

JEE (Main) CHEMISTRY SOLVED PAPