JEE (Main) CHEMISTRY SOLVED PAPER | 2023 8th April Shift 1

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 reaction

   $$\frac{1}{2}H_2(g) + AgCl(s) \rightleftharpoons H^+(aq) + Cl^-(aq) + Ag(s)$$
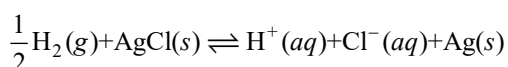
   Occurs in which of the given galvanic cell.
   (1) $Pt\,|H_2(g)\,|HCl(sol^n)\,|AgNO_3(sol^n)\,|Ag$
   (2) $Pt\,|H_2(g)\,|HCl(sol^n)\,|AgCl(s)\,|Ag$
   (2) $Pt\,|H_2(g)\,|KCl(sol^n)\,|AgCl(s)\,|Ag$
   (4) $Ag\,|AgCl(s)\,|KCl(sol^n)\,|AgNO_3\,|Ag$

2. Sulphur (S) containing amino acids from the following are:
   (a) isoleucine
   (b) cysteine
   (c) lysine
   (d) methionine
   (e) glutamic acid
   (1) b, c, e   (2) a, d
   (3) a, b, c   (4) b, d

3. Which of the following complex is octahedral, diamagnetic and the most stable?
   (1) $K_3[Co(CN)_6]$ (2) $[Ni(NH_3)_6]Cl_2$
   (3) $[Co(H_2O)_6]Cl_2$ (4) $Na_3[CoCl_6]$

4. Which of the following metals can be extracted through alkali leaching technique?
   (1) Cu   (2) Au
   (3) Pb   (4) Sn

5. The correct order of spin only magnetic moments for the following complex ions is
   (1) $[CoF_6]^{3-} < [MnBr_4]^{2-} < [Fe(CN)_6]^{3-} < [Mn(CN)_6]^{3-}$
   (2) $[Fe(CN)_6]^{3-} < [CoF_6]^{3-} < [MnBr_4]^{2-} < [Mn(CN)_6]^{3-}$
   (3) $[MnBr_4]^{2-} < [CoF_6]^{3-} < [Fe(CN)_6]^{3-} < [Mn(CN)_6]^{3-}$
   (4) $[Fe(CN)_6]^{3-} < [Mn(CN)_6]^{3-} < [CoF_6]^{3-} < [MnBr_4]^{2-}$

6. The water gas on reacting with cobalt as a catalyst forms
   (1) Methanoic acid   (2) Methanal
   (3) Ethanol   (4) Methanol

7. $2IO_3^- + xI^- + 12H^+ \rightarrow 6I_2 + 6H_2O$
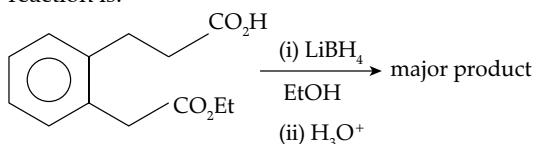   What is the value of x?
   (1) 12   (2) 10
   (3) 2   (4) 6

8. What is the purpose of adding gypsum to cement?
   (1) To give a hard mass
   (2) To speed up the process of setting
   (3) To facilitate the hydration of cement
   (4) To slow down the process of setting

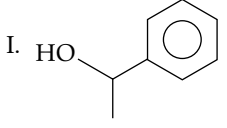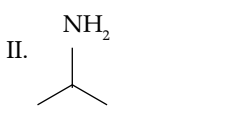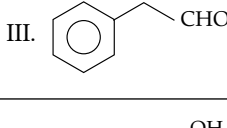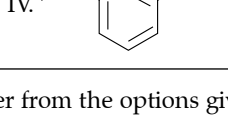9. The major product formed in the following reaction is:

10. Match list I with list II:

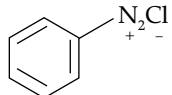| List I (species)	List II (Maximum allowed concentration in ppm in drinking water)
A. F^-	I. <50 ppm
B. SO_4^{2-}	II. <5 ppm
C. NO_3^-	III. <2 ppm
D. Zn	IV. <500 ppm

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

11. In chromyl chloride, the number of d-electrons present on chromium is same as in (Given at no. of Ti: 22, V : 23, Cr : 24, Mn : 25, Fe : 26)
(1) Fe (III)   (2) V (IV)
(3) Ti (III)   (4) Mn (VII)

12. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: Butan-1-ol has higher boiling point than ethoxyethane.
Reason R: Extensive hydrogen bonding leads to stronger association of molecules.
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) Both A and R are true and R is the correct explanation of A
(3) A is false but R is true
(4) A is true but R is false
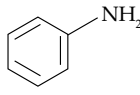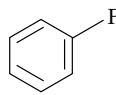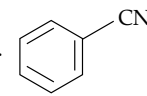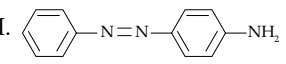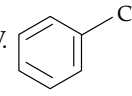
13. Match List I with List II:

List I (Reagents used)	List II (Compound with Functional group detected)
A. Alkaline solution of copper sulphate and sodium citrate	I.
B. Neutral $FeCl_3$ solution	II.
C. Alkaline chloroform solution	III.
D. Potassium iodide and sodium hypochloride	IV.

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

14. Match List I with List II:

 is reacted with reagents in List I to form products in List II.

List I (Reagent)	List II (Product)
A.	I.
B. HBF_4, Δ	II.
C. Cu, HCl	III.
D. CuCN/KCN	IV.

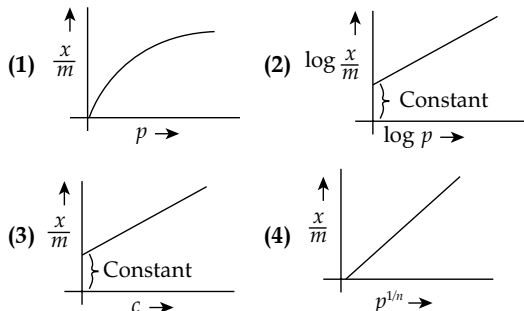Choose the correct answer from the options given below:
(1) A-I, B-III, C-IV, D-II (2) A-III, B-I, C-II, D-IV
(3) A-III, B-I, C-IV, D-II (4) A-IV, B-III, C-II, D-I

15. Match List I with List II:

List I	List II
A. Saccharin	I. High potency sweetener
B. Aspartame	II. First artificial sweetening agent
C. Alitame	III. Stable at cooking temperature
D. Sucralose	IV. Unstable at cooking temperature

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

16. The correct order of electronegativity for given elements is:
(1) P > Br > C > At (2) C > P > At > Br
(3) Br > P > At > C (4) Br > C > At > P

17. Given below are two statements:
Statement I: Lithium and Magnesium do not form superoxide
Statement II: The ionic radius of Li^+ is larger than ionic radius of Mg^{2+}
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) Statement I is incorrect but Statement II is correct

