

JEE (Main) CHEMISTRY SOLVED PAPER

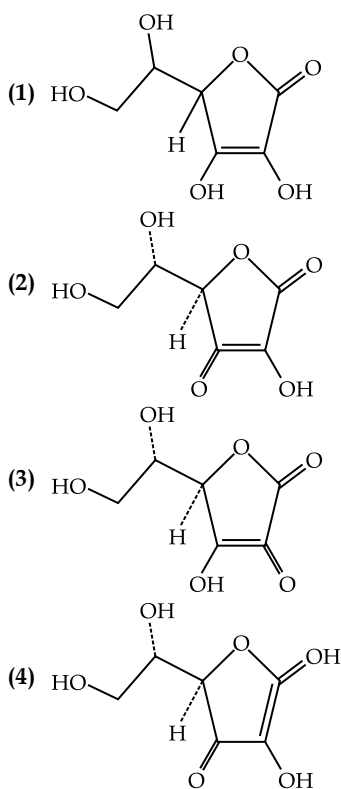
2023
01st Feb. Shift 2

Section A

Q. 1. For electron gain enthalpies of the elements denoted as $\Delta_{eg}H$, the incorrect option is :

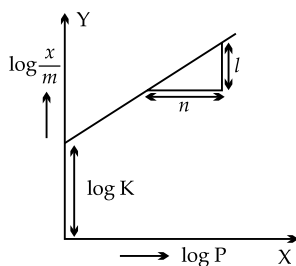
- (1) $\Delta_{eg}H(\text{Te}) < \Delta_{eg}H(\text{Se})$
- (2) $\Delta_{eg}H(\text{Se}) < \Delta_{eg}H(\text{S})$
- (3) $\Delta_{eg}H(\text{Cl}) < \Delta_{eg}H(\text{F})$
- (4) $\Delta_{eg}H(\text{I}) < \Delta_{eg}H(\text{At})$

Q. 2. All structures given below are of vitamin C. Most stable of them is :



Q. 3. In figure, a straight line is given for Freundlich Adsorption ($y = 3x + 2.505$). The value of $\frac{1}{n}$ and $\log K$ are respectively.

- (1) 0.3 and 0.7033
- (2) 0.3 and $\log 2.505$
- (3) 3 and 0.7033
- (4) 3 and 2.505



Q. 4. The correct order of bond enthalpy (kJmol^{-1}) is :

- (1) $\text{C} - \text{C} > \text{Si} - \text{Si} > \text{Sn} - \text{Sn} > \text{Ge} - \text{Ge}$
- (2) $\text{C} - \text{C} > \text{Si} - \text{Si} > \text{Ge} - \text{Ge} > \text{Sn} - \text{Sn}$

(3) $\text{Si} - \text{Si} > \text{C} - \text{C} > \text{Sn} - \text{Sn} > \text{Ge} - \text{Ge}$

(4) $\text{Si} - \text{Si} > \text{C} - \text{C} > \text{Ge} - \text{Ge} > \text{Sn} - \text{Sn}$

Q. 5. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : An aqueous solution of KOH when used for volumetric analysis, its concentration should be checked before the use.

Reason (R) : On aging, KOH solution absorbs atmospheric CO_2 .

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

- (1) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
- (2) (A) is correct but (R) is not correct
- (3) Both (A) and (R) are correct and (R) is the correct explanation of (A)
- (4) (A) is not correct but (R) is correct

Q. 6. O - O bond length in H_2O_2 is X than the O - O bond length in F_2O_2 . The O - H bond length in H_2O_2 is Y than that of the O - F bond in F_2O_2 .

Choose the correct option for X and Y from those given below

- (1) X-shorter, Y - longer
- (2) X-shorter, Y-shorter
- (3) X - longer, Y-shorter
- (4) X-longer, Y - longer

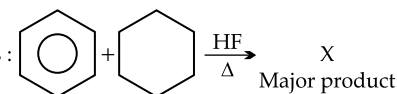
Q. 7. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

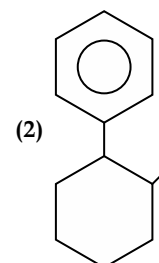
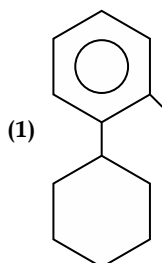
Assertion (A) : Cu^{2+} in water is more stable than Cu^+ .

