JEE (Main) CHEMISTRY SOLVED PAPER

2023
10^{th} April Shift 2

Section A

1. The correct relationships between unit cell edge length 'a' and radius of sphere 'r' for face-centred and body-centred cubic structures respectively are:

(1) $2\sqrt{2}r = a$ and $\sqrt{3}r = 4a$

(2) $r = 2\sqrt{2}a$ and $4r = \sqrt{3}a$

(3) $r = 2\sqrt{2}a$ and $\sqrt{3}r = 4a$

(4) $2\sqrt{2}r = a$ and $4r = \sqrt{3}a$

2. The reaction used for preparation of soap from fat is :

(1) an addition reaction
(2) an oxidation reaction
(3) alkaline hydrolysis reaction
(4) reduction reaction

3. Match List I with List II

LIST I	LIST II
(A). 16 g of CH_4 (g)	**I.** Weight 28 g
(B). 1 g of H_2 (g)	**II.** 6.02×10^{23} electrons
(C). 1 mole of N_2 (g)	**III.** Weight 32 g
(D). 0.5 mol of SO_2 (g)	**IV.** Occupies 11.4 L volume at STP

Choose the correct answer from the options given below:

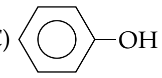
(1) A-II, B-IV, C-I, D-III **(2)** A-II, B-IV, C-III, D-I
(3) A-II, B-III, C-IV, D-I **(4)** A-I, B-III, C-II, D-IV

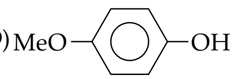
4. The correct order of metallic character is

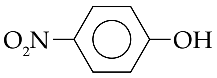
(1) K>Be>Ca **(2)** Be>Ca>K
(3) K>Ca>Be **(4)** Ca>K>Be

5. The correct order for acidity of the following hydroxyl compound is :

(A) CH_3OH (B) $(CH_3)_3COH$

(C) 

(D) 

(E) 

Choose the correct answer from the options given below:

(1) E > C > D > A > B **(2)** D > E > C > A > B
(3) E > D > C > B > A **(4)** C > E > D > B > A

6. Match List I with List II

LIST I Complex	LIST II Crystal Field splitting energy (Δ_0)
(A). $[Ti(H_2O)_6]^{2+}$	I. –1.2
(B). $[V(H_2O)_6]^{2+}$	II. –0.6
(C). $[Mn(H_2O)_6]^{3+}$	III. 0
(D). $[Fe(H_2O)_6]^{3+}$	IV. –0.8

Choose the correct answer from the options given below:

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

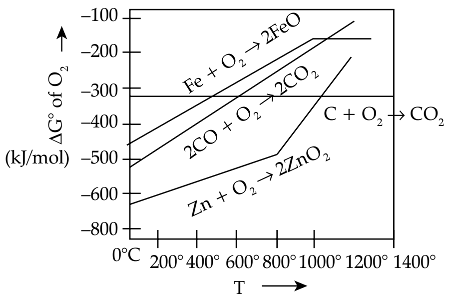
7. In Carius tube, an organic compound 'X' is treated with sodium peroxide to form a mineral acid 'Y'. The solution of $BaCl_2$ is added to 'Y' to form a precipitate 'Z'. 'Z' is used for the quantitative estimation of an extra element. 'X' could be

(1) Chloroxylenol **(2)** Methionine
(3) A nucleotide **(4)** Cytosine

8. Number of water molecules in washing soda and soda ash respectively are:

(1) 1 and 0 **(2)** 1 and 10
(3) 10 and 0 **(4)** 10 and 1

9. Gibbs energy vs T plot for the formation of oxides is given below.



For the given diagram, the correct statement is –

(1) At 600° C, C can reduce ZnO
(2) At 600° C, C can reduce FeO
(3) At 600° C,CO cannot reduce FeO
(4) At 600° C, CO can reduce ZnO

10. Buna–S can be represented as:

(1) $\left[CH_2 - CH = CH - CH = \underset{}{\overset{C_6H_5}{C}} - CH_2 \right]_n$

(2) $\left[CH_2 - CH = CH - CH_2 - \overset{C_6H_5}{CH} - CH_2 \right]_n$

(3) $\left[CH = CH - CH = CH - \overset{C_6H_5}{CH} - CH_2 \right]_n$

(4) $\left[CH_2 - CH = \overset{C_6H_5}{C} - CH = CH - CH_2 \right]_n$

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

Assertion A: Physical properties of isotopes of hydrogen are different.

