FINAL JEE–MAIN EXAMINATION – APRIL, 2024

(Held On Thursday 04th April, 2024) **TIME : 9 : 00 AM to 12 : 00 NOON**

SECTION-A

61. What pressure (bar) of H_2 would be required to make emf of hydrogen electrode zero in pure water at 25ºC ?

(1) 10^{-14} (2) 10^{-7} (3) 1 (4) 0.5

Allen Ans. (1)

NTA Ans. (3)

Sol. $2e^- + 2H^+(aq) \rightarrow H_2(g)$

$$E = E^o - \frac{0.059}{n}\log\frac{P_{H_2}}{[H^+]^2}$$

$$0 = 0 - \frac{0.059}{2}\log\frac{P_{H_2}}{(10^{-7})^2}$$

$$\log\frac{P_{H_2}}{(10^{-7})^2} = 0$$

$$\frac{P_{H_2}}{10^{-14}} = 1$$

$$P_{H_2} = 10^{-14}\,\text{bar}$$

62. The correct sequence of ligands in the order of decreasing field strength is :

(1) $CO > H_2O > F^- > S^{2-}$

(2) $^-OH > F^- > NH_3 > CN^-$

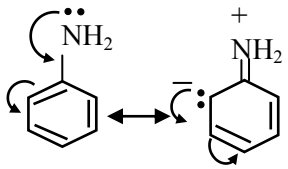
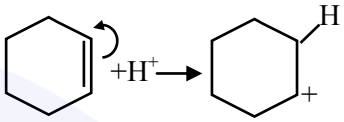
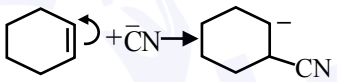
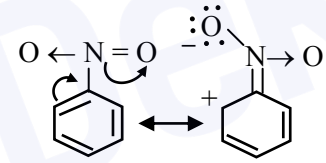
(3) $NCS^- > EDTA^{4-} > CN^- > CO$

(4) $S^{2-} > ^-OH > EDTA^{4-} > CO$

Ans. (1)

Sol. According to spectrochemical series ligand field strength is $CO > H_2O > F^- > S^{2-}$

63. Match List -I with List II:

List - I Mechanism steps		List - II Effect	
(A)		(I)	– E effect
(B)		(II)	– R effect
(C)		(III)	+ E effect
(D)		(IV)	+ R effect

Choose the **correct** answer from the options given below :

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

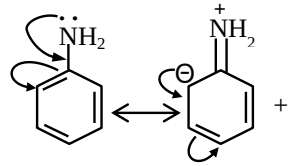
(2) (A) – (III), (B) – (I), (C) – (II), (D) – (IV)

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

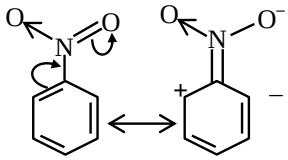
(4) (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

Ans. (1)

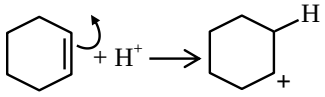
Sol.



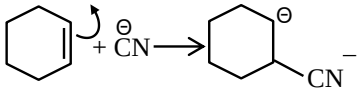
+ R effect ($\ddot{N}H_2$ electron donating)



– R effect (NO_2 electron withdrawing)



+E Effect H^+ electron deficient species)



– E Effect ($\bar{C}N$ electron deficient species)

64. What will be the decreasing order of basic strength of the following conjugate bases ?

$^-OH, R\bar{O}, CH_3CO\bar{O}, C\bar{l}$

(1) $C\bar{l} > OH > R\bar{O} > CH_3CO\bar{O}$

(2) $R\bar{O} > ^-OH > CH_3CO\bar{O} > C\bar{l}$

(3) $^-OH > R\bar{O} > CH_3CO\bar{O} > C\bar{l}$

(4) $C\bar{l} > R\bar{O} > ^-OH > CH_3CO\bar{O}$

Ans. (2)

Sol. Strong acid have weak conjugate base

Acidic strength :

$H–Cl > CH_3COOH > H_2O > R–OH$

Conjugate base strength :

$Cl^- < CH_3COO^- < \bar{O}H < RO^-$

65. In the precipitation of the iron group (III) in qualitative analysis, ammonium chloride is added before adding ammonium hydroxide to :