(3) Both statement I and Statement II are correct

(4) Both statement I and Statement II are incorrect

18. Which of the following represent the Freundlich adsorption isotherms?

(1) $\frac{x}{m}$ vs $p \rightarrow$

(2) $\log \frac{x}{m}$ vs $\log p \rightarrow$, } Constant

(3) $\frac{x}{m}$ vs $c \rightarrow$, } Constant

(4) $\frac{x}{m}$ vs $p^{1/n} \rightarrow$

19. Which halogen is known to cause the reaction given below:

$2Cu^{2+}+4X^- \rightarrow Cu_2X_2(s)+X_2$

(1) All halogens   **(2)** Only chlorine

(3) Only Bromine   **(4)** Only Iodine

20. Choose the halogen which is most reactive towards S_N1 reaction in the given compounds (A, B, C, & D)

A. Br(a) ... Br(b) (phenyl)

B. I(a) ... I(b)

C. Br(a) — Br(b), Me

D. Br(b) ... Br(a)
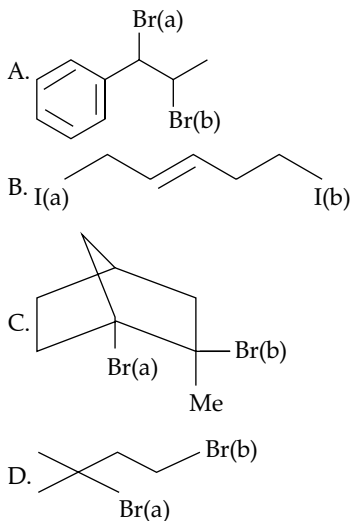
(1) A-Br(a) ; B-I(a) ; C-Br(b) ; D-Br(a)

(2) A-Br(b) ; B-I(a) ; C-Br(a) ; D-Br(a)

(3) A-Br(b) ; B-I(b) ; C-Br(b) ; D-Br(b)

(4) A-Br(a) ; B-I(a) ; C-Br(a) ; D-Br(a)

Section B

21. Molar mass of the hydrocarbon (X) which on ozonolysis consumes one mole of O_3 per mole of (X) and gives one mole each of ethanal and propanone is _____ g mol^{-1} (Molar mass of C : 12 g mol^{-1}, H : 1 gmol^{-1})

22. XeF_4 reacts with SbF_5 to form

$[XeF_m]^{n+}[SbF_y]^{z-}$

$m + n + y + z =$ _____

23. The number of following statements which is/are incorrect is_____

(1) Line emission spectra are used to study the electronic structure.

(2) The emission spectra of atoms in the gas phase show a continuous spread of wavelength from red to violet.

(3) An absorption spectrum is like the photographic negative of an emission spectrum.

(4) The element helium was discovered in the sun by spectroscopic method.

24. The titration curve of a weak acid vs. strong base with phenolphthalein as indictor is shown below. The $K_{phenolphthalein} = 4 \times 10^{-10}$

Given: $\log 2 = 0.3$
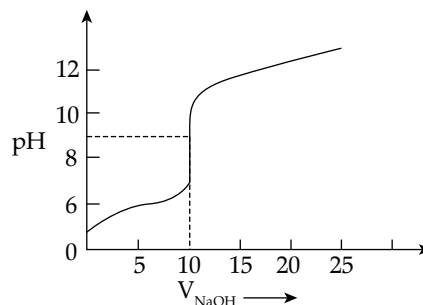
The number of following statement/s which is/are correct about phenolphthalein is_____

(1) It can be used as an indicator for the titration of weak acid with weak base.

(2) It begins to change colour at pH = 8.4

(3) It is a weak organic base

(4) It is colourless in acidic medium

25. When a 60 W electric heater is immersed in a gas for 100s in a constant volume container with adiabatic walls, the temperature of the gas rises by 5°C. The heat capacity of the given gas is_____J K^{-1}(Nearest integer).

26. The vapour pressure vs. temperature curve for a solution solvent system is shown below:
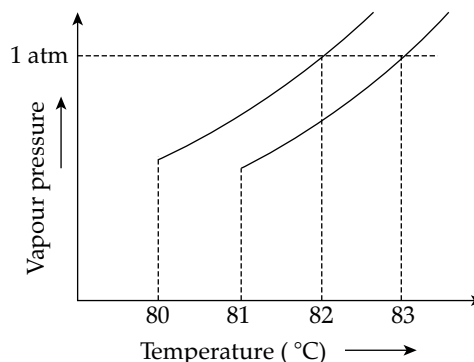
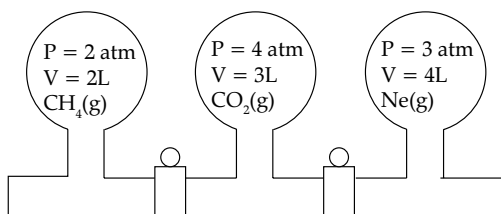The boiling point of the solvent is_____°C

27. 0.5 g of an organic compound (X) with 60% carbon will produce_____$\times$ 10^{-1} g of CO_2 on complete combustion.

28. The number of following factors which affect the percent covalent character of the ionic bond is_____

  (1) Polarising power of cation

  (2) Extent of distortion of anion

  (3) Polarisability of the anion

  (4) Polarising power of anion

29.

  Three bulbs are filled with CH_4, CO_2 and Ne as shown the picture. The bulbs are connected through pipes of zero volume. When the stopcocks are opened and the temperature is kept constant throughout, the pressure of the system is found to be_____atm. (Nearest integer)

30. The number of given statement/s which is/are correct is_____

  (1) The stronger the temperature dependence of the rate constant, the higher is the activation energy.

  (2) If a reaction has zero activation energy, its rate is independent of temperature.

  (3) The stronger the temperature dependence of the rate constant, the smaller is the activation energy

  (4) If there is no correlation between the temperature and the rate constant then it means that the reaction has negative activation energy.

Answer Key

Q No	Answer	Topic's Name	Chapter's Name
1	(2)	Electrochemical Cell	Electrochemistry
2	(4)	Proteins and Polysaccharide	Biomolecules
3	(1)	Crystal Field Theory	Coordination Compounds
4	(4)	Concentration of Ores	General Principles and Processes of Isolation of Elements
5	(4)	Crystal Field Theory	Coordination Compounds
6	(4)	Catalysis	Surface Chemistry
7	(2)	Applications of Oxidation Number	Redox Reaction
8	(4)	Some Important Compounds of Calcium	S-Block Elements
9	(4)	Reactions of Carboxylic Acid	Aldehydes, Ketones & Carboxylic Acids
10	(1)	Water Pollution	Environmental Chemistry
11	(4)	Some Transition Elements	d & f Block Elements
12	(2)	Physical Properties	Alcohols, Phenols & Ethers
13	(1)	Detection of Functional Group	Salt Analysis
14	(3)	Naming Reaction	Nitrogen Containing Compounds
15	(2)	Chemicals in Food	Chemistry In Everyday Life
16	(4)	Trends in Physical Properties	Classification of Elements and Periodicity in Properties
17	(3)	Trends in Physical Properties	Classification of Elements and Periodicity in Properties
18	(BONUS)	Freundlich Isothermal	Surface Chemistry
19	(4)	Some Transition Elements	d & f Block Elements
20	(1)	Fundamental Concepts in Organic Reaction Mechanism	Organic Chemistry - Some Basic Principles and Techniques
21	[70]	Law of Chemical Combinations	Some Basic Concepts of Chemistry
22	[11]	Some Transition Elements	d & f Block Elements
23	[1]	Evidence for Quantized Electronic Energy Levels	Atomic Structure
24	[2]	Hydrolysis of Salts and the pH of their Solutions	Ionic Equilibrium
25	[1200]	Adiabatic	Thermodynamics
26	[82]	Vapour Pressure of Solutions of Liquids in Liquids	Solutions
27	[11]	Stoichiometry	Some Basic Concepts of Chemistry
28	[3]	Ionic And Electrovalent Bond	Chemical Bonding & Molecular Structure
29	[3]	Ideal Gas Equation	States of Matter
30	[2]	Effect of Temperature and Catalyst on Rate of a Reaction	Chemical Kinetics