Reason: Mass difference between isotopes of hydrogen is very large.

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 false but R is true

(3) A is true but R is false

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

12. The correct order of the number of unpaired electrons in the given complexes is

(A) $[Fe(CN)_6]^{3-}$ **(B)** $[FeF_6]^{3-}$

(C) $[CoF_6]^{3-}$ **(D)** $[Cr(oxalate)_3]^{3-}$

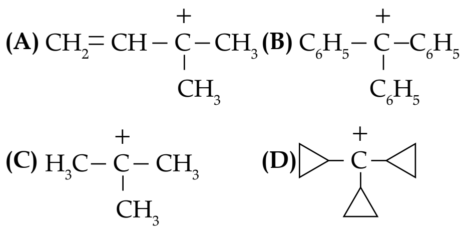
(E) $[Ni(CO)_4]$

Choose the correct answer from the options given below:

(1) E < A < D < C < B **(2)** A < E < C < B < D

(3) A < E < D < C < B **(4)** E < A < B < D < C

13. The decreasing order of hydride affinity for following carbonations is:



Choose the correct answer from the given below:

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

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

14. Incorrect method of preparation for alcohols from the following is:

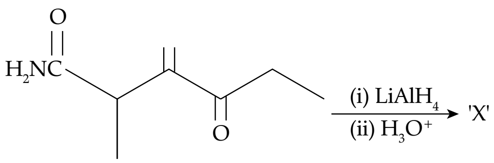
(1) Ozonolysis of alkene.

(2) Hydroboration-oxidation of alkene.

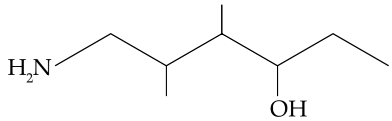
(3) Reaction of alkyl halide with aqueous NaOH.

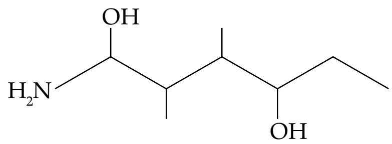
(4) Reaction of Ketone with RMgBr followed by hydrolysis.

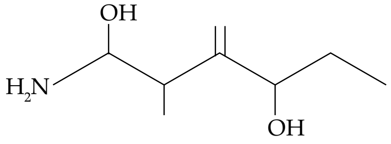
15. In the reaction given below:

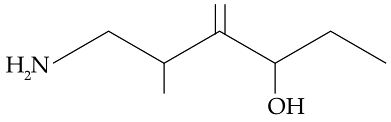


The product 'X' is:

(1) 

(2) 

(3) 

(4) 

16. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R

Assertion A: The energy required to form Mg^{2+} from Mg is much higher than that required to produce Mg^+

Reason R: Mg^{2+} is small ion and carry more charge than Mg^+

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

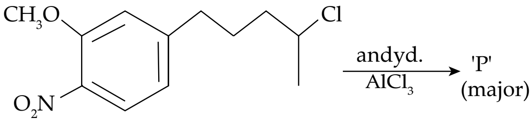
(1) Both A and R are true and R is the correct explanation of A

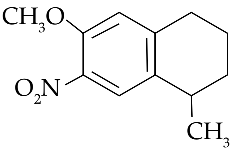
(2) A is true but R is false

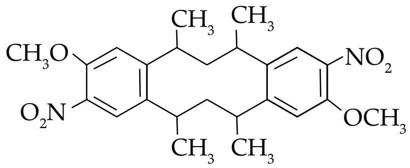
(3) A is false but R is true

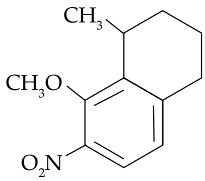
(4) Both A and R are true but R is NOT the correct explanation of A

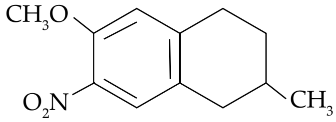
17. The major product 'P' formed in the given reaction is:



(1) 

(2) 

(3) 

(4) 

18. Ferric chloride is applied to stop bleeding because -

(1) Blood absorbs $FeCl_3$ and forms a complex.

