Section A

Q. 1. According to MO theory the bond orders for O_2^{2-}, CO and NO^+ respectively, are
(1) 1, 2 and 3
(2) 1,3 and 2
(3) 2,3 and 3
(4) 1, 3 and 3

Q. 2. A doctor prescribed the drug Equanil to a patient. The patient was likely to have symptoms of which disease
(1) Hyperacidity
(2) Anxiety and stress
(3) Depression and hypertension
(4) Stomach ulcers

Q. 3. Reaction of propanamide with $Br_2/KOH(aq)$ produces :
(1) Propylamine
(2) Ethylnitrile
(3) Propanenitrile
(4) Ethylamine

Q. 4. The one giving maximum number of isomeric alkenes on dehydrohalogenation reaction is (excluding rearrangement)
(1) 2–Bromopropane
(2) 2–Bromo–3, 3–dimethylpentane
(3) 1–Bromo–2–methylbutane
(4) 2–Bromopentane

Q. 5. An indicator ' X ' is used for studying the effect of variation in concentration of iodide: on the rate of reaction of iodide ion with H_2O_2 at room temp. The indicator ' X ' forms blue colored complex with compound ' A ' present in the solution. The indicator ' X ' and compound 'A' respectively are
(1) Methyl orange and H_2O_2
(2) Starch and iodine
(3) Starch and H_2O_2
(4) Methyl orange and iodine

Q. 6. The major component of which of the following ore is sulphide based mineral?
(1) Siderite
(2) Sphalerite
(3) Malachite
(4) Calamine

Q. 7. A solution of CrO_5 in amyl alcohol has a _____ colour.
(1) Green
(2) Orange–Red
(3) Yellow
(4) Blue

Q. 8. The set of correct statements is :
(i) Manganese exhibits +7 oxidation state in its oxide.
(ii) Ruthenium and Osmium exhibit +8 oxidation in their oxides.
(iii) Sc shows +4 oxidation state which is oxidizing in nature.
(iv) Cr shows oxidising nature in +6 oxidation state.
(1) (ii) and (iii)
(2) (i), (ii) and (iv)
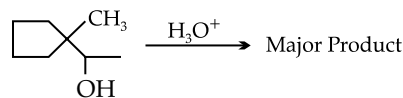(3) (ii), (iii) and (iv)
(4) (i) and (iii)

Q. 9. Following tetrapeptide can be represented as
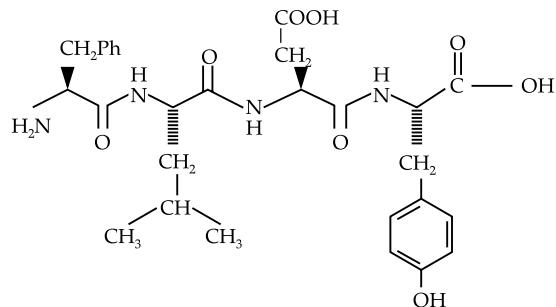
(F, L, D, Y, I, Q, P are one letter codes for amino acids)
(1) PLDY
(2) FIQY
(3) YQLF
(4) FLDY

Q. 10. Find out the major product for the following reaction.

(1)
(2)
(3)
(4)

Q. 11.

List I	List II
A. van't Hoff factor, i	**I.** Cryoscopic constant
B. k_f	**II.** Isotonic solutions
C. Solution with same with same osmotic pressure	**III.** $\dfrac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
D. Azeotropes	**IV.** Solutions with same composition of vapour above it

Choose the correct answer from the options given below :
(1) A–I, B–III, C–II, D–IV
(2) A–III, B–I, C–IV, D–II
(3) A–III, B–I, C–II, D–IV
(4) A–III, B–II, C–I, D–IV

