KEA –VIKASANA PROGRAMME

CHEMISTRY

By

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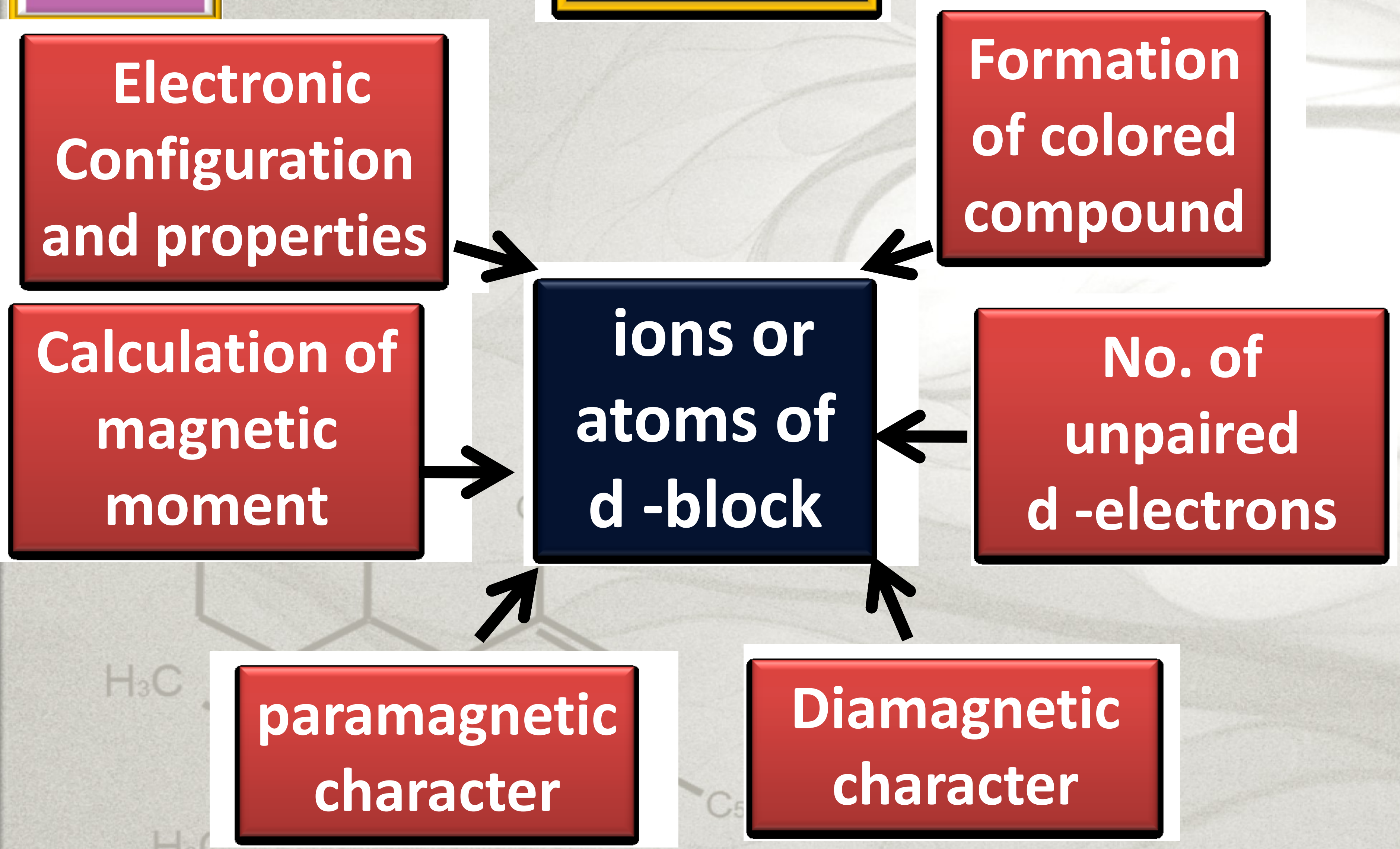
d-block elements

- Electronic configuration-3d series
- Periodic properties – variation of atomic size, ionic size and electronegativity.
- Variable oxidation state.
- Formation of colored compounds.
- Magnetic property.

