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CHEMISTRY

TARGET : JEE Advanced – 2023

CAPS-2

CHEMICAL BONDING
PERIODIC PROPERTIES

SINGLE CHOICE QUESTIONS

1. The xenon compounds that are iso-structural with IBr_2^- and BrO_3^- respectively are

(A) linear XeF_2 and pyramidal XeO_3 (B) bent XeF_2 and pyramidal XeO_3

(C) bent XeF_2 and planar XeO_3 (D) linear XeF_2 and tetrahedral XeO_3

2. The d-orbital participating in the hybridization of the central atom of the polar molecule of K_3IO_x is (Where x is an odd number less than or equal to 5)

(A) d_{z^2} (B) $d_{x^2-y^2}$ (C) d_{xy} (D) d_{zx}

3. Incorrect order of ionic size is:

(a) $La^{3+} > Gd^{3+} > Eu^{3+} > Lu^{3+}$ (b) $V^{2+} > V^{3+} > V^{4+} > V^{5+}$

(c) $Tl^{+} > In^{+} > Sn^{2+} > Sb^{3+}$ (d) $K^{+} > Sc^{3+} > V^{5+} > Mn^{7+}$

4. Which of the following statements is incorrect?

(A) The seconds ionization energy of Sulphur is greater than that of chlorine

(B) The third ionization energy of aluminium is greater than that of phosphorus

(C) The first ionization energy of aluminium is approximately the same as that of gallium

(D) The second ionization energy of boron is greater than that of carbon

5. Statement-1: The crystal structures of $NaHCO_3$ and $KHCO_3$, both show intermolecular hydrogen bonding but are different.

Statement-2: In $NaHCO_3$ the HCO_3^- ions are linked together through intermolecular hydrogen bonds into an infinite chain, while in $KHCO_3$, HCO_3^- ions form dimeric anions through intermolecular hydrogen bonds.

(A) STATEMENT-1 is true, STATEMENT-2 is true, and STATEMENT-2 is correct explanation for STATEMENT-1.

(B) STATEMENT-1 is true, STATEMENT-2 is true, and STATEMENT-2 is not correct explanation for STATEMENT-1.

(C) STATEMENT-1 is true, STATEMENT-2 is false.

(D) STATEMENT-1 is false, STATEMENT-2 is true.

6. Identify the species containing banana bonds.

(A) $(BeH_2)_n$ (B) BF_3 (C) $(AlCl_3)_2$ (D) $(BeCl_2)_n$

7. In which of the following species, d-orbitals having xz and yz two nodal planes are involved in hybridization of central atom?

(A) $IO_2F_2^-$ (B) ClF_4^- (C) IF_7 (D) None of these

8. In which of the following cases C–C bond length will be highest?

(A) $CH_3 - CF_3$ (B) $FCH_2 - CH_2F$ (C) $F_2CH - CHF_2$ (D) $CF_3 - CF_3$

9. Select the incorrect statement about N_2F_4 and N_2H_4

(I) In N_2F_4, d-orbitals are contracted by electronegative fluorine atoms, but d-orbital contraction is not possible by H-atom in N_2H_4.

(II) The N–N bond energy in N_2F_4 is more than N–N bond energy in N_2H_4.

(III)The N–N bond length in N_2F_4 is more than that of in N_2H_4.

(IV) The N–N bond length in N_2F_4 is less than that of in N_2H_4.

Choose the correct code:

(A) I, II and III (B) I and III (C) II and IV (D) II and III

10. Which order are correct?

(I) Thermal stability: $BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$

(II) Basic nature: ZnO > BeO > MgO > CaO

(III) Solubility in water: LiOH > NaOH > KOH > RbOH > CsOH

(IV) Melting point: NaCl > KCl > RbCl > CsCl > LiCl

(A) (I), (IV) (B) (I), (II) and (IV) (C) (II), (III) (D) All correct

11. The correct solubility order is/are:

(I) $CaCO_3 > SrCO_3 > BaCO_3$ (II) $Li_2CO_3 < Na_2CO_3 < K_2CO_3$

(III) $K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$ (IV) $Na_2CO_3 > K_2CO_3 > Rb_2CO_3$

(A) II, IV (B) I, IV (C) II, III, IV (D) I, II, III

12. From the statements given below,

(I) Ionisation energy of oxygen molecule is more than that of nitrogen molecule

(II) Electron affinity of nitrogen molecule is higher than that of oxygen molecule

(III) Electronegativity order of carbon atoms in the hydrocarbons - $C_2H_2 > C_2H_4 > C_2H_6$

(IV) N_2 is as stable as CO as bond order of both the species is 3 as per MOT.

