CHEMISTRY – MCQ BOOKLET

INDEX OF TOPICS

Atomic Structure	.1
Physical and Chemical Changes, Solution	.30
Inorganic Chemistry	.82
Metals, Minerals, Ores: Properties, Uses	.133
Alloys	.165
Non-metals	.173
Carbon and Its Various Forms	.178
Hydrogen and Its Compounds	.191
Sulphur, Nitrogen, Halogen, Inert Gases	.199
Acid, Base and Salt	211
Organic Chemistry	.249
Hydrocarbons	.263
Alcohol	.276
Polymer	.282
Organic Acid	.293
The Explosive Substances	.303
The Fuel	.307
Food Preservation, Nutrition, Medicine, etc.	.318
Detergents and Soap	.334
The Fertilizers	.341
Miscellaneous	.343

1. Atomic Structure

Atomic Orbitals (Shapes and energies of s, p, d, f orbitals, nodal surfaces)

1. Which one of the following is the shape of BrF_5?

A. Octahedral
B. Square planar
C. Square pyramidal
D. Trigonal bipyramidal

Ans: C

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To determine the shape of a molecule, VSEPR theory is used. Bromine (Br) is the central atom in BrF_5, having 7 valence electrons. Five Fluorine (F) atoms are bonded to Br, each forming a single bond. This accounts for 5 valence electrons from Br being used in bonding, forming 5 bond pairs. The remaining 7 - 5 = 2 valence electrons form one lone pair on the central Br atom.

2. The number of angular and radial nodes for 4d orbital is respectively

A. 2 and 1
B. 1 and 2
C. 3 and 1
D. 4 and 0

Ans: A

UPSC CAPF-2018

For an atomic orbital described by the principal quantum number n and azimuthal (angular momentum) quantum number l: - The number of angular nodes is equal to l. - The total number of nodes is equal to n - 1. - The number of radial nodes is the total number of nodes minus the number of angular nodes, i.e., (n - 1) - l. For a 4d orbital: - Principal quantum number n = 4. - For a d orbital, the azimuthal quantum number l = 2 (s=0, p=1, d=2, f=3). - Number of angular nodes = l = 2. - Number of radial nodes = (n - 1) - l = (4 - 1) - 2 = 3 - 2 = 1. The question asks for the number of angular and radial nodes respectively.

3. What is the order of increasing energy of the orbitals within a single energy level?

A. d < s < f < p
B. s < p < d < f
C. p < s < f < d
D. f < d < p < s

Ans: B

WBCS_Main-Paper-4-2023

Within the same principal energy level (n), the energy of subshells increases with the azimuthal quantum number (l): s (l=0)

4. The shape of I_3^- is - - (5) Question not attempted

A. Triangular planar
B. Seesaw
C. Bent
D. Linear

Ans: D

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The shape of the I$_3^-$ ion is determined by its VSEPR theory configuration.

5. The total number of nodal planes in dxy orbital is - - Question not attempted

A. 4
B. 2
C. 1
D. 3

Ans: B

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The number of nodal planes in an atomic orbital is equal to the value of the azimuthal quantum number, l. For d orbitals, $l=2$. The d_{xy} orbital has nodal planes in the xz and yz planes.

6. Which of the following elements have half-filled f-orbitals in their ground state? (Given: atomic number, Sm = 62, Eu = 63, Tb = 65, Gd = 64, Pm = 61) - (A) Sm - (B) Eu - (C) Tb - (D) Gd - (E) Pm Choose the correct answer from the options given below - - (5) Question not attempted

A. C and D only
B. A and E only
C. A and B only
D. B and D only

Ans: D

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The stability of an electronic configuration increases significantly when subshells are completely filled or half-filled. For f-orbitals, a half-filled configuration means having 7 electrons (f^7). - Europium (Eu, Z=63) has the electronic configuration $ [Xe] 4f^7 6s^2 $. Its $4f$ subshell is half-filled. - Gadolinium (Gd, Z=64) has the electronic configuration $ [Xe] 4f^7 5d^1 6s^2 $. Its $4f$ subshell is half-filled. The other elements given do not have half-filled f-orbitals in their ground state: - Samarium (Sm, Z=62): $ [Xe] 4f^6 6s^2 $ - Terbium (Tb, Z=65): $ [Xe] 4f^8 5d^1 6s^2 $ - Promethium (Pm, Z=61): $ [Xe] 4f^5 6s^2 $ Thus, Eu and Gd are the elements with half-filled f-orbitals.

