

CHEMISTRY

PART-I 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 correct stability order of the following resonance structures is

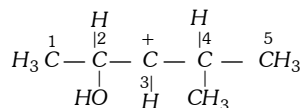


- (A) (I) > (III) > (IV) > (II) (B) (I) > (III) > (II) > (IV) (C) (II) > (I) > (III) > (IV) (D) (III) > (I) > (IV) > (II)

- Sol. (B) $H_2C = \overset{+}{N} = \overset{-}{N}$ $H_2\overset{+}{C} - N = \overset{-}{N}$ $H_2\overset{-}{C} - \overset{+}{N} \equiv N$ $H_2\overset{-}{C} - N = \overset{+}{N}$
 (I) (II) (III) (IV)

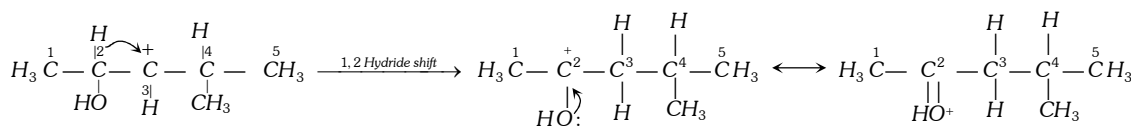
octet complete octet incomplete octet complete octet incomplete
 -ve charge on nitrogen -ve charge on nitrogen -ve charge on carbon -ve charge on carbon

2. In the following carbocation, H / CH₃ that is most likely to migrate to the positively charged carbon is



- (A) CH₃ at C-4 (B) H at C-4 (C) CH₃ at C-2 (D) H at C-2

- Sol. (D)



(More stable carbocation due to
 +m effect of -OH group and +I and
 hyperconjugative effect of -CH₃ group)

3. 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) $1.0 \times 10^6 s^{-1}$ and $9.2 kJ mol^{-1}$ (B) $6.0 s^{-1}$ and $16.6 kJ mol^{-1}$
 (C) $1.0 \times 10^6 s^{-1}$ and $16.6 kJ mol^{-1}$ (D) $1.0 \times 10^6 s^{-1}$ and $38.3 kJ mol^{-1}$

- Sol. (D) From Arrhenius equation $K = A e^{-E_a/RT}$

$$\ln k = \ln A - \frac{E_a}{RT}$$

$$2.303 \log K = 2.303 \log A - \frac{E_a}{Rt}$$

$$\log K = \frac{-E_a}{2.303 R} \times \frac{1}{T} + \log A \quad \dots(i)$$

$$\log K = -(2000) \frac{1}{T} + 6 \quad \dots(ii)$$

On comparing equation (i) and (ii)

$$\frac{-E_a}{2.303 R} = -2000$$

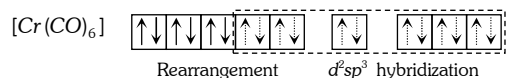
$$E_a = 2.303 \times 8.314 \times 2000 = 38.29 kJ$$

$$\text{and } \log A = 6 \quad A = 10^6$$

4. 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) The chromium is in zero oxidation state having configuration $[Ar]^{18} 3d^5 4s^1$. The CO is a strong field ligand so compels for the pairing of electrons. Thus the complex has d^2sp^3 hybridisation and is diamagnetic.



$$\mu_{BM} = \sqrt{n(n+2)} = 0 \text{ as there is no unpaired electrons.}$$

SECTION – II

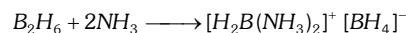
Multiple Correct Choice Type

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

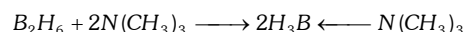
5. In the reaction, $2X + B_2H_6 \rightarrow [BH_2(X)_2]^+ [BH_4]^-$, the amine(s) X is (are)

- (A) NH_3 (B) CH_3NH_2 (C) $(CH_3)_2NH$ (D) $(CH_3)_3N$

Sol. (A,B,C) Small amines such as NH_3 , CH_3NH_2 and $(CH_3)_2NH$ give unsymmetrical cleavage of diborane according to following reaction.