(2) $FeCl_3$ reacts with the constituents of blood which is a positively charged sol.

(3) Fe^{3+} ions coagulate blood which is a negatively charged sol.

(4) Cl^- ions cause coagulation of blood.

19. The delicate balance of CO_2 and O_2 is NOT disturbed by
(1) Burning of Coal
(2) Deforestation
(3) Burning of petroleum
(4) Respiration

20. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A: 3.1500 g of hydrated oxalic acid dissolved in water to make 250.0 mL solution will result in 0.1M oxalic acid solution.
Reason R: Molar mass of hydrated oxalic acid is 126 g mol^{-1}
In the light of the above statements, choose the correct answer from the options given below:
(1) A is false but R is true
(2) A is true but R is false
(3) Both A and R are true but R is NOT the correct explanation of A
(4) Both A and R are true and R is the correct explanation of A

Section B

21. The number of molecules from the following which contain only two lone pair of electrons is________
H_2O, N_2, CO, XeF_4, NH_3, NO, CO_2,F_2

22. The specific conductance of 0.0025M acetic acid is 5×10^{-5} S cm^{-1} at a certain temperature. The dissociation constant of acetic acid is __________$\times10^{-7}$.(Nearest integer)
Consider limiting molar conductivity of CH_3COOH as 400 S cm^2 mol^{-1}.

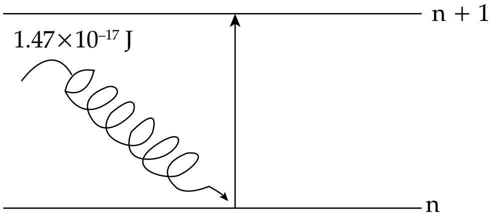
23. An aqueous solution of volume 300cm^3 contains 0.63 g of protein. The osmotic pressure of the solution at 300 K is 1.29 mbar. The molar mass of the protein is _______ g mol^{-1}
Given: R = 0.083 L bar K^{-1} mol^{-1}

24. The difference in the oxidation state of Xe between the oxidised product of Xe formed on complete hydrolysis of XeF_4 and XeF_4 is ____________

25. The number of endothermic process/es from the following is
(A) $I_2(g) \rightarrow 2I(g)$
(B) $HCl(g) \rightarrow H(g)+Cl(g)$
(C) $H_2O(l) \rightarrow H_2O(g)$
(D) $C(s)+O_2(g) \rightarrow CO_2(g)$
(E) Dissolution of ammonium chloride in water

26. The number of incorrect statement/s from the following is
(A) The successive half-lives of zero order reactions decreases with time.
(B) A substance appearing as reactant in the chemical equation may not affect the rate of reaction
(C) Order and molecularity of a chemical reaction can be a fractional number
(D) The rate constant units of zero and second order reaction are mol L^{-1} s^{-1} and mol^{-1} Ls^{-1} respectively.

27.



The electron in the nth orbit of Li^{2+} is excited to (n+1) orbit using the radiation of energy 1.47×10^{17} J (as shown in the diagram). The value of n is_________
Given: $R_H = 2.18\times10^{-18}$ J

28. For a metal ion, the calculated magnetic moment is 4.90BM. This metal ion has___________ number of unpaired electrons.

29. In alkaline medium, the reduction of permanganate anion involves a gain of ______ electrons.

30. $A(g) \rightarrow 2B(g) + C(g)$
For the given reaction, if the initial pressure is 450 mmHg and the pressure at time *t* is 720 mmHg at a constant temperature T and constant volume V. The fraction of A(g) decomposed under these conditions is $x \times 10^{-1}$. The value of x is ____________ (nearest integer).