Q. 12. Correct order of spin only magnetic moment of the following complex ions is:
(Given At.no. Fe: 26, Co:27)

(1) $[FeF_6]^{3-} > [Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-}$

(2) $[FeF_6]^{3-} > [CoF_6]^{3-} > [Co(C_2O_4)_3]^{3-}$

(3) $[Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-} > [FeF_6]^{3-}$

(4) $[CoF_6]^{3-} > [FeF_6]^{3-} > [Co(C_2O_4)_3]^{3-}$

Q. 13. Match List I with List II

| List I	List II
A. Elastomeric polymer	**I.** Urea formaldehyde resin
B. Fibre Polymer	**II.** Polystyrene
C. Thermosetting Polymer	**III.** Polyester
D. Thermoplastic Polymer	**IV.** Neoprene

Choose the correct answer from the options given below:

(1) A–II, B–III, C–I, D–IV

(2) A–IV, B–III, C–I, D–II

(3) A–IV, B–I, C–III, D–II

(4) A–II, B–I, C–IV, D–III

Q. 14. The concentration of dissolved Oxygen in water for growth of fish should be more than X ppm and Biochemical Oxygen Demand in clean water should be less than Y ppm. X and Y in ppm are, respectively.

(1)
X	Y
4	8

(2)
X	Y
6	5

(3)
X	Y
4	15

(4)
X	Y
6	12

Q. 15. Find out the major products from the following reaction sequence.

(1) A =

B =

(2) A =

B = Me

(3) Ph

(4) Ph
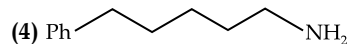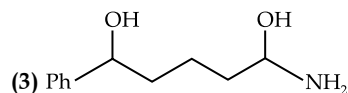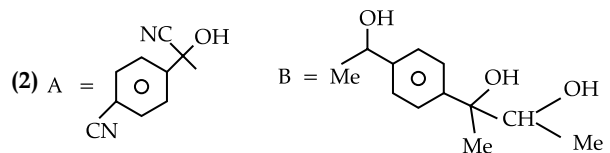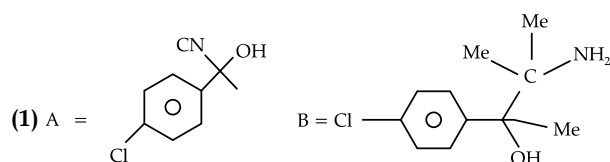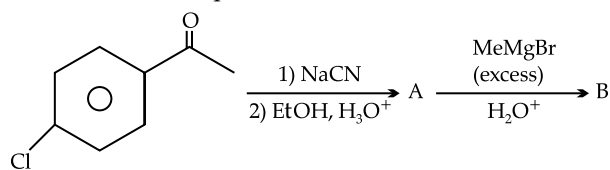
Q. 16. When a hydrocarbon A undergoes combustion in the presence of air, it requires 9.5 equivalents of oxygen and produces 3 equivalents of water. What is the molecular formula of A?

(1) C_9H_9 **(2)** C_8H_6 **(3)** C_9H_6 **(4)** C_6H_6

Q. 17. Given below are two statements:

Statement I: Nickel is being used as the catalyst for producing syn gas and edible fats.

Statement II: Silicon forms both electron rich and electron deficient hydrides.

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

(1) Statement I is correct but statement II is incorrect

(2) Both the statements I and II are incorrect

(3) Statement I is incorrect but statement II is correct

(4) Both the statements I and II are correct

Q. 18. Which of the following relations are correct?

(A) $\Delta U = q + p\Delta V$ **(B)** $\Delta G = \Delta H - T\Delta S$

(C) $\Delta S = \dfrac{q_{rev}}{T}$ **(D)** $\Delta H = \Delta U - \Delta nRT$

Choose the most appropriate answer from the options given below:

(1) B and D Only   **(2)** A and B Only

(3) B and C Only   **(4)** C and D Only

Q. 19. Given below are two statements :

Statement I: The decrease in first ionization enthalpy from B to Al is much larger than that from Al to Ga.

Statement II: The d orbitals in Ga are completely filled.