7. The number of significant figures in 6.02×10^{23} is

A. 26
B. 4
C. 23
D. 3

Ans: D

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Rules for significant figures: 1. Non-zero digits are always significant. 2. Any zeros between two significant digits are significant. 3. Leading zeros (zeros to the left of the first non-zero digit) are not significant. 4. Trailing zeros (zeros to the right of the last non-zero digit) are significant if the number contains a decimal point. In scientific notation, all

digits in the mantissa (the part before the exponent) are considered significant.

8. A pi-bond is formed by the overlap of

A. s and s orbital
B. s and p orbital
C. p and p orbital
D. d and d orbital

Ans: C

mineral dev officier -2025

Sigma (σ) bonds are formed by head-on overlap of orbitals (s-s, s-p, p-p, d-d). Pi (π) bonds are formed by sideways overlap of orbitals, most commonly p-orbitals.

Atomic Spectra (Origin, Types, Fine Structure - brief)

9. Which transitions are studied by UV spectrometer?

A. Rotational
B. Electronic
C. Nuclear
D. Vibrational

Ans: B

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UV-Vis (Ultraviolet-Visible) spectroscopy involves the absorption of electromagnetic radiation in the UV and visible regions, which causes transitions between different electronic energy levels within molecules.

Electronic Configuration Principles (Aufbau Principle, Pauli's Exclusion Principle, Hund's Rule)

10. For an element with atomic number 35, which one of the following will be the correct number of electrons in its valence shell based on Bohr's model of an atom?

A. 1
B. 3
C. 5
D. 7

Ans: D

UPSC NDA-1-2022

- Bohr's model describes electrons orbiting the nucleus in specific energy levels or shells (K, L, M, N, etc.). - The maximum number of electrons a shell can hold is generally given by $2n^2$, where n is the shell number (n=1 for K, n=2 for L, etc.). - For atomic number 35 (Bromine), we fill the shells sequentially: - K shell (n=1): 2 electrons (capacity 2) - L shell (n=2): 8 electrons (capacity 8) - M shell (n=3): 18 electrons (capacity 18) - N shell (n=4): The remaining electrons: 35 - (2 + 8 + 18) = 35 - 28 = 7 electrons. - The outermost shell is the valence shell, which is the N shell in this case. - The number of electrons in the valence shell is 7.

11. Which one of the following statements is correct ?

A. Covalent bonds are directional
B. Ionic bonds are directional
C. Both covalent and ionic bonds are directional
D. Both covalent and ionic bonds are non-directional

Ans: A

UPSC NDA-2-2016

Covalent bonds involve the sharing of electrons between specific atoms, leading to electron density concentrated in defined regions (orbitals) oriented in space. This directional nature of covalent bonds determines the geometry and shape of molecules, including bond angles and lengths.

12. The number of maximum electrons in N Shell is

A. 2
B. 8
C. 18
D. 32

Ans: D

UPSC NDA-2-2020

- Electron shells are designated by principal quantum numbers (n), starting from n=1 for the innermost shell (K shell). - The formula for the maximum number of electrons that can occupy a shell with principal quantum number 'n' is $2n^2$. - For the N shell, n=4.