Answer Key

Q. No.	Answer	Topic name	Chapter name
1	(4)	Relationship Between Edge Length and Radius of an Atom	Solid State
2	(3)	Preparation of Soap	Carboxylic Acid
3	(1)	Calculation of Mole	Some Basic Concepts of Chemistry
4	(3)	Order of Metallic Character	s Block
5	(1)	Acidity of Hydroxyl Compounds	Alcohol Phenol and Ether
6	(1)	CFSE Value	Coordination Chemistry
7	(3)	Carius Experiments	General Organic Chemistry
8	(3)	Number of Water Molecules in the Sample	Chemical Bonding
9	(2)	Ellingham Diagram	Metallurgy
10	(2)	Monomers of Addition Polymer	Polymer

11	**(4)**	Properties of Isotopes	Hydrogen
12	**(1)**	Calculation of Number of Unpaired Electrons In Coordination Compounds	Coordination Chemistry
13	**(4)**	Stability of carbocation	General Organic Chemistry
14	**(1)**	Preparation of Alcohol	Alcohol Phenol and Ether
15	**(4)**	Reduction of Amide	Amines
16	**(1)**	Ionization Enthalpy of Metal	Periodic Classification of Elements
17	**(1)**	Chemical properties	Aromatic Hydrocarbons
18	**(3)**	Coagulation of colloidal Solution	Surface Chemistry
19	**(4)**	Air Pollutants	Environmental Chemistry
20	**(4)**	Concentration of the Solution	Liquid Solution
21	**[4]**	Shape of Molecule	Chemical Bonding
22	**[66]**	Dissociation constants of an acid	Ionic Equilibrium
23	**[40535]**	Calculation of Molar Mass of Protein	Liquid Solution
24	**[2]**	Calculation of different Oxidation State	p Block
25	**[4]**	Endothermic Process	Thermodynamics and Thermochemistry
26	**[1]**	Order and Molecularity Mixed Concept	Chemical Kinetics
27	**[1]**	Calculation of Number of Orbit	Structure of Atom
28	**[4]**	Magnetic Moment	Structure of Atom
29	**[3]**	Electron Transfer during Redox Reaction	Redox Reaction
30	**[3]**	Calculation of Degree of Dissociation	Chemical Equilibrium

Solutions

Section A

1. **Option (4) is correct.**
For face centered cubic lattice

$$\sqrt{2}a = 4r,\ a = \frac{4r}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}},\ a = 2\sqrt{2}r$$

For body centered cubic lattice $\sqrt{3}a = 4r$

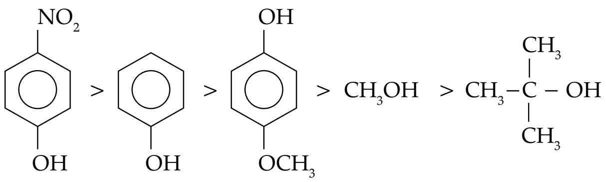
2. **Option (3) is correct.**
During the preparation of soap, esters of fatty acids are hydrolyzed in the presence of strong bases like NaOH or KOH to give alcohol and soap. This process is known as saponification and the type of reaction used is alkaline hydrolysis reaction.

$$\text{Ester} + \text{base} \rightarrow \text{alcohol} + \text{soap}$$

3. **Option (1) is correct.**
(A) 16g of CH_4 = 1 mole = N_A
$\therefore$ 16g of CH_4 = 6.02×10^{23} electrons
(B) 2g of H_2 occupies 22.4L volume at STP
$\therefore$ 1g of H_2 occupies = $\frac{22.4}{2}L$
= 11.2 L volume at STP
(C) 1 mole of N_2 = molecular mass of N_2 = N_A
1 mole of N_2 = 28g
(D) 1 mole of SO_2 = molecular mass of SO_2 = N_A
Molecular mass of SO_2 = 32 + 32 = 64 g
1 mole of SO_2 = 64
0.5 mole of SO_2 = 64 × 0.5 = 32g
$\therefore$ (A)-(II);(B)-(IV);(C)-(I);(D)-(III)

4. **Option (3) is correct.**
The metallic character decreases across the period whereas it increases down the group. Be and Ca lie in a same group while K and Ca lie in a same period. Therefore the correct order of metallic character is K>Ca>Be.