CHEMISTRY



Electronic Configuration and properties
Formation of colored compound
ions or atoms of d -block
Calculation of magnetic moment
No. of unpaired d -electrons
paramagnetic character
Diamagnetic character

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CHEMISTRY

Which one of the following is *__NOT TRUE__* about transition metals?

ANSWER transitional elements are predominantly metallic

(b) In aqueous solution many of their simple ions are coloured

(c) Most of the transitional elements show

Show variable oxidation state or valence

(d) Most of the transitional elements show only one oxidation state

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An element in +3 oxidation state has the electronic configuration [*Ar*]3*d*³. It's atomic number is

a ANSWER

b) 23

c) 22

d) 21

Ar- $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ + $3d^3$ = 18 +3 +3 =24

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Which of the following compound is ***NOT*** colored ?

a) co ANSWER lphate

b) Zinc(II)Chloride

c) Chromium (III) sulphate

d) Manganese(II) oxalate

Hence no d-d transition is possible in Zn(II) ion

ion	EC
Cu(II)	[Ar] $3d^9$
Zn(II)	[Ar] $3d^{10}$
Cr(III)	[Ar] $3d^3$
Mn(II)	[Ar] $3d^5$

CHEMISTRY

The configuration of transition element, which shows highest magnetic moment is

a) $3d^8$

b

ANSWER

c) $3d^7$

d) $3d^9$

EC	Unpaired electrons
$3d^8$	↑↓ ↑↓ ↑↓ ↑ ↑
$3d^5$	↑ ↑ ↑ ↑ ↑
$3d^7$	↑↓ ↑↓ ↑ ↑ ↑
$3d^9$	↑↓ ↑↓ ↑↓ ↑↓ ↑

ion with higher no. of unpaired electrons exhibits maximum magnetic moment

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CHEMISTRY

Which of the following is diamagnetic?

a) Fe^{2+}

b) Cr^{3+}

ANSWER

d) Cu^{2+}

ELECTRONIC CONFIGURATION OF IRON IS

[Ar] $3d^6 4s^2$

ELECTRONIC CONFIGURATION OF Fe^{2+} IS

[Ar] $3d^6$

CONTAINS 4 UNPAIRED ELECTRONS.

$\mu = \sqrt{n(n + 2)}$

$\sqrt{24} = 4.89$ BM

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ion	EC	Un paired electrons
Cu^{2+}	[Ar] $3d^9 4s^0$	1
V^{2+}	[Ar] $3d^3 4s^0$	3
Cr^{2+}	[Ar] $3d^4 4s^0$	4
Mn ANSWER	Ar] $3d^5 4s^0$	5

With increase in no. of unpaired electrons paramagnetic property increases.