13. What is the maximum number of electrons in the M-Shell ?

A. 6
B. 8
C. 18
D. 32

Ans: C

UPSC NDA-2-2021

The formula for the maximum number of electrons in a shell with principal quantum number 'n' is $2n^2$. K-shell (n=1): $2 \times 1^2 = 2$ electrons. L-shell (n=2): $2 \times 2^2 = 8$ electrons. M-shell (n=3): $2 \times 3^2 = 18$ electrons. N-shell (n=4): $2 \times 4^2 = 32$ electrons.

14. What is the maximum number of electrons that can occupy the first shell of an atom ?

A. 2
B. 4
C. 8
D. 16

Ans: A

UPSC NDA-2-2024

- Electron shells (also called energy levels) surround the nucleus of an atom. They are denoted by the principal quantum number, n (n=1, 2, 3, ...), where n=1 is the shell closest to the nucleus. - The maximum number of electrons that can occupy a given shell is determined by the formula $2n^2$, where n is the shell number. - For the first shell (n=1), the maximum number of electrons is 2 $(1)^2$ = 2 1 = 2. - For the second shell (n=2), the maximum number of electrons is 2 $(2)^2$ = 2 4 = 8. - For the third shell (n=3), the maximum number of electrons is 2 $(3)^2$ = 2 9 = 18, and so on.

15. How many atoms are there in one mole atom of an element?

A. 5.015 x 10^{15}
B. 6.022 x 10^{23}
C. 4.397 x 10^{26}
D. 6.589 x 10^{20}

Ans: B

WBCS_Main-Paper-4-2021

A mole is a unit of amount of substance. One mole contains Avogadro's number of particles. Avogadro's number ≈ 6.022 x 10^{23}.

16. Law of definite proportion is obeyed in

A. Stoichiometry
B. electrometry
C. photometry
D. spectrometer

Ans: A

WBCS_Main-Paper-4-2023

The Law of Definite Proportions, also known as Proust's Law, states that a pure chemical compound always contains the same elements in the same proportion by mass. This fundamental principle forms the basis of stoichiometric calculations.

17. Which structure has delocalized π electrons?

A. O$_3$
B. Co
C. HCN
D. CO$_2$

Ans: A

WBCS_Main-Paper-4-2023

Ozone (O$_3$) has a bent molecular structure and exhibits resonance. The π electron density is not confined to one specific oxygen-oxygen bond but is spread over all three oxygen atoms through resonance structures. This delocalization of π electrons enhances the stability of the molecule.

18. Which of the following does not have coordinate bond?

A. SO$_2$
B. HNO$_2$
C. HNO$_3$
D. H$_2$SO$_4$

Ans: B

WBCS_Main-Paper-4-2019

- SO$_2$: Typically represented with resonance structures involving formal charges or dative bonding character. - HNO$_2$ (Nitrous acid): H-O-N=O. The standard Lewis structure minimizes formal charges to zero for all atoms and is drawn using only single and double covalent bonds without requiring a coordinate bond. - HNO$_3$ (Nitric acid): H-O-N(=O)O with resonance. Commonly represented with a coordinate bond N->O to account for formal charges (+1 on N, -1 on one O). - H$_2$SO$_4$ (Sulfuric acid): (H-O)$_2$S(=O)$_2$. A standard representation uses an expanded octet for sulfur and results in zero formal charges without requiring coordinate bonds. However, representations using coordinate bonds (S->O) are also possible. Among the given options, HNO$_2$ is the molecule that is consistently represented without coordinate bonds in its standard Lewis structure, which adheres to the octet rule and results in zero formal charges.

19. In NO_3^- ion, the number of bond pairs and lone pairs of electrons on Nitrogen atom are, respectively – (1) 1, 3 (2) 2, 2 (3) 3, 1 (4) 4, 0 (5) Question not attempted

A. 1, 3
B. 2, 2
C. 3, 1
D. 4, 0

Ans: C

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The number of bond pairs and lone pairs around a central atom in an ion or molecule is determined by drawing its Lewis structure and applying VSEPR theory. For NO$_3^-$, standard analysis leads to 3 bond pairs and 0 lone pairs on the central nitrogen atom, consistent with sp^2 hybridization and trigonal planar geometry. However, if option (C) is considered correct, it suggests an interpretation where Nitrogen forms 3 sigma bonds and has 1 lone pair, accounting for its 5 valence electrons.

