JEE (Main) CHEMISTRY SOLVED PAPER

2023
8th April Shift 2

General Instructions :

1. *In Chemistry Section, there are 30 questions (Q. no. 1 to 30).*
2. *In Chemistry, Section A consists of 20 multiple choice questions & Section B consists of 10 numerical value type question. In Section B, candidates have to attempt any five questions out of 10.*
3. *There will be only one correct choice in the given four choices in Section A. For each question for Section A. 4 marks will be awarded for correct choice, 1 mark will be deducted for incorrect choice questions and zeor mark wil be awarded for not attempted question.*
4. *For Section B question, 4 marks will be awarded for correct answer and for unattempted and incorrect answer.*
5. *Any textual, printed or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.*
6. *All calculation/written work should be done in the rough sheet is provided with Question Paper.*

Section A

1. The statement/s which are true about antagonists from the following is/are :

A. They bind to the receptor site

B. Get transferred inside the cell for their action

C. Inhibit the natural communication of the body

D. Mimic the natural messenger.

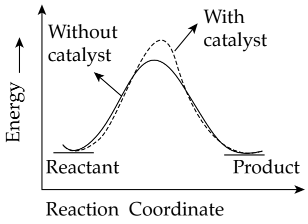
Choose the correct answer from the options given below:

(1) A and B **(2)** A and C

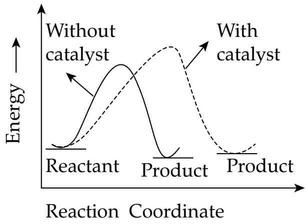
(3) A, C and D **(4)** B only

2. The correct reaction profile diagram for a positive catalyst reaction.

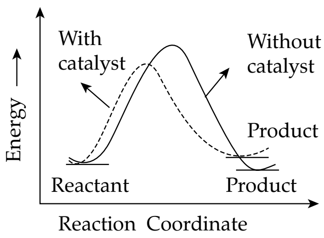
(1)



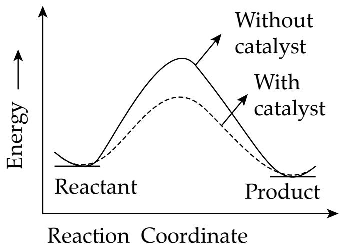
(2)



(3)



(4)



3. Given below are two statements: One is labelled as **Assertion A** and other is labelled as **Reason R**

Assertion A: Sodium is about 30 times as abundant as potassium in the oceans.

Reason R: Potassium is bigger in size than sodium.

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

(1) Both A and R are true but R is NOT the correct explanation of A

(2) A is true but R is false

(3) A is false but R is true

(4) Both A and R are true and R is the correct explanation of A

4. Which of these reactions is not a part of breakdowns of ozone in stratosphere?

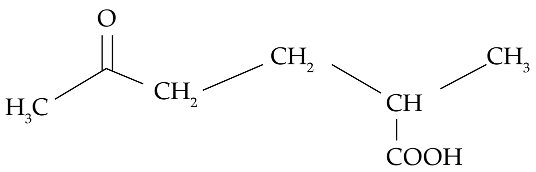
(1) $CF_2Cl_2(g) \xrightarrow{uv} \dot{C}l(g) + \dot{C}F_2Cl(g)$

(2) $\dot{C}l(g) + O_3(g) \rightarrow Cl\dot{O}(g) + O_2(g)$

(3) $2Cl\dot{O} \rightarrow ClO_2(g) + \dot{C}l(g)$

(4) $Cl\dot{O}(g) + O(g) \rightarrow \dot{C}l(g) + O_2(g)$

5. The correct IUPAC nomenclature for the following compound is :



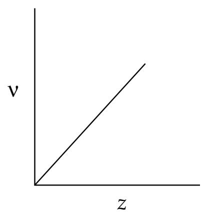
(1) 2-Methyl-5-oxohexanoic acid
(2) 2-Formyl-5-methylhexan-6-oic acid
(3) 5-Formyl-2-methylhexanoic acid
(4) 5-Methyl-2-oxohexan-6-oic acid

6. Henry Moseley studied characteristic X-ray spectra of elements. The graph which represents his observation correctly is

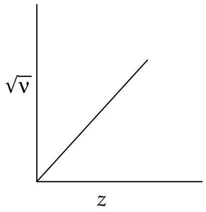
Given ν = frequency of X-ray emitted

z = atomic number

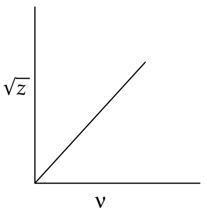
(1)



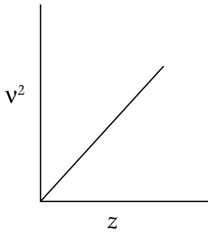
(2)



(3)



(4)

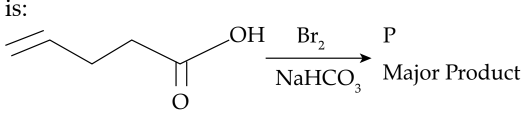


7. Match list I with list II

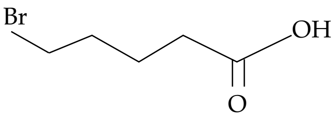
List I Coordination complex	List II Number of unpaired electrons
A. $[Cr(CN)_6]^{3-}$	I. 0
B. $[Fe(H_2O)_6]^{2+}$	II. 3
C. $[Co(NH_3)_6]^{3+}$	III. 2
D. $[Ni(NH_3)_6]^{2+}$	IV. 4