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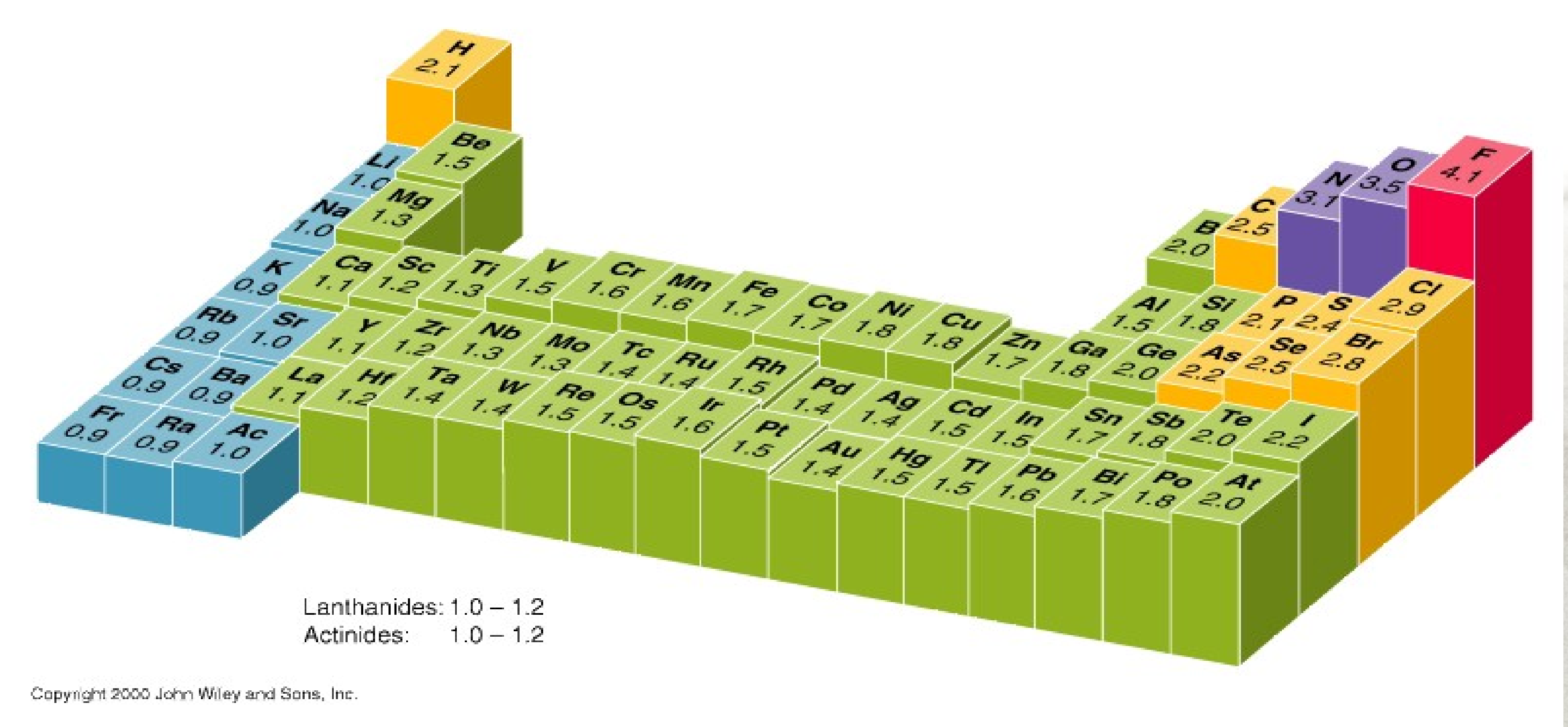
ELEMENT	OS	ELECTRONIC CONFIGURATION	NO. OF UNPAIRED d - e^-
$TiCl_4$	+4	[Ar] $3d^2 4s^2$ [Ar] $3d^0 4s^0$	0
VCl_3	+3	[Ar] $3d^3 4s^2$ [Ar] $3d^2 4s^0$	2
$FeCl_2$	+2	[Ar] $3d^6 4s^2$ [Ar] $3d^6 4s^0$	4
$ZnCl_2$	+2	[Ar] $3d^{10} 4s^2$ [Ar] $3d^{10} 4s^0$	0

ANSWER

CHEMISTRY

Which statement about *d*-block elements is true as you move from left to right in the periodic table?



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ELEMENT	ELECTRONIC CONFIGURATION	NO. OF UNPAIRED ELECTRONS
Ti	$[Ar]\ 3d^2 4s^2$	2
V	$[Ar]\ 3d^3 4s^2$	3
ANSWER	$[Ar]\ 3d^5 4s^1$	6
Co	$[Ar]\ 3d^7 4s^2$	3

Coordination compounds

- Molecular compounds-complexes and double salts
- Ligands and its classification
- Central metal atom , oxidation state, coordination number
- Ionisation and coordination sphere
- Werner's theory
- Sidgwick theory and EAN
- VBT and structure of complexes
- Isomerism
- IUPAC nomenclature.