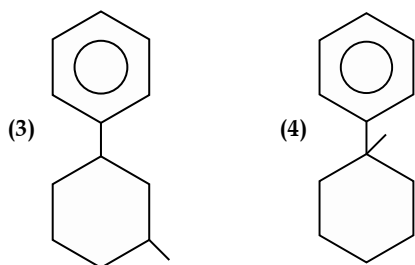
Reason (R) : Enthalpy of hydration for Cu^{2+} is much less than that of Cu^+ .

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

- (1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
- (2) (A) is not correct but (R) is correct
- (3) (A) is correct but (R) is not correct
- (4) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

Q. 8. 'X' is : 

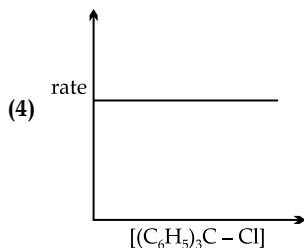
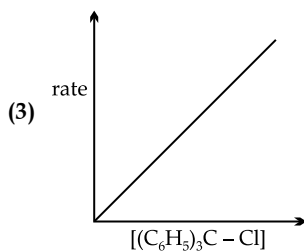
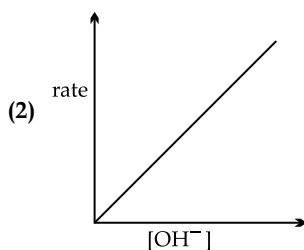
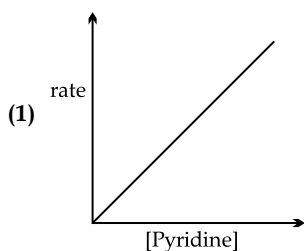
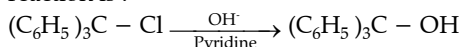




Q. 9. The complex cation which has two isomers is :

- (1) $[\text{Co}(\text{NH}_3)_5\text{NO}_2]^{2+}$ (2) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
 (3) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^+$ (4) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$

Q. 10. The graph which represents the following reaction is :



Q. 11. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : α -halocarboxylic acid on reaction with dil NH_3 gives good yield of α -amino carboxylic acid whereas the yield of amines is very low when prepared from alkyl halides.

Reason (R) : Amino acids exist in zwitter ion form in aqueous medium.

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

- (1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
 (2) (A) is not correct but (R) is correct
 (3) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
 (4) (A) is correct but (R) is not correct

Q. 12. The industrial activity held least responsible for global warming is :

- (1) Industrial production of urea
 (2) Electricity generation in thermal power plants
 (3) steel manufacturing
 (4) manufacturing of cement

Q. 13. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Gypsum is used for making fireproof wall boards.

Reason (R): Gypsum is unstable at high temperatures.

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

- (1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
 (2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
 (3) (A) is correct but (R) is not correct
 (4) (A) is not correct but (R) is correct

Q. 14. The starting material for convenient preparation of deuterated hydrogen peroxide (D_2O_2) in laboratory is :

- (1) BaO
 (2) $\text{K}_2\text{S}_2\text{O}_8$
 (3) BaO_2
 (4) 2-ethylanthraquinol