(1) prevent interference by phosphate ions

(2) decrease concentration of ^-OH ions

(3) increase concentration of Cl^- ions

(4) increase concentration of NH_4^+ ions

Ans. (2)

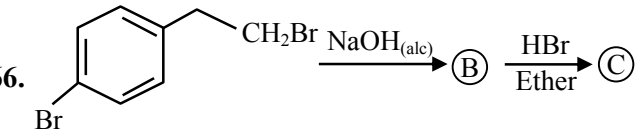
Sol. $NH_4OH \rightleftharpoons NH_4^+ + OH^-$

$NH_4Cl \rightarrow NH_4^+ + Cl$

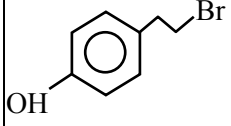
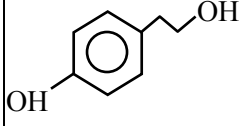
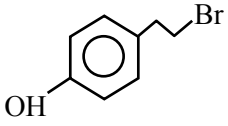
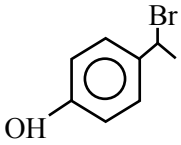
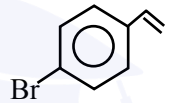
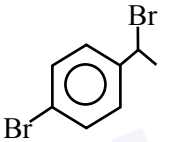
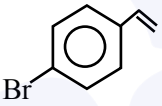
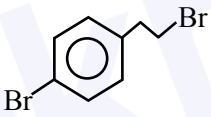
Due to common ion effect of NH_4^+,

$[OH^-]$ decreases in such extent that only group-III cation can be precipitated , due to their very low K_{sp} in the range of 10^{-38}.

66.

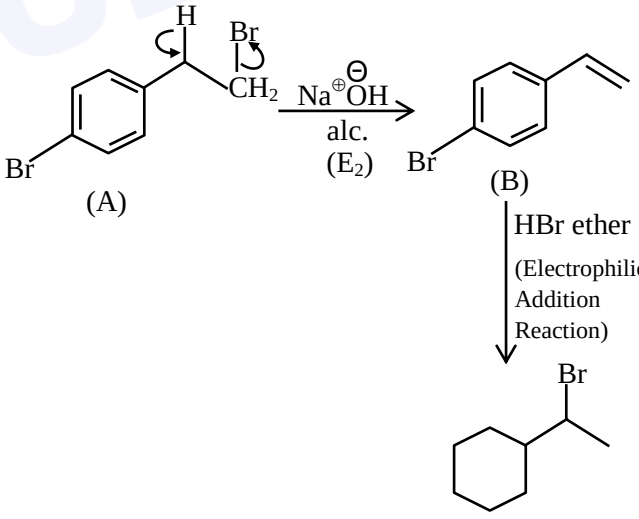


Identify Ⓑ and Ⓒ and how are Ⓐ and Ⓒ related ?

	(B)	**(C)**	
(1)			functional group isomers
(2)			Derivative
(3)			position isomers
(4)			chain isomers

Ans. (3)

Sol.



A and C are position isomer.

67. One of the commonly used electrode is calomel electrode. Under which of the following categories calomel electrode comes ?

(1) Metal – Insoluble Salt – Anion electrodes

(2) Oxidation – Reduction electrodes

(3) Gas – Ion electrodes

(4) Metal ion – Metal electrodes

Ans. **(1)**

Sol. Theory based

68. Number of complexes from the following with even number of unpaired "d" electrons is____.

$[V(H_2O)_6]^{3+}$, $[Cr(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{3+}$, $[Ni(H_2O)_6]^{3+}$, $[Cu(H_2O)_6]^{2+}$

[Given atomic numbers : V = 23, Cr = 24, Fe = 26, Ni = 28, Cu = 29]

(1) 2 (2) 4

(3) 5 (4) 1

Ans. **(1)**

Sol. $[V(H_2O)_6]^{3+} \rightarrow d^2sp^3$

$_{23}V$:- $[Ar]3d^34s^2$

V^{+3} :- $[Ar]3d^2$, n = 2 (even number of unpaired e^-)