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complex species

- IUPAC nomenclature → complex species
- CN and OS of central metal atom → complex species
- Reaction data Identification of formula → complex species
- No. of unpaired d -electrons → complex species
- magnetic character and Calculation of magnetic moment → complex species

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Which of the following pair contains complex salt and double salt respectively?

a) $FeSO_4$, $K_4[Fe(CN)_6]$

b) $[Cu(NH_3$ ANSWER $O_4 .7H_2O$

c) $[Cu(NH_3)_4]SO_4$, $K_2\ SO_4Al_2(SO_4)_3\ .24H_2O$

d) $MgSO_47H_2O$, $CuSO_4$

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In the following reaction

$Cu^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$ (aq),

Cu^{2+} is acting as a(n)

a) oxidizing agent

b) ANSWER

c) solvent

d) ligand

μ = 2.82 BM means vanadium has two unpaired electrons with an oxidation state of +3 **[Ar]** $3d^2$

let the charge on the complex ion be X

Then X = 1(+3) + (-2) 3 =+ 3 - 6 =-3

To balanc $K_3 [V (OX)_3]$ *put 3* K^+ *ions*

Hence n = 3

$$K_3 [V (OX)_3]$$

$K_3[Co(CN)_6]$

Oxidation state of cobalt in this complex is +3

ANSWER

c configuration of

Co is [Ar] $3d^7$ $4s^2$

Electronic configuration of

Co^{3+} [Ar] $3d^6$

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$$[Cr(en)_2(NH_3)_2]\ Cl_3$$

$$[Cr(en)_2(NH_3)_2]^{+3} + 3\ Cl^{-}$$

ANSWER

$$X + 0\ (2) + (0)(2) = +3$$

$$X = +3$$

CHEMISTRY

$[Cu(en)(NH_3)_2]Cl_2$

$[Cu(en)(NH_3)_2]^{+2} + 2Cl^-$

$X + 0(1) + (0)(2) = +2$

OS= $X = +2$

ANSWER

$[Cu(en)(NH_3)_2]Cl_2$

(ethylene diammine bidentate ligand + two monodentate ligands)

CO = 2+2 = 4

$Co(H_2O)_5\,Cl_3 \rightarrow [Co\,Cl\,(H_2O)_5\,]^{+2} + 2Cl^-$

(3 moles)

$\downarrow$ $2AgNO_3$

$Co(H_2O)_5\,Cl_3 + 2AgNO_3 \rightarrow 2\;AgCl$

(2 moles)

ANSWER

the complex is $[Co\,Cl\,(H_2O)_5\,]\,Cl_2$

CHEMISTRY

The IUPAC name of $[CoCl(NO_2)(en)_2]Cl$ is

a)Chloronitrobis(ethylenediamine) cobaltic(III) chloride

ANSWER

b)chloronitrobis([illegible]ne)cobalt(II) chloride

c)chlorobis(ethylenediamine)nitrocobalt(III) chloride

d)bis(ethylenediamine)Chloronitrocobalt (III) chloride

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The formula of potassium trioxalatoaluminate(III) is

a) ANSWER $)_3]$

b) $K_2[Al(C_2O_4)_3]$

c) $Al\ [K_3\ (C_2O_4)_3]$

d) $K[Al(C_2O_4)_3]$

pentamminesulphatocobalt(III) bromide

$[Co(NH_3)_5 SO_4] Br$

pentamminechlorocobalt(III) sulphate

ANSWER

$[Co Cl (NH_3)_5] SO_4$

CHEMISTRY

$K_4[Fe(CN)_6]$

CENTRAL METAL ION IS Fe OS IS +2

ELECTRONIC CONFIGURATION OF IRON IS

[Ar] $3d^6 4s^2$

ELECTRONIC CONFIGURATION OF Fe^{2+} IS

[Ar] $3d^6$

CONTAINS 4 UNPAIRED ELECTRONS.

$\mu = \sqrt{n(n + 2)} = \sqrt{24} = 4.89$ BM

CHEMISTRY

$PtCl_2\,4NH_3$ + $AgNO_3$ → 2AgCl

Hence the formula of the complex is $[Pt(NH_3)_4]\,Cl_2$

Sec. valency = coordination number = 4

ANSWER

$CoCl_3\,4NH_3$ + $AgNO_3$ → AgCl

Hence the formula of the complex is $[CoCl_2(NH_3)_4]Cl$

Sec. valency = coordination number = 6

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CHEMISTRY

$[Co\,SO_4\,(NH_3)_5\,]Br$ (0.02 mole)/2L = 0.01mol/L 1 litre of above m ANSWER cess $AgNO_3 \rightarrow$0.01 mol/L of AgBr (Y)	$[Co\,Br\,(NH_3)_5\,]\,SO_4$ (0.02 mole)/2L = 0.01mol/L 1 litre of above mixture +excess $BaCl_2$ $\rightarrow$0.01 mol/L of $BaSO_4$ (Z)