Q. 15. The effect of addition of helium gas to the following reaction in equilibrium state, is :

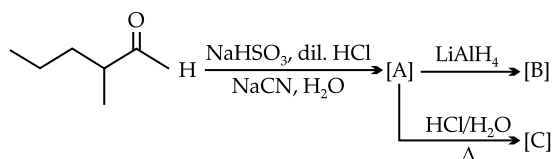


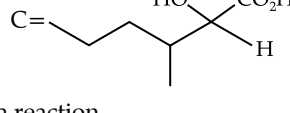
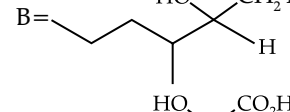
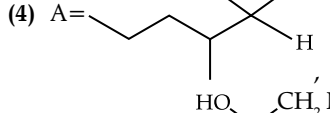
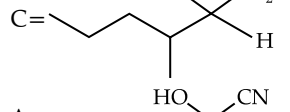
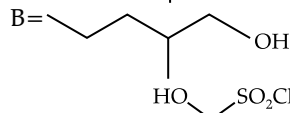
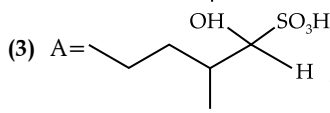
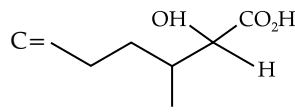
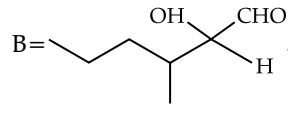
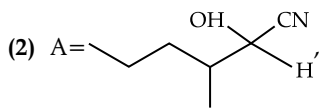
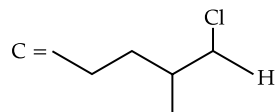
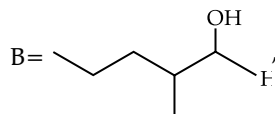
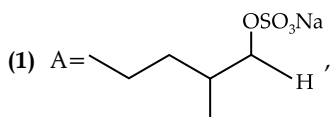
- (1) helium will deactivate PCl_5 and reaction will stop.
 (2) the equilibrium will shift in the forward direction and more of Cl_2 and PCl_3 gases will be produced.
 (3) the equilibrium will go backward due to suppression of dissociation of PCl_5 .
 (4) addition of helium will not affect the equilibrium.

Q. 16. Which element is not present in Nessler's reagent?

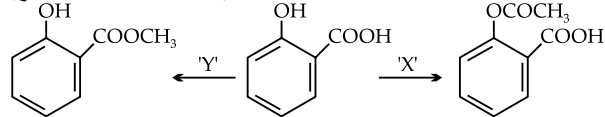
- (1) Oxygen (2) Potassium
 (3) Mercury (4) Iodine

Q. 17. The structures of major products A, B and C in the following reaction are sequence.





Q. 18. In a reaction,



reagents 'X' and 'Y' respectively are :

- (1) $(\text{CH}_3\text{CO})_2\text{O}/\text{H}^+$ and $(\text{CH}_3\text{CO})_2\text{O}/\text{H}^+$
- (2) $\text{CH}_3\text{OH}/\text{H}^+$, Δ and $(\text{CH}_3\text{CO})_2\text{O}/\text{H}^+$
- (3) $\text{CH}_3\text{OH}/\text{H}^+$, Δ and $\text{CH}_3\text{OH}/\text{H}^+$, Δ
- (4) $(\text{CH}_3\text{CO})_2\text{O}/\text{H}^+$ and $\text{CH}_3\text{OH}/\text{H}^+$, Δ

Q. 19. Which one of the following sets of ions represents a collection of isoelectronic species ?

(Given: Atomic Number : F: 9, Cl: 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21)

- (1) Ba^{2+} , Sr^{2+} , K^+ , Ca^{2+}
- (2) Li^+ , Na^+ , Mg^{2+} , Ca^{2+}

- (3) N^{3-} , O^{2-} , F^- , S^{2-}
- (4) K^+ , Cl^- , Ca^{2+} , Sc^{3+}

Q. 20. Given below are two statements :

Statement I : Sulphanilic acid gives esterification test for carboxyl group.

Statement II : Sulphanilic acid gives red colour in Lassaigne's test for extra element detection.

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 Statement I and Statement II are incorrect
- (3) Statement I is correct but Statement II is incorrect
- (4) Both Statement I and Statement II are correct

Section B

Q. 21. 0.3 g of ethane undergoes combustion at 27°C in a bomb calorimeter. The temperature of calorimeter system (including the water) is found to rise by 0.5°C . The heat evolved during combustion of ethane at constant pressure is _____ kJ mol^{-1} . (Nearest integer)

[Given : The heat capacity of the calorimeter system is 20 kJ K^{-1} , $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$.

Assume ideal gas behaviour.