$[Cr(H_2O)_6]^{2+} \rightarrow sp^3d^2$

$_{24}Cr$:- $[Ar]3d^54s^1$

Cr^{+2} :- $[Ar]3d^4$, n = 4 (even number of unpaired e^-)

e_g | 1 | |

t_{2g} | 1 | 1 | 1 |

$[Fe(H_2O)_6]^{3+} \rightarrow sp^3d^2$

Fe^{3+} :– $[Ar]3d^54s^0$

n = 5 (odd number of unpaired e^-)

$[Ni(H_2O)_6]^{3+} \rightarrow sp^3d^2$

Ni :- $[Ar]3d^84s^2$

Ni^{+3} :- $[Ar]3d^7$, n = 3 (odd number of unpaired e^-)

$[Cu(H_2O)_6]^{2+} \rightarrow sp^3d^2$

Cu :- $[Ar]3d^94s^0$

n = 1 (odd number of unpaired e^-)

69. Which one of the following molecules has maximum dipole moment ?

(1) NF_3 (2) CH_4

(3) NH_3 (4) PF_5

Ans. **(3)**

Sol. CH_4 & PF_5 , $\mu_{net} = 0$ (non polar)

μ_{NH_3} (Vector addition of bond moment & lone pair moment) > μ_{NF_3} (Vector subtraction of bond moment & lone pair moment)

70. Number of molecules/ions from the following in which the central atom is involved in sp^3 hybridization is _____.

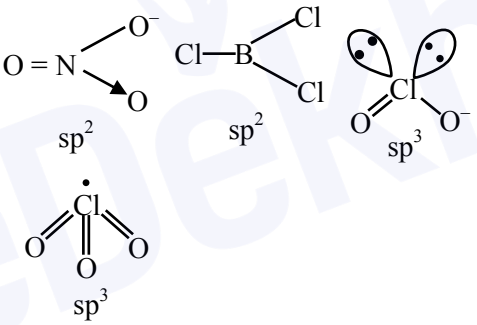
NO_3^-, BCl_3, ClO_2^-, ClO_3

(1) 2 (2) 4

(3) 3 (4) 1

Ans. **(1)**

Sol.



71. Which among the following is **incorrect** statement?

(1) Electromeric effect dominates over inductive effect

(2) The electromeric effect is, temporary effect

(3) The organic compound shows electromeric effect in the presence of the reagent only

(4) Hydrogen ion (H^+) shows negative electromeric effect

Ans. **(4)**

Sol. Hydrogen ion (H^+) shows positive electromeric effect.

72. Given below are two statements :

Statement I : Acidity of α-hydrogens of aldehydes and ketones is responsible for Aldol reaction.

Statement II : Reaction between benzaldehyde and ethanal will NOT give Cross – Aldol product.

In the light of above statements, choose the **most appropriate** answer from the options given below.

(1) Both **Statement I** and **Statement II** are correct.

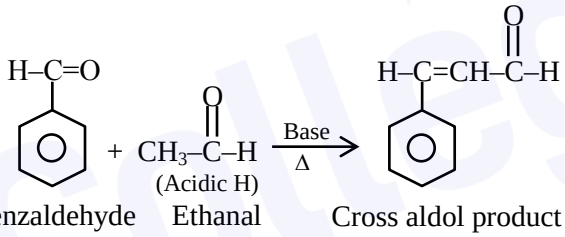
(2) Both **Statement I** and **Statement II** are incorrect.

(3) **Statement I** is incorrect but **Statement II** is correct.

(4) **Statement I** is correct but **Statement II** is incorrect.

Ans. (4)

Sol. Aldehyde and ketones having acidic α-hydrogen show aldol reaction



Benzaldehyde Ethanal Cross aldol product

73. Which of the following nitrogen containing compound does not give Lassaigne's test ?

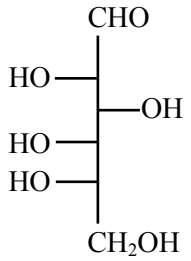
(1) Phenyl hydrazine (2) Glycene

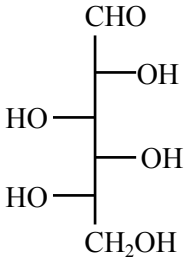
(3) Urea (4) Hydrazine

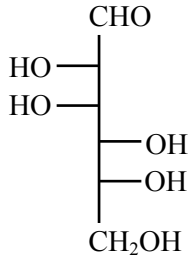
Ans. (4)

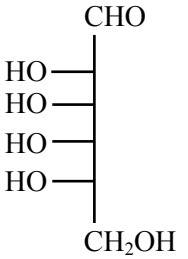
Sol. Hydrazine ($NH_2–NH_2$) have no carbon so does not show Lassaigne's test.