ANSWERS WITH EXPLANATIONS

SECTION - A

1. Option (2) is correct.
    Explanation:
    H_2 gets oxidised to HCl in the galvanic cell.
    Pt, H_2 | HCl(*sol*) forms anode.
    AgCl(*s*) | Ag forms cathode.
    ∴ The cell can be written as
    Pt, $H_2(g)$ | HCl(*sol*) || AgCl(*s*) | Ag
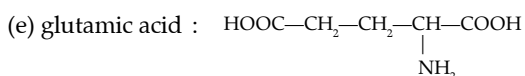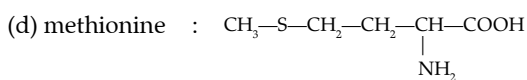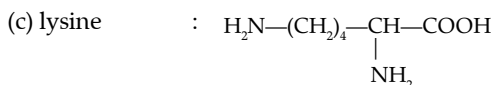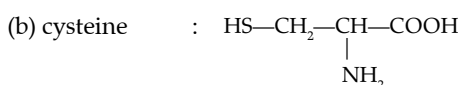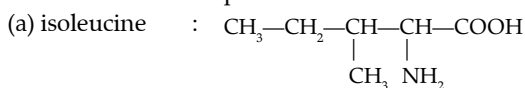
2. Option (4) is correct.
    Explanation:
    Isoleucine is an α-amino acid that is used in the biosynthesis of proteins. It contains an α amino group, an α-carboxylic acid group, and a hydrocarbon side chain with a branch. It is classified as a non-polar, uncharged, branched-chain, aliphatic amino acid.

    Lysine is an α-amino acid that is a precursor to many proteins. It contains an α-amino group, an alpha-carboxylic acid group, and a side chain lysyl, classifying it as a basic, charged, aliphatic amino acid. It is encoded by the codons AAA and AAG.

    Glutamic acid is an amino acid used to form proteins.

    Cysteine and methionine are sulphur containing amino acids. Amino acids get linked to one another by peptide bond formation and form a polypeptide chain of proteins. Hence cysteine and methionine are found in several proteins.
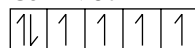
    (a) isoleucine :
    $$CH_3-CH_2-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{NH_2}{|}}{CH}-COOH$$

    (b) cysteine :
    $$HS-CH_2-\underset{\underset{NH_2}{|}}{CH}-COOH$$

    (c) lysine :
    $$H_2N-(CH_2)_4-\underset{\underset{NH_2}{|}}{CH}-COOH$$

    (d) methionine :
    $$CH_3-S-CH_2-CH_2-\underset{\underset{NH_2}{|}}{CH}-COOH$$

    (e) glutamic acid :
    $$HOOC-CH_2-CH_2-\underset{\underset{NH_2}{|}}{CH}-COOH$$

3. Option (1) is correct.
    Explanation:
    $\left[Co(CN)_6\right]^{3-}$ and $\left[Co(H_2O)_6\right]^{3+}$ are diamagnetic but first one is more stable as Δ_0 is high for first complex.

    $K_3[Co(CN)_6]$
    $+3 + x - 6 = 0$
    $\boxed{x = +3}$
    ⇓
    $Co^{+3} \rightarrow 3d^6$

    | ⇅ | ↑ | ↑ | ↑ | ↑ |

    ∴ CN^- is SFL so pairing occur so

    | ⇅ | ⇅ | ⇅ | | |
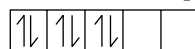
    $U_e = 0$
    ↓
    So diamagnetic in nature
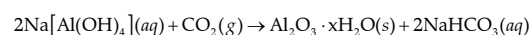
4. Option (4) is correct.
    Explanation:
    Alkali-acid leaching is an effective method used to purify graphite and remove silicate minerals. In this study, the dissolution behavior and mechanism of sericite in alkali-acid leaching were investigated.

    In this method, the ore is treated with aqueous alkali to form a soluble complex. For example, bauxite, an important ore of aluminium is heated with a solution of sodium hydroxide or sodium carbonate in the temperature range 470–520 K at 35 atm to form soluble sodium meta- aluminate leaving behind the impurities, iron oxide and titanium oxide

    $$Al_2O_3(s) + 2NaOH(aq) + 3H_2O(l) \rightarrow 2Na\left[Al(OH)_4\right](aq)$$
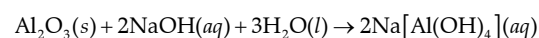
    The hot solution is decanted, cooled, and diluted. This solution is neutralised by passing gas, to form hydrated Al_2O_3 precipitate.

    $$2Na\left[Al(OH)_4\right](aq) + CO_2(g) \rightarrow Al_2O_3 \cdot xH_2O(s) + 2NaHCO_3(aq)$$
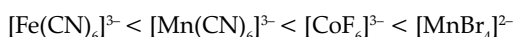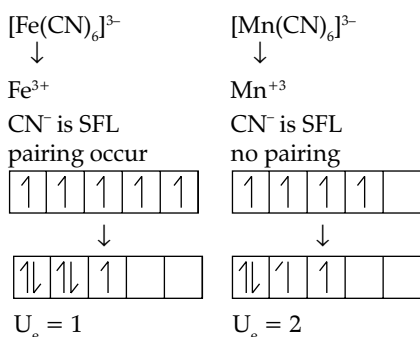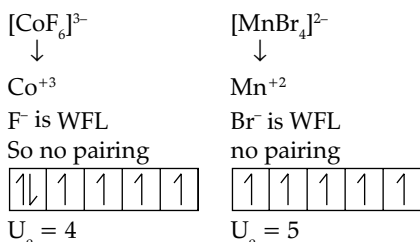
    The precipitate is filtered off and heated around 1670K to get pure alumina Al_2O_3.

5. Option (4) is correct.

Explanation:
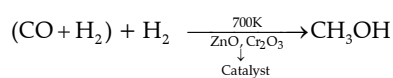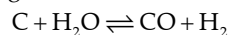
Br^- is a weak ligand while CN^- is a strong ligand. More the number of unpaired electrons, more the value of magnetic moment.