Atomic mass of C and H are 12 and 1 g mol^{-1} respectively]

Q. 22. Among the following, the number of tranquilizer/s is/are _____

- A. Chloroliazepoxide B. Veronal
C. Valium D. Salvarsan

Q. 23. Among following compounds, the number of those present in copper matte is _____

- A. CuCO_3 B. Cu_2S C. Cu_2O D. FeO

Q. 24. A metal M crystallizes into two lattices :- face centred cubic (fcc) and body centred cubic (bcc) with unit cell edge length of 2.0 and 2.5 respectively. The ratio of densities of lattices fcc to bcc for the metal M is _____ (Nearest integer)

Q. 25. The spin only magnetic moment of $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ complexes is _____ B.M. (Nearest integer) (Given: Atomic no. of Mn is 25)

Q. 26. $1 \times 10^{-5} \text{ M AgNO}_3$ is added to 1 L of saturated solution of AgBr. The conductivity of this solution at 298 K is _____ $\times 10^{-8} \text{ S m}^{-1}$

[Given : $K_{\text{sp}}(\text{AgBr}) = 4.9 \times 10^{-13}$ at 298 K

$\lambda_{\text{Ag}^+}^0 = 6 \times 10^{-3} \text{ S m}^2 \text{ mol}^{-1}$

$\lambda_{\text{Br}^-}^0 = 8 \times 10^{-3} \text{ S m}^2 \text{ mol}^{-1}$

$\lambda_{\text{NO}_3^-}^0 = 7 \times 10^{-3} \text{ S m}^2 \text{ mol}^{-1}$]

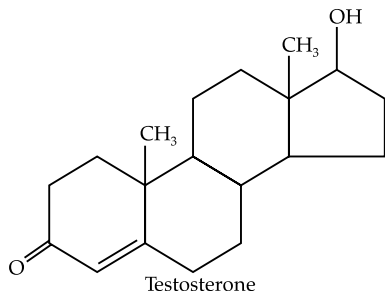
Q. 27. 20% of acetic acid is dissociated when its 5 g is added to 500 mL of water. The depression in freezing point of such water is _____ $\times 10^{-3}^\circ\text{C}$ Atomic mass of C, H and O are 12, 1 and 16 a.m.u. respectively.

[Given : Molal depression constant and density of water are $1.86 \text{ K kg mol}^{-1}$ and 1 g cm^{-3} respectively.]

Q. 28. $A \rightarrow B$

The above reaction is of zero order. Half life of this reaction is 50 min. The time taken for the concentration of A to reduce to one-fourth of its initial value is _____ (Nearest integer) min.

Q. 29. Testosterone, which is a steroidal hormone, has the following structure.



The total number of asymmetric carbon atom/s in testosterone is _____

Q. 30. The molality of a 10% (v/v) solution of di-bromine in CCl_4 (carbon tetrachloride) is 'x'.

$$x = \text{_____} \times 10^{-2} \text{M. (Nearest integer)}$$

[Given : molar mass of $\text{Br}_2 = 160 \text{ g mol}^{-1}$

atomic mass of C = 12 g mol^{-1}

atomic mass of Cl = 35.5 g mol^{-1}

density of dibromine = 3.2 g cm^{-3}

density of $\text{CCl}_4 = 1.6 \text{ g cm}^{-3}$]

Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	(4)	Electron gain enthalpy	Periodic classification of elements
2	(1)	Structure of vitamin	Biomolecules
3	(4)	Frenndluich adsorption isotherm	Surface chemistry
4	(2)	Order of bond energy	p block
5	(3)	Property of KOH	s block
6	(3)	Comparison of bond length	Chemical bonding
7	(3)	Stability of ions	d and f block
8	(4)	Electrophilic aromatic substitution	Hydrocarbon
9	(1)	Isomerism in coordination compounds	Coordination chemistry
10	(3)	Energy profile diagram	Hal alkane and Halo arenes
11	(3)	Zwitter ions	Amines
12	(1)	Factors responsible of global warming	Environmental chemistry
13	(2)	Properties of gypsum	s block
14	(2)	Properties of hydrogen peroxide	Hydrogen
15	(2)	Le chateliers principle	Chemical equilibrium
16	(1)	Nessler's reagent	Qualitative analysis
17	(4)	Properties of carbonyl compounds	Aldehyde and ketones
18	(4)	Chemical properties of aspirin	Alcohol phenol and ether
19	9	Isoelectronic species	Structure of atom
20	(1)	Lassaigne's test	Qualitative analysis
21	[1006]	Heat of combustion	Thermodynamics
22	[3]	Tranquilizers	Chemistry in everyday life
23	[2]	Extraction of metals	Metallurgy
24	[4]	Ratio of densities in solid	Solid state
25	[6]	Spin magnetic moment	Coordination chemistry
26	[13039]	Calculation of conductivity of solution	Electro chemistry
27	[372]	Depression in freezing point	Liquid solution
28	[75]	Zero order reaction	Chemical kinetics
29	[6]	Calculation of number of asymmetric carbon atom	Chemistry in everyday life
30	[139]	Calculation of molality	Liquid solution

Solutions

Section A

1. Option (4) is correct.

Electron gain enthalpy decreases down the group due to increasing atomic sizes.