74. Which of the following is the correct structure of L-Glucose ?

(1)


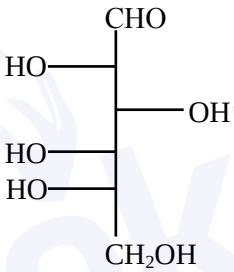
(2)


(3)


(4)


Ans. (1)

Sol. Structure of L-Glucose is



75. The element which shows only one oxidation state other than its elemental form is :

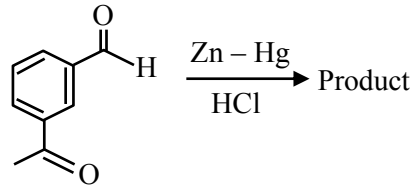
(1) Cobalt (2) Scandium

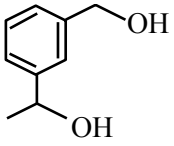
(3) Titanium (4) Nickel

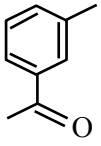
Ans. (2)

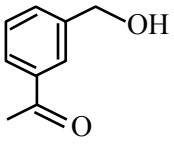
Sol. Co, Ti, Ni can show +2, +3 and +4 oxidation state, But 'Sc' only shows +3 stable oxidation state.

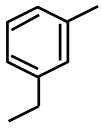
76. Identify the product in the following reaction :



(1)


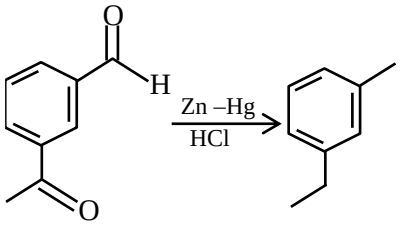
(2)


(3)


(4)


Ans. (4)

Sol.



(Clemmensen reduction)

77. Number of elements from the following that CANNOT form compounds with valencies which match with their respective group valencies is _____.

B, C, N, S, O, F, P, Al, Si

(1) 7 (2) 5 (3) 6 (4) 3

Ans. (4)

Sol. N,O, F can't extend their valencies upto their group number due to the non-availability of vacant 2d like orbital.

78. The Molarity (M) of an aqueous solution containing 5.85 g of NaCl in 500 mL water is :

(Given : Molar Mass Na : 23 and Cl : 35.5 $gmol^{-1}$)

(1) 20 (2) 0.2

(3) 2 (4) 4

Ans. (2)

Sol. $M = \frac{n_{NaCl}}{V_{sol}\,(\text{in L})}$

$$M = \frac{\frac{5.85}{58.5}}{0.5} = 0.2\,M$$

79. Identify the correct set of reagents or reaction conditions 'X' and 'Y' in the following set of transformation.

$$CH_3 - CH_2 - CH_2 - Br \xrightarrow{\text{'X'}} \text{Product} \xrightarrow{\text{'Y'}} CH_3 - \underset{\underset{Br}{|}}{CH} - CH_3$$

(1) X = conc.alc. NaOH, 80°C, Y = $Br_2/CHCl_3$

(2) X = dil.aq. NaOH, 20°C, Y = HBr/acetic acid

(3) X = conc.alc. NaOH, 80°C, Y = HBr/acetic acid

(4) X = dil.aq. NaOH, 20°C, Y = $Br_2/CHCl_3$

Ans. (3)

Sol. $CH_3–CH_2–CH_2–Br \xrightarrow[80\,^oC]{X=\text{conc.alc.NaOH}}$

$$CH_3–CH=CH_2 \xrightarrow{Y\equiv HBr/\text{Acetic acid}} CH_3–CHBr – CH_3$$

80. The correct order of first ionization enthalpy values of the following elements is :

(A) O (B) N

(C) Be (D) F

(E) B

Choose the correct answer from the options given below :

(1) B < D < C < E < A (2) E < C < A < B < D

(3) C < E < A < B < D (4) A < B < D < C < E

Ans. (2)

Sol. Correct order of I^{st} IE

Li < B < Be < C < O < N < F < Ne

↓ ↓ ↓ ↓ ↓

E < C < A < B < D

SECTION-B

81. The enthalpy of formation of ethane (C_2H_6) from ethylene by addition of hydrogen where the bond-energies of C – H, C – C, H – H are 414 kJ, 347 kJ, 615 kJ and 435 kJ respectively is - _____ kJ.

