H_2O \xrightarrow[-10H_2O]{\Delta} 2NaBO_2 + B_2O_3$$

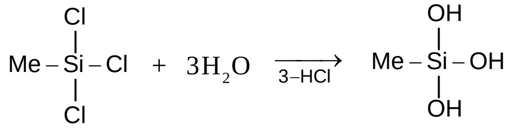
$2CuSO_4 \rightarrow 2CuO + 2SO_2 + O_3$
$CuO + B_2O_3 \rightarrow Cu(BO_2)_2$ (blue bead)
(C) $AlCl_3 + 3H_2O \rightarrow Al(OH)_3 + 3HCl$ (white fumes)
(D) $Cr_2O_3 + 2Al \xrightarrow{\Delta} Al_2O_3 + 2Cr$

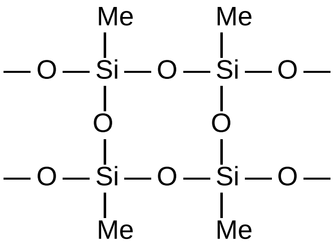
Q.15 (BCD)
Both are diamagnetic as all electrons are paired. Remaining statements are correct.

Q.16 (C)

S₁ : $B_4O_7^{2-} \xrightarrow[\text{hydrolysis}]{H^+/H_2O} B(OH)_3$;

S₂ : $SiO_4^{4-} \xrightarrow[\text{hydrolysis}]{H^+/H_2O} Si_2O_7^{6-}$

S₃ : 

$\xrightarrow{\text{Condensation}}$ 

Complex cross-linked polymer of silicones

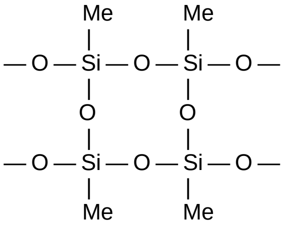
S₄ : As the metallic character decreases, the basic character decreases and acidic character increases. In other words if electronegativities difference between elements and oxygen decreases the acidic character increases. CaO is most basic, CuO is weakly basic, H_2O is neutral and CO_2 is acidic.

Q.17 (AB)

$HCOOH \xrightarrow{\Delta} H_2O + CO$; $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \longrightarrow 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO$
Malonic acid gives C_3O_2 and Mg_2C_3 gives 1-propyne.

Q.18 (AC)
(A) HCO_3^- does not give pink colour with phenolphthalein.
(B) Because phenol is weakly acidic.
(C) $2HCO_3^- + Mg^{2+} \longrightarrow Mg(HCO_3)_2$
$Mg(HCO_3)_2$ is water soluble.

Q.19 (C)
As chain can grow in three places as



Q.20 (ABCD)
(A) The double chain silicates can be drawn in which two simple chains are joined together by shared oxygen. Such compounds are also known as amphiboles.
(B) If two oxygen atoms per tetrahedron are shared to form closed rings such that the structure with general formula $(SiO_3^{2-})_n$ or $(SiO_3)_n^{2n-}$ is obtained, the silicates containing these anions are called cyclic silicates.

(C) Orthosilicates contain discrete $[SiO_4]^{4-}$ units i.e., there is no sharing of corners with one another.

(D) The asbestos mineral is a well known example of double chain silicates. The anions of double chain silicates have general formula $(Si_4O_{11})_n^{6n-}$.

Q.21 (B)

Q.22 (B)

Q.23 (B)

Q.24 (B)

(21 to 24)

(21) (B) Be_2C on hydrolysis yields methane while others give ethylene.

(22) (B) CaC_2 has NaCl like structure, so co-ordination number is six.

(23) (C) Only Al_4C_3 and Be_2C yield methane on hydrolysis.

(24) (B) It is best explanation.

Q.25 (B)

Q.26 (B)

Q.27 (C)

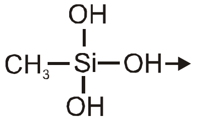
Q.28 (A)

Q.29 (B)

Q.30 (A – p, q) ; (B– p, r) ; (C – q, s) ; (D – q)

(A) $Al_2(C_2)_3 + 6H_2O \longrightarrow 2\,Al(OH)_3 + 3C_2H_2$; (HC≡CH)

(B) $3CH_2(COOH)_2 + P_4O_{10} \rightarrow 3C_3O_2 + 4H_3PO_4$; (O=C=C=C=O)

