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SOLUTIONS OF IIT-JEE 2009

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PAPER - II
[CHEMISTRY]

SECTION - I
Single Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

1. The spin only magnetic moment value (in Bohr magneton units) of $Cr(CO)_6$ is :

(A) 0 (B) 2.84
(C) 4.90 (D) 5.92

Sol.(A) Cr^0

$_{24}Cr$ $[Ar]$ 3d: ↑ ↑ ↑ ↑ ↑ ; 4S: ↑

Electronic Configuration in presence of CO

Cr $[Ar]$

↑↓ ↑↓ ↑↓ xx xx xx xx xx xx

CO CO CO CO CO CO

2. For a first order reaction $A \rightarrow P$, the temperature (T) dependent rate constant (k) was found to follow the equation $\log k = -(2000)\frac{1}{T} + 6.0$. The pre-exponential factor A and the activation energy E_a, respectively, are :

(A) $1.0\times10^6 s^{-1}$ and $9.2 kJ\ mol^{-1}$

(B) $6.0 s^{-1}$ and $16.6 kJ\ mol^{-1}$

(C) $1.0\times10^6 s^{-1}$ and $16.6 kJ\ mol^{-1}$

(D) $1.0\times10^6 s^{-1}$ and $38.3 kJ\ mol^{-1}$

Sol.(D) $\log k = 6 - 2000\frac{1}{T}$

$$\log k = \log A - \frac{ta}{2.303RT}$$

$\therefore \log A = 6 \qquad \therefore A = 106\,\text{sec}^{-1}$

$$\frac{Ea}{2.303R} = 2000$$

$$Ea = 2000\times2.303\times R = 2000\times2.303\times8.314$$
$$= 2\times2.303\times8.314 kj\ mol^{-1}$$
$$= 38.3 kj\ mol^{-1}$$

3. The correct stability order of the following resonance structures is :

$H_2C=\overset{+}{N}=\overset{-}{N}$ (I) $\qquad H_2\overset{+}{C}-N=\overset{-}{N}$ (II)

$H_2\overset{-}{C}-\overset{+}{N}\equiv N$ (III) $\qquad H_2\overset{-}{C}-N\equiv\overset{+}{N}$ (IV)

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

Sol.(B) In resonating structures octet of all atoms should be completed acc. to this structure (I) is most stable then (III) is more stable.

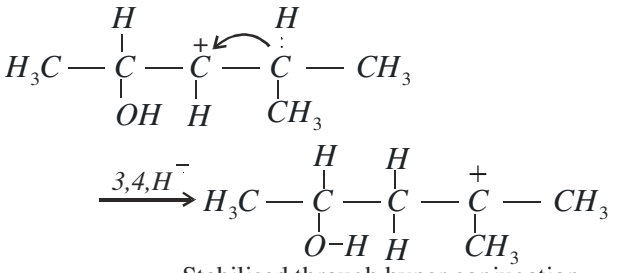
4. In the following carbocation; H / CH_3 that is most likely to migrate to the positiviely charged carbon is

$$H_3\overset{1}{C}-\overset{2}{\underset{HO}{\underset{|}{C}}}-\overset{3}{\overset{+}{\underset{H}{\underset{|}{C}}}}-\overset{4}{\underset{CH_3}{\underset{|}{C}}}-\overset{5}{H}CH_3$$

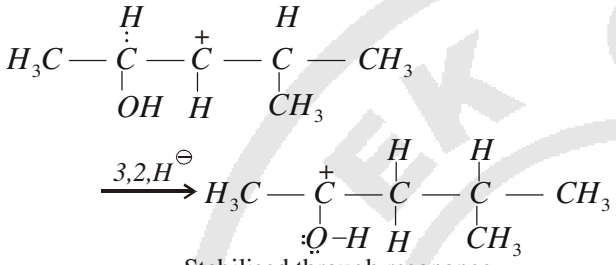
(A) CH_3 at $C-4$ (B) H at $C-4$

(C) CH_3 at $C-2$ (D) H at $C-2$

Sol.(D)



Stabilised through hyper conjugation and by I effect



Stabilised through resonance and by + I effect

SECTION - II

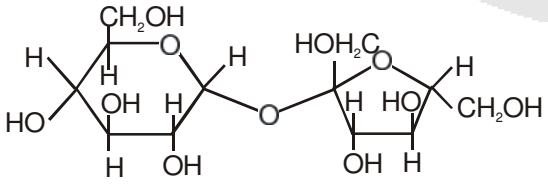
Multiple Correct Answer Type

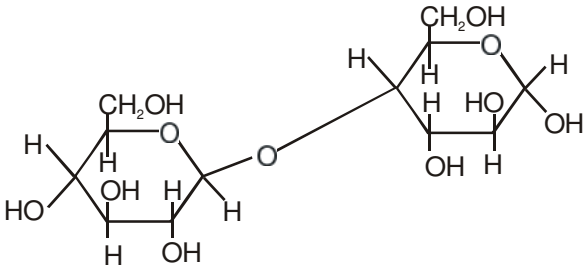
This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

9. Among the following, the state function(s) is(are):
(A) Internal energy
(B) Irreversible expansion work
(C) Reversible expansion work
(D) Molar enthalpy

Sol. **(A,D)**
State functions are internal energy and molar enthalpy.