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

(1) Statement I is incorrect but statement II is correct

(2) Both the statements I and II are correct

(3) Both the statements I and II are incorrect

(4) Statement I is correct but statement II is incorrect

Q. 20. Match List I and List II

List I	List II
A. Osmosis	**I.** Solvent molecules pass through semi permeable membrane towards solvent side.
B. Reverse osmosis	**II.** Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes.

C.	Electro osmosis	III.	Solvent molecules pass through semi permeable membrane towards solution side.
D.	Electrophoresis	IV.	Dispersion medium moves in an electric field.

Choose the correct answer from the options given below:

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

Section B

Q. 21. Assume that the radius of the first Bohr orbit of hydrogen atom is 0.6Å. The radius of the third Bohr orbit of He^+ is _____ picometer. (Nearest Integer)

Q. 22. Total number of acidic oxides among N_2O_3, NO_2, N_2O, Cl_2O_7, SO_2, CO, CaO, Na_2O and NO is _____

Q. 23. The denticity of the ligand present in the Fehling's reagent is _____

Q. 24. The equilibrium constant for the reaction
$Zn(s) + Sn^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Sn(s)$ is 1×10^{20} at 298 K. The magnitude of standard electrode potential of Sn/Sn^{2+} if $E°_{Zn^{2+}/Zn} = -0.76V$ is _____ $\times 10^{-2}$ V (Nearest integer).

Given: $\dfrac{2.303RT}{F} = 0.059$ V

Q. 25. The volume of HCl, containing 73 g L^{-1}, required to completely neutralise NaOH obtained by reacting 0.69 g of metallic sodium with water, is _____ mL. (Nearest Integer)
(Given: molar Masses of Na, Cl, O, H, are 23, 35.5, 16 and 1 g mol^{-1} respectively)

Q. 26. For conversion of compound A $\rightarrow$ B, the rate constant of the reaction was found to be 4.6×10^{-5} L mol^{-1} s^{-1}. The order of the reaction is _____.

Q. 27. On heating, $LiNO_3$ gives how many compounds among the following? _____ Li_2O, N_2, O_2, $LiNO_2$, NO_2

Q. 28. When 0.01 mol of an organic compound containing 60% carbon was burnt completely, 4.4 g of CO_2 was produced. The molar mass of compound is _____ $gmol^{-1}$ (Nearest integer).

Q. 29. At 298 K
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $K_1 = 4 \times 10^5$
$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$, $K_2 = 1.6 \times 10^{12}$
$H_2(g) + \dfrac{1}{2} O_2(g) \rightleftharpoons H_2O(g)$, $K_3 = 1.0 \times 10^{-13}$
Based on above equilibria, the equilibrium constant of the reaction,
$2NH_3(g) + \dfrac{5}{2} O_2(g) \rightleftharpoons 2NO(g) + 3H_2O(g)$ is
_____ $\times 10^{-33}$ (Nearest integer).

Q. 30. A metal *M* forms hexagonal close–packed structure. The total number of voids in 0.02 mol of it is _____ $\times 10^{21}$ (Nearest integer).
(Given $N_A = 6.02 \times 10^{23}$)

Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	(4)	Bond orders	Chemical bonding
2	(3)	Classification of drugs	Chemistry in everyday life
3	(4)	Hofmann bromamide reaction	Amines
4	(4)	Dehydro halogenation reaction	Halo alkane and Halo arene
5	(2)	Study of indicator	Ionic equilibrium
6	(2)	Classification of ores	Metallurgy
7	(4)	Identification of radicals	Qualitative analysis
8	(2)	Properties of D block compounds	d and f block
9	(1)	Peptides	Biomolecules
10	(4)	Dehydration of alcohol	Alcohol phenol and ether
11	(3)	Colligative properties	Liquid solution
12	(2)	Spin magnetic moment	Coordination chemistry
13	(2)	Classification of polymer	Polymer
14	(2)	Dissolved oxygen and BOD value	Environmental chemistry
15	(4)	Nucleophilic reaction of grignard reagent	Aldehyde and ketones
16	(2)	Molecular formula	Some basic concepts of chemistry
17	(1)	Classification of hydrides	Hydrogen
18	(3)	Thermodynamics relationship	Thermodynamics