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

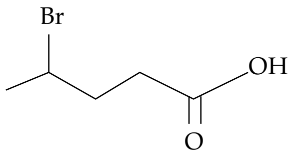
8. Major product 'P' formed in the following reaction is:



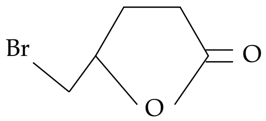
(1)



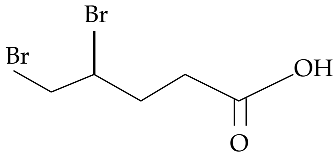
(2)



(3)



(4)



9. For a good quality cement, the ratio of lime to the total of the oxides of Si, Al and Fe should be as close as to
(1) 2 **(2)** 1
(3) 3 **(4)** 4

10. Match list I with list II

List I Natural amino acid	List II One letter code
A. Glutamic acid	I. Q
B. Glutamine	II. W
C. Tyrosine	III. E
D. Tryptophan	IV. Y

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

11. Which of the following have same number of significant figures?
A. 0.00253 B. 1. 0003
C. 15.0 D. 163
Choose the correct answer from the options given below
(1) B and C only **(2)** A, B and C only
(3) A, C and D only **(4)** C and D only

12. Given below are two statements:
Statement I: Methyl orange is a weak acid.
Statement II: The benzenoid form of methyl orange is more intense/deeply coloured than the quinonoid form.
In the light of the above statement, choose the most appropriate answer from the options given below:
(1) Both statement I and Statement II are incorrect
(2) Both statement I and Statement II are correct
(3) Statement I is correct but statement II is incorrect
(4) Statement I is incorrect but statement II is correct

13. The descending order of acidity for the following carboxylic acid is –

A. CH_3COOH B. $F_3C–COOH$

C. $ClCH_2–COOH$ D. $FCH_2–COOH$

E. $Br–CH_2COOH$

Choose the correct answer from the options given below:

(1) D > B > A > E > C

(2) B > D > C > E > A

(3) E > D > B > A > C

(4) B > C > D < E > A

14. In Hall-Heroult process, the following is used for reducing Al_2O_3:

(1) Magnesium **(2)** Graphite

(3) Na_3AlF_6 **(4)** CaF_2

15. Arrange the following gases in increasing order of van der waals constant 'a'

A. Ar B. CH_4

C. H_2O D. C_6H_6

Choose the correct options from the following

(1) A, B, C and D **(2)** B, C, D and A

(3) C, D, B and A **(4)** D, C, B and A

16. Given below are two statement:

Statement I: In redox titration, the indicators used are sensitive to change in pH of the solution.

Statement II: In acid-base titration, the indicators used are sensitive to change in oxidation potential.

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

(1) Both statement I and Statement II are incorrect

(2) Statement I is incorrect but Statement II is correct

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

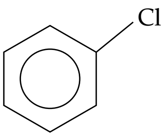
(4) Both Statement I and Statement II are correct

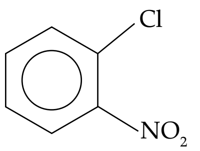
17. Which of the following can reduce decomposition of H_2O_2 on exposure to light

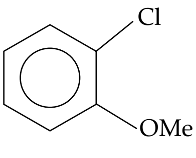
(1) Dust **(2)** Urea

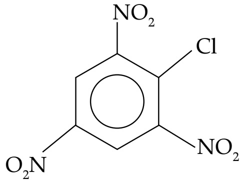
(3) Glass containers **(4)** Alkali

18. The correct order of reactivity of following haloarenes towards nucleophilic substitution with aqueous NaOH is

A. 

B. 

C. 

D. 

Choose the correct answer from the options given below:

(1) D > B > A > C **(2)** A > B > D > C

(3) C > A > D > B **(4)** D > C > B > A

19. A compound 'X' when treated with phthalic anhydride in presence of concentrated H_2SO_4 yields 'Y'. 'Y' is used as an acid/base indicator. 'X' and 'Y' are respectively.

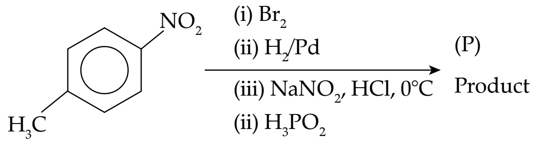
(1) Anisole, methyl orange

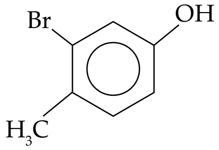
(2) Toluidine, Phenolphthalein

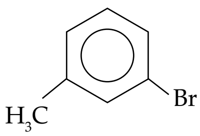
(3) Carbolic acid, Phenolphthalein

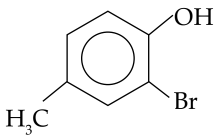
(4) Salicylaldehyde, Phenolphthalein

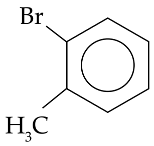
20. The product (P) formed from the following multistep reaction is:



(1) 

(2) 

(3) 

(4) 