(A) I and II are correct. (B) III and IV are correct.

(C) only III is correct. (D) II and III is correct.

MULTIPLE CHOICE QUESTIONS

13. Which type of hybridization(s) is/are observed in phosphazene P_2NCl_7 ?

(A) sp^3 (B) sp^3d (C) sp^2 (D) sp^3d^2

14. Which of the following statements is/are correct :

(A) Individual oxidation number of two sulphur atoms in thiosulphate ($S_2O_3^{2-}$) ion are +4 and 0, however the average oxidation number of sulphur is +2.

(B) The reason for $Ka_2 <<< Ka_1$ for peroxymonosulphuric acid is, intramolecular H–bonding in the anion of acid after first ionisation.

(C) NH_3 has a higher boiling point than SbH_3, because of H–bonding between NH_3 molecules.

(D) Among HCl, HBr and HI, HI is the strongest acid while HCl is the weakest acid while among HOCl, HOBr and HOI, HOCl is the strongest acid while HOI is the weakest acid.

15. Which of the following statement(s) is/are correct?

(A) Ethyne gas is more soluble in acetone than in water.

(B) CH_3F is more polar than CD_3F due to deuterium (D) being less electronegative than hydrogen (H).

(C) Silyl isocyanate (SiH_3NCO) is linear in shape while methyl isocyanate (CH_3NCO) is bent in shape.

(D) All of these

16. The sum of IE_1 and IE_2, IE_3 and IE_4 for element P and Q are given below:

	$IE_1 + IE_2$	$IE_3 + IE_4$
(P)	2.45	8.82
(Q)	2.85	6.11

Then according to the given information, the correct statement(s) is/are:

(A) P^{2+} is more stable than Q^{2+} (B) P^{2+} is less stable than Q^{2+}

(C) P^{4+} is more stable than Q^{4+} (D) P^{4+} is less stable than Q^{4+}

17. Which of the following is incorrect order of property as indicated?

(A) $Na^+ < F^- < O^{2-} < Ne < Ar$: Atomic size

(B) Br < Se < As < Ge : Metallic character

(C) Na < Al < Si < Mg : Ionisation energy

(D) I < Br < Cl < F : Electron affinity

COMPREHENSION :

PARAGRAPH

When hybridisation involving d-orbitals are considered then all the d-orbitals are not degenerate, rather $d_{x^2-y^2}, d_{z^2}$ and d_{xy}, d_{yz}, d_{zx} form two different sets of orbitals and orbitals of apppropriate set is involved in the hybridisation.

18. In sp^3d^2 hybridisation, which sets of d-orbitals is involved ?

(A) $d_{x^2-y^2}, d_{z^2}$ (B) d_{z^2}, d_{xy} (C) d_{xy}, d_{yz} (D) $d_{x^2-y^2}, d_{xy}$

19. In sp^3d^3 hybridisation, which orbitals are involved ?

(A) $d_{x^2-y^2}, d_{z^2}, d_{xy}$ (B) d_{xy}, d_{yz}, d_{zx} (C) $d_{x^2-y^2}, d_{xy}, d_{xz}$ (D) d_{z^2}, d_{yz}, d_{zx}

20. Molecule having trigonal bipyramidal geometry and sp^3d hybridisation, d-orbitals involved is :

(A) d_{xy} (B) d_{yz} (C) $d_{x^2-y^2}$ (D) d_{z^2}

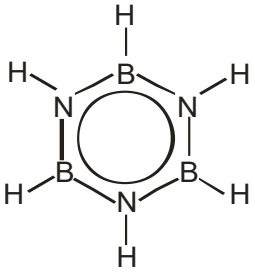
21. Which of the following orbitals can not undergo hybridisation amongst themselves.

(I) 3d, 4s (II) 3d, 4d (III) 3d, 4s & 4p (IV) 3s, 3p & 4s

(A) only II (B) II & III (C) I, II, & IV (D) II & IV

INTEGER ANSWER TYPE

22. The structure of $B_3N_3H_6$ is as follows



How may derivatice structures of $B_3N_3H_4X_2$ can be derived from the basic structure, by the replacement of two hydrogen atoms?