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In the process of extraction of gold,

Roasted gold ore $+ CN^- + H_2O \xrightarrow{O_2} [X] + OH^-$

$$[X] + Zn \longrightarrow [Y] + Au$$

Identify the complexes [*X*] and [*Y*]

ANSWER

a) $X = [Au(CN)_2]^-$ and $Y = [Zn(CN)_4]^{2-}$

b) $X = [Au(CN)_4]^{3-}$ and $Y = [Zn(CN)_4]^{2-}$

c) $X = [Au(CN)_2]^-$ and $Y = [Zn(CN)_6]^{4-}$

d) $X = [Au(CN)_4]^-$ and $Y = [Zn(CN)_4]^{2-}$

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Chemical bonding-II

- Formation of molecular orbital's by the LCAO in homo diatomic molecules H_2, Li_2, O_2, He_2.
- BMO and ABMO
- Bond order
- Energy level diagram
- Extend the concept to the formation of H_2^+, Li_2^+, O_2^+, O_2^-, He_2^+ etc.

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molecular species

- Antibonding electron pair, Highest occupied orbital
- Formation of MO from AO
- Calculation of magnetic moment and comparison
- Bond order calculation and comparison of stability
- magnetic character and comparison

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To overlap, AO's must possess

1. Same symmetry,

2. Similar energy,

ANSWER

3. Close contact.

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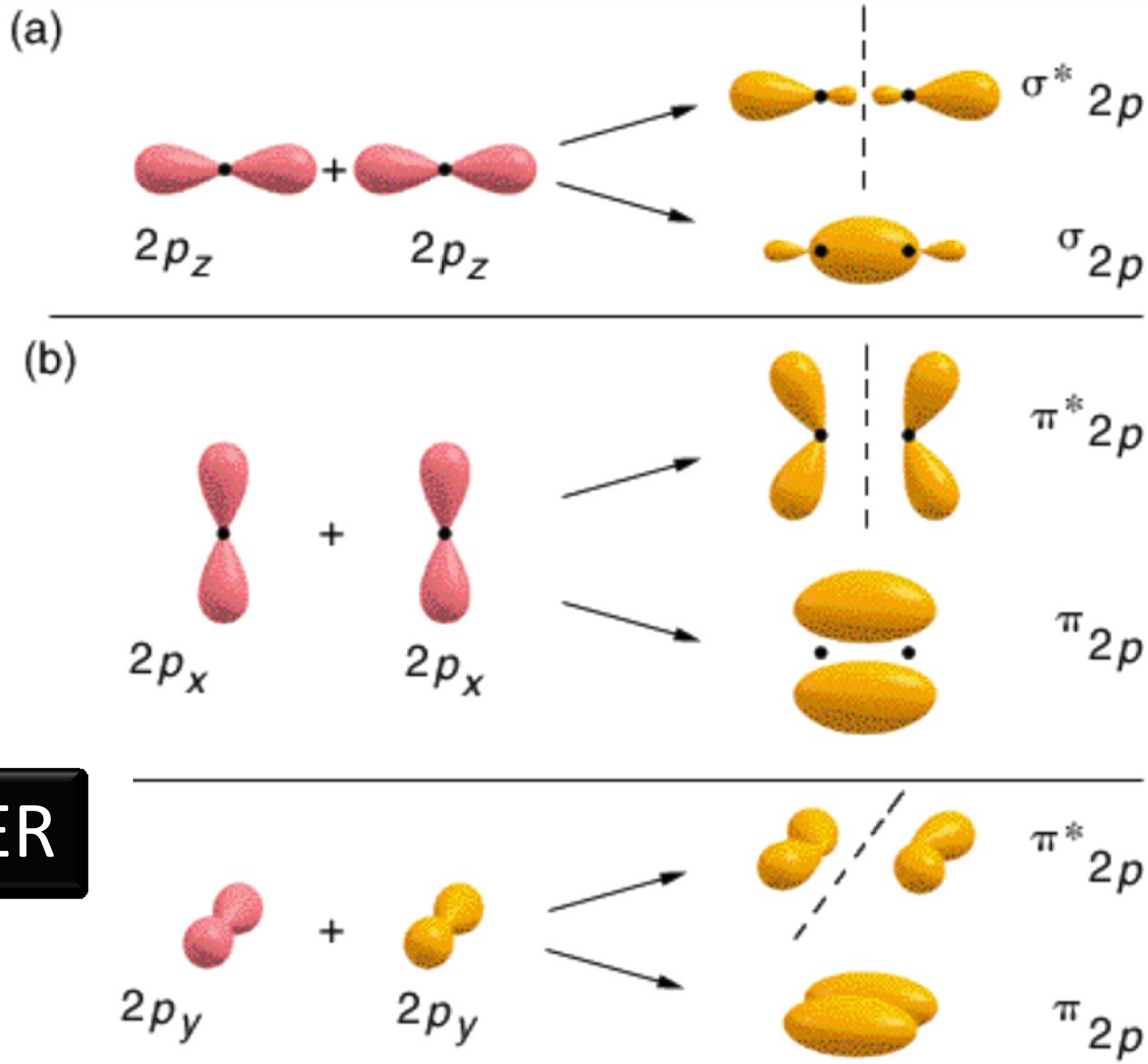