Section B

21. The observed magnetic moment of the complex $[Mn(NCS)_6]^{x-}$ is 6.06 BM. The numerical value of x is ________.

22. For complete combustion of ethene.

$C_2H_4(g)+3O_2(g) \rightarrow 2CO_2(g)+2H_2O(l)$

The amount of heat produced as measured in bomb calorimeter is 1406 kJ mol^{-1} at 300K. The mimimum value of $T\Delta S$ needed to reach equilibrium is (-)________kJ (Nearest integer)

23. The solubility product of $BaSO_4$ is 1×10^{-10} at 298 K. The solubility of $BaSO_4$ in 0.1 M $K_2SO_4(aq)$ solute is________$\times10^{-9}$ g L^{-1} (Nearest integer)

Given: Molar mass of $BaSO_4$ is 233 g mol^{-1}

24. The number of atomic orbitals from the following having 5 radial nodes is________

7s, 7p, 6s, 8p, 8d

25. The number of incorrect statement from the following is________

(1) The electrical work that a reaction can perform at constant pressure and temperature is equal to the Gibbs energy

(2) E°_{cell} is dependent on the pressure

(3) $\dfrac{dE^\circ_{cell}}{dT} = \dfrac{\Delta S^\circ}{nF}$

(4) A cell is operating reversibly if the cell potential is exactly balanced by an opposing source of potential difference

26. Coagulating value of the electrolytes $AlCl_3$ and NaCl for As_2S_3 are 0.09 and 50.04 respectively. The coagulating power of $AlCl_3$ is x times the coagulating power of NaCl. The value of x is______

27. If the boiling points of two solvents X and Y (having same molecular weights) are in the ratio 2 : 1 and their enthalpy of vaporizations are in the ratio 1 : 2, then the boiling point elevation constant of X is m times the boiling point elevation constant of Y. The value of m is________(nearest integer)

28. The number of species from the following carrying a single lone pair on central atom Xenon is_______
XeF_5^+, XeO_3, XeO_2F_2, XeF_5^-, XeO_3F_2, $XeOF_4$, XeF_4

29. The ratio of sigma and π bonds present in pyrophosphoric acid is________

30. The sum of oxidation state of the metals in $Fe(CO)_5$, VO^{2+} and WO_3 is_______

Answer Key

Q No	Answer	Topic's Name	Chapter's Name
1	(2)	Drug-Target Interaction	Chemistry in Everyday Life
2	(4)	Catalysis	Surface Chemistry
3	(1)	Alkali Metals	s-Block Elements
4	(3)	Atmospheric Pollution	Environmental Chemistry
5	(1)	Nomenclature of Organic Compounds	Organic Chemistry - Some Basic Principles and Techniques
6	(2)	Dual Nature of Radiation And Matter	Atomic Structure
7	(1)	Crystal Field Theory	Coordination Compounds
8	(3)	Chemical Reactions of Alcohols And Phenols	Alcohols, Phenols & Ethers
9	(1)	Some Important Compounds of Calcium	s-Block Elements
10	(1)	Amino Acids	Biomolecules
11	(3)	Significant Figures	Some Basic Concepts of Chemistry
12	(3)	Qualitative Analysis	Organic Chemistry - Some Basic Principles and Techniques
13	(2)	Chemical Reactions of Carboxylic Acids	Aldehydes, Ketones and Carboxylic Acids
14	(2)	Electrochemical Principles of Metallurgy	General Principles and Processes of Isolation of Elements
15	(1)	Behaviour of Real Gases	States of Matter
16	(1)	Titrations	Redox Reactions
17	(2)	Hydrogen Peroxide	Hydrogen
18	(1)	Reactions of Haloarenes	Haloalkanes And Haloarenes
19	(3)	Reactions of Phenols	Alcohols, Phenols & Ethers
20	(4)	Reactions of Nitro Compounds	Amines
21	[4]	Some Transition Elements	d & f Block Elements
22	[1411]	Bomb Calorimetery	Thermochemistry
23	[233]	Solubility Equilibria	Ionic Equilibrium
24	[3]	Shapes of Orbitals and Nodes	Atomic Structure
25	[1]	Nernst Equation	Electrochemistry
26	[556]	Properties of Colloids	Surface Chemistry
27	[8]	Colligative Properties and Determination of Molar Mass	Solutions
28	[4]	Valence Bond Theory	Chemical Bonding And Molecular Structure
29	[6]	Oxoacids of Phosphorus	p-Block Elements
30	[10]	Oxidation Number	Redox Reactions

JEE (Main) CHEMISTRY SOLVED PAPER 2023

8th April Shift 2

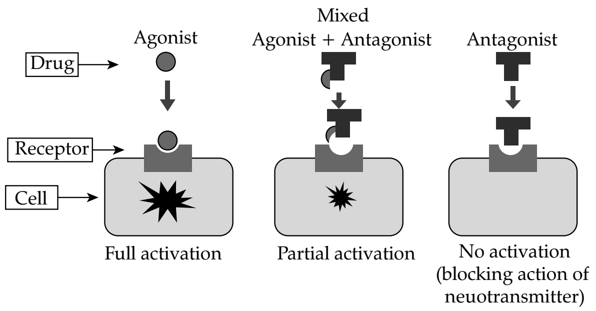
ANSWERS WITH EXPLANATIONS

SECTION - A

1. Option (2) is correct.

Explanation:

Drugs that bind to the receptor site and inhibit its natural function are called antagonists. These are useful when blocking of message is required.



