

Chemistry

General Instructions:

SECTION 1 (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +3 If ONLY the correct option is chosen;
Zero Marks	: 0 If none of the options is chosen (i.e., the question is unanswered);
Negative Marks	: -1 In all other cases.

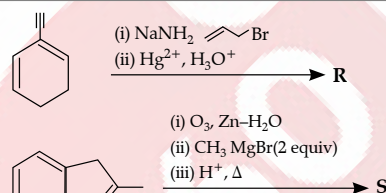
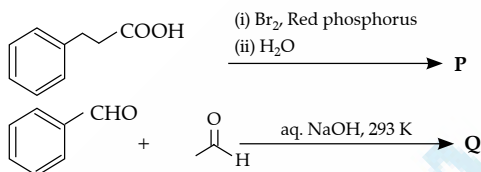
1. During sodium nitroprusside test of sulphide ion in an aqueous solution, one of the ligands coordinated to the metal ion is converted to

- (A) NOS^- (B) SCN^-
(C) SNO^- (D) NCS^-

2. The complete hydrolysis of ICl , ClF_3 and BrF_5 , respectively, gives

- (A) IO_3^- , ClO_2^- and BrO_3^-
(B) IO_3^- , ClO_2^- and BrO_3^-
(C) IO_3^- , ClO_2^- and BrO_2^-
(D) IO_3^- , ClO_4^- and BrO_2^-

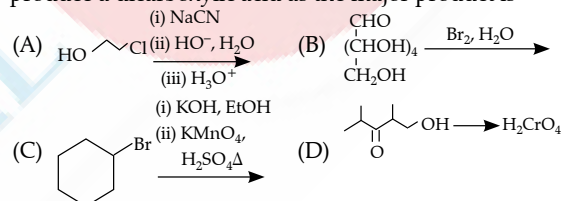
3. Monocyclic compounds P, Q, R and S are the major products formed in the reaction sequences given below.



The product having the highest number of unsaturated carbon atom(s) is

- (A) P (B) Q
(C) R (D) S

4. The correct reaction/reaction sequence that would produce a dicarboxylic acid as the major product is



General Instructions:

SECTION 2 (Maximum Marks: 16)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +4 ONLY if (all) the correct option(s) is(are) chosen;
Partial Marks	: +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks	: +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks	: +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	: 0 If none of the options is chosen (i.e., the question is unanswered);
Negative Marks	: -2 in all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
 - choosing ONLY (A), (B) and (D) will get +4 marks;
 - choosing ONLY (A) and (B) will get +2 marks;
 - choosing ONLY (A) and (D) will get +2 marks;
 - choosing ONLY (B) and (D) will get +2 marks;
 - choosing ONLY (A) will get +1 mark;
 - choosing ONLY (B) will get +1 mark;
 - choosing ONLY (D) will get +1 mark;
 - choosing no option (i.e., the question is unanswered) will get 0 marks and
 - choosing any other combination of option(s) will get -2 marks.

- statement(s) is(are)
- (i) $\text{KMnO}_4, \text{H}^+, \Delta$
(ii) $\text{NH}_3, \Delta, -2\text{H}_2\text{O}$
- (i) Strong heating
(ii) Ethanolic KOH
(iii) R-Br
- c1ccc2ccccc2c1 $\xrightarrow{\text{(i) \& (ii)}}$ X $\xrightarrow{\text{(iii)}}$ Y $\xrightarrow{\text{NaOH}}$ Aromatic compound + Z