ANSWER

CHEMISTRY

Which one of the following combinations is *NOT* allowed

(assume z-axis as inter nuclear axis)

a) 2s and 2s

b) $2p_x$ and $2p_x$

c) 1s and 1s

ANSWER d $2p_y$

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CHEMISTRY

For a homonuclear diatomic molecule, the energy of σ_{2S} orbital is

Increasing order of energy of molecular orbital is

σ ANSWER σ_{2S} σ^*_{2S} σ_{2Pz}

$\pi_{2Px} = \pi_{2Py}$ $\pi^*_{2Px} = \pi^*_{2Py}$

Example for super oxide is KO_2 and contains $O_2^{\ -}$ ion.

Electronic configuration of $O_2^{\ -}$ ion is

$\sigma_{1S}^2\ \sigma^*_{1S}{}^2\ \sigma_{2S}^2\ \sigma^*_{2S}{}^2\ \sigma_{2Pz}^2\ \pi_{2Px}^2 = \pi_{2Py}^2\ \pi^*_{2Px}{}^2 = \pi^*_{2Py}{}^1$

ANSWER

The Bond order

$= \ Nb - Na/2 = 10 - 7/2 = 3/2 = \ 1.5$

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CHEMISTRY

The no. of anti bonding electron pairs in O_2^{2-} according to molecular orbital theory is

Electronic configuration of $O_2^{\ 2-}$ ion is

σ_{1S}^2 $\sigma *_{1}$ ANSWER $\sigma *_{2S}^2$ σ_{2Pz}^2

$\pi_{2Px}^2 = \pi_{2Py}^2$ $\pi^*_{2Px}^2 = \pi^*_{2Py}^2$

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CHEMISTRY

How many unpaired electrons are there in O_2^{2-} ion?

ANSWER

Electronic configuration of O_2^{2-} ion is

$\sigma_{1S}^2 \; \sigma^*_{1S}{}^2 \; \sigma_{2S}^2 \; \sigma^*_{2S}{}^2 \; \sigma_{2Pz}^2$