2. Option (4) is correct.

Explanation:

In the presence of a catalyst, the activation energy is reduced between reactant and product. The intermediate formed is faster in presence of catalyst followed by an alternate and short pathway.

Always remember that the activation energy in a reaction is always positive. We know that the energy changes which result from a chemical reaction can either be positive, negative, or even zero, but it is also true that in all of the cases, an energy barrier has to be overcome before any reaction takes place. It should be noted that higher the activation energy, slower will be the chemical reaction.

3. Option (1) is correct.

Explanation:

Sodium is the most abundant alkali metal in the earth's crust. Sodium and potassium are the seventh and eighth most abundant elements by weight in the earth's crust. Owing to its high reactivity, sodium is found in nature only as a compound and never as the free element.

Potassium atom is in 4th period and sodium is in 3rd period, the number of outermost orbits is greater in potassium than sodium. So, the nuclear attractions decreases in potassium which ultimately leads to the larger size of it.

4. Option (3) is correct.

Explanation:

In the stratosphere, ozone is a product of the action of UV radiations on dioxygen as:

(i) $O_2(g) \xrightarrow{UV} O(g) + O(g)$

(ii) $O_2(g) + O(g) \xleftrightarrow{UV} O_3(g)$

Reaction (ii) indicates the dynamic equilibrium existing between the production and decomposition of ozone molecules. Any factor that disturbs the equilibrium may cause depletion of ozone layer by its decomposition. One such factor is the release of chlorofluorocarbon compounds (CFCs). These are non-reactive, non-flammable molecules that are used in refrigerators, air conditioners, plastics, and electronic industries. Once released CFCs mix with atmospheric gases and reach the stratosphere, where they are decomposed by UV radiations.

(iii) $CF_2Cl_2(g) \xrightarrow{UV} \dot{C}l(g) + CF_2\dot{C}l(g)$

The chlorine free radical produced in reaction (iii) reacts with ozone as:

(iv) $\dot{C}l(g) + O_3(g) \rightarrow \dot{C}lO(g) + O_2(g) + \dot{C}l(g)$

The radicals further react with atomic oxygen to produce more chlorine radicals as:

(v) $\dot{C}lO(g) + \dot{O}(g) \rightarrow \dot{C}l(g) + O_2(g)$

(vi) The regeneration of causes a continuous breakdown of ozone present in the stratosphere, damaging the ozone layer.

5. Option (1) is correct.

Explanation:

Functional group as suffix or prefix:When an organic compound contains two or more different functional groups

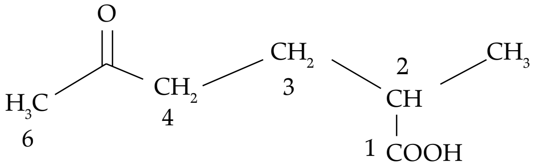
1. Highest priority:
   1.1 Use suffix
2. Other functional groups (act as a substituent):
   2.1 use as prefix

The choice of the principal functional group is made on the basis of the order of preferences.

Note:

$-R$, $-C_6H_5$, $-X$ (F, Cl, Br, I), $-NO$, $-NO_2$, $-OR$ (alkoxy) do not have any priority order and considered as alkyl substituents while numbering.

The IUPAC name of the compound is 2-Methyl-5-oxohexanoic acid



6. Option (2) is correct.

Explanation:

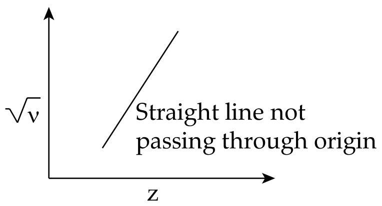
Moseley's Law describes the relationship between atomic number and frequency of a spectral line of characteristic X-rays.

The atomic number of an element can be related to the square root of the frequency of a spectral line of characteristic X-rays using Moseley's law. Moseley's law is an empirical law concerning the characteristic X-rays emitted by atoms. It states that the square root of the frequency of emitted X-rays is approximately proportional to the atomic number.

Mathematically, the law can be represented using the equation $\sqrt{\nu} = z$ where ν is the frequency of the emitted X-ray.The final equation of Moseley's law can be written as

$\nu = A(z - b)^2$

where A and b are constants depending upon the X-ray emission. Moseley measured and plotted the X-ray frequencies of about 40 elements of the periodic table following his law and observed the graph to be a straight line. The plot of the graph with atomic numbers on the x-axis and the square root of frequencies on the y-axis furnished a straight line not passing through the origin.



7. Option (1) is correct.

Explanation:

For option A:

The six cyanide ligands are arranged around the chromium ion in an octahedral geometry

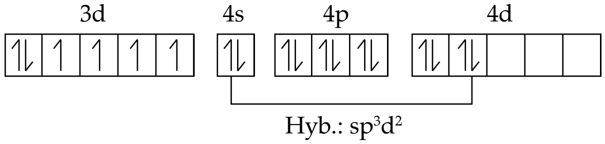
Cr^{+3} : $3d^3$

$CN^- \rightarrow$ SFL $\Rightarrow$ No. of unpaired electrons = 3

For option B:

$Fe[(H_2O)_6]^{2+}$ is a high spin complex and contains 4 unpaired electrons. And H_2O being a weak field ligand do not pair up electrons and due to the presence of unpaired electrons, it is paramagnetic in nature. Its magnetic moment is 5.4 B.M. It has pale green color.