Ans. (125)

Sol. $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

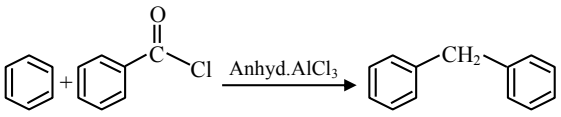
ΔH = BE(C = C) + 4BE (C – H) + BE (H – H) – BE(C – C) – 6BE (C – H)

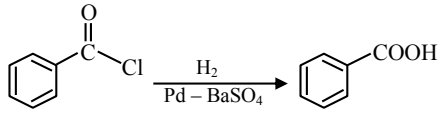
ΔH = BE(C = C) + BE(H – H) – BE(C – C) – 2BE(C – H)

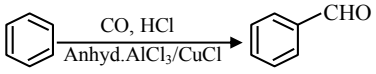
= 615 + 435 – 347 – 2 × 414

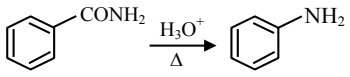
= – 125 kJ

82. The number of correct reaction(s) among the following is _____.

(A) 

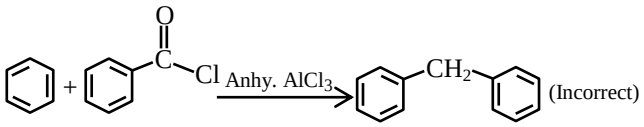
(B) 

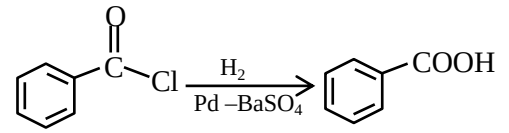
(C) 

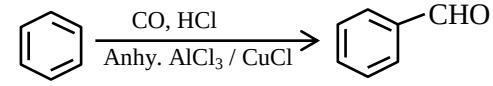
(D) 

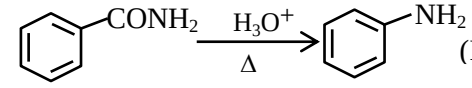
Ans. (1)

Sol.

(A)  (Incorrect)

(B)  (Incorrect)

(C)  (Correct)

(D)  (Incorrect)

83. X g of ethylamine is subjected to reaction with $NaNO_2/HCl$ followed by water; evolved dinitrogen gas which occupied 2.24 L volume at STP.

X is _____ $\times 10^{-1}$ g.

Ans. (45)

Sol.

$$\underset{\text{Mol.wt.45g}}{CH_3CH_2NH_2} \xrightarrow{NaNO_2+HCl} \xrightarrow{H_2O} CH_3CH_2{-}OH + \underset{14g}{N_2}$$

given : N_2 evolved is 2.24 L i.e. 0.1 mole.

i.e. $CH_3CH_2NH_2$ (ethyl amine) will be 4.5 g

(=0.1 mole)

Hence the answer = 45×10^{-1} g

84. The de-Broglie's wavelength of an electron in the 4^{th} orbit is _____ πa_0. (a_0 = Bohr's radius)

Ans. (8)

Sol. $2\pi r_n = n\lambda_d$

$$2\pi a_0 \frac{n^2}{Z} = n\lambda_d$$

$$2\pi a_0 \frac{4^2}{1} = 4\lambda_d$$

$$\lambda_d = 8\pi a_0$$

85. Only 2 mL of $KMnO_4$ solution of unknown molarity is required to reach the end point of a titration of 20 mL of oxalic acid (2 M) in acidic medium. The molarity of $KMnO_4$ solution should be _____ M.

Allen Ans. (8)

NTA Ans. (50)

Sol. eq.($KMnO_4$) = eq.($H_2C_2O_4$)

$M \times 2 \times 5 = 2 \times 20 \times 2$

$M = 8M$

86. Consider the following reaction

$MnO_2 + KOH + O_2 \rightarrow A + H_2O$.

