Download IIT-JEE Previous Year Paper - II "2009" (Chemistry)

IITJEE 2009 (PAPER-2, CODE-1)

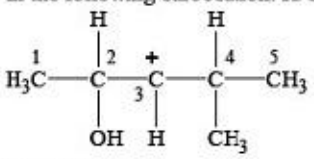
PART I: CHEMISTRY

SECTION-I

Single Correct Choice Type

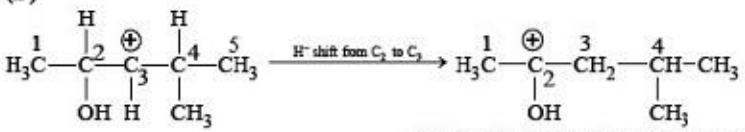
This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** is correct.

1. In the following carbocation. H/CH_3 that is most likely to migrate to the positively charged carbon is



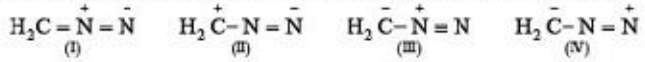
(A) CH_3 at C-4
(B) H at C-4
(C) CH_3 at C-2
(D) H at C-2

Sol. **(D)**



(driving force is conjugation from oxygen)

2. The correct stability order of the following resonance structures is



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

Sol. **(B)**
On the basis of stability of resonating structures.

3. 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)**
$[Cr(CO)_6]$
$Cr(24) = [Ar]3d^5 4s^1$
Since (CO) is strong ligand, in $Cr(CO)_6$ no unpaired electron is present. So 'spin only' magnetic moment is zero.

4. For a first order reaction A → 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) $1.0 \times 10^6\ s^{-1}$ and $9.2\ kJmol^{-1}$
(B) $6.0\ s^{-1}$ and $16.6\ kJmol^{-1}$
(C) $1.0 \times 10^6\ s^{-1}$ and $16.6\ kJmol^{-1}$
(D) $1.0 \times 10^6\ s^{-1}$ and $38.3\ kJmol^{-1}$

Sol. **(D)**

Given, $\log K = 6 - \frac{2000}{T}$

Since, $\log K = \log A - \frac{Ea}{2.303RT}$ So, $A = 10^6\ sec^{-1}$ and $Ea = 38.3\ kJ/mole$

SECTION-II

Multiple Correct Choice Type

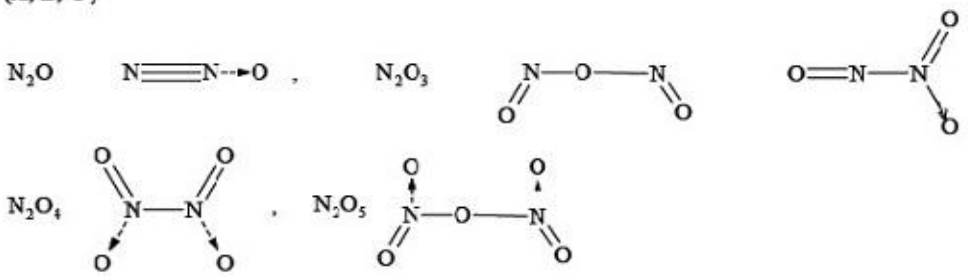
This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

5. 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)**



6. In the reaction

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

the amine(s) X is(are)

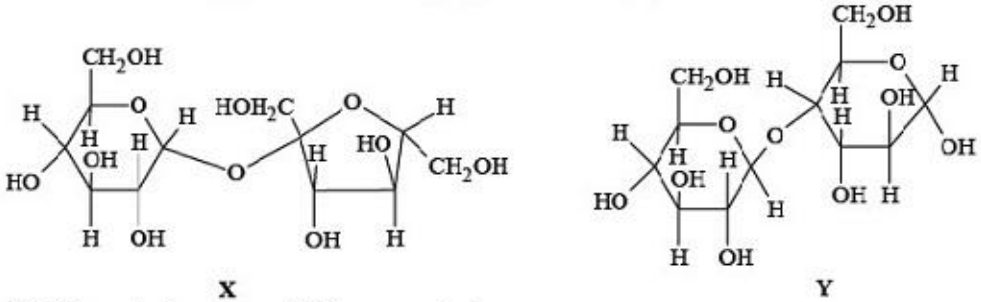
(A) NH_3 (B) CH_3NH_2

(C) $(CH_3)_2NH$ (D) $(CH_3)_3N$

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

Due to bulkiness of trimethylamine, it does not react.

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



X **Y**

(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)**

8. 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)**

9. For the reduction of NO_3^- ion in an aqueous solution, E^0 is +0.96 V. Values of E^0 for some metal ions are given below

$V^{2+}(aq) + 2e^- \rightarrow V \quad E^0 = -1.19\ V$

$Fe^{3+}(aq) + 3e^- \rightarrow Fe \quad E^0 = -0.04\ V$

$Au^{3+}(aq) + 3e^- \rightarrow Au \quad E^0 = +1.40\ V$

$Hg^{2+}(aq) + 2e^- \rightarrow Hg \quad E^0 = +0.86\ V$

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)**

$E^0_{\underset{(SRP)}{NO_3^-(aq)}} = 0.96\ V$ All V, Fe, Hg have less SRP w.r.t. NO_3^-.