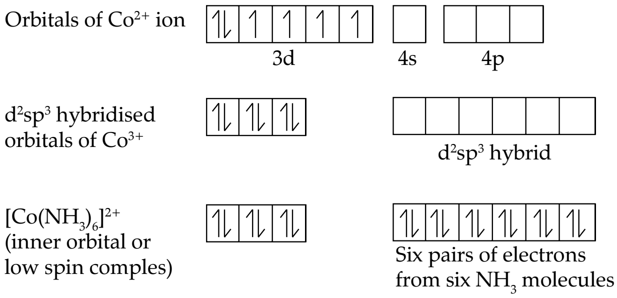
Fe^{2+} in $[Fe(H_2O)_6]^{2+}$



For option C:

In $[Co(NH_3)_6]^{3+}$ the oxidation state of cobalt is +3.Ammonia is a strong field ligand so it pair up 4 unpaired electron and free up 2 3−d orbitals. These 3−d orbitals are involved in hybridisation with one 4S and three 4P orbitals forming an inner orbital complex, so hybridisation of $[Co(NH_3)_6]^{3+}$ is d^2sp^3

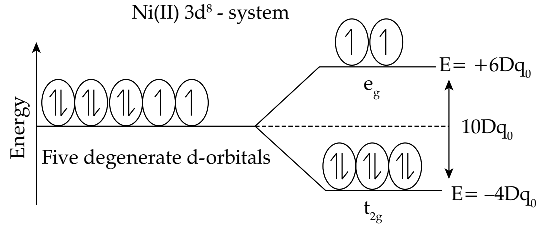
Since it has no unpaired electrons, $[Co(NH_3)_6]^{3+}$ is diamagnetic.



For option D

In case of $[Ni\ (NH_3)_6]^{2+}$ ion, ligand NH_3 act as a weak field ligand as crystal field stabilization energy is less than pairing energy. That is, 10Dq < P.

Therefore, under the influence of octahedral crystal field, the electronic configuration is $t_{2g}^{6}\ e_g^{2}$.

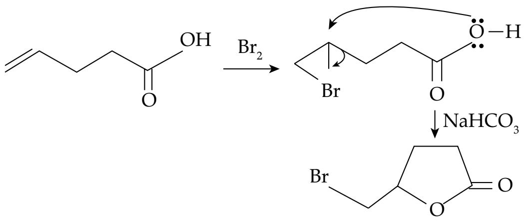


From the above electronic configuration, it has been found that the complex has two unpaired electrons. Hence the complex $[Ni\ (NH_3)_6]^{2+}$ is paramagnetic.

8. Option (3) is correct.

Explanation:

Addition of Bromine (Br_2) To Alkenes is stereoselective, giving "Anti" Addition Stereo-chemistry. The stereospecificity of bromine addition can be explained by considering the anti-addition or trans-addition, alkene to form a flat carbocation. Then the bromide ion would attack the bottom face of the alkene. Thus, anti-addition to cis-2 butene leads to the formation of an enantiomer.



9. Option (1) is correct.

Explanation:

The raw materials required for the manufacture of cement are lime stone, stone and clay. Lime stone or calcium carbonate ($CaCO_3$) provides calcium oxide. (CaO) Clay is hydrated aluminium silicate, ($Al_2O_3.2SiO_2.2H_2O$) and it provides alumina as well as silica. A small amount of gypsum, $CaSO_4.2H_2O$ is also required. It is added in calculated quantity in order to adjust the rate of setting of cement.

Manufacture : Cement is made by strongly heating a mixture of lime stone and clay in a rotatory kiln. Lime stone and clay are finely powdered and a little water is added to get a thick paste called slurry. The slurry is fed into a rotatory kiln from the top through the hopper.

The hot gases produce a temperature of about 1770–1870 K in the kiln. At this high temperature the lime stone and clay present in slimy combine to form cement in the form of small pieces called clinker. This clinker is mixed with 2–3% by weight of gypsum ($CaSO_4.2H_2O$) to regulate the setting time and is then ground to an exceedingly fine powder.

$$\text{Limestone + Clay} \xrightarrow[\text{Clinker}]{1770-1870\text{K}} \text{Cement} + CO_2\uparrow$$

When mixed with water the cement reacts to form gelatinous mass which sets to a hard mass when three dimensional cross lines are formed between silica oxygen silica and silica oxygen aluminium as ....Si - O - Si....... and Si - O - Al........

Composition of cement:

$CaO = 50–60\%$

$SiO_2 = 20–25\%$

$Al_2O_3 = 5–10\%$

$MgO = 2–3\%$

$Fe_2O_3 = 1–2\%$

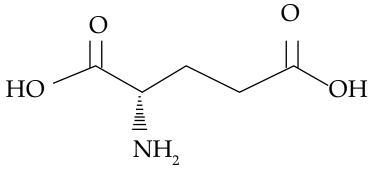
$SO_3 = 1–2\%$

For a good quality cement the ratio of silica (SiO_2) and alumina (Al_2O_3) should be between 2.5 to 4.0. Similarly the ratio of lime (CaO) to the total oxide mixtures consisting of SiO_2, Al_2O_3 and Fe_2O_3 should be roughly 2:1:1, If lime is in excess, the cement cracks during setting. On the other hand, if lime is less than the required, the cement is weak in strength. Therefore, a proper composition of cement must be maintained to get cement of good quality.