The electron gain enthalpy of group-16 and group-17 elements are as follows:

$$\text{Cl} = -345 \quad \text{F} = -328$$

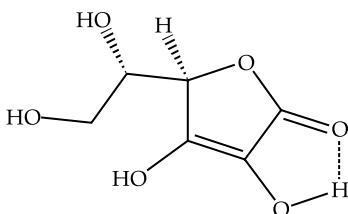
$$\text{Se} = -195 \quad \text{S} = -200$$

$$\text{I} = -295 \quad \text{At} = -270$$

$$\text{Te} = -190 \quad \text{Po} = -183$$

2. Option (1) is correct.

The enediol structure is stabilized through H-bonding.



3. Option (4) is correct.

As per Freundlich isotherm:

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

$$y = 3x + 2.505$$

Comparing the equations, we get

$$\frac{y = \log x / m, x = \log p1}{n} = 3, \log K = 2.505$$

4. Option (2) is correct.

With the increase in the size of an atom, the bond length increases and bond enthalpy decreases.

Thus the correct order of bond enthalpy (kJmol^{-1}) is $:\text{C} - \text{C} > \text{Si} - \text{Si} > \text{Ge} - \text{Ge} > \text{Sn} - \text{Sn}$

5. Option (3) is correct.

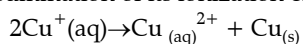
KOH being alkaline reacts with atmospheric CO_2 which is acidic in nature to produce K_2CO_3 . Hence, its concentration needs to be checked.

6. Option (3) is correct.

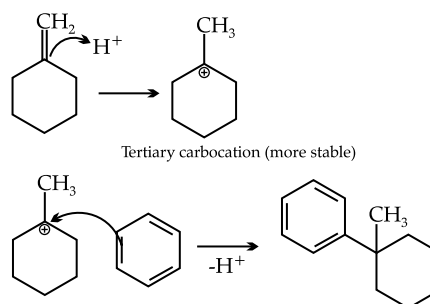
The O-O bond length in H_2O_2 is longer than O_2F_2 because of higher electronegativity of bonded F-atoms. The O-H bond length in H_2O_2 is shorter than O-F bond length in O_2F_2 .

7. Option (3) is correct.

The Cu^+ ion is unstable in an aqueous solution and readily disproportionates to Cu^{2+} and Cu . This is because the hydration enthalpy of Cu^{2+} ion is higher than the summation of its ionization enthalpy.



8. Option (4) is correct.



It is an example of electrophilic aromatic substitution

9. Option (1) is correct.

The complex cation which has two isomers is $[\text{Co}(\text{NH}_3)_5\text{NO}_2]^{2+}$ as

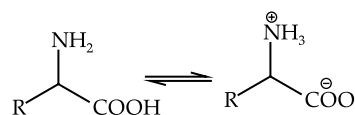
NO_2^- is an ambidentate ligand. The two isomers are: $[\text{Co}(\text{NH}_3)_5\text{NO}_2]^{2+}$ and $[\text{Co}(\text{NH}_3)_5(\text{ONO})]^{2+}$.

10. Option (3) is correct.

The reaction proceeds through $\text{S}_{\text{N}}1$ mechanism via tertiary carbocation formation. Hence, the rate of reaction depends only on the concentration of the substrate.

11. Option (3) is correct.

a -halocarboxylic acid on reaction with dil NH_3 gives good yield of a -amino carboxylic acid. Whereas the yield of amines is very low when prepared from alkyl halides. This is because a primary amine produced is itself a nucleophile that can react with more alkyl halide to give mixture of amines.



Zwitter ion

Amino acids exist in zwitter ion form in aqueous medium.

12. Option (1) is correct.

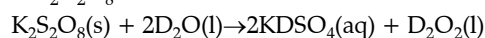
The industrial activity which held least responsible for global warming is by industrial production of urea. This is because during its production NH_3 and CO_2 are consumed which causes least global warming.