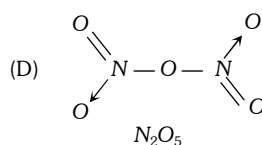
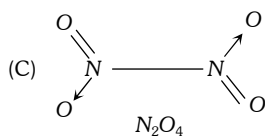
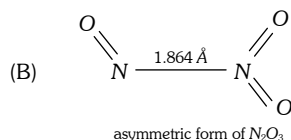
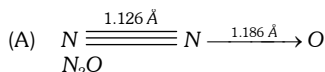
Large amines, such as $(CH_3)_3N$ gives symmetrical cleavage of diborane according to following reaction.



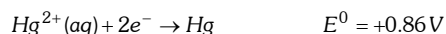
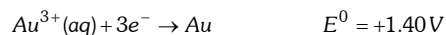
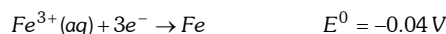
6. The nitrogen oxide(s) that contain(s) N – N bond(s) is (are)

- (A) N_2O (B) N_2O_3 (C) N_2O_4 (D) N_2O_5

Sol. (A,B,C)



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



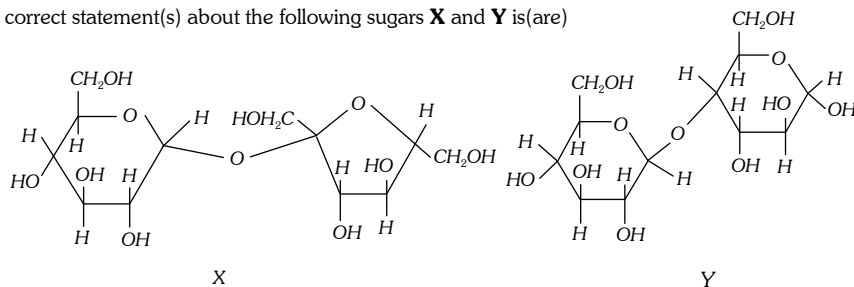
The pair(s) of metals that is(are) oxidized by NO_3^- in aqueous solution is(are)

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

Sol. (A,B,D) The species having less reduction potential with respect to NO_3^- ($E^0 = 0.96V$) will be oxidised by NO_3^- .

These species are V, Fe, Hg.

8. 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 glycosidic linkages in **X** and **Y** are α and β , respectively
 (D) The glycosidic linkages in **X** and **Y** are β and α , respectively

Sol. (B,C) **X** has acetal linkage and **Y** has hemiacetal linkage. Carbohydrate with hemiacetal linkage are reducing sugars and carbohydrate with acetal linkage are non reducing sugars.

X is α -anomer and **Y** is β -anomer of D (+) glucose.

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 function are internal energy and molar enthalpy.

Work is path function whether it is reversible or irreversible.

SECTION - III

Matrix - Match Type

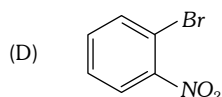
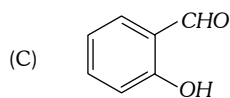
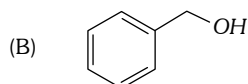
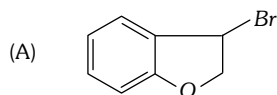
This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching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

	p	q	r	s	t
A	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
B	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
C	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>

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

(p) Nucleophilic substitution

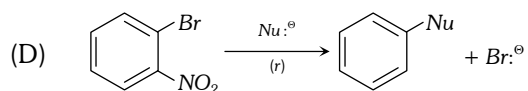
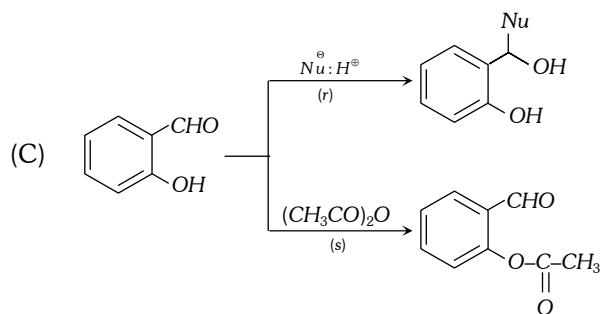
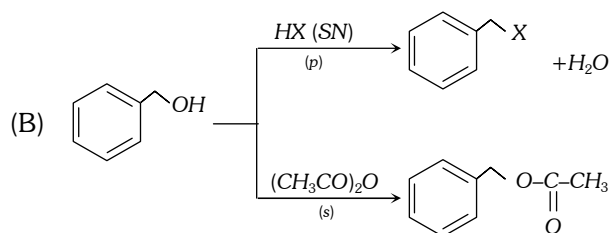
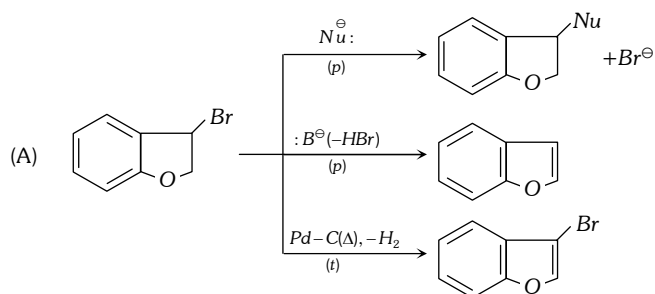
(q) Elimination