(C) $CH_3\,SiCl_3 + 3H_2O \xrightarrow[-3HCl]{}$ 

$$CH_3-\overset{\overset{OH}{|}}{\underset{\underset{OH}{|}}{Si}}-OH \rightarrow$$

complex crosslinked polymer (Silicones)

(D) $SnCl_2 + 2H_2O \longrightarrow Sn(OH)_2\downarrow$ (white) + 2HCl

NUMERICAL VALUE BASED

Q.1 [21]

x = 4

B, Aℓ, In & Tℓ are solid at 40ºC. Melting point for Gallium is 30ºC.

y = 4

I.E. : B > Aℓ < Ga < In < Tℓ

z = 3

Al is third most abundant element after oxygen and silicon. So it has to be most abundant element in the family.

⇒ x + 2y + 3z = 4 + (2 × 4) + (3 × 3) = 21.

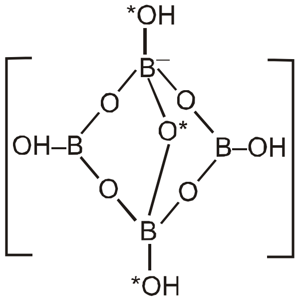
Q.2 [6]

(c) is wrong as anthracite is the purest form of coal, not carbon.

Q.3 [3]

Q.4 [3]

Borax $Na_2[B_4O_5(OH)_4].8H_2O$



'*' Marked oxygen do not take part in pπ–pπ Back bonding.

Q.5 [26]

$B_{12}H_{12}^{2-}$

x + y + z = 12 + 12 + 2 = 26

Q.6 [26]

a = 12, b = 20, c = 30

3 × 12 – 2 × 20 + 30 = 26

Q.7 [11]

(a) $CO_2 \rightarrow C \rightarrow sp$

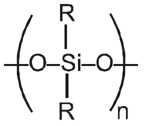
(b) Graphite → sp^2

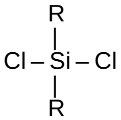
(c) Diamond → sp^3

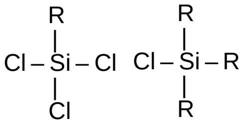
(d) CO

(e) H_3BO_3 (aq) → B → sp^3

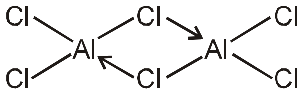
(f) Zeolite → Si → sp^3

(g) Silicones  → sp^3

(h) Chlorosilane  or

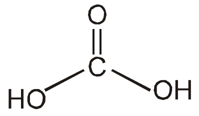
 all are sp^3

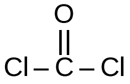
(i) Borax 2-Borons are sp^3 and 2 Borons are sp^2

(k)  (sp^3)

(ℓ) B_2H_6 (3-centre-2- electron bond) B → sp^3.

(m) SiO_2 (3-D silicate) Si → sp^3

(n)  c = sp^2

(o) 

$Cl-\overset{\overset{\displaystyle O}{\|}}{C}-Cl$ c = sp^2

(p) CH_4 sp^3

(q) CCl_4 sp^3

Q.8 [7]

$2B + 6\,HNO_3(conc) \longrightarrow \underset{(A)}{2H_3BO_3} + \underset{(B)}{6NO_2}$

NO_2 forms a dimer N_2O_4 (diamagnetic white solid) Bond angle about Boron in H_3BO_3 (=120°) is less than bond angle about N in NO_2 (132°).

Q.9 [3]

Acidic nature	H_3PO_4, H_3BO_3, $H_3P_3O_9$
Basic nature	$Na_2B_4O_7.10H_2O$, $Ba(OH)_2$, $Ca(OH)_2$
Amphoteric	PbO
Neutral oxide	CO

Q.10 [8]

Q.11 [5]

$B_2O_3 \longrightarrow$ Acidic oxide

Tl_2O_3, $NaAlO_2$, $Sr(OH)_2 \longrightarrow$ Basic nature

Cr_2O_3, $Al(OH)_3$, Al_2O_3, $Ga(OH)_3$, $Ga_2O_3 \longrightarrow$ Amphoteric oxide

Q.12 [20]

$2NaBH_4 + I_2 \longrightarrow B_2H_6 + NaI + H_2$

4 moles 2 moles 2 moles

Total moles of $H_2 = 4$

Volume at STP = 4 × 22.4 litres

$= \dfrac{89.6}{4.48} = 20$

Q.13 [5]

$3Mg + 2B \longrightarrow Mg_3B_2 \xrightarrow{HCl}$ diborane + $MgCl_2$

$\therefore$ x = 3 & y = 2

Q.14 [6]