5. **Option (1) is correct.**
The acidity of aromatic alcohols are greater than the aliphatic alcohols due to stabilization of phenoxide through resonance. Also the EWG increases the acidic strength while EDG decreases on any compound. Between methyl alcohol and 3° alcohol, 3° alcohol is less acidic due to more no. of EDGs thus the correct order of hydroxyl compound is

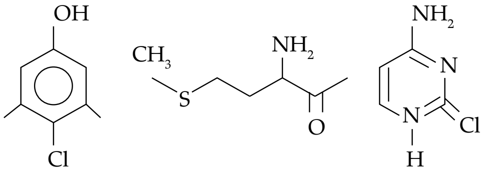


E > C > D > A > B

6. **Option (1) is correct.**
$[Ti(H_2O)_6]^{2+}$
The electronic configuration of $Ti^{2+} = 3d^2 4s^0$

$CFSE = [-0.4 \times t_{2g}e^-s + 0.6 \times e_g e^-s]\Delta_0$
$= [-0.4 \times 2 + 0.6 \times 0]\Delta_0 = -0.8\Delta_0$
For $[v(H_2O)_6]^{2+}$
The electronic configuration of $V^{2+} = 3d^3 4s^0$
$CFSE = [-0.4 \times 3 + 0.6 \times 0]\Delta_0 = -1.2\Delta_0$
For $[Mn(H_2O)_6]^{3+}$
The electronic configuration of $Mn^{3+} = 4d^4 4s^0$
$CFSE = [-0.4 \times 3 + 0.6 \times 1]\Delta_0$
$= -0.6\Delta_0$
For $[Fe(H_2O)_6]^{3+}$
The electronic configuration of $Fe^{3+} = 3d^5 4s^0$
$CFSE = [-0.4 \times 3 + 0.6 \times 2]\Delta_0 = 0$

7. Option (3) is correct.
Since carius method is used for the quantitative analysis of sulphur. So compound (x) should be a sulphur containing compound. The structure of given compounds are as follows-



Chloroxylenol Methionine Cytosine

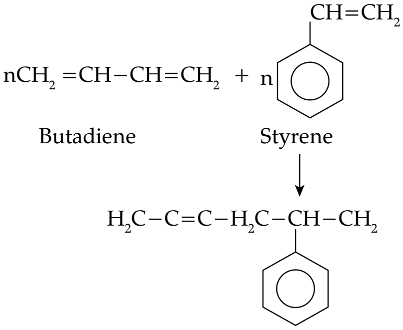
Nucleotides are organic molecules composed of a nitrogenous base, a pentose sugar and a phosphate. Thus compound x is methionine.

8. Option (3) is correct.
The formula for washing soda is $Na_2CO_3.10H_2O$ and that of soda Ash is Na_2CO_3 Thus number of water molecules are 10 and 0 respectively.

9. Option (2) is correct.
For any reaction, to be spontaneous the value of ΔG should be negative. Thus C can reduce FeO at 600°C

$$FeO + C \rightarrow Fe + CO_2$$

10. Option (2) is correct.

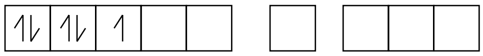


(Buna-s)

11. Option (4) is correct.
The three isotopes of Hydrogen protium, deuterium, and tritium Hydrogen is the only element whose isotopes have different physical properties. This is because there is difference in the masses of its isotopes.

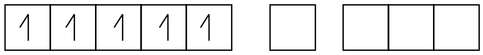
Isotopes	**Mass**
Protium	1.00794 amu
Deutrium	2.014 amu
Tritium	3.0160 amu

12. Option (1) is correct.
(A) $[Fe(CN)_6]^{3-}$
The configuration of $Fe^{3+} = 3d^5 4s^0$
Since CN^- is a strong ligand thus it would pair up the d electrons so it will have 1 unpaired electron.
$[Fe(CN)_6]^{3-}$



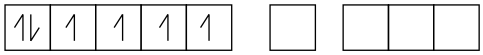
3d 4s 4p

(B) $[FeF_6]^{3-}$
Since F^- is a weak, so it will not be able to pair up the electron so it will have 5 unpaired electron.
$[FeF_6]^{3-}$



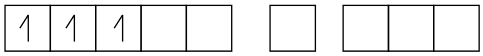
3d 4s 4p

(C) $[COF_6]^{3-}$
The configuration of $CO^{3+} = 3d^6$
F^- is a weak ligand, so it will pair up the electrons.
$\therefore$ it will have 4 unpaired electrons
$[COF_6]^{3-}$