9. The density (in g cm^{-3}) of the metal which forms a cubic close packed (ccp) lattice with an axial distance (edge length) equal to 400 pm is _____.
Use: Atomic mass of metal = 105.6 amu and Avogadro's constant = $6 \times 10^{23} \text{ mol}^{-1}$
10. The solubility of barium iodate in an aqueous solution prepared by mixing 200 mL of 0.010 M barium nitrate with 100 mL of 0.10 M sodium iodate is $X \times 10^{-6} \text{ mol dm}^{-3}$. The value of X is _____. **Use:** Solubility product constant (K_{sp}) of barium iodate = 1.58×10^{-9}
11. Adsorption of phenol from its aqueous solution on to fly ash obeys Freundlich isotherm. At a given temperature, from 10 mg g^{-1} and 16 mg g^{-1} aqueous phenol solutions, the concentrations of adsorbed phenol are measured to be 4 mg g^{-1} and 10 mg g^{-1} , respectively. At this temperature, the concentration (in mg g^{-1}) of adsorbed phenol from 20 mg g^{-1} aqueous solution of phenol will be _____.
Use: $\log_{10} 2 = 0.3$
12. Consider a reaction $A + R \rightarrow \text{Product}$. The rate of this reaction is measured to be $k[A][R]$. At the start of the reaction, the concentration of R, $[R]_0$, is 10 times the concentration of A, $[A]_0$. The reaction can be considered to be a pseudo first-order reaction with assumption that $k[R] = k'$ is constant. Due to this assumption, the relative error (in %) in the rate when this reaction is 40 % complete, is _____.
[k and k' represent corresponding rate constants]
13. At 300 K, an ideal dilute solution of a macromolecule exerts osmotic pressure that is expressed in terms of the height (h) of the solution (density = 1.00 g cm^{-3}) where h is equal to 2.00 cm. If the concentration of the dilute solution of the macromolecule is 2.00 g dm^{-3} , the molar mass of the macromolecule is calculated to be $X \times 10^4 \text{ g mol}^{-1}$. The value of X is _____.
Use: Universal gas constant (R) = $8.3 \text{ J K}^{-1} \text{ mol}^{-1}$ and acceleration due to gravity (g) = 10 m s^{-2}
14. An electrochemical cell is fuelled by the combustion of butane at 1 bar and 298 K. Its cell potential is $X/F \times 10^3$ volts, where F is the Faraday constant. The value of X is _____.
Use: Standard Gibbs energies of formation at 298 K are: $\Delta_f G^\circ_{\text{CO}_2} = -394 \text{ kJ mol}^{-1}$; $\Delta_f G^\circ_{\text{water}} = -237 \text{ kJ mol}^{-1}$; $G^\circ_{\text{butane}} = -18 \text{ kJ mol}^{-1}$
15. The sum of the spin only magnetic moment values (in B.M.) of $[\text{Mn}(\text{Br})_6]^{3-}$ and $[\text{Mn}(\text{CN})_6]^{3-}$ is _____.
16. A linear octasaccharide (molar mass = 1024 g mol^{-1}) on complete hydrolysis produces three monosaccharides: ribose, 2-deoxyribose and glucose. The amount of 2-deoxyribose formed is 58.26% (w/w) of the total amount of the monosaccharides produced in the hydrolysed products. The number of ribose unit(s) present in one molecule of octasaccharide is _____.
Use: Molar mass (in g mol^{-1}): ribose = 150, 2-deoxyribose = 134, glucose = 180; Atomic mass (in amu): H = 1, O = 16

Answer Key

Q.No.	Answer key	Chapter name	Topic's name
1	(A)	Practical Organic Chemistry	Organic Chemistry - Basic Principles and Techniques
2	(A)	Inter Halogen Compound	p Block Elements
3	(D)	Carboxylic Acid	Aldehyde, Ketone and Carboxylic Acid
4	(C)	Elimination Reaction	Haloalkanes and Haloarenes
5	(C, D)	Secondary Forces	Chemical Bonding and Molecular Structure
6	(B, D)	Group 15 Elements	p Block
7	(A, C)	Phthalimide Synthesis Reaction	Amines
8	(B, C)	Oxidation and Reduction Reaction	Alcohol Phenol and Ether
9	[10.85–11.1]	Density Formula	Solid State
10	[3.85–4.15]	Solubility and Solubility Product	Equilibrium
11	[15.5–16.5]	Freundlich Isotherm	Surface Chemistry
12	[4 to 4.25]	Order of Reaction	Chemical Kinetics
13	[2.4 to 2.55]	Osmotic Pressure	Solution
14	[105.4 to 105.6]	Electrode Potential	Electrochemistry
15	[7.5 to 7.8]	Magnetic Moment	d and f Block Elements
16	[2]	Stoichiometry	Some Basic Concepts of Chemistry

P does not contain chiral carbon that's why *p* is optically inactive. So, option A is incorrect. S can give bayer's test. So, option B is correct. Q contain -COOH group that's why it gives effervescence with aq. NaHCO_3 . So, option C is also correct. R does not contain triple bond that's why option D is incorrect.