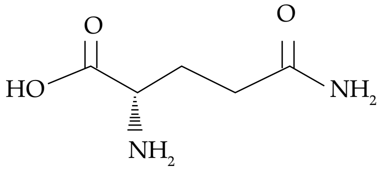
10. Option (1) is correct.

Explanation:

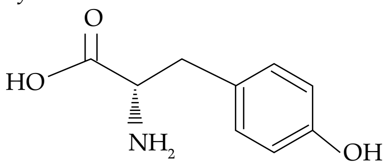
A. Glutamic acid – E



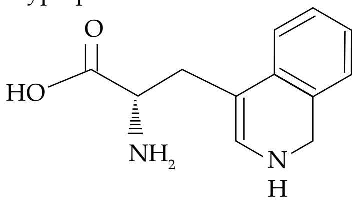
B. Glutamine – Q



C. Tyrosine – Y



D. Tryptophan – W



11. Option (3) is correct.

Explanation:

The number of single digits that are important in the coefficient of an expression in scientific notation is termed as significant number.

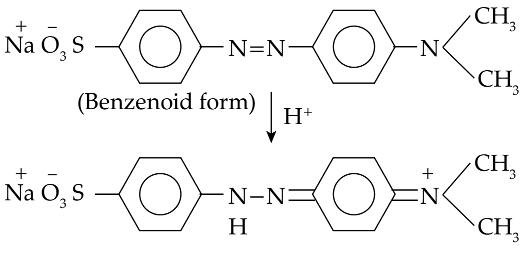
0.00253, 15.0, 163

All have three significant figures.

12. Option (3) is correct.

Explanation:

Methyl orange is a weak acid. So, statement- 1 is correct. In acidic medium, it exists in quinonoid form which is red in colour and in alkaline medium it exists in benzenoid form which is yellow in colour. Since red is more deeply coloured than yellow, so statement- 2 is wrong.



Red color (quinonoid form)

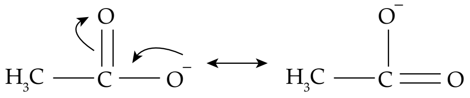
13. Option (2) is correct.

Explanation:

Acidic strength depends on the stability of the conjugate base after the release of H^+ ion.

Comparing the stabilities of the conjugate bases

1. Among the conjugate bases, CH_3COO^- is more stable than $CH_3CH_2O^-$ because the negative charge developed in CH_3COO^- is stabilised by two equivalent resonating structures.



Resonating structures of acetate ion

Electron withdrawing substituent increases the acidity by increasing the ionic character of O–H by inductive effect. Electronegativity decreases in the order F > Cl > Br and hence –I effect also decreases in the same order

Acidity α stability of conjugate base

Stability order – $F_3C-COO^- > F-CH_2-COO^- > Cl-CH_2-COO^- > Br-CH_2-COO^- > CH_3COO^-$

14. Option (2) is correct.

Explanation:

The electrolysis of alumina by Hall and Heroult's process is carried by using a fused mixture of alumina and cryolite along with minor quantities of aluminium fluoride and fluorspar. The addition of cryolite and fluorspar increases the electrical conductivity of alumina and lowers the fusion temperature. Also at anode, alumina reacts with fluorine to give oxygen. The liberated oxygen reacts with carbon to form CO and CO_2. These gases are liberated at anode. In case of Hall's process, reduction of Al_2O_3 to Al can be done using graphite. In electrolytic reduction of alumina, oxygen gas is evolved at the anode which oxidises the carbon (graphite) anode to CO and further, to CO_2 .As a result ,the graphite anode is consumed and needs to be replaced gradually.

15. Option (1) is correct.

Explanation:

Van der Waals' constant 'a' is a measure of intermolecular forces of attractions. Stronger is the force of attraction, greater will be 'a' and easily a gas can be liquified. Vander waal force depends on molecular size and molecular mass. The value of Vander waal constant 'a' is as follows

Ar – 1.355

CH_4 – 2.283

H_2O – 5.536

C_6H_6 – 18.24

16. Option (1) is correct.

Explanation:

The indicators used in redox reactions are sensitive to change in oxidation potential. The ideal oxidation-reduction indicators have an oxidation potential intermediate between the values for the solution being titrated and the titrant and these show sharp readily detectable colour change.

Acid-Base Titration: An acid-base titration involves a neutralization reaction between the analyte (the solution with the unknown concentration) and the acidic or basic titrant.

17. Option (2) is correct.

Explanation:

H_2O_2 decomposes slowly on exposure to light

$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$

In the presence of metal surfaces or traces of alkali (present in glass containers), the above reactions is catalysed. It is, therefore stored in wax-lined glass or plastic vessels in dark. Urea be added as a stabiliser. It is kept away from dust because dust can induce explosive decomposition of the compound.

18. Option (1) is correct.

Explanation:

Nucleophilic substitution reaction:-

It is basically a chemical reaction in which, an electron rich nucleophile will attack the positively charged electrophile and will replace with a leaving group.