$[CoF_6]^{3-}$ $[MnBr_4]^{2-}$
$\downarrow$ $\downarrow$

Co^{+3} Mn^{+2}

F^- is WFL Br^- is WFL

So no pairing   no pairing

| ⇅ | ↑ | ↑ | ↑ | ↑ |

| ↑ | ↑ | ↑ | ↑ | ↑ |

$U_e = 4$ $U_e = 5$

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

Fe^{3+} Mn^{+3}

CN^- is SFL CN^- is SFL

pairing occur   no pairing

| ↑ | ↑ | ↑ | ↑ | ↑ |

| ↑ | ↑ | ↑ | ↑ | |

$\downarrow$ $\downarrow$

| ⇅ | ⇅ | ↑ | | |

| ⇅ | ↑ | ↑ | | |

$U_e = 1$ $U_e = 2$

$[Fe(CN)_6]^{3-} < [Mn(CN)_6]^{3-} < [CoF_6]^{3-} < [MnBr_4]^{2-}$
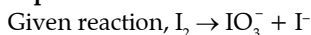
6. Option (4) is correct.

Explanation:

Water gas shift reaction is defined as the reaction between carbon and water vapor to form carbon monoxide and hydrogen. The mixture of carbon monoxide and hydrogen is known as water gas. This reaction is more catalyzed on iron catalysts and merely catalyzed by cobalt catalysts. The chemical equation for the formation of water gas shift reaction follows:
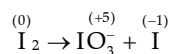
$$C + H_2O \rightleftharpoons CO + H_2$$

$$(CO + H_2) + H_2 \xrightarrow[\underset{\text{Catalyst}}{ZnO, Cr_2O_3}]{700K} CH_3OH$$

7. Option (2) is correct.

Explanation:

Given reaction, $I_2 \rightarrow IO_3^- + I^-$

Disproportionation reaction is the reaction in which an element under go both oxidation and reduction.

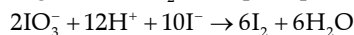$$\overset{(0)}{I_2} \rightarrow \overset{(+5)}{IO_3^-} + \overset{(-1)}{I^-}$$

I has oxidised from O to +5 and reduced from 0 to –1.

n factor of IO_3^- and I^- in the given redox reaction are 5 and 1 respectively. Therefore, will always react in the molar ratio 1 : 5 to get I_2.

$$IO_3^- + 6H^+ + 5I^- \rightarrow 3I_2 + 3H_2O$$
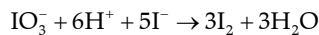
To get 6 molar I_2, multiple equation by 2

$$2IO_3^- + 12H^+ + 10I^- \rightarrow 6I_2 + 6H_2O$$

So, $x = 10$

8. Option (4) is correct.
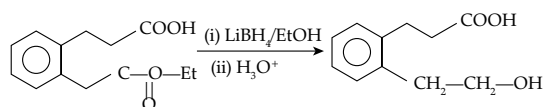
Explanation:

Gypsum ($CaSO_4.2H_2O$) plays an important role in controlling the rate of hardening of the cement. During cement manufacturing process upon cooling of clinker a small amount of gypsum is added during the final grinding process. Gypsum controls the setting of the cement and if not added the cement will set immediately leaving no time for concrete placing.

9. Option (4) is correct.

Explanation:

$NaBH_4$ (Sodium borohydride) is a weak reducing agent, it reduces aldehydes/ketones but not esters, it produces alcohols through reduction.

ketones reduces to 2° alcohol.

Note: Lithium borohydride is commonly used for selective reduction of esters and lactones to the corresponding alcohol.

10. Option (1) is correct.

Explanation:

NO_3^- The maximum limit of nitrate NO_3^- in drinking water is 50 ppm and its source is fertilisers, if the maximum limit is increased in water it will cause methemoglobinemia (blue baby syndrome SO_4^{2-}. The maximum limit of sulphate (SO_4^{2-}) according to WHO is 500 pm and its source are acid rain, industries. Excess SO_4^{2-} has laxative effect. F^- The maximum limit of fluoride (F^-) is about 1.5 ppm. Its higher concentration converts enamel to more harder fluorapatite. Concentration (>2ppm) causes brown mottling of teeth and high concentration (>10 ppm) are harmful for bones and teeth. SO_4^{2-} (100 ppm) and NO_3^- (50 ppm) in water is suitable for drinking but the concentration of F^- (10 ppm makes water unsuitable for dirnking.

Zinc is one of the important trace elements that play a vital role in the physiological and metabolic process of many organisms. Nevertheless, higher concentrations of zinc can be toxic to the organism. It plays an important role in protein synthesis and is a metal which shows fairly low concentration in surface water due to its restricted mobility from the place of rock weathering or from the natural sources.

According to the standards maximum prescribed limit of Zn in drinking water is 5 ppm.

11. Option (4) is correct.

Explanation:

When a mixture containing chloride ion is heated with $K_2Cr_2O_7$ and concentrated H_2SO_4, deep orange-red fumes of chromyl chloride (CrO_2Cl_2) are formed
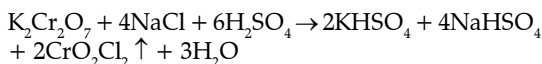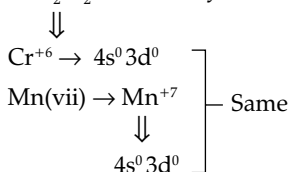
$K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \rightarrow 2KHSO_4 + 4NaHSO_4 + 2CrO_2Cl_2 \uparrow + 3H_2O$
Orange-red fumes

So in this case, X in CrO_2Cl_2.

Oxidation state of $Cl = -1$, $O = -2$, $Cr = x$

$x + 2 \times (-2) + 2 \times (-1) = 0 \Rightarrow x = +6$

$CrO_2Cl_2 \rightarrow$ Chromyl chloride

$\Downarrow$

$\left. \begin{array}{l} Cr^{+6} \rightarrow 4s^0 3d^0 \\[4pt] Mn(vii) \rightarrow Mn^{+7} \\ \qquad \Downarrow \\ \qquad 4s^0 3d^0 \end{array} \right\}$ Same

12. Option (2) is correct.

Explanation:

Both are functional isomers. However, intermolecular hydrogen bonding is present in butan-1-ol molecules while it is absent in the molecules of diethyl ether. Therefore, boiling point of alcohol (390 K) is higher as compared to that of ether (308 K).
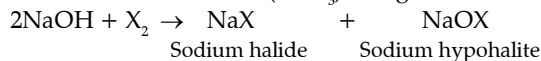
13. Option (1) is correct.

Explanation:

(A) Fehling's solution is used to distinguish between aldehyde and ketone functional groups. Aldehydes oxidize to give a positive result but ketones won't react to the test (except for α-hydroxy ketones). Fehling's test is used as a general test for determining monosaccharides and other reducing sugars.


(B)
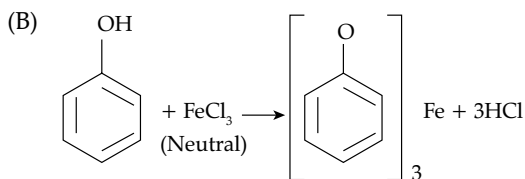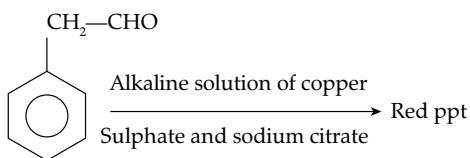
(C) This reaction is a chemical test for detection of primary amines, in which the amine is heated with alcoholic potassium hydroxide and chloroform. If a primary amine is present, the isocyanide is formed. The reaction is known as carbylamine reaction.