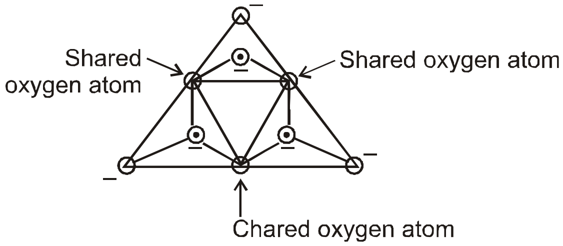
$2BCl_3 + 6H_2 \xrightarrow[\text{Electric discharge}]{\text{Silent}} B_2H_6 + 6HCl$

one mole 3 mole

$HCl + NaOH \longrightarrow NaCl + H_2O$

3 moles 3 moles

Q.15 [3]



Q.16 [2]

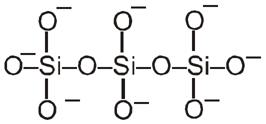
It is cyclic silicate anion.

Q.17 [12]

$[Si_6O_{18}]^{-12}$. So answer is 12.

Q.18 [10]

Unit can be



$Si_3O_{10}^{-8}$

Q.19 [11]

[x] is $(CH_3)_2SiCl_2$

Q.20 [10]

p = 4, q = 4, r = 0, t = 2

Q.21 [4]

$Al_4Cl_3 + H_2O \longrightarrow CH_4 + Al(OH)_3$

$BaC_2 + H_2O \longrightarrow C_2H_2 + Ba(OH)_2$

$Mg_2C_3 + H_2O \longrightarrow C_3H_4 + Mg(OH)_2$

$SiC + H_2O \longrightarrow X$

$B_2H_6 + H_2O \longrightarrow 2\,B(OH)_3 + H_2\uparrow$

$Fe_3C + H_2O \longrightarrow X$

Q.22 [6]

(1) $K_2SO_4\,Al_2\,(SO_4)_3$ is a white crystaline solid.

(2) upon heating it swells up due to the evolution of water molecules.

$K_2SO_4 \cdot Al_2\,(SO_4)_3 \cdot 24\,H_2O \xrightarrow{\Delta} K_2SO_4 \cdot Al_2\,(SO_4)_3 + 24\,H_2O$.

(3) becauese of presence of potassium it imparts. Volilet color to bunsen flame.

(4) $Ba^{2+} + SO_4^{2-} \rightarrow \underset{\text{whiteppt.}}{BaSO_4\downarrow}$

$BaSO_4 + H_2SO_4 \rightarrow Ba\,(HSO_4)_2$ Soluble

(5) $\underset{\text{white}}{Al^{3+} + 30H^- \rightarrow Al\,(OH)_3\downarrow} \xrightarrow{NaOH} \underset{\text{soluble}}{NaAeO_2}$

$\xrightarrow{NH_4Cl} Al\,(OH)_3\downarrow$

(6) $4K^+ + [CO(NO_2)_6]^{4+} \rightarrow K_4\,[CO\,(NO_2)_6]$
yellow ppt

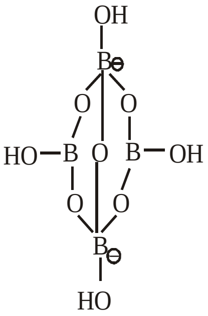
(7) $2Al^{3+} + 3S^{-2} \rightarrow Al_2S_3 \xrightarrow[\text{Hydrolysis}]{H_2O} Al\,(OH)_3\downarrow$
whiteppt.

KVPY
PREVIOUS YEAR'S

Q.1 (B)
$NaBH_4 + I_2 \rightarrow NaI + B_2H_6 + H_2$

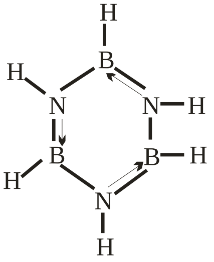
Q.2 (B)
$BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$
$4H_3BO_3 + Na_2CO_3 \longrightarrow Na_2B_4O_7 + CO_3 + 6H_2O$

Q.3 (A)



Q.4 (D)
Al_2O_3 is amphoteric so it dissolve in acid as well in alkalis

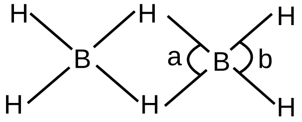
Q.5 (D)
$B_2H_6 + 2NH_3 \xrightarrow{\Delta} B_3N_3H_6$



Borazole or Inorganic benzene

JEE-MAIN
PREVIOUS YEAR'S

Q.1 (2)



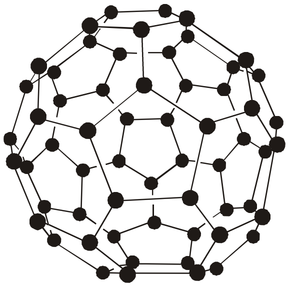
Bond angle b > a
% S-character ∞ B.A.
Therefore external bond has more % s-character or less % p-character.