(r) Nucleophilic addition

(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

- (A) $\text{Cu} + \text{dil HNO}_3$
 (B) $\text{Cu} + \text{conc HNO}_3$
 (C) $\text{Zn} + \text{dil HNO}_3$
 (D) $\text{Zn} + \text{conc HNO}_3$

Column II

- (p) NO
 (q) NO_2
 (r) N_2O
 (s) $\text{Cu}(\text{NO}_3)_2$
 (t) $\text{Zn}(\text{NO}_3)_2$

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

- (A) $3\text{Cu} + 8\text{HNO}_3$ (dilute HNO_3) $\longrightarrow 2\text{NO} + \text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O}$
 (B) $\text{Cu} + 4\text{HNO}_3$ (concentrated) $\longrightarrow 2\text{NO}_2 + \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$
 (C) $4\text{Zn} + 10\text{HNO}_3$ (dilute) $\longrightarrow 4\text{Zn}(\text{NO}_3)_2 + \text{N}_2\text{O} + 5\text{H}_2\text{O}$
 (D) $\text{Zn} + 4\text{HNO}_3$ (concentrated) $\longrightarrow \text{Zn}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$

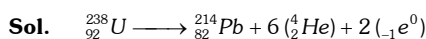
SECTION - IV

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 :

	X	Y	Z	W
0	0	0	0	0
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9

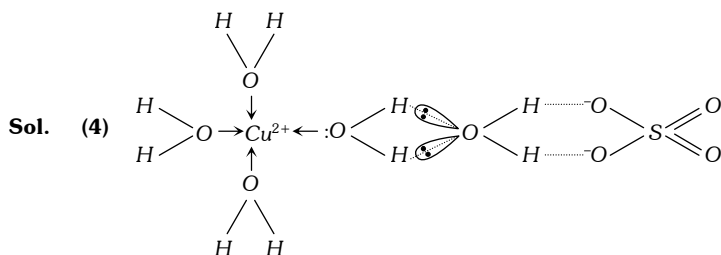
- 12.** The total number of α and β particles emitted in the nuclear reaction ${}_{92}^{238}\text{U} \rightarrow {}_{82}^{214}\text{Pb}$ is



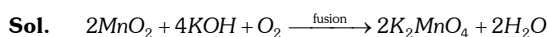
$$\alpha = 6, \beta = 2$$

$$\text{Total} = 8.$$

- 13.** The number of water molecule(s) directly bonded to the metal centre in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is



- 14.** The oxidation number of Mn in the product of alkaline oxidative fusion of MnO_2 is



Let the oxidation state of Mn in MnO_4^{2-} is x .

$$\text{So, } x + 4(-2) = -2 \text{ or } x = 6.$$

- 15.** The coordination number of Al in the crystalline state of AlCl_3 is

Sol. (6)

- 16.** In a constant volume calorimeter, 3.5g of a gas with molecular weight 28 was burnt in excess oxygen at 298.0K. The temperature of the calorimeter was found to increase from 298.0K to 298.45K 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 kJ mol^{-1} is

Sol. $n = \frac{3.5}{28}$

$$\Delta T = T_2 - T_1 = 298.45 - 298 = 0.45$$

$$C_V = 2.5 \text{ kJ K}^{-1} = 2500 \text{ JK}^{-1}$$

$$C_P = C_V + R = 2500 + 8.314 = 2508.314 \text{ JK}^{-1}$$

$$Q_P = C_P \Delta T = 1128.74 \text{ J}$$

$$\Delta H = \frac{Q_P}{n} = \frac{1128.74}{3.5/28} \Rightarrow 9030 \text{ J mol}^{-1} = 9.030 \text{ KJ mol}^{-1} = 9 \text{ KJ mol}^{-1}.$$