$RNH_2 + CHCl_3 + 3KOH \rightarrow RN^+ \equiv C^- + 3KCl + 3H_2O$
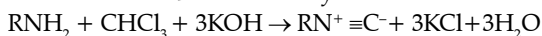
When a methyl ketone (even acetaldehyde) is reacted with halogen in aqueous sodium hydroxide, the ketone gets oxidised to the sodium salt of acid with one carbon less than ketone and at the same time haloform (CHX_3) also gets formed.

$2NaOH + X_2 \rightarrow NaX + NaOX$
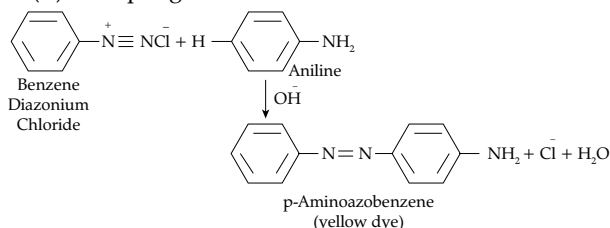   Sodium halide   Sodium hypohalite

The hydroxide ion acts as a nucleophile and attacks the electrophilic carbon which is doubly bonded to oxygen. This carbon-oxygen double bond becomes a single bond making the oxygen atom anionic.
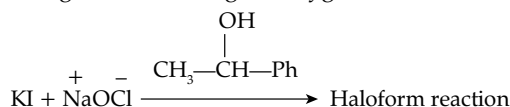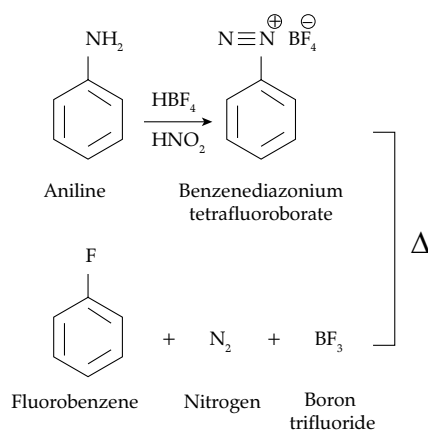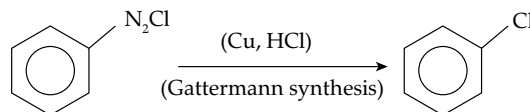

14. Option (3) is correct.

Explanation:

(A) Coupling Reaction:

(B) Balz–Schiemann reaction:

(C) Gattermann Reaction → In this reaction, chlorine or bromine can be introduced in the benzene ring by treating the benzene diazonium salt solution with corresponding halogen acid in the presence of copper powder.

(D) In the given reaction when benzene diazonium salt is treated with KCN and copper powder, it forms aryl nitrile or benzyl nitrile as a product.

15. Option (2) is correct.

Explanation:

A. Saccharin is first popular artificial sweetening agent. It is 550 times as sweet as cane sugar. It is used as intake by diabetic person.

B. Aspartame is 100 times as sweet as cane sugar. It is used in cold foods and soft drinks because it is unstable at cooking temperature.

C. Alitame is 2000 times as sweet compared to cane sugar. It has excellent stability at high temperature. So, can be used in cooking and baking.

D. Sucralose is 600 times as sweet as cane sugar. It is heat stable and finds its use in baked goods.

16. Option (4) is correct.

Explanation:

Electronegativity is a measure of an atom's ability to attract shared electrons to itself. On the periodic table, electronegativity generally increases as we move from left to right across a period due to increase in effective nuclear charge.

C (2.5)

P (2.1) $\Rightarrow$ Br > C > At > P

Br (2.8)

At (2.2)

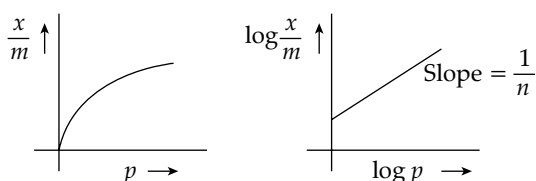**17.** Option (3) is correct.

Explanation:

Lithium and Magnesium does not form superoxides because they are very small in size.

18. Option (1 & 2) is correct.

Explanation:

The equation $\dfrac{x}{m} = kp^{1/n}$ represents Freundlich adsorption isotherm. It is an empirical relationship between the amount of gas adsorbed by a given amount of solid adsorbent surface and pressure of the gas at a particular temperature.
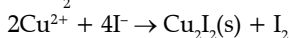
$$\frac{x}{m} = kp^{1/n} \qquad\qquad \log\frac{x}{m} = \log K + \frac{1}{n}\log p$$
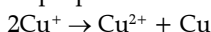

19. Option (4) is correct.

Explanation:

$2Cu^{+2} + 4X_2 \rightarrow Cu_2X_2 + X_2$ and the same applies to CuX. On the other hand, all Cu(II) halides are known except the iodide. In this case, Cu^{2+} oxidises I^- to I_2:

$2Cu^{2+} + 4I^- \rightarrow Cu_2I_2(s) + I_2$
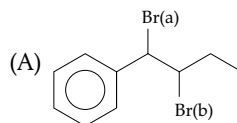
However, many copper (I) compounds are unstable in aqueous solution and undergo disproportionation.
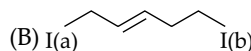
$2Cu^+ \rightarrow Cu^{2+} + Cu$

20. Option (1) is correct.

Explanation:
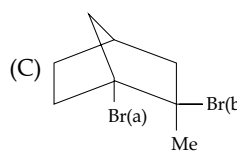
Organic compounds are more reactive towards SN 1, if the carbocation is stable compared to others. Reactivity in reactions depends upon the stability of the carbocation intermediate.
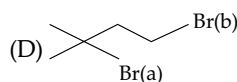

(A) → Br(a), Becuase formed intermediate carbocation get stable by conjugation with phenyl ring

(B) → I(a), Becuase formed intermediate carbocation become more stable by conjugation

(C) → Br(b), Becuase we can't remove Br(a) from bridge head carbon (Bredt's rule

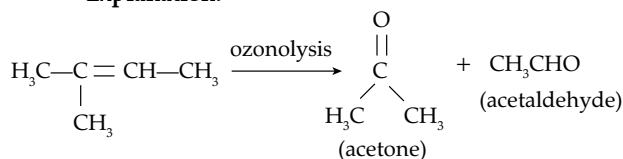(D) → Br(a), because formed intermediate 3° carbocation is more stable (stability of carbocation 3° > 2° > 1°)

SECTION - B

21. Correct answer is [70].

Explanation:

Hydrocarbon (X) is 2-methyl- but-2-ene (C_5H_{10})

And the molecular mass is 5 (12) + 10 (1) = 70.

22. Correct answer is [11].

Explanation:

XeF_4 reacts with SbF_5 which is a lewis acid and forms adduct. The reaction is

$XeF_4 + SbF_5 [XeF_3]^+[SbF_6]^-$
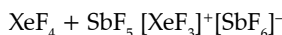
The cation is T-shaped and the anion is octahedral.

$m + n + x + y = 3 + 1 + 6 + 1 = 11$

Xenon fluoride act as F⁻ donor.