Rate of Subtitution $\propto$ Presence of EWG at O/P position

R $\propto$ -M group present at o/p position

Rate $\propto$ EWG $\propto \dfrac{1}{\text{EDG}}$

–NO_2 is an EWG while

–OMe is an EDG

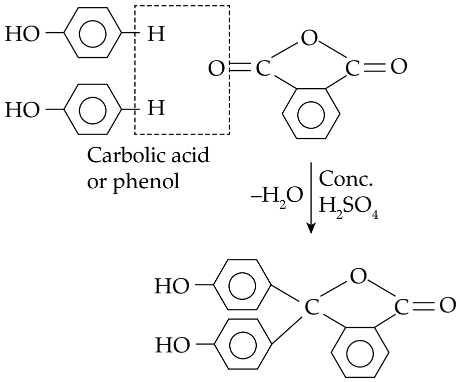
19. Option (3) is correct.

Explanation:

The reaction between phenol and phthalic anhydride in the presence of sulphuric acid is a well- known reaction for the production of phenolphthalein.

Sulphuric acid in this reaction acts as a dehydrating agent.

Phenolphthalein is renowned as the indicator dye. Phenolphthalein can be synthesized by the condensation of phthalic anhydride with two equivalents of phenol under acidic condition, hence is named as Phenolphthalein by Adolf von Baeyer.

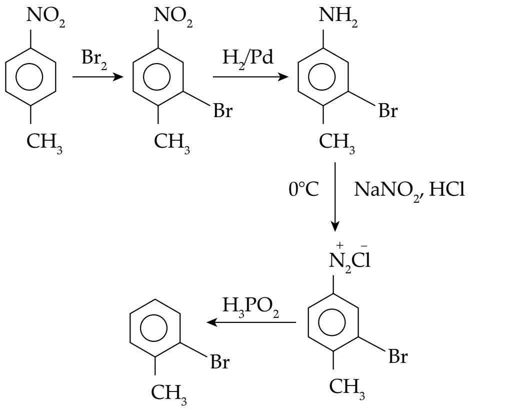


Phenolphthalein

20. Option (4) is correct.

Explanation:

Conversion of 4-nitrotoluene to 2-bromotoluene can be achieved by the following steps, which are shown below:



SECTION - B

21. Correct answer is [4].

Explanation:

Magnetic moment (μ) is given as $\mu = \sqrt{n}\ (n+2)$

$[Mn(NCS)_6]^{x-}$ Number of unpaired electron = 5

So, Mn must be in +2 oxidation state (Mn^{+2})

$\Rightarrow 2 + (-6) = -x$

$\Rightarrow -4 = -x$

$\Rightarrow x = 4$

22. Correct answer is [1411].

Explanation:

Amount of heat produced in the bomb calorimeter $= -1406\ kJmol^{-1}$

Enthalpy of a combustion reaction is:

$\Delta H = \Delta U + \Delta n_g RT$

Where, ΔU = internal energy

Δn_g = moles of gas (products -reactants), R = Gas constant=, T = Temperature in K

As per the equation,

$\Delta n_g = 2-4=-2$

$\Delta G = \Delta H - T\Delta S$ at equilibrium:-

$\Delta G = 0$

$T\Delta S = \Delta H = \Delta U + \Delta n_g RT$

$= -1406 + (-2)\ 8.3 \times 300 \times 10^{-3} = 1410.98 \approx 1411$

23. Correct answer is [233].

Explanation:

$BaSO_4$ ionizes completely in solution as:

$$BaSO_{4(s)} \rightleftharpoons \underset{s}{Ba^{2+}_{(aq)}} + \underset{s}{SO^{2-}_{4(aq)}}$$

In presence of 0.1 M K_2SO_4(aq)

Let S mole/litre $BaSO_4$ is dissolved

$K_{SP} = [Ba^{2+}]\ [SO_4^{2-}]$

$1 \times 10^{-10} = S(S + 0.1) = S \times 0.1$

as S<<0.1 so 0.1 + S = 0.1

$S = 10^{-9}$ M

S(in g/l) $= 233 \times 10^{-9}$

24. Correct answer is [3].

Explanation:

Number of radial nodes $= n - l - 1$

where, n is the Principal quantum number and l is the Azimuthal quantum number.

For $6S \rightarrow 6 - 0 - 1 = 5$,

$7P \rightarrow 7 - 1 - 1 = 5$

$8d \rightarrow 8 - 2 - 1 = 5$

25. Correct answer is [1].

Explanation:

The cell potential (E_{cell}) of a reaction is related as

$\Delta G = -nF\ E_{cell}$

where ΔG represents maximum useful electrical work.

n = no. of moles of electrons exchanged during the reaction.

For reversible cell reaction

$d(\Delta G)=(\Delta V)dp-(\Delta S)dT$

At const. P, $d(\Delta G)=-(\Delta S)dT$

At const. P, $\Delta G = \Delta H - T\Delta S$ (i)

$\therefore \Delta G = \Delta H + T(d(\Delta G)\Delta T)P$ (ii)

$\left(\dfrac{dE_{cell}}{dT}\right)$P is known as temperature coefficient of the emf of the cell.

From equations (i) and (ii)

$$-\Delta S = \frac{d\Delta G}{dT} = \frac{d - nFE}{dT}$$

$$\Delta S = nF = \frac{dF}{dT}$$

$$\text{or } \frac{dE}{dT} = \frac{\Delta S}{dF}$$

26. Correct answer is [556].

Explanation:

The precipitation of colloidal solution through induced aggregation by the addition of suitable electrolyte is called coagulation or flocculation.