6. The correct statement(s) about the following sugars **X** and **Y** is(are) :





(A) **X** is a reducing sugar and **Y** is a non-reducing sugar.
(B) **X** is a non-reducing sugar and **Y** is a reducing sugar.
(C) The glucosidic linkages in **X** and **Y** are α and β, respectively.
(D) The glucosidic linkages in **X** and **Y** are β and α, respectively.

Sol. **(B, C)**

7. For the reduction of NO_3^- ion in an aqueous solution E° is +0.96 V. Values of E° for some metal ions are given below

V^{2+} (aq) + $2e^+ \rightarrow V$ $\quad E^\circ = -1.19$ V

Fe^{3+} (aq) + $3e^- \rightarrow Fe$ $\quad E^\circ = -0.04$ V

Au^{3+} (aq) + $3e^- \rightarrow Au$ $\quad E^\circ = +1.40$ V

Hg^{2+} (aq) + $2e \rightarrow Hg$ $\quad E^\circ = +0.86$ V

The pair(s) of metals that is(are) oxidized by NO_3^- in aqueous solution is(are) :

(A) V and Hg (B) Hg and Fe
(C) Fe and Au (D) Fe and V

Sol. **(A,B,D)**

8. In the reaction

$$2X + B_2H_6 \rightarrow \left[BH_2\left(X\right)_2\right]^+ \left[BH_4\right]^-$$

the amine(s) **X** is(are) :

(A) NH_3 (B) CH_3NH_2

(C) $\left(CH_3\right)_2 NH$ (D) $\left(CH_3\right)_3 N$

Sol.(A) When B_2H_6 reacts with excess of NH_3 at low temperature $(-120^0 C)$ it forms an addition compound called diammoniate of diborane $B_2H_6 \cdot 2NH_3$ which forms a conducting solution in liquid ammonia

$B_2H_6 + 2NH_3$(Excess)
$\rightarrow B_2H_6 \cdot 2NH_3$white nv solid
(Ionic Compound)

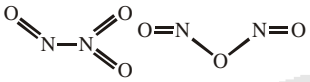
9. The nitrogen oxide(s) that contain(s) N.N bond(s) is (are) :

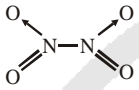
(A) N_2O (B) N_2O_3

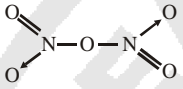
(C) N_2O_4 (D) N_2O_5

Sol. (A, B, C)

Assymmetrical form Symmetrical form

(i) $N_2O_3 \rightarrow$ 

(ii) $N_2O_4 \rightarrow$ 

(iii) $N_2O_5 \rightarrow$ 

(iv) $N=N=O \rightarrow N \equiv \overset{+}{N}-O^-$

SECTION - III

Matrix - Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column-I** are labelled A, B, C and D, while the statements in **Column-II** are labelled p, q, r, s and t. Any given statement in **Column-I** can have correct matching with **ONE OR MORE** statement(s) in **Column-II**. The appropriate bubbles corresponding to the answers to these questions have to be drakened as illustrated in the following example.

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following :

10. Match each of the reactions given in **column I** with the corresponding products (s) given in **column II**

Column I	**Column II**
(A) $Cu +$ dil HNO_3	(p) NO
(B) $Cu +$ conc HNO_3	(q) NO_2
(C) $Zn +$ dil HNO_3	(r) N_2O
(D) $Zn +$ conc HNO_3	(s) $Cu(NO_3)_2$
	(t) $Zn(NO_3)_2$

Sol. A $\rightarrow$ p, s C $\rightarrow$ r, t

B $\rightarrow$ q, s D $\rightarrow$ q, t

(A)

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

(B)

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + NO_2 + 2H_2O$$

(C)

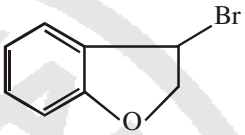
$$4Zn + 10HNO_3(dil) \rightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$$

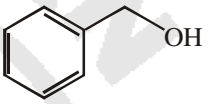
(D)

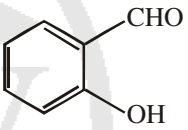
$$Zn + 4HNO_3(conc) \rightarrow Zn(NO_3)_2 + 2N_2O + 2H_2O$$

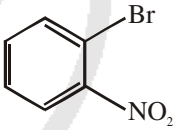
11. Match each of the compounds given in **Column I** with the reaction(s), that they can undergo, given in **Column II**

Column I

(A) 

(B) 

(C) 

(D) 