23. Correct answer is [1].

Explanation:

The emission spectra of atoms in the gaseous phase do not show a continuous spread of wavelength from red to violet, rather they emit light only at specific wavelengths with dark spaces between them.

24. Correct answer is [2].

Explanation:

Phenolphthalein is used as an indicator in titrations involving weak acids and strong bases because it changes color at the point of neutralization. At a pH of 8.2-9.8, phenolphthalein is colorless, but at a pH above 10, it becomes pink. This change in color allows for a visual indication of neutralisation. acid and base. Additionally, phenolphthalein has a relatively low detection limit, making it useful for determining the end point of a titration accurately.

25. Correct answer is [1200].

Explanation:

Adiabatic wall {no heat exchange between system and surrounding}

$C_v \times \Delta T = E \times t$

$C_v \times 5 = 60 \times 100$

$C_v = 1200$

26. Correct answer is [82].

Explanation:

At any temperature, the vapour pressure of the solution is lower than that of the pure solvent. Hence vapour pressure- temperature curve of solution lies below that of solvent.

The more volatile liquid evaporates fast as compared to the less volatile liquid at a low temperature because the volume increases with respect to temperature so it has a low boiling point.

27. Correct answer is [11].

Explanation:

Mass of Carbon = 12

Molar Mass of CO_2 = 12 + (16 × 2) = 44

Mass of Compound = 0.5 g

$$\% \text{ of C} = \frac{\text{Molar mass of C} \times \text{Mass Of } CO_2}{\text{Mass Of Compound} \times \text{Molar Mass Of } CO_2}$$

$$\frac{60}{100} = \frac{12 \times x}{0.5 \times 44}$$

$1.1 = x$

$x = 11 \times 10^{-1}$

28. Correct answer is [3].

Explanation:

Percent covalent character of the ionic bond depends upon

(1) Polarising power of cation

(2) Extent of distortion of anion

(3) Polarisability of the anion

Every ionic compound having some percentage of covalent character according to Fajan's rule. The percentage of ionic character in a compound having covalent character, can also be calculated by the following equation.

The percent ionic character

$$= \frac{\text{observed dipole moment}}{\text{Calculated dipole moment assuming 100\% ionic bond}} \times 100$$

29. Correct answer is [3].

Explanation:

Dalton's law of partial pressure states that whenever two or more gases, which do not react chemically, are enclosed in vessel, the total pressure is equal to sum of partial pressure of each gas.

From Dalton's partial pressure law,

$P_f V_f = P_1 V_1 + P_2 V_2 + P_3 V_3$

$P_f \times 9 = 2 \times 2 + 4 \times 3 + 3 \times 4$

$P_f = \dfrac{28}{9} = 3.11 = 3$

30. Correct answer is [2].

Explanation:

Clearly, if $E_a = 0$, K is temperature independent

if $E_a > 0$, K increase with increase in temperature

if $E_a < 0$, K decrease with increase in temperature

- Rate constant increases with increase in temperature. This is due to a greater number of collisions whose energy exceeds the activation energy.
- Higher the magnitude of activation energy, stronger is the temperature dependence of the rate constant.
- The pre-exponential factor is a measure of the rate at which collisions occur, irrespective of their energy.
  a. A high activation energy usually implies a slow reaction.
  b. $k = P \times Z \times e^{-E_a/RT}$
  c. The pre-exponential factor (A = P×Z) is independent of the activation energy and the energy of molecules.

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.
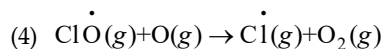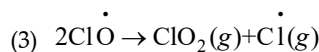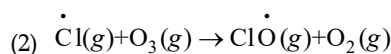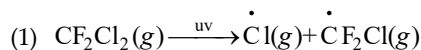
   (1)

   (2)

   (3)

   (4)
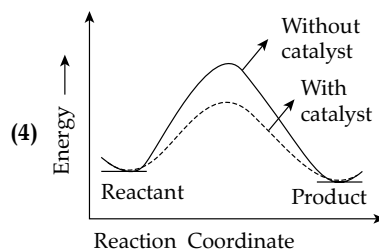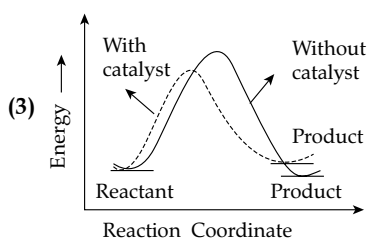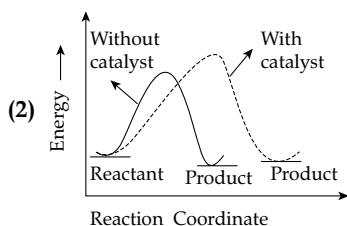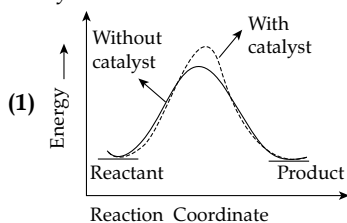
3. Given below are two statements: One is labelled as **Assertion A** and other is labelled as **Reason R**
   Assertion A: Sodium is about 30 times as abundant as potassium in the oceans.
   **Reason R:** Potassium is bigger in size than sodium.
   In the light of the above statements, choose the correct 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) $CF_2Cl_2(g) \xrightarrow{uv} \overset{\bullet}{C}l(g) + \overset{\bullet}{C}F_2Cl(g)$

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

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

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

5. The correct IUPAC nomenclature for the following compound is :
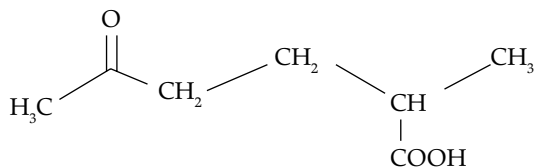
(1) 2-Methyl-5-oxohexanoic acid
(2) 2-Formyl-5-methylhexan-6-oic acid
(3) 5-Formyl-2-methylhexanoic acid
(4) 5-Methyl-2-oxohexan-6-oic acid

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

Given v = frequency of X-ray emitted

z = atomic number
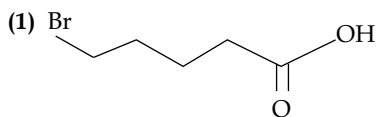
(1)

(2)

(3)

(4)
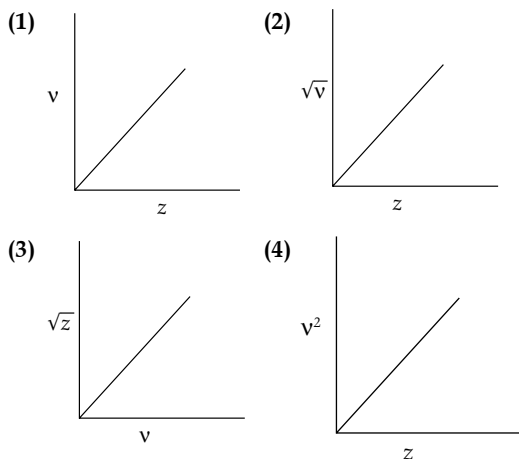
7. Match list I with list II

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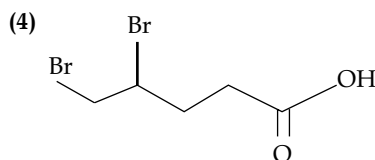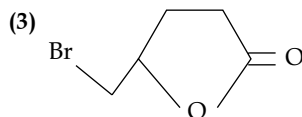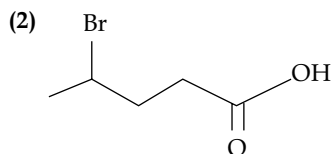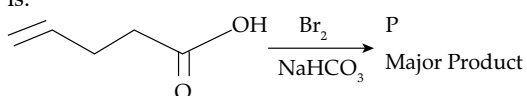
9. For a good quality cement, the ratio of lime to the total of the oxides of Si, Al and Fe should be as close as to