19	(1)	Ionization enthalpy of elements	Periodic classification of elements
20	(2)	Purification of colloidal solution	Surface chemistry
21	[270]	Bohr atomic radius	Structure of atom
22	[4]	Acidic oxides	p block elements
23	[4]	Denticity of ligands	Coordination chemistry
24	[17]	Emf of the cell	Electro chemistry
25	[15]	Equivalent concept	Ionic equilibrium
26	[2]	Order of reaction	Chemical kinetics
27	[3]	Heating effect of compounds	s block
28	[200]	Identification of molar mass	Some basic concepts of chemistry
29	[4]	Calculation of equilibrium constant	Chemical equilibrium
30	[36]	Calculation of number of voids	Solid state

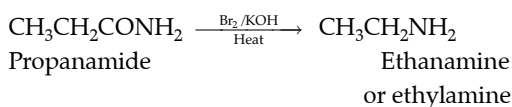# Solutions

Section A

1. Option (4) is correct.

Molecules	Total no. Electrons	Bond Order
O_2^{2-}	18	1
CO	14	3
NO^+	14	3

2. Option (3) is correct.

Equanil is used in treatment of hypertension and depression. It is a tranquilizer drug.

3. Option (4) is correct.

The reaction is Hofmann bromamide Degradation. The amide is converted to the amine with one carbon atom less in the chain than the parent compound.

$$CH_3CH_2CONH_2 \xrightarrow[\text{Heat}]{Br_2/KOH} CH_3CH_2NH_2$$
Propanamide   Ethanamine
                   or ethylamine

4. Option (4) is correct.

2-Bromopentane gives three alkenes on dehydrohalogenation in the presence of strong base.

2-Bromopentane   KOH Ethanol HBr   +   + HBr (cis+trans) isomers
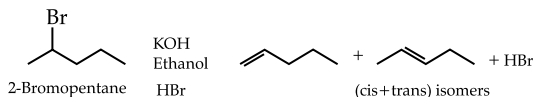
5. Option (2) is correct.

H_2O_2 oxidizes iodide ion to iodine. The formation of iodine is confirmed by the change in colour of the starch indicator to blue.

$$I^- + H_2O_2 = I_2 + H_2O$$

$$I_2 + Starch = Blue colour$$
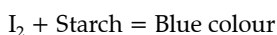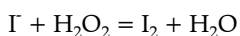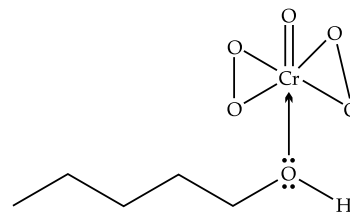
6. Option (2) is correct.

Sphalerite $FeCO_3$

Malahite - $CuCO_3.Cu(OH)_2$

Clamine - $ZeCO_3$

Sphalerite (Zinc Blende) is the sulphide ore of the zinc.

7. Option (4) is correct.

The amyl alcohol forms a complex with the CrO_5 that results in the blue colour.

8. Option (2) is correct.

(i) In Mn_2O_7, Mn is in +7 oxidation state.

(ii) Ru and Os exhibits highest oxidation state of +8. [OsO_4 and RuO_4]

(iii) Sc exists in maximum oxidation state of +3.

(iv) Cr show maximum oxidation state of +6. It act as an oxidizing agent in +6 state.

9. Option (1) is correct.

The tetrapeptide on hydrolysis gives Phenyl alanine (P), Leucine (L), Aspartic acid (D) and Tyrosine (Y).