Column II

(p) Nucleophilic substitution

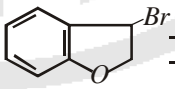
(q) Elimination

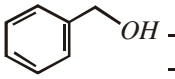
(r) Nucleophilic addition

(s) Esterification with acetic anhydride

(t) Dehydrogenation

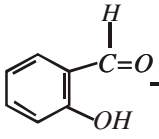
Sol. **(A) $\rightarrow$ p, q (B) $\rightarrow$ p,s,t (C) $\rightarrow$ r, s (D) $\rightarrow$ p**

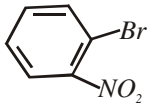
 $\rightarrow$ *NPSR* $\rightarrow$ *Elimination* (A) $\rightarrow$ p,q

 $\rightarrow$ *NPSR* (B) $\rightarrow$ p,s,t

$\rightarrow$ Esterification with acetice anhydride

$\rightarrow$ Dehydrogenation because of α – hydrogen

 $\rightarrow$ *Nucleophilic addtion* (C) $\rightarrow$ r,s

 $\rightarrow$ *Nucleophilic substitution (p)*

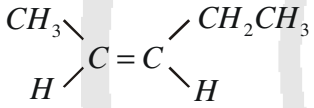
SECTION - IV
Integer Answer Type

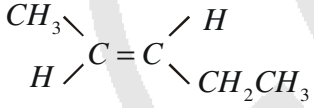
This section contains 8 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The appropriate bubbles below the respectively question numbers in the ORS have to be darkened. For example, if the correct answers to question number X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will like the following :

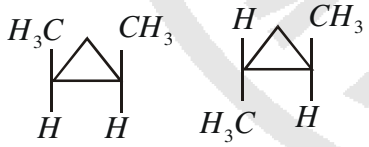
12. The total number of cyclic structural as well as stereo isomers possible for a compound with the molecular formula C_5H_{10} is

Sol. **7**

C_5H_{10}







13. The total number of α and β particles emitted in the nuclear reaction $^{238}_{92}U \rightarrow ^{214}_{82}Pb$ is

Sol. **8**

$^{238}_{92}U \rightarrow ^{214}_{82}pb$

number of $\alpha-$particle $= \dfrac{238-214}{4} = \dfrac{24}{4} = 6$

number of $\beta-$particle $= 6\times2-(92-82)$

$= 12-10 = 2$

$\therefore$ sum of α and β-particle = 6 + 2 = 8

14. At 400 K, the root mean square (rms) speed of a gas X (molecular weight = 40) is equal to the most probable speed of gas Y at 60 K. The molecular weight of the gas Y is

Sol. **4**

$$\sqrt{\frac{3RT_x}{M_x}} = \sqrt{\frac{2RT_y}{M_y}}$$

$$\frac{3T_x}{M_x} = \frac{2T_y}{M_y}$$

$$\frac{3\times400}{40} = \frac{2\times60}{M_y}$$

$$M_y = \frac{2\times60}{3\times10} = 4$$

15. The oxidation number of Mn in the product of alkaline oxidative fusion of MnO_2 is

Sol. **6**

Reaction of alkaline oxidative fusion of MnO_2 is

$$2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$$

$\therefore$ oxidation number of Mn in $K_2MnO_4 = +6$

16. The Coordination number of Al in the crystalline state of $AlCl_3$ is

Sol. **6**

$AlCl_3$ exists as a close packed lattice of Cl^- with Al^{3+} occupying octahedral holes. Hence cordination number of $Al^{3+} = 6$

17. The dissociation constant of a substituted benzoic acid at $25°C$ is 1.0×10^{-4}. The pH of $0.01M$ solution of its sodium salt is

Sol. **8**

$$pH = 7 + \frac{1}{2}pKa + \frac{1}{2}\log C$$

$$= 7 + \frac{1}{2}\times4 + \frac{1}{2}\log(0.01)$$

$$= 7 + 2 - \frac{2}{2} = 8$$

18. In a constant volume calorimeter, 3.5 g of a gas with molecular weight 28 was burnt in excess oxygen at 298.0 K. The temperature of the calorimeter was found to increases from 298.0 K to 298.45 K due to the combustion process. Given that the heat capacity of the calorimeter is $2.5kJ\ K^{-1}$, the numerical value for the enthalpy of combustion of the gas in $kJ\ \text{mol}^{-1}$ is

Sol. **9**

$$\Delta E = \frac{(m+w)S(T_2-T_1)}{\left(w^1/m\right)}$$

$$= \frac{2.5\times(298.5-298)}{(3.5/28)}$$

$$= \frac{2.5\times0.45\times28}{3.5} \qquad = 9Kj/mol^{-1}$$

19. The number of water molecule (s) directly bonded to the metal centre in $CuSO_4\cdot5H_2O$ is

Sol. **4**

The Cu^{2+} ion is found to be at the centre of an octahedron of Six -vely changed O-atom. Form of them belong to four water molecule and they form. Sequare with the Cu^{2+} ion and the other two $O-$ atoms comes from sulphate ion.