(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
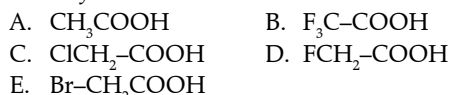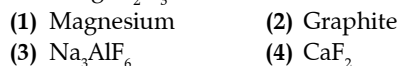
14. In Hall-Heroult process, the following is used for reducing Al_2O_3:
    (1) Magnesium
    (2) Graphite
    (3) Na_3AlF_6
    (4) CaF_2

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
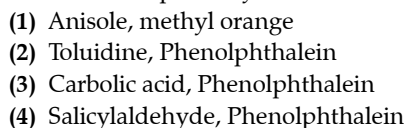   (1) Both statement I and Statement II are incorrect
    (2) Statement I is incorrect but Statement II is correct
    (3) Statement I is correct but Statement II is incorrect
    (4) Both Statement I and Statement II are correct

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
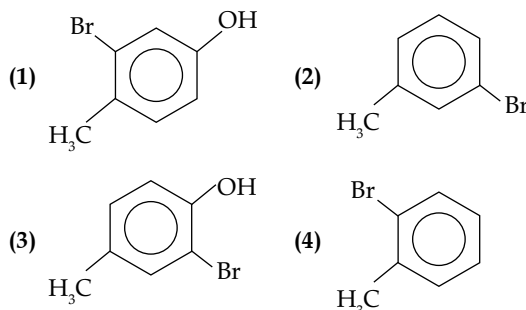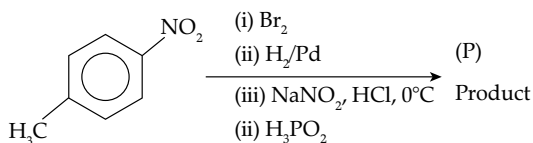

    Choose the correct answer from the options given below:
    (1) D > B > A > C
    (2) A > B > D > C
    (3) C > A > D > B
    (4) D > C > B > A
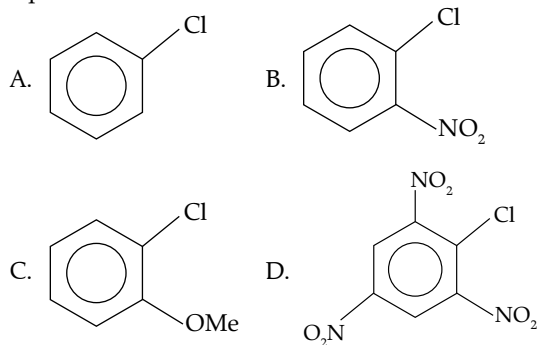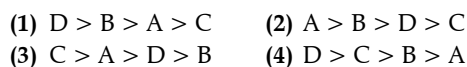
19. A compound 'X' when treated with phthalic anhydride in presence of concentrated H_2SO_4 yields 'Y'. 'Y' is used as an acid/base indicator. 'X' and 'Y' are respectively.
    (1) Anisole, methyl orange
    (2) Toluidine, Phenolphthalein
    (3) Carbolic acid, Phenolphthalein
    (4) Salicylaldehyde, Phenolphthalein

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

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_____ $\times 10^{-9}$ 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) $\dfrac{dE°_{cell}}{dT} = \dfrac{\Delta S°}{nF}$
    (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

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.
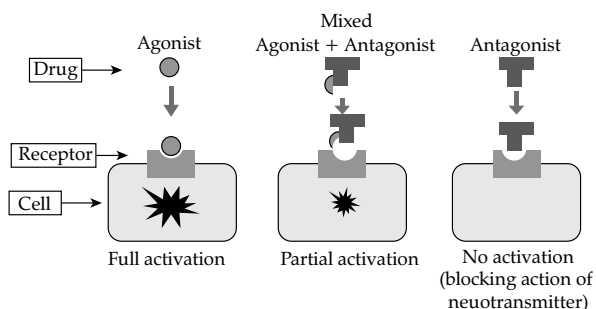
2. Option (4) is correct.
Explanation:
In the presence of a catalyst, the activation energy is reduced between reactant and product. The intermediate formed is faster in presence of catalyst followed by an alternate and short pathway.

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.
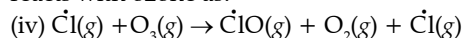
4. Option (3) is correct.
Explanation:
In the stratosphere, ozone is a product of the action of UV radiations on dioxygen as:

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

(ii) $O_2(g) + O(g) \underset{}{\overset{\text{UV}}{\longleftrightarrow}} O_3(g)$
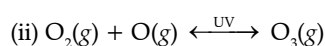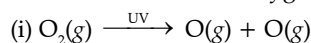
Reaction (ii) indicates the dynamic equilibrium existing between the production and decomposition of ozone molecules. Any factor that disturbs the equilibrium may cause depletion of ozone layer by its decomposition. One such factor is the release of chlorofluorocarbon compounds (CFCs). These are non-reactive, 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) $CF_2Cl_2(g) \xrightarrow{\text{UV}} \dot{C}l(g) + CF_2\dot{C}l(g)$
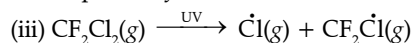
The chlorine free radical produced in reaction (iii) reacts with ozone as:

(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) $\dot{C}lO(g) + \dot{O}(g) \rightarrow \dot{C}l(g) + O_2(g)$
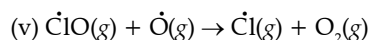
(vi) The regeneration of causes a continuous breakdown of ozone present in the stratosphere, damaging the ozone layer.