$\pi_{2Px}^2 = \pi_{2Py}^2 \; \pi^*_{2Px}{}^2 = \pi^*_{2Py}{}^2$

no unpaired electrons

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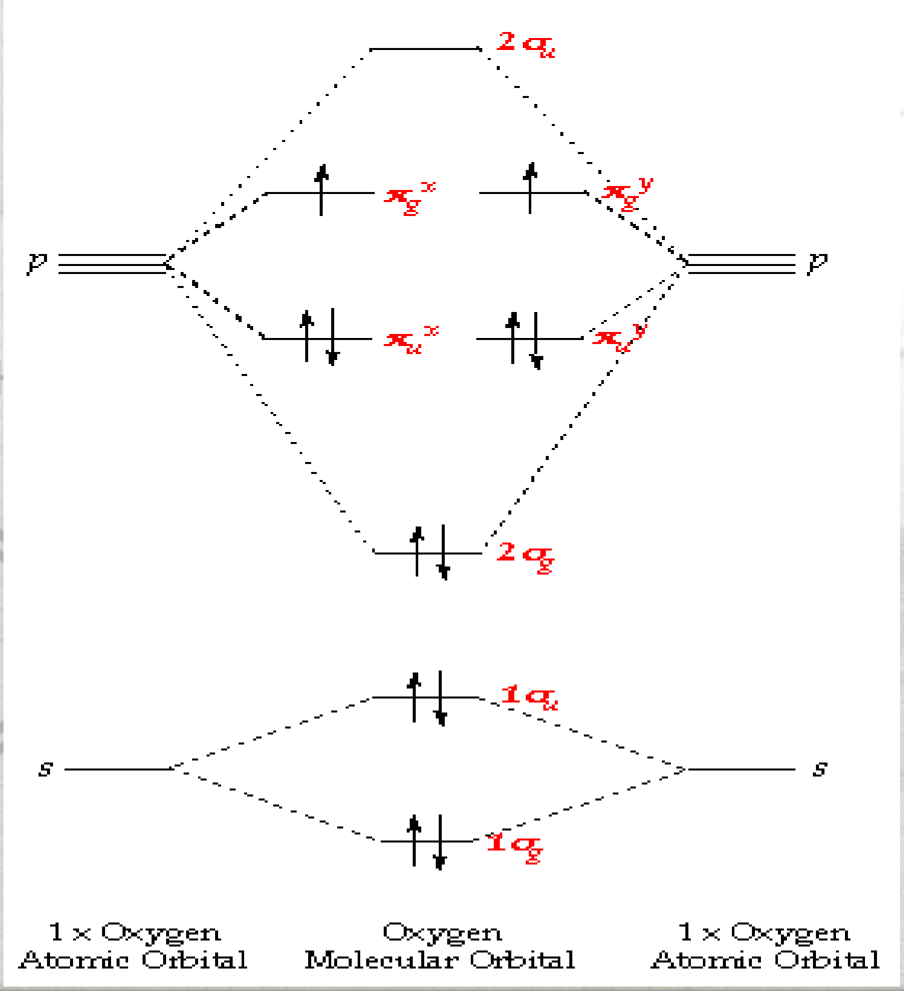
In the molecular orbital diagram for O_2^+ ion the highest occupied orbital is

a) σ_{2s}^*

b) σ_{2Pz}^*

ANSWER

d) π_{2Px}



CHEMISTRY

Electronic configuration of O_2^+ ion is

$\sigma_{1S}^2 \ \sigma^*_{1S}^2 \ \sigma_{2S}^2 \ \sigma^*_{2S}^2 \ \sigma_{2Pz}^2$

π_{2P} ANSWER $\pi^*_{2Px}{}^1 = \pi^*_{2Py}{}^0$

Bond order = 10-5/2 = 2.5

No. of unpaired electrons =1

Paramagnetic

Stability more than O_2 due to higher bond order

$O_2 + e^- \rightarrow O_2^-$

Added electron goes to π^*_{2Px} molecular orbital

Bond order decreases from 2 to 1.5 but bond order is inversely related to bond length. Hence bond length increases.