The minimum concentration of electrolyte in millimoles required to cause coagulation of one litre of colloidal solution is called coagulation value.

It needs to be noted that the coagulation of a colloidal solution by an electrolyte does not take place until the added electrolyte has certain minimum concentration in the solution.

Coagulation power is inversely proportional to coagulation value.

$$\text{Coagulating power} \propto \frac{1}{\text{Coagulation Value}}$$

Coagulation power of $AlCl_3$ = Coagulation power of NaCl

$$\frac{\text{Coagulation power of } AlCl_3}{\text{Coagulation power of NaCl}}$$

$$= \frac{\text{Coagulation value of NaCl}}{\text{Coagulation value of } AlCl_3} = \frac{50.04}{0.09} = 556$$

27. Correct answer is [8].

Explanation:

The boiling point of a substance is the temperature at which the vapor pressure of the liquid equals the pressure surrounding the liquid and the liquid changes into a vapor. The boiling point of a liquid varies depending upon the surrounding environmental pressure.

Molal elevation constant:

It is defined as the elevation in boiling point when the molality of the solution is unity i.e 1 mole of the solute is dissolved in 1 kg of the solvent. The units are degree/molality i.e K/m

Molal elevation constant from enthalpy of vapourisation

$$K_b = \frac{RT_b^2}{1000l_v}$$

$$l_v = \frac{\Delta_{vap}H}{M}$$

T_b = boiling point of liquid

l_v = latent heat of vaporization per gram of the solvent

$\Delta_{vap}H$ = latent heat of vaporization per mole of the solvent

M = molecular mass of the solvent

$$\frac{(K_b)_x}{(K_b)_y} = \frac{(T_b^2M)_x}{(T_b^2M)_y} \times \frac{(\Delta H)_y}{(\Delta H)_x} = \left(\frac{2}{1}\right)^2 \times \left(\frac{2}{1}\right) = \frac{8}{1}$$

28. Correct answer is [4].

Explanation:

The lone pairs are the valence electrons which do not take part in the bonding. Determine the valence electrons involved in the molecules and then subtract the total number of bonding electrons from the valence electrons to calculate the number of lone pairs.

Lone pairs = $\frac{1}{2}$(Valence e^- in the molecule – Bonding e^- in the molecule)

The lone pairs are a pair of valence electrons that are not shared by another atom in the covalent bond, it is also termed as the unshared pair or the non-bonding pair. The lone pairs are in the outermost shell of atoms. These pairs of electrons are not used in chemical bonding.

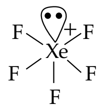
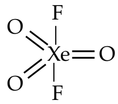
The lone pairs can find out by knowing the geometry of the molecule.

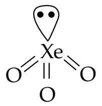
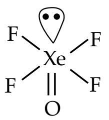
Step 1) Count all the number of valence electrons in the molecule.

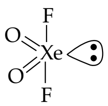
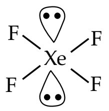
Step 2) Count the total number of atoms that are bonded to the central atom and multiply it by 8 so that all the atoms complete the octet.

Step 3) Find the number of lone pairs by subtracting the valence electrons and bonded atoms from the total valence electrons.

Step 4) now we divide the lone pair electrons found in step 3) by 2 to get the number of lone pairs on the central atom.

XeF_5^+  XeO_3F_2 

XeO_3  $XeOF_4$ 

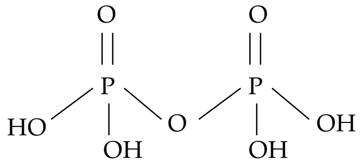
XeO_2F_2  XeF_4 

29. Correct answer is [6].

Explanation:

We know that phosphorus on oxidation and condensation forms various oxoacids and the condensation of two molecules of phosphoric acid results in the pyrophosphoric acid formation that has a formula of ($H_4P_2O_7$)

We also know that σ and π bonds are formed by overlapping atomic orbitals. End to end overlapping of atomic orbitals results in sigma bonds formation and pi bond is formed by sideways overlapping of atomic orbitals.



Pyrophosphoric acid

Number of σ bond = total number of atom – 1

= 13 – 1 = 12

Number of π bond = 2

$$\frac{\sigma}{\pi} = \frac{12}{2} = 6$$

30. Correct answer is [10].

Explanation:

The charge on a complex is the sum of the oxidation state of the metal center and the charges on the ligands.

CO is a neutral ligand. Hence, the charge on the ligand is 0. The total charge on the complex is also 0.

The oxidation number of Fe in the complex, $Fe(CO)_5$ is as follows;

(Charge on Fe) + 5(Charge on CO) = 0

(Charge on Fe) + 5(0) = 0

(Charge on Fe) = 0

Thus, the oxidation number of Fe in $Fe(CO)_5$ is 0.

For VO^{2+}

Here the oxidation state of vanadium is +4.

The steps include:

$x - 2 = 2$

$x = +4$

Therefore, the oxidation state of vanadium in VO^{2+} is 4.

For WO_3

Tungsten trioxide (WO_3) consists of one tungsten atom and three oxygen atoms. Tungsten is a d-block metal from group 6 and has an oxidation state +6 in the compound.

So, Sum of oxidation state = 0 + 4 + 6 = 10