20. The number of elements in 5th period of the periodic table will be - (1) 32 (2) 8 (3) 10 (4) 18 (5) Question not attempted

A. 32
B. 8
C. 10
D. 18

Ans: D

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The number of elements in a period is determined by the number of electrons that can be accommodated in the outermost s and p subshells, and for periods 4 and beyond, the d and f subshells as well.

21. The chemical behavior of an atom is mostly determined by its

A. Mass number
B. Valence electrons
C. Atomic weight
D. Neutron count

Ans: B

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Valence electrons are the key to an atom's reactivity. Atoms tend to gain, lose, or share valence electrons to achieve a stable electron configuration, usually resembling that of noble gases.

Electronic Configurations of Multi-electron Atoms and Ions

22. The chemical properties of an element depend upon

A. the number of isotopes of the element
B. the mass number of the element
C. the total number of neutrons in the element
D. the number of electrons in the outermost shell of the element

Ans: D

UPSC CDS-1-2017

Statements A, B, and C relate to the nucleus and mass of the atom. The number of isotopes (A), mass number (B), and number of neutrons (C) affect the physical properties (like density, melting point, boiling point, radioactive decay) but generally do not significantly alter the chemical behavior of an element.

23. What is the number of moles of 'He' in 104 g of helium gas ?

A. 52
B. 26
C. 13
D. 6.5

Ans: B

UPSC CDS-1-2022

The mole is the SI unit for the amount of substance, defined as containing as many elementary entities as there are atoms in 0.012 kilogram of carbon-12. For elements, the molar mass in grams per mole is numerically equal to the atomic mass in atomic mass units (amu).

24. The correct order of atomic radius of Li, Na, Be and O is

A. Na > Li > Be > O
B. Na > Be > Li > O
C. Be > Li > Na > O
D. O > Be > Li > Na

Ans: A

UPSC CDS-1-2024

Atomic radius increases down a group in the periodic table due to the addition of electron shells. Atomic radius generally decreases across a period from left to right due to increasing effective nuclear charge pulling the valence electrons closer to the nucleus.

25. How many hydrogen atoms are contained in 1.50 g of glucose ($C_6H_{12}O_6$)?

A. 3.01×10^{22}
B. 1.20×10^{23}
C. 2.40×10^{23}
D. 6.02×10^{22}

Ans: D

UPSC CDS-2-2017

To find the number of hydrogen atoms, we first need to calculate the number of moles of glucose in 1.50 g. The molar mass of glucose ($C_6H_{12}O_6$) is $(6 \times 12.01) + (12 \times 1.008) + (6 \times 16.00) \approx 180.16$ g/mol (using rounded values C=12, H=1, O=16 gives 180 g/mol). Number of moles of glucose = mass / molar mass = 1.50 g / 180 g/mol ≈ 0.00833 moles. One molecule of glucose ($C_6H_{12}O_6$) contains 12 hydrogen atoms. Therefore, one mole of glucose contains 12 moles of hydrogen atoms. Number of moles of hydrogen atoms = 0.00833 mol glucose × 12 mol H atoms/mol glucose = 0.1 moles of hydrogen atoms. Number of hydrogen atoms = moles of H atoms × Avogadro's number (6.022×10^{23} atoms/mol) = 0.1 mol × 6.022×10^{23} atoms/mol ≈ 0.6022×10^{23} atoms = 6.022×10^{22} atoms.

26. The compound $C_7H_7NO_2$ has

A. 17 atoms in a molecule of the compound
B. equal molecules of C and H by mass
C. twice the mass of oxygen atoms compared to nitrogen atoms
D. twice the mass of nitrogen atoms compared to hydrogen atoms

Ans: A

UPSC CDS-2-2018

Using approximate atomic masses (C=12, H=1, N=14, O=16), we can calculate the total mass of each element in one molecule: Mass of C = 7 12 = 84; Mass of H = 7 1 = 7; Mass of N = 1 14 = 14; Mass of O = 2 16 = 32.