13. Option (2) is correct.

When exposed to fire, the water from gypsum slowly releases into steam thereby preventing a heat transmission. Thus, it is used for making fire proof wall boards. Also Gypsum is unstable at high temperatures.

14. Option (2) is correct.

The starting material for convenient preparation of deuterated hydrogen peroxide (D_2O_2) in laboratory is $\text{K}_2\text{S}_2\text{O}_8$

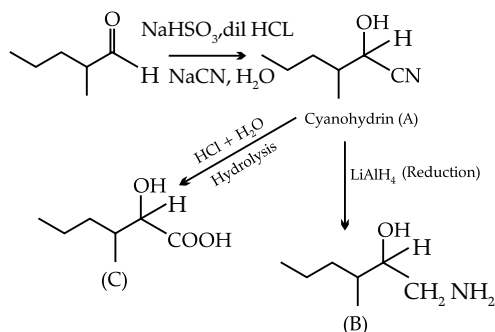
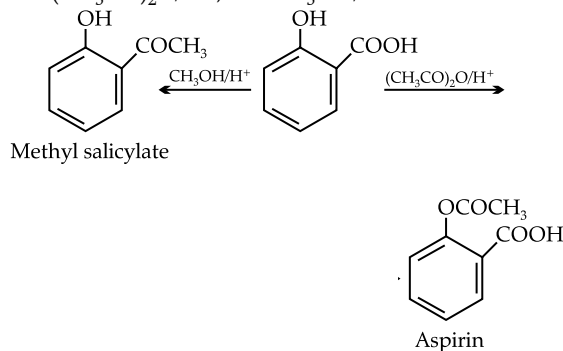
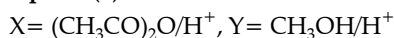


15. Option (2) is correct.

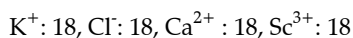
At constant volume, the addition of inert gas cause no change in equilibrium. At the constant pressure, the addition of inert gas increases the volume. Thus, the number of moles of gas per unit volume decreases. Thus according to Le-chatelier's principle the equilibrium shifts towards the greater number of moles of the gas. *i.e.* the equilibrium will shift in the forward direction and more of C_{12} and PC_{13} gases will be produced.

16. Option (1) is correct.

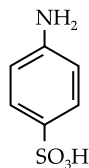
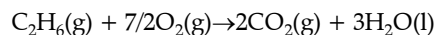
Nessler's reagent is $K_2[HgI_4]$. The oxygen is not present in the Nessler's reagent.

17. Option (4) is correct.**18. Option (4) is correct.****19. Option (4) is correct.**

Isoelectronic species are those species which have same number of electrons. Among the given species, following are isoelectronic with each other.

**20. Option (1) is correct.**

Sulphanilic acid does not have the carboxylic acid group. Hence, no esterification reaction. The presence of sulphur and nitrogen gives red color to Lassaigne's test.

**Section B****21. The correct answer is [1006].**

The change in internal energy

$$\Delta U = \frac{-20 \times 0.5}{0.3} \times 30 = -1000 \text{ kJ}$$

$$\Delta n(g) = 2 - \left(2 + \frac{7}{2}\right) = -\frac{7}{2}$$

$$\Delta H = \Delta U + \Delta n(g) RT$$

$$\Delta H = -1000 - \left(-\frac{7}{2}\right) \times 8.3 \times 300 = -1006 \text{ kJ}$$

22. The correct answer is [3].

Chlordiazepoxide, Veronal and Valium are Tranquilizers. Salvarsan is an anti-biotic drug.

23. The correct answer is [2].

Copper matte is an alloy that consists mainly of copper and sulfur. It is a mixture of $Cu_2S + FeO$. The composition of copper matte includes copper sulphide (80-95%), and it also includes the alloys of Fe - Co which makes up 5-17% of the mixture, even in the place of Fe - Co, metallic copper, or silver, Pb - Ag alloys, and arsenide can be present too.