10. Option (4) is correct.
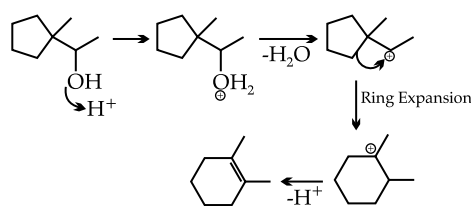
11. Option (3) is correct.

(i) Van't Hoff factor (i) is the ratio of the normal molecular mass to the abnormal molecular mass.

$$i = \frac{\text{Normal Molecular Mass}}{\text{Abnormal Molecular Mass}}$$

(ii) K_f = Cryoscopic constant.

(iii) Solutions with the same osmotic pressure are known as isotonic solutions.

(iv) Solutions with same composition of vapour pressure over them are called Azeotropes.

12. Option (2) is correct.

| Compound	Electronic Configuration	Number of unpaired electrons	Magnetic moment
$[FeF_6]^{3-}$	$Fe^{3+} : t_{2g}^3, e_g^2$	5	$\mu = \sqrt{35}$ B.M
$[CoF_6]^{3-}$	$Co^{3+:} t_{2g}^4, e_g^2$	4	$\mu = \sqrt{24}$ B.M
$[Co(C_2O_4)_3]^{3-}$	$Co^{3+:} t_{2g}^6, e_g^0$	0	$\mu = 0$

13. Option (2) is correct.

Neoprene- Elastomer, Polyester-Fibre, Polystyrene-Thermoplastic,

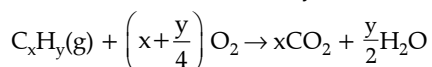Urea-Formaldehyde Resin- Thermosetting Plastic Polymer

14. Option (2) is correct.

BOD value of water is in the range of 3-5 and dissolved oxygen in water for growth of fish is less than 6.

15. Option (4) is correct.
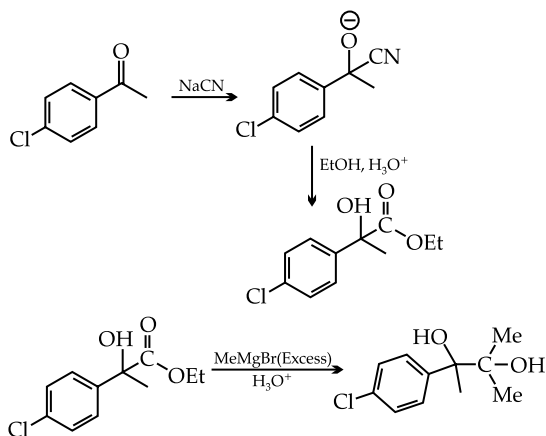
16. Option (2) is correct.

The combustion reaction of hydrocarbon is:

$$C_xH_y(g) + \left(x+\frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$$

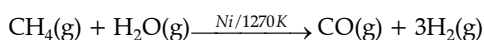$$\left(x+\frac{y}{4}\right) = 9.5$$

and

$$\frac{y}{2} = 3 \Rightarrow y = 6$$

$$\therefore \left(x+\frac{6}{4}\right) = 9.5 \Rightarrow x = 8$$

17. Option (1) is correct.

Nickel catalyses the reaction of methane with steam to produce syn-gas.

$$CH_4(g) + H_2O(g) \xrightarrow{Ni/1270K} CO(g) + 3H_2(g)$$

Silicon forms electron precise hydride only.

18. Option (3) is correct.

The Gibb's free energy (G) = H-TS. At constant temperature and pressure,

$$\Delta G = \Delta H - T\Delta S$$

The entropy change is:

$$dS = \frac{q_{rev}}{T}$$

19. Option (1) is correct.

The order of First Ionization enthalpy of G-13 elements is : B >Al<Ga>In<Tl. The d-orbitals in Ga are completely occupied.

20. Option (2) is correct.

Osmosis- Movement of solvent molecules to solution in the presence of SPM.