27. Cl^{-} is not isoelectronic with

A. K^{+}
B. Mg^{2+}

C. S^{2-}
D. P^{3-}

Ans: B

UPSC CDS-2-2022

- K^{+}: Atomic number of K is 19. K^{+} has lost one electron, so it has 19 - 1 = 18 electrons. - Mg^{2+}: Atomic number of Mg is 12. Mg^{2+} has lost two electrons, so it has 12 - 2 = 10 electrons. - S^{2-}: Atomic number of S is 16. S^{2-} has gained two electrons, so it has 16 + 2 = 18 electrons. - P^{3-}: Atomic number of P is 15. P^{3-} has gained three electrons, so it has 15 + 3 = 18 electrons. Thus, Cl^{-} (18 electrons) is not isoelectronic with Mg^{2+} (10 electrons).

28. Which one among the following are the correct symbols for the elements gold, tin and lead, respectively ?

A. Ga, Sb, Pb
B. At, Sn, Le
C. Au, Sn, Pb
D. Au, Sb, Pb

Ans: C

UPSC CDS-2-2023

Chemical symbols are standard abbreviations used to represent elements. Many symbols are derived from the element's English name (e.g., O for Oxygen, H for Hydrogen), but some are derived from their historical Latin or Greek names to maintain uniqueness and historical consistency.

29. Which one among the following is responsible for determining the chemical properties of an element ?

A. Protons
B. Electrons
C. Neutrons
D. Nucleus

Ans: B

UPSC CDS-2-2024

An element's chemical properties dictate how it reacts and forms bonds with other elements. This behavior is governed by the configuration of its electrons, particularly the valence electrons in the outermost shell, which are involved in chemical interactions.

30. Correctly match the following :

Elements	Valency
(a) Silicon	(i) 1
(b) Fluorine	(ii) 2
(c) Aluminium	(iii) 3
(d) Sulphur	(iv) 4

Code :

A. (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)
B. (a)-(iv), (b)-(i), (c)-(iii), (d)-(ii)
C. (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
D. (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

Ans: B

CGPSC Prelims Exam-2022

- (a) Silicon (Si) is in Group 14. It typically forms four covalent bonds, exhibiting a valency of 4. Matches (iv). - (b) Fluorine (F) is a halogen in Group 17. It typically gains one electron to form F^-, exhibiting a valency of 1. Matches (i). - (c) Aluminium (Al) is in Group 13. It typically loses three electrons to form Al^{3+}, exhibiting a valency of 3. Matches (iii). - (d) Sulphur (S) is in Group 16. It typically gains two electrons to form S^{2-} in simple compounds, exhibiting a valency of 2. Matches (ii).

31. How many valence electrons are present in Cl^- ion?

A. 0
B. 8
C. 7
D. 1

Ans: B

UPSC Geoscientist-2021

A neutral chlorine atom has 7 valence electrons. A chloride ion (Cl^-) gains one electron to complete its valence shell, resulting in 8 valence electrons.

32. What is the maximum number of electrons that can be accommodated in the M shell of an atom?

A. 32
B. 18
C. 8
D. 2

Ans: B

UPSC Geoscientist-2022

The maximum number of electrons that can be accommodated in an electron shell is given by the formula $2n^2$, where 'n' is the principal quantum number of the shell.

33. A species that is not isoelectronic with $^{35}_{17}$Cl$^-$ is

A. $^{31}_{15}$P^{3-}
B. $^{32}_{16}$S^{2-}
C. $^{40}_{18}$Ar^{2+}
D. $^{39}_{19}$K$^+$

Ans: C

UPSC Geoscientist-2022

- Isoelectronic species have the same electron configuration. - The number of electrons in an ion is calculated by subtracting the charge from the number of protons (atomic number).