24. The correct answer is [4].

$$d = \frac{Z \times m}{N \times a^3}$$

$$\frac{d_{FCC}}{d_{BCC}} = \frac{\frac{4 \times M}{N \times (2)^3}}{\frac{2 \times M}{N \times (2.5)^3}} = 3.90 \approx 4$$

(For $f_{cc}, z=4$

for $b_{cc}, z=2$)

25. The correct answer is [6].

Mn^{2+} : $[\text{Ar}]3d^5 4s^0$. The total number of unpaired electrons are 5. Thus, $n=5$

$$\mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = 5.92 \approx 6$$

26. The correct answer is [13039].

$$[\text{Ag}^+] = [\text{NO}_3^-] = 10^{-5} \text{ mol/L}$$

$$[\text{Br}^-] = \frac{K_{sp}}{[\text{Ag}^+]} = \frac{4.9 \times 10^{-13}}{10^{-5}} = 4.9 \times 10^{-8}$$

$$\Lambda = \frac{K \times 1000}{M}$$

$$\Lambda(\text{Ag}^+) = \frac{k(\text{Ag}^+) \times 10^{-3} \text{ Sm}^2 / \text{mol}}{M}$$

$$\Rightarrow K(\text{Ag}^+) = 1000 \times 10^{-5} \times 6 \times 10^{-3} = 6000 \times 10^{-8}$$

$$\Lambda(\text{Br}^-) = \frac{K(\text{Br}^-) \times 10^{-3} \text{ Sm}^2 / \text{mol}}{M}$$

$$\Rightarrow K(\text{Br}^-) = 1000 \times 4.9 \times 10^{-8} \times 8 \times 10^{-3} = 39.2 \times 10^{-8}$$

$$\Lambda(\text{NO}_3^-) = \frac{K(\text{NO}_3^-) \times 10^{-3} \text{ Sm}^2 / \text{mol}}{M} \Rightarrow K(\text{NO}_3^-)$$

$$= 1000 \times 10^{-5} \times 7 \times 10^{-3} = 7000 \times 10^{-8}$$

according to Kohlrausch law

$$\text{Total conductivity} = \Lambda m(\text{Ag}^+) + \Lambda m(\text{Br}^-) + \Lambda m(\text{NO}_3^-)$$

$$(7000 + 39.2 + 6000) \times 10^{-8}$$

$$= 13039.2 \times 10^{-8} \text{ Sm}^{-1}$$

27. The correct answer is [372].

$$\alpha = \frac{i-1}{n-1} \Rightarrow 0.2 = \frac{i-1}{2-1} \Rightarrow i = 1.2$$

$$\Delta T_f = K_f \times i \times \text{molality}$$

$$\Delta T_f = 1.2 \times 1.86 \times \frac{5 \times 1000}{60 \times 500} = 3.72 = 372 \times 10^{-2}$$

28. The correct answer is [75].

For zero order reaction

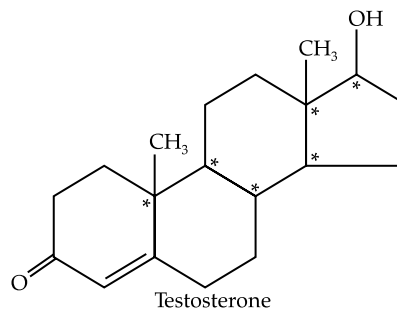
$$K = \frac{[R]}{2t_1} = \frac{1}{2(50)} = 0.01$$

$$0.01 = \frac{[R]_i - \frac{1}{4}[R]_i}{t}$$

$$0.01 = \frac{1 - \frac{1}{4}}{t}$$

$$t = 75 \text{ min}$$

29. The correct answer is [6].



30. The correct answer is [139].

$$\text{Volume of dibromine} = 10 \text{ cm}^3$$

$$\text{Volume of } \text{C}_2\text{Cl}_4 = 90 \text{ cm}^3$$

$$\text{molality} = \frac{\text{No. of moles of dibromine}^{(Br_2)}}{\text{Mass of } \text{C}_2\text{Cl}_4 \text{ (g)}} \times 1000$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Given Mass of } \text{C}_2\text{Cl}_4 = 3.6 \times 90 = 144 \text{ g.}$$

$$\text{Given Mass of } \text{Br}_2 = 3.2 \times 10 = 32 \text{ g.}$$

$$\text{No. of moles of } \text{Br}_2 = \frac{32}{160}$$

$$= 0.2.$$

$$\text{Molality} = \frac{0.2}{144} \times 1000$$

$$= 1.388$$

$$= 139 \times 10^{-2} \text{ M}$$