Q.2 (3)

Q.3 (Cu)

Q.4 (1)

Q.5 (4)
Structure of C_{60}



It contain 20 hexagons ⬡20 and 12 pentagons

⬠12 so option 4 is incorrect.

Q.6 (3)

Q.7 (2)

Q.5 (2)

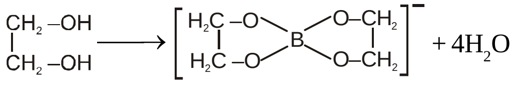
Q.8 (7)

JEE-ADVANCED
PREVIOUS YEAR'S

Q.1 (BD)
H_3BO_3 does not undergo self ionization.
On adding cis-diols, they form complexing species with orthoboric acid.
Hence the acidity increases on adding ethylene glycol.

$H_3BO_3 + H_2O \longrightarrow B(OH)_4^- + H^+$

$B(OH)_4^- + 2$



It arranges into planar sheets due to H-bonding.
Hence, it has 2- dimensional structure due to H-bonding.
It acts as a weak acid in water, so it is a weak electrolyte in water

Q.2 (6)

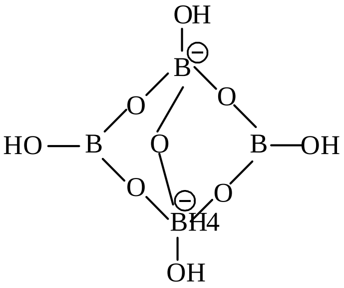
$$B_2H_6 + 6CH_3OH \longrightarrow 2B(OCH_3)_3 + 6H_2$$

For 3 moles of B_2H_6 mole of B containing product formed = 6

Q.3 (B)

For linear polymer, we need R_2SiCl_2 and for termination, we need R_3SiCl.

Q.4 (ACD)

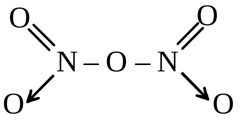


Q.5 (BD)

$$4HNO_3 + P_4O_{10} \longrightarrow 2N_2O_5 + 4HPO_3$$

$$P_4 + 20HNO_3 \longrightarrow 4H_3PO_4 + 20NO_2 + 4H_2O$$

$$N_2O_5 + Na \longrightarrow NO_2 + NaNO_3$$



Q.6 (B)

(A) Pb_3O_4 is insoluble in water or do not react with water.

(B) $2KO_2 + 2H_2O \rightarrow 2KOH + H_2O_2 + O_{2(g)}\uparrow$

(C) $Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$

(D) $Li_2O_2 + 2H_2O \rightarrow 2LiOH + H_2O_2$

Q.7 (A,B OR A,B,C)

(A) $SnCl_2.2H_2O$ is a reducing agent since Sn^{2+} tends to convert into Sn^{4+}.

(B) $\underset{(\text{AMphoteric})}{SnO_2} + \underset{(\text{Base})}{2KOH_{(aq.)}} + 2H_2O \rightarrow K_2\left[Sn(OH)_6\right]$

(C) First group cations (Pb^{2+}) form insoluble chloride with HCl that is $PbCl_2$ however it is slightly soluble in water and therefore lead +2 ion is never completely precipitated on adding hydrochloric acid in test sample of Pb^{2+}, rest of the Pb^{2+} ions are quantitatively precipitated with H_2S in acidic medium.

So that we can say that filtrate of first group contain solution of $PbCl_2$ in HCl which contains Pb^{2+} and Cl^-

However in the presence of conc. HCl or excess HCl it can produce $H_2[PbCl_4]$

So, we can conclude A, B or A,B,C should be answers.

(D) $\underset{\substack{(2PbO,PbO_2)\\(\text{mixture of oxides})}}{Pb_3O_4} + 4HNO_3 \rightarrow PbO_2(\downarrow) + 2Pn(NO_3)_2 + 2H_2O$

It is not a redox reaction.