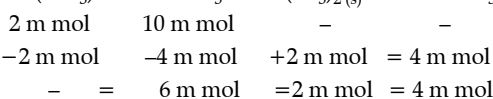
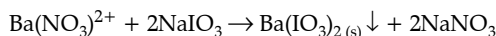
9. Correct answer is [11.00].

For CCP: $Z = 4$, $a = 400 \text{ pm} - 10 = 400 \times 10^{-10} \text{ cm}$

$$d = \frac{Z \times Mw}{N_A \times a^3} = \frac{4 \times 105.6}{6 \times 10^{23} \times (400 \times 10^{-10})^3}$$

$$= \frac{4 \times 105.6}{6 \times 10^{23} \times 4 \times 4 \times 4 \times 10^{-24}} = 11 \text{ g/cm}^3.$$

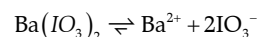
10. Correct answer is [3.95].



Further,

$$[\text{NaIO}_3] = \frac{6}{300} = 2 \times 10^{-3} \text{ M}$$

Further,



$$\text{S} \quad 2\text{S} + \frac{6}{300}$$

$$K_{sp} = (\text{Ba}^{2+})(\text{IO}_3^-)^2$$

$$(\text{S})(2\text{S} + 0.02)^2 = 1.58 \times 10^{-9}$$

$$\text{S} = 3.95 \times 10^{-6} \text{ M}$$

$$\text{X} = 3.95$$

11. Correct answer is [15.62].

$$\left(\frac{x}{m}\right) = K(C)^{1/n}$$

$$\log\left(\frac{x}{m}\right) = \log K + \frac{1}{n} \log C$$

$$\log 4 = \log K + \frac{1}{n} \log 10$$

$$0.6 = \log K + \frac{1}{n}$$

...(i)

$$\log 10 = \log K + \frac{1}{n} \log 16$$

$$1 = \log K + \frac{1}{n} \times 1.2$$

...(ii)

From Eqs. (i) and (ii)

$$-0.4 = \frac{1}{n} \times -0.2 \Rightarrow \frac{1}{n} = 2$$

$$n = 0.5$$

and from equation (ii) $\log K = -1.4$

$$\log \frac{x}{m} = \log K + \frac{1}{n} \log C$$

$$= -1.4 + 2 \times \log 20 = 1.4 + 2.6 = 1.2$$

$$\frac{x}{m} = 10^{1.2} = 16$$

$$\frac{x}{m} = K \times C^{\frac{1}{n}}$$

$$4 = k(10)^{1/n} - (1)$$

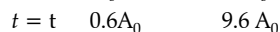
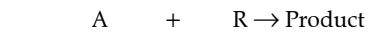
$$10 = k(16)^{1/n} - (2)$$

$$x = k(20)^{1/n} - (3)$$

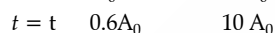
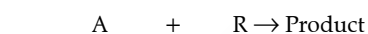
$$\text{On solving 1 and 3, } \frac{4}{x} = \left(\frac{10}{20}\right)^2 \Rightarrow x = 16$$

$$\text{On solving 2 and 3, } \frac{10}{x} = \left(\frac{16}{20}\right)^2 \Rightarrow x = 15.625$$