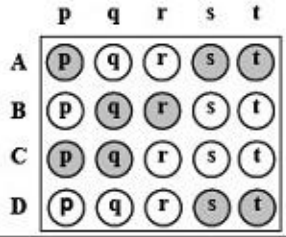
So, V, Fe, Hg can be oxidized by NO_3^- in aqueous solution.

SECTION – III

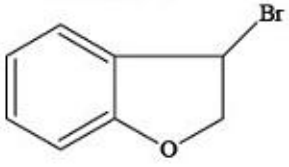
Matrix – Match Type

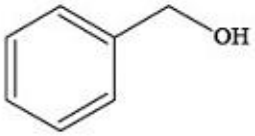
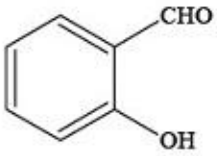
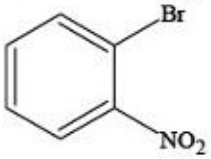
This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching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

Column – I	Column – II
(A) 	(p) Nucleophilic substitution

(B)		(q)	Elimination
(C)		(r)	Nucleophilic addition
(D)		(s)	Esterification with acetic anhydride
		(t)	Dehydrogenation

Sol. **((A – p, q, t) (B – p, s, t) (C – r, s) (D – p))**

11. Match each of the reactions given in **Column I** with the corresponding product(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 – p, s) (B – q, s) (C – r, t) (D – q, t))**

$$3Cu + \text{dil.}\, 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$$

$$Cu + \text{conc.}\, 4HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + 2NO_2$$

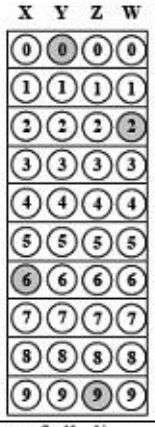
$$4Zn + \text{dil.}\, 10HNO_3 \rightarrow 4Zn(NO_3)_2 + 5H_2O + N_2O$$

$$Zn + \text{conc.}\, 4HNO_3 \rightarrow Zn(NO_3)_2 + 2H_2O + 2NO_2$$

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 respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the following:



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

Sol. **6**

$2MnO_2 + 4KOH + O_2 \rightarrow \underset{\text{(Potassium manganate)}}{2K_2MnO_4} + 2H_2O$ O. S. of Mn = +6 in K_2MnO_4

13. The number of water molecule(s) directly bonded to the metal centre in $CuSO_4 \cdot 5H_2O$ is

Sol. **4**

$CuSO_4 \cdot 5H_2O \rightarrow \left[Cu(H_2O)_4\right]SO_4 \cdot H_2O$

So, water molecules directly attached to Cu are 4.

14. The coordination number of Al in the crystalline state of $AlCl_3$ is

Sol. **6**

Coordination number of Al is 6. It exists in ccp lattice with 6 coordinate layer structure.

15. 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 increase from 298.0 K to 298.45 K due to the combustion process. Given that the heat capacity of the calorimeter is 2.5 kJ K^{-1}, the numerical value for the enthalpy of combustion of the gas in $kJmol^{-1}$ is

Sol. **9**

Energy release at constant volume due to combustion of 3.5 gm of a gas = 2.5 x 0.45

Hence energy released due to the combustion of 28 gm (i.e., 1 mole) of a gas $= 2.5 \times 0.45 \times \frac{28}{3.5} = 9\ kJmol^{-1}$

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

Sol. **8**

$K_a (C_6H_5COOH) = 1 \times 10^{-4}$

pH of 0.01 M C_6H_5COONa

$$\underset{0.01(1-h)}{C_6H_5COO^-} + H_2O \rightleftharpoons \underset{0.01\,h}{C_6H_5COOH} + \underset{0.01\,h}{OH^-}$$

$$K_h = \frac{K_w}{K_a} = \frac{0.01\,h^2}{1-h}$$

$$\frac{10^{-14}}{10^{-4}} = \frac{10^{-2}h^2}{1-h} \quad (1-h \approx 1)$$

$[OH^-] = 0.01\,h = 0.01 \times 10^{-4} = 10^{-6}$

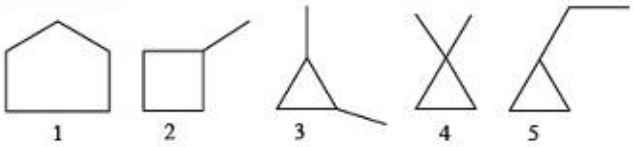
$[H^+] = 10^{-8}$

pH = 8

17. 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**

Cyclic C_5H_{10}



1 2 3 4 5

For 3rd structure 2 cis-trans and 1 optical isomer are possible.

Total 7 isomers.

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

Sol. **8**

$_{92}U^{238} \xrightarrow{-6\alpha} {}_{80}X^{214} \xrightarrow{-2\beta} {}_{82}Pb^{214}$ $(6\alpha, 2\beta)$, total 8 paritcles.

19. 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**

$V_{rms_{(X\,gas)(400\,K)}} = V_{mp_{(Y\,gas)(60\,K)}}$

M.W. (X gas) = 40; M.W. (Y gas) = x

$$\sqrt{\frac{3RT_1}{M_1}} = \sqrt{\frac{2RT_2}{M_2}}$$

$$\sqrt{\frac{400 \times 3}{40}} = \sqrt{\frac{2 \times 60}{x}}$$

$$30 = \frac{120}{x}$$

x = 4