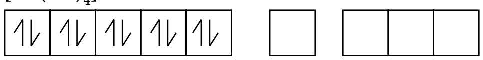
3d 4s 4p

(D) $[Cr(ox)_3]^{3-}$
The configuration of $Cr^{3+} = 3d^3$
ox^- is a strong ligand it will pair up the electrons but in this case it already have vacant orbital . thus it will have 3 unpaired electrons.
$[Cr(ox)_3]^{3-}$



3d 4s 4p

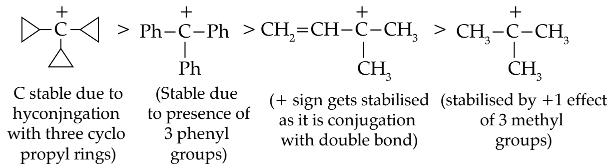
(E) $[Ni(CO)_4]$
The electronic configuration of Ni is $3d^8 4s^2$ since Co is a strong ligand it will pair up the electrons and will not have any unpaired electrons.
$[Ni(Co)_4]$



3d 4s 4p

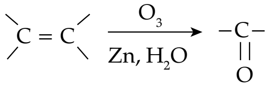
Thus the correct order is E < A < D < C < B

13. Option (4) is correct.
More is the stability of carbocation lesser will be affinity towards hydride. The stability of given carbocation are as follows-

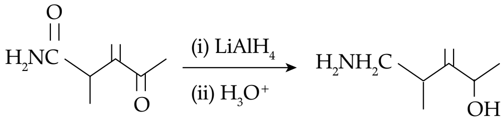


14. Option (1) is correct.

Ozonolysis of alkene gives aldehyde or ketone depending upon the type of alkene taken. Hence it is not the correct method for the preparation of alcohol.



15. Option (4) is correct.

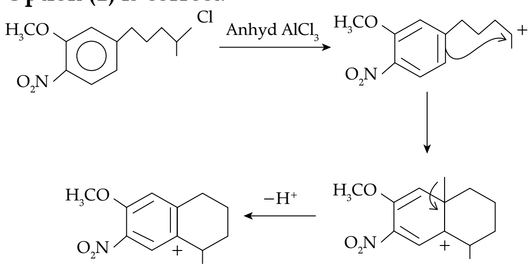


16. Option (1) is correct.

$$Mg \xrightarrow{IE_1} Mg^{+} \xrightarrow{IE_2} Mg^{2+}$$

The energy required to form Mg^{2+} from Mg i.e. its second ionization energy is much higher than required to produce Mg^{+}. This is because Mg^{2+} is smaller ion and carry more charge than Mg^{+}.

17. Option (1) is correct.



18. Option (3) is correct.

Ferric Chloride is applied to stop bleeding because Fe^{3+} ions coagulate blood which is a negatively charged sol.

19. Option (4) is correct.

The delicate balance of CO_2 and O_2 is not disturbed by the process of respiration and photosynthesis as they are natural phenomenon. The balance of O_2 and CO_2 is maintained in the atmosphere by the oxygen released by plants during photosynthesis and carbon dioxide released by humans, animals and plats during respiration.

20. Option (4) is correct.

$$\text{Molarity} = \frac{\text{No. of moles of hydrated oxalic acid}}{\text{volume of the solution}} \times 1000$$

No. of moles of of oxalic acid hydrated

$$= \frac{\text{given mass}}{\text{molecular mass}}$$

$$= \frac{3.1500}{126}$$

$$\therefore \quad \text{molarity} = \frac{\frac{3.1500}{126}}{250} \times 1000$$

$$= \frac{12.6}{126} = 0.1\text{ M}$$

Section B

21. Correct answer is [4].

$$\text{No. of lone pairs} = \frac{\text{total no. of } e^- - \text{bp } e^-}{2}$$

No. of lone pairs of electrons in the given molecules are as follows.

H_2O

Total no. of electrons = 2 + 6 = 8

$$\text{No. of Lp} = \frac{8-4}{2} = 2$$

No. of lone pairs in case of N_2 CO, F_2 and NO can't be calculated by above method, so we need to draw their Lewis structures.

$$:N\equiv N:, \; :C\equiv O:, \; \cdot\ddot{N}=\ddot{\underset{\cdot\cdot}{O}}, \; :\underset{\cdot\cdot}{\ddot{F}}-\underset{\cdot\cdot}{\ddot{F}}:$$

XeF_4

Total no. of electrons = 8 + 4 = 12

$$\text{No. of lp} = \frac{12-8}{2} = \frac{4}{2} = 2$$

NH_3

Total No. of electrons = 5 + 3 = 8

$$\text{No. of lp} = \frac{8+6}{2} = 1$$

Thus, 4 molecules (H_2O, N_2, CO, XeF_4) which contain only two lone pair of electrons.