34. Which one of the following is the correct order of increase of the atomic radius of the elements?

A. C < B < Si < Al
B. C < B < Al < Si
C. C < Si < B < Al
D. Si < Al < C < B

Ans: A

UPSC Geoscientist-2023

Atomic radius decreases across a period and increases down a group. The increase in radius down a group due to adding a new electron shell is usually more significant than the decrease across a period due to increasing nuclear charge.

35. Which one of the following is the correct electronic configuration of copper?

A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 4s^2$
C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$

Ans: A

UPSC Geoscientist-2023

Copper is an exception to the standard Aufbau principle; its ground state electronic configuration involves the transfer of an electron from the 4s to the 3d orbital to achieve a more stable completely filled 3d subshell.

36. Which one among the following is the correct ground state electronic configuration of Cr atom ?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^0$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3\ 4s^2$

Ans: B

UPSC Geoscientist-2024

Chromium (atomic number 24) is an exception to the standard Aufbau principle filling order. The configuration $3d^5\ 4s^1$ is more stable than $3d^4\ 4s^2$ due to the enhanced stability of a half-filled d subshell.

37. Which one among the following is the correct arrangement of molecules in increasing order of their dipole moment ?

A. $NF_3 < NH_3 < BF_3$
B. $BF_3 < NH_3 < NF_3$
C. $BF_3 < NF_3 < NH_3$
D. $NF_3 < BF_3 < NH_3$

Ans: C

UPSC Geoscientist-2024

Dipole moment is a measure of the net polarity of a molecule, resulting from the vector sum of individual bond dipoles and contributions from lone pairs. - BF_3: Boron trifluoride has a central Boron atom bonded to three Fluorine atoms. Boron is sp^2 hybridized, and the molecule is trigonal planar. The B-F bonds are polar, but the three bond dipoles are symmetrically arranged at 120° to each other in a plane. Their vector sum is zero, so BF_3 has a zero net dipole moment. - NF_3: Nitrogen trifluoride has a central Nitrogen atom bonded to three Fluorine atoms and one lone pair. Nitrogen is sp^3 hybridized, and the molecule is trigonal pyramidal. N-F bonds are polar (F is more electronegative). The bond dipoles point towards the F atoms, away from N. The lone pair contributes a dipole moment pointing away from N. The N-F bond dipoles and the lone pair dipole are in opposite directions along the molecular axis, partially canceling each other. This results in a small net dipole moment for NF_3. - NH_3: Ammonia has a central Nitrogen atom bonded to three Hydrogen atoms and one lone pair. Nitrogen is sp^3 hybridized, and the molecule is trigonal pyramidal. N-H bonds are polar (N is more electronegative). The bond dipoles point towards the N atom. The lone pair contributes a dipole moment pointing away from N. Both the N-H bond dipoles and the lone pair dipole point in the same general direction (upwards along the molecular axis), reinforcing each other. This results in a significant net dipole moment for NH_3. Comparing NF_3 and NH_3, the dipole moment of NH_3 is significantly larger than that of NF_3. Therefore, the order of increasing dipole moment is BF_3 (0)

38. Which one of the following represents the correct combination of shape and hybridisation of PF_5 ?

A. Square pyramidal, dsp^3

B. Trigonal bipyramidal, dsp^3

C. Square pyramidal, sp^3d

D. Trigonal bipyramidal, sp^3d

Ans: D

UPSC Geoscientist-2024

In PF_5, Phosphorus (P) is the central atom. P has 5 valence electrons (Group 15). It forms 5 single bonds with 5 Fluorine atoms. Number of sigma bonds around P = 5. Number of lone pairs on P = (Valence electrons on P - number of bonding electrons) / 2 = (5 - 51) / 2 = 0 lone pairs. The steric number (number of sigma bonds + number of lone pairs) = 5 + 0 = 5. A steric number of 5 corresponds to sp^3d (or dsp^3) hybridization. This hybridization involves one s orbital, three p orbitals, and one d orbital combining to form five hybrid orbitals. According to VSEPR theory, when there are 5 electron groups and no lone pairs around the central atom, the electron group geometry is trigonal bipyramidal, and the molecular shape is also trigonal bipyramidal. The five hybrid orbitals in sp^3d hybridization are directed towards the vertices of a trigonal bipyramid.