(A) 2 (B) 3 (C) 4 (D) 5

23. Consider the following orders:

(i) $CH_4 < CCl_4 < CF_4$: Electronegativity of central 'C'-atom

(ii) $Mg2+ < K^+ < S^{2-} < Se^{2-}$: Ionic radius

(iii) Ni > Pd > Pt : Ionisation energy

(iv) $As^{5+} > Sb^{5+} > Bi^{5+}$: Stable oxidation state

(v) LiF > NaF > KF > RbF : Lattice energy

(vi) $Li^+ < Mg^{2+} < Al^{3+}$: Hydration energy

(vii) Cl > Br > F > I : Electron affinity

(Viii) $BeCl_2 < AlCl_3 < SiCl_4$: Lewis acidic character

How many of the following statements are correct ?

24. At high temperatures Sulphur vapour is predominantly in the form of S2 (gas) molecules. If the molecular orbitals for third row diatomic molecules (homonuclear) are analogous to those for second-row molecules. Answer the following questions by putting correct number in the boxes provided at the bottom.

P	Q	R	S

P: The number of unpaired electrons in S_2.

Q: The bond order of S_2.

R: The number of π bond(s) in S_2.

S: The bond order of S_2^{2-}, disulphide ion formed by the gain of two electrons.

25. Consider the following combination of atomic orbitals:

Combining orbitals (internuclear axis)

(i) $s + p_x$ (x) (ii) $d_{xy} + d_{xy}$ (x) (iii) $d_{yz} + p_z$ (z) (iv) s + s (z)

(v) $d_{yz} + d_{yz}$ (x) (vi) $p_y + p_y$ + (y) (vii) $d_{z^2} + d_{z^2}$ (z) (viii) $d_{xy} + d_{xy}$ (z)

(ix) $p_x + p_x$ (y) (x) $s + p_2$ (x)

Then calculate value of "$a^2 + b^2 + 2cd$". (where a = σ M.O.; b = π M.O.; c = δ M.O.; c = Non-bonding M.O.)

26. Consider the following five groups (According to modern periodic table) of elements with their increasing order of atomic numbers:

Group 1 $\rightarrow$ A, B, C, D, E Group 2 $\rightarrow$ F, G, H, I, J

Group 13 $\rightarrow$ K, L, M, N, O Group 15 $\rightarrow$ P, Q, R, S, T

Group 17 $\rightarrow$ U, V, W, X, Y

If first and last element of each group belongs to 2nd and 6th period respectively and Z represents the carbonate ion (CO_3^{2-}), then consider the following orders.

(i) $O^+ > H^{2+}$; Polarizing power

(ii) $T^{3+} > S^{3+} > R^{3+}$; Stability of cation

(iii) U^- (aq.) > V^- (aq.) > W^- (aq.) > X^- (aq.); Size

(iv) $JV_2 < IV_2 < GV_2 < LV_3$; Covalent character

(v) GZ > IZ > JZ; Thermal stability

(vi) AV > BV > CV > DV > EV; Thermal stability

(vii) $C_3P > B_3P > A_3P$; Lattice energy

(viii) $KU_3 < KV_3 < KW_3 < KX_3$; Melting point

Then calculate value of $|p - q|^2$, here p and q are correct and incorrect orders in the given eight orders respectively.

27. Match the following:

Column-I (Compounds)	**Column-II (Characteristics)**
(A) H_4SiO_4	(P) Back bond
(B) H_2SeO_4	(Q) Intermolecular hydrogen bond
(C) H_3BO_3	(R) Hypo valent compound
(D) H_2NBF_2	(S) Proton donor acid
	(T) Hypervalent compound

28. Match the column

Column-I	**Column-II**
(A) $H_2S_2O_5$	(P) Central atom is sp3 hybridized
(B) $H_6B_2O_7^{2-}$	(Q) M–O–M oxo linkage is present
(C) $H_4P_2O_6$	(R) M–O–M oxo linkage is absent
(D) $H_6Si_2O_7$	(S) Non-planar

29. Match the column

Column–I	**Column–II**
Elements (Electrons in K, L, M, N …)	**Statements**
(A) W(2, 8, 7)	(P) Paramagnetic
(B) X(2, 8, 18, 8)	(Q) 3^{rd} group element
(C) Y(2, 8, 14, 2)	(R) Last electron does not enter to valence shell
(D) Z(2, 8, 18, 25, 8, 2)	(S) Reactive non-metal
	(T) Diamagnetic

SUBJECTIVE ANSWER TYPE

30. Find number of $p\pi - d\pi$ bonds in

(a) Disulphate

(b) triphosphate

(c) trimetaphosphate

(d) trimer of SO_3

(e) P_4O_{10}

(f) P_4O_6