22. Correct answer is [66].

$$\text{Molar conductivity of } \lambda_m = \frac{k}{c} \times 100$$

$k = 5 \times 10^{-5}$ Scm^{-1}

$c = 0.0025$ m

$$\lambda_m = \frac{5 \times 10^{-5} \times 10^{3}}{0.0025}$$

$$= 205 \text{ Scm}^2 \text{ mol}^{-1}$$

$$\lambda = \frac{\lambda_m}{\lambda_m^{\infty}} = \frac{20}{400} = \frac{1}{20}$$

$$k_a = \frac{c\alpha^2}{1-\alpha}$$

$$= \frac{0.0025 \times \frac{1}{20} \times \frac{1}{20}}{\frac{19}{20}}$$

$$= \frac{0.0025}{19 \times 20} = 66 \times 10^{-7}$$

23. Correct answer is [40535].

Osmotic pressure, $\pi = cRt$

$$\pi = \frac{n}{v} RT$$

$$\pi = \frac{mRT}{Mv} \quad \left(n = \frac{m}{M}\right)$$

$$M = \frac{mRT}{V\pi}$$

$$M = \frac{0.63 \times 0.083 \times 300}{1.29 \times 10^{-3} \times 300 \times 10^{-3}}$$

$$M = 40535 \text{ g/mol}$$

24. Correct answer is [2].

The hydrolysis reaction of XeF_4 is as follows:

$$\overset{+4}{Xe}F_4 + H_2O \rightarrow \overset{+6}{Xe}O_3 + Xe + HF + O_2$$

$\therefore$ difference in the oxidation state of Xe = 6 – 4 = 2

25. Correct answer is [4].

(A) $I_2(g) \rightarrow 2I(g)$
This reaction is atomization reaction. The energy would be absorbed, thus it is endothermic process.

(B) $HCl(g) \rightarrow H(g) + Cl(g)$
This is again atomization reaction, accompanied by endothermic process.

(C) $H_2O(l) \rightarrow H_2O(g)$
This is vapourisation reaction and involves endothermic process.

(D) $C(s) + O_2(g) \rightarrow CO_2(g)$
This is combustion reaction the energy would be released and this is exothermic reaction

(E) Dissolution is an endothermic process.
Thus, there are 4 endothermic process.

26. Correct answer is [1].

(A) For zero order, $t_{1/2} = \frac{[A_0]}{2k}$ as concentration decreases half life decreases.

(B) If it is a zero order reaction, then the concentration of reactant will not affect the rate of the reaction.

(C) order can be fractional but molecularity can't

(D) For zero second order reactions, the units of rate constant are mol/L/s and L/mol/s respectively. Therefore only (c) statement is incorrect

27. Correct answer is [1].

$$\Delta E = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$1.47 \times 10^{-17} = 2.18 \times 10^{-18} \times 9\left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right)$$

On solving, we get $n = 1$

28. Correct answer is [4].

m calculated = 4.90

$m = \sqrt{n(n+2)}$

on solving we get $n = 4$

29. Correct answer is [3].

In alkaline medium the reduction of permanganate anion involves following reaction.

$$\overset{+7}{Mn}O_4^- + 3e^- + 2H_2O \rightarrow \overset{+4}{Mn}O_2 + 4OH^-$$

30. Correct answer is [3].

	A(g)	$\rightleftharpoons$	2B(g)	+	C(g)
$t = 0$	450		0		0
$t = t$	$450 - x$		$2x$		x

$$P_T = P_A + P_B + P_C$$

$$720 = 450 - x + 2x + x$$

$$270 = 2x$$

$$x = 135$$

$$\text{Fraction of a decomposed} = \frac{135}{450}$$

$$= 0.3 \approx 3 \times 10^{-1}$$

$$x = 3$$

❑❑