ANSWER

onfiguration of O_2^-

$\sigma_{1S}^2 \ \sigma^*_{1S}^2 \ \sigma_{2S}^2 \ \sigma^*_{2S}^2 \ \sigma_{2Pz}^2 \ \pi_{2Px}^2 = \pi_{2Py}^2$

$\pi^*_{2Px}^2 = \pi^*_{2Py}^1$

Bond order = 10 – 7/2 =1.5

CHEMISTRY

Which of the species is diamagnetic?

a) O_2^{+}
b) O_2
c) O_2^{-}
d) O_2^{2-}

species	No. of unpaired electrons
O_2^{+}	1 (PARAMAGNETIC)
O_2	2 (PARAMAGNETIC)
O_2^{-}	1 (PARAMAGNETIC)
O_2^{2-}	0 (DIAMAGNETIC)

ANSWER

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CHEMISTRY

The ascending order of number of unpaired electrons in O_2, O_2^- and O_2^{2-} is

a) O_2^{2-}, O_2, O_2^-

b) O_2^{2-}, O_2^-, O_2

c) O_2^-, O_2^{2-}, O_2

d) O_2, O_2^-, O_2^{2-}

ion	No. of unpaired electrons
O_2	2
O_2^-	1
O_2^{2-}	0

ANSWER

About the species O_2^{+}, O_2^{2-}, O_2 and O_2^{-}, which one of the following statements is *CORRECT* ?

	N_b	N_a	$N_b - N_a/2$
O_2^{+}	10		2.5
O_2	10	6	2
O_2^{-}	10	7	1.5
O_2^{2-}	10	8	1

ANSWER

According to MO theory, which of the following statements about the magnetic character and bond order is *CORRECT* regarding O_2^+

	N_b	ANSWER	N_b - N_a/2
O_2^+	10	5	2.5

$\sigma_{1S}^2\ \sigma^*_{1S}^2\ \sigma_{2S}^2\ \sigma^*_{2S}^2\ \sigma_{2Pz}^2$

$\pi_{2Px}^2 = \pi_{2Py}^2\quad \pi^*_{2Px}^1 = \pi^*_{2Py}$

$\sigma_{1S}^{2}\ \sigma^{*}_{1S}^{2}\ \ \sigma_{2S}^{2}\ \ \sigma^{*}_{2S}^{2}\ \ \sigma_{2Pz}^{2}$

$\pi_{2Px}^{2} = \pi_{2Py}^{2}\ \ \ \pi^{*}_{2Px}^{1} = \pi^{*}_{2Py}^{1}$

(For oxygen with obeying Hund's rule)

$\sigma_{1S}^{2}\ \sigma^{*}_{1S}^{2}\ \ \sigma_{2S}^{2}\ \ \sigma^{*}_{2S}^{2}\ \ \sigma_{2Pz}^{2}$

$\pi_{2Px}^{2} = \pi_{2Py}^{2}\ \ \ \pi^{*}_{2Px}^{2} = \pi^{*}_{2Py}^{0}$

(For oxygen without obeying Hund's rule)

ANSWER ed electrons- diamagnetic

But no. of e- in antibonding MO remains same hence bond order does not changes.(BO-2)

CHEMISTRY

Which of the following have been arranged in increasing order of bond order as well as bond dissociation energy?

	N_b	N_a	N_b - N_a /2
O_2	0	5	2.5
O_2	10	6	2
O_2^{-}	10	7	1.5
O_2^{2-}	10	8	1

ANSWER

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CHEMISTRY

Number of moles of ions present in a solution of 1 molar pottassium ferrocyanide is

a)2

b)3

c)4

d)

ANSWER

Potassium Ferrocyanide is $K_4[Fe(CN)_6]$

$K_4[Fe(CN)_6] \rightarrow 4K^+ + 1[Fe(CN)_6]^{4-}$

CHEMISTRY

According to IUPAC nomenclature sodium nitroprusside is named as

a)sod

b)sod

c)sodium pe rosyl ferrate (II)

d)sodium pentacyanonitrosylferrate (III)

$Na_2[Fe(CN)_5 NO]$

ANSWER

CHEMISTRY

Which of the following is *TRUE* ?

a)bond order α $\frac{1}{bond\ length}$ α bond energy

b) bond order α $\frac{1}{bond\ energy}$ α bond length

c) bond order α $\frac{1}{bond\ energy}$ α $\frac{1}{bond\ length}$

d) bond order α bond length α bond energy

CHEMISTRY

Werner's theory ***DOES NOT*** explain

a)sec. Valency of metal atom

b)ionisable and non ionisable valency

c)directional nature of sec. Valency

ANSWER ive atomic number