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
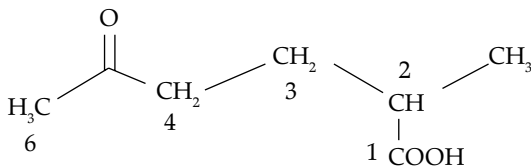2. Other functional groups (act as a substituent):
   2.1 use as prefix

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.
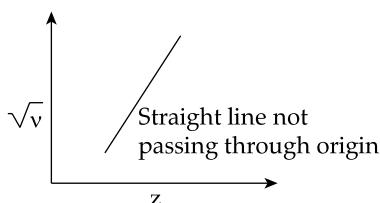
Explanation:

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

$v = A(z − b)^2$

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.
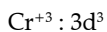

7. Option (1) is correct.

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 $[Fe(H_2O)_6]^{2+}$
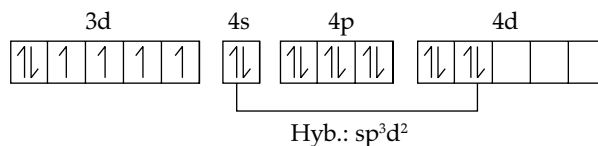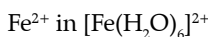
For option C:

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

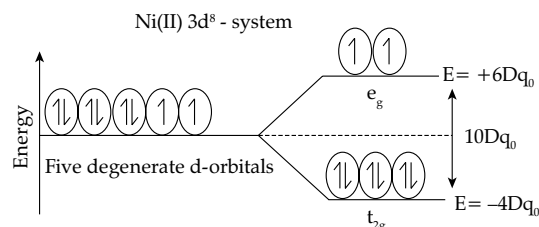Since it has no unpaired electrons, $[Co(NH_3)_6]^{3+}$ is diamagnetic.
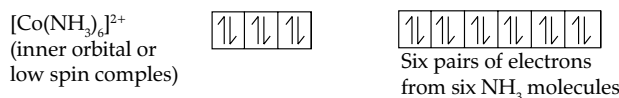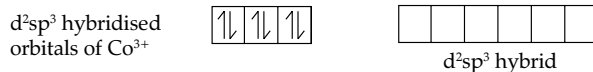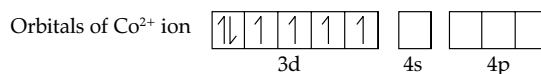
For option D

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.
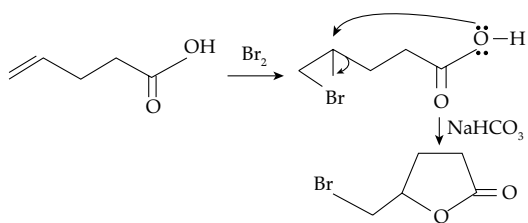
9. Option (1) is correct.

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.

$$\text{Limestone + Clay} \xrightarrow[\text{Clinker}]{1770-1870K} \text{Cement} + CO_2\uparrow$$
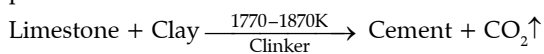
When mixed with water the cement reacts to form gelatinous mass which sets to a hard mass when three dimensional cross lines are formed between silica oxygen silica and silica oxygen aluminium as ....Si - O - Si....... and Si - O - Al........

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
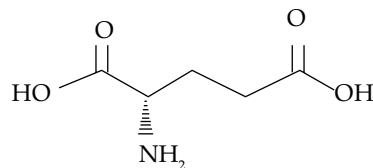
B. Glutamine – Q
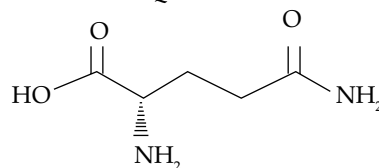
C. Tyrosine – Y
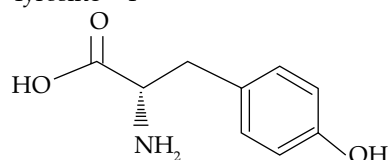
D. Tryptophan – W
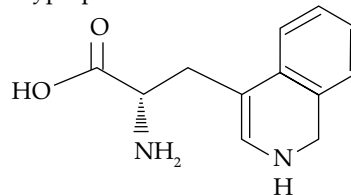
11. Option (3) is correct.

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

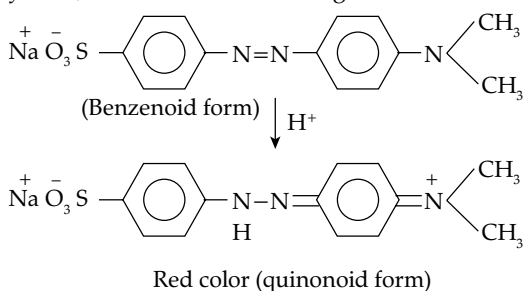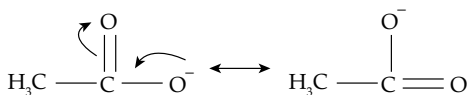Electron withdrawing substituent increases the acidity by increasing the ionic character of O–H by inductive effect. Electronegativity decreases in the order F > Cl > Br and hence –I effect also decreases in the same order

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

$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$
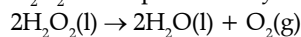
In the presence of metal surfaces or traces of alkali (present in glass containers), the above reactions is catalysed. It is, therefore stored in wax-lined glass or plastic vessels in dark. Urea be added as a stabiliser. It is kept away from dust because dust can induce explosive decomposition of the 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 $\propto \dfrac{1}{EDG}$

–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
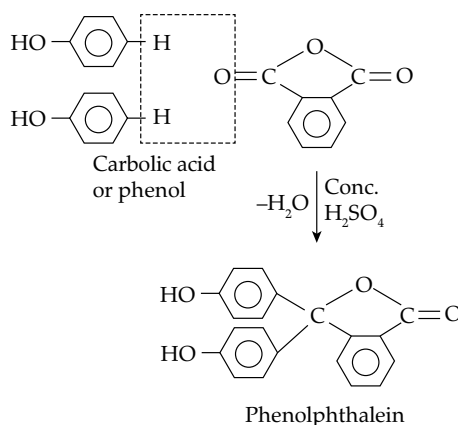
20. Option (4) is correct.

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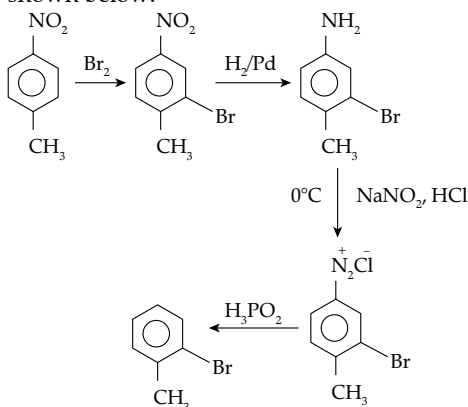
$\Rightarrow 2 + (-6) = -x$

$\Rightarrow -4 = -x$

$\Rightarrow x = 4$

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, $\Delta U =$ internal energy

$\Delta n_g =$ 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:

$$BaSO_{4(s)} \underset{s}{\overset{}{\rightleftharpoons}} \underset{s\ (aq)}{Ba^{2+}} + \underset{s(aq)}{SO_4^{2-}}$$

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

$\Delta G = -n F\ E_{cell}$

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

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

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

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

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

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.
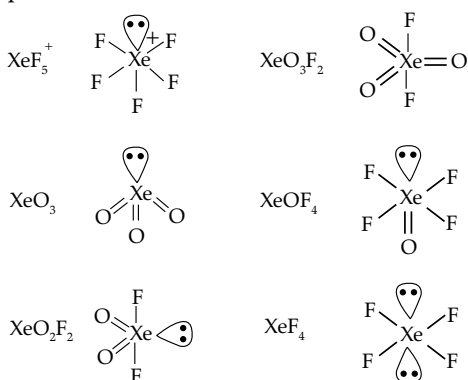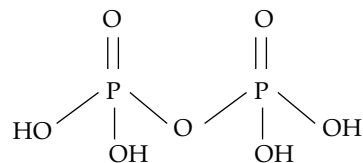

29. Correct answer is [6].

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