Product 'A' in neutral or acidic medium disproportionate to give products 'B' and 'C' along with water. The sum of spin-only magnetic moment values of B and C is _____ BM. (nearest integer)

(Given atomic number of Mn is 25)

Ans. (4)

Sol. $MnO_2 + KOH + O_2 \rightarrow K_2MnO_4 + H_2O$

(A)

$$K_2MnO_4 \xrightarrow{\text{Neutral/acidic solution}} KMnO_4 + MnO_2$$

Mn^{+4} :- $[Ar]3d^3$

$n = 3$, $\mu = \sqrt{3(3+2)} = 3.87$ B.M.

Nearest integer is (4)

87. Consider the following transformation involving first order elementary reaction in each step at constant temperature as shown below.

$$A + B \underset{\text{Step 3}}{\overset{\text{Step 1}}{\rightleftharpoons}} C \xrightarrow{\text{Step 2}} P$$

Some details of the above reaction are listed below.

Step	Rate constant (sec^{-1})	Activation energy (kJ mol^{-1})
1	k_1	300
2	k_2	200
3	k_3	Ea_3

If the overall rate constant of the above transformation (k) is given as $k = \frac{k_1 k_2}{k_3}$ and the overall activation energy (E_a) is 400 kJ mol^{-1}, then the value of Ea_3 is _____ kJ mol^{-1} (nearest integer)

Ans. (100)

Sol. $K = \frac{K_1 K_2}{K_3}$

$$Ae^{\frac{-E_a}{RT}} = \frac{A_1 e^{\frac{-E_{a_1}}{RT}} A_2 e^{\frac{-E_{a_2}}{RT}}}{A_3 e^{\frac{-E_{a_3}}{RT}}}$$

$$Ae^{\frac{-E_a}{RT}} = \frac{A_1 A_2}{A_3} e^{\frac{-(E_{a_1}+E_{a_2}-E_{a_3})}{RT}}$$

$$E_a = E_{a_1} + E_{a_2} - E_{a_3}$$

$400 = 300 + 200 - E_{a_3}$

$E_{a_3} = 100$ kJ/mole

88. 2.5 g of a non-volatile, non-electrolyte is dissolved in 100 g of water at 25°C. The solution showed a boiling point elevation by 2°C. Assuming the solute concentration in negligible with respect to the solvent concentration, the vapour pressure of the resulting aqueous solution is _____ mm of Hg (nearest integer)

[Given : Molal boiling point elevation constant of water (K_b) = 0.52 K. kg mol^{-1},

1 atm pressure = 760 mm of Hg, molar mass of water = 18 g mol^{-1}]

Ans. (707)

Sol. $2 = 0.52 \times m$

$$m = \frac{2}{0.52}$$

According to question, solution is much diluted

so $\frac{\Delta P}{P^o} = \frac{n_{solute}}{n_{solvent}}$

$$\frac{\Delta P}{P^o} = \frac{m}{1000} \times M_{solvent}$$

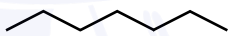
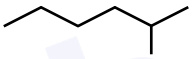
$$\Delta P = P^o \times \frac{m}{1000} \times M_{solvent}$$

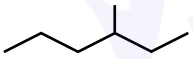
$$= 760 \times \frac{\frac{2}{0.52}}{1000} \times 18 = 52.615$$

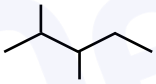
$P_5 = 760 - 52.615 = 707.385$ mm of Hg

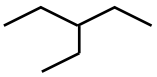
89. The number of different chain isomers for C_7H_{16} is _____.

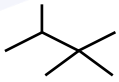
Ans. (9)

Sol. (i)  (ii) 

(iii)  (iv) 

(v)  (vi) 

(vii)  (viii) 

(ix) 

90. Number of molecules/species from the following having one unpaired electron is _____.

O_2, O_2^{-1}, NO, CN^{-1}, O_2^{2-}

Ans. (2)

Sol. According to M.O.T.

$O_2 \rightarrow$ no. of unpaired electrons = 2

$O_2^- \rightarrow$ no. of unpaired electron = 1

NO $\rightarrow$ no. of unpaired electron = 1

$CN^- \rightarrow$ no. of unpaired electron = 0

$O_2^{2-} \rightarrow$ no. of unpaired electron = 0