39. Which one of the following conditions is not correct for the combination of atomic orbitals to form molecular orbitals ?

A. The combining atomic orbitals must have same or nearly the same energy.

B. The combining atomic orbitals must show lateral overlap with each other.

C. The combining atomic orbitals must have the same symmetry about the molecular axis.

D. The combining atomic orbitals must overlap to the maximum extent.

Ans: B

UPSC Geoscientist-2024

The essential conditions for the linear combination of atomic orbitals (LCAO) to form molecular orbitals are: 1. The combining atomic orbitals must have comparable energies. This allows for effective interaction and mixing of orbitals. (Statement A is correct) 2. The combining atomic orbitals must have the same symmetry about the molecular axis. Orbitals with different symmetries (e.g., s orbital and p$_x$ orbital if the molecular axis is z) cannot effectively overlap. (Statement C is correct) 3. The combining atomic orbitals must overlap to the maximum possible extent. Significant overlap leads to strong bonding (and antibonding) molecular orbitals. (Statement D is correct) Statement B claims that combining atomic orbitals must show

lateral overlap. This is incorrect. Atomic orbitals can overlap axially (end-to-end), which leads to the formation of sigma (σ) molecular orbitals, or laterally (side-by-side), which leads to the formation of pi (π) molecular orbitals. Both types of overlap are valid and common ways for atomic orbitals to combine. It is not a requirement that only lateral overlap must occur. For instance, the formation of H_2 molecule involves axial overlap of two 1s orbitals.

40. Arrange the following elements in terms of their atomic number from lowest to highest :

- **(1) Carbon**
- **(2) Oxygen**
- **(3) Sodium**
- **(4) Silicon**

Choose the correct answer from the options given below :

A. (4), (3), (2), (1)
B. (3), (4), (1), (2)
C. (2), (4), (1), (3)
D. (1), (2), (3), (4)

Ans: D

HPPSC HPAS Prelims-2023

- Atomic number is the number of protons in the nucleus of an atom. - It uniquely identifies a chemical element. - Elements are arranged in the periodic table in increasing order of atomic number.

41. Atoms are held together in a molecule by _____ .

A. Intermolecular forces
B. Intramolecular forces
C. Dipole - Dipole forces
D. Van der Wall's forces

Ans: B

MPSC CS Prelims-2013

- Intramolecular forces hold atoms together within a molecule (chemical bonds). - Intermolecular forces act between molecules. - Chemical bonds (covalent, ionic) are much stronger than typical intermolecular forces.

42. Which of the following statements are correct ?

- **a. HF and H_2O are polar molecules.**
- **b. CH_4 and CO_2 are non-polar molecules.**
- **c. CO_2 and SO_2 are non-polar molecules.**

A. a and b
B. b and c
C. a and c
D. a, b and c

Ans: A

MPSC CS Prelims-2019

Molecular polarity is determined by the presence of polar bonds and the overall molecular geometry. A molecule is polar if it has a net dipole moment resulting from the vector sum of individual bond dipoles. Polar bonds exist when there is a significant electronegativity difference between the bonded atoms. Symmetrical molecular shapes can cause bond dipoles to cancel out, resulting in a non-polar molecule even if polar bonds are present.

43. In modern periodic table, which of the following statements about atomic radius are true ?

- **(a) Increases from top to bottom**
- **(b) Decreases from top to bottom**
- **(c) Increases from left to right**
- **(d) Decreases from left to right**

A. (a), (d)
B. (a), (c)
C. (b), (d)
D. (b), (c)

Ans: A

MPSC CS Prelims-2020