Reverse Osmosis- Movement of solvent molecules from solution to solvent side in the presence of SPM.

Electro-osmosis- Dispersion medium moves in an electric field.

Electrophoresis- Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes.

Section B

21. The correct answer is [270].

$$r \propto \frac{n^2}{z}$$
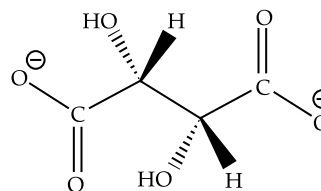
$$\therefore \quad r(He^+) = r_H \times \frac{n^2}{Z}$$

$$\therefore \quad r(He^+) = 0.6 \times \frac{3^2}{2} = 270 \; pm$$

22. The correct answer is [4].

Acidic Oxides : N_2O_3, NO_2, Cl_2O_7, SO_2

23. The correct answer is [4].

The ligand in the Fehling's reagent is the tartrate ion. There are four oxygen atoms that donates an electron pair to the copper ion. Hence, the denticity is four.

24. The correct answer is [17].

At equilibrium,

$$E° = \frac{0.059}{2} \log_{10} K = \frac{0.059}{2} \log 1 \times 10^{20}$$

$$E° = \frac{0.059}{2} (20) = 0.59 \; V$$

$$E° = E° (Sn^{2+}|Sn) - E° (Zn^{2+}|Zn)$$

$$0.59 = E°(Sn^{2+}|Sn) - (-0.76)$$

$$E° (Sn^{2+}|Sn) = 0.17 \; V = 17 \times 10^{-2} \; V$$

25. The correct answer is [15].

Eq of Acid = Eq of Base = Eq of Sodium

$\therefore \quad \dfrac{73}{36.5} \times 1L \times V = \dfrac{0.69}{23}$
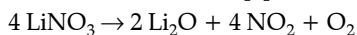
$\Rightarrow V = 1.5 \times 10^{-2} \, L = 15 mL$

26. The correct answer is [2].

By using unit of rate constant, we can calculate vehicle of order.

Unit of Rate constant = $(mol\, L^{-1})^{1-n} \, (time)^{-1}$, n= order of reaction

For second order kinetics, n=2

Unit of Rate constant = $(mol\, L^{-1})^{1-2} \, (second)^{-1} = (mol^{-1} L) \, s^{-1}$.

27. The correct answer is [3].

$4\, LiNO_3 \rightarrow 2\, Li_2O + 4\, NO_2 + O_2$

$LiNO_3$ decomposes to give Li_2O, NO_2 and O_2

28. The correct answer is [200].

The percentage of carbon in organic compound is calculated as:

$\%C = \dfrac{12x}{44} \times \dfrac{100}{w}$

$60 = \dfrac{12 \times 4.4}{44} \times \dfrac{100}{w}$, $w = 2\, g$

Molecular mass $= \dfrac{w}{\text{No. of moles}} = \dfrac{2}{0.01} = 200 \, gmol^{-1}$

29. The correct answer is [4].

The equilibrium constant of the desired equation is:

$K_c = \dfrac{[NO]^2 [H_2O]^3}{[O_2]^{5/2} [NH_3]^2}$

Reverse Equation (1), the equilibrium constant is:

$K_{c1} = \dfrac{1}{K_1}$

Multiply equation (3) by (3), we get:

$K_{c3} = K_3^3$

Adding equations, we get:

$K_c = \dfrac{K_2 \times K_3^3}{K_1} = \dfrac{1.6 \times 10^{12} \times 1 \times 10^{-39}}{4 \times 10^5} = 4 \times 10^{-33}$

30. The correct answer is [36].

One unit cell of HCP contains = 18 voids

No. of Voids in 0.02 mol of HCP

No. of voids $= \dfrac{18}{6} \times 6.022 \times 10^{23} \times 0.02 = 36 \times 10^{21}$

□□