12. Correct answer is [4.17].



$$(\text{Rate})_1 = K(\text{A})(\text{R}) = k(0.6 \text{A}_0) \times (9.6 \text{A}_0) \quad \dots(i)$$



$$\text{Rate} = K'[\text{A}], \text{ as } K' = K[\text{R}]$$

$$(\text{Rate}_2) = (K \times 10\text{A}_0) \times (0.6 \text{A}_0)$$

$$\text{relative error in } (\%) = 100 \times \frac{\Delta(\text{Rate})}{(\text{Rate})_1} = \frac{(0.6 \times 10) - (0.6 \times 9.6)}{0.6 \times 9.6}$$

$$\times 100 = 4.166$$

$$= 4.17\%$$

13. Correct answer is [2.49].

$$\text{Given } d = 1 \text{ g/cm}^3 = 10^3 \text{ kg/m}^3$$

$$h = 2 \text{ cm} = 2 \times 10^{-2} \text{ m}$$

$$\pi = dgh = 10^3 \frac{\text{kg}}{\text{m}^3} \times 10 \frac{\text{m}}{\text{s}^2} \times 2 \times 10^{-2} \text{ m} = 200 \frac{\text{kg}}{\text{ms}^2}$$

$$C = \frac{\text{Weight of Salute}}{\text{md} \cdot \text{wt}} \times \frac{1}{V(\text{in dm}^3)} = \frac{2\text{gm}}{\text{M}} \times \frac{1}{1\text{dm}^3}$$

$$1 \text{ dm}^3 = 10^{-3} \text{ m}^3$$

$$C = \frac{2g}{x} \times \frac{10^3}{\text{m}^3}$$

$$R = 8.3 \frac{\text{J}}{\text{K mol}} = 8.3 \frac{\text{kgm}^2}{\text{s}^2} \times \frac{1}{\text{K mol}}$$

$$\text{from } \pi = C R T$$

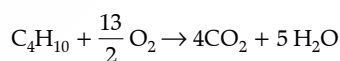
$$200 \frac{\text{K}}{\text{ms}^2} = \frac{2\text{gm}}{\text{M}} \times \frac{10^3}{\text{m}^3} \times 8.3 \frac{\text{kgm}^2}{\text{s}^2 \text{K mol}} \quad 300 \text{ K}$$

$$M = \frac{2 \times 10^3 \times 8.3 \times 300}{200} \text{ m/mol}$$

$$M = 2.49 \times 10^4 \text{ g/mol}$$

$$\text{X} = 2.49$$

14. Correct answer is [105.5].



$$\Delta_r G^0 = 4 \times (\Delta G_f^0 \text{ CO}_2) + 5(\Delta G_f^0 \text{ H}_2\text{O}) - (\Delta G_f^0 \text{ C}_4\text{H}_{10})$$

$$= 4 \times -394 + 5 \times -237 - (-18)$$

$$= -1576 + (-1185) + 18$$

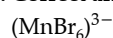
$$\Delta_r G^0 = -2743 \text{ kJ/mol}$$

$$\text{So, } \Delta G_r^0 = -nFE_{\text{cell}}^0$$

$$(n = 26 \text{ for combustion of butane})$$

$$E_{\text{cell}}^0 = \frac{2743 \times 10^3}{26 \times F} = \frac{105.5 \times 10^3}{F}, \text{ X} = 105.50$$

15. Correct answer is [7.73].



Oxidation State of Mn = +3

E.C. of $\text{Mn}^{3+} = 3d^4 t_{2g}^3 e_g^1$

Number of unpaired $e^- = 4$

Spin only magnetic moment = $\sqrt{n(n+2)}$ B.M

$$= \sqrt{4(4+2)} = \sqrt{24} = 4.9 \text{ B.M}$$

$[\text{Mn}(\text{CN})_6]^{3-}$

$\text{Mn}^{3+} \Rightarrow t_{2g}^4 e_g^0$

Number of unpaired $e^- = 2$

$$\mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83 \text{ B.M}$$

So, total spin only magnetic moment = $4.9 + 2.83 = 7.73$

16. Correct answer is [2].

Octasaccharide $\xrightarrow{\text{H}_2\text{O}^\oplus}$ Ribose + 2-deoxyribose + glucose

It has 7 C – O – C linkage. So, it will have 7 H_2O molecule for hydrolysis.

(w/w%) of 2-deoxyribose = 58.26

$$58.26 = \frac{134 \times n \times 100}{1150}$$

$$n = 5$$

mass of ribose + mass of glucose

$$= 1150 - 134 \times 5 = 480$$

So, number of ribose of unit will be 2 and number of glucose unit will be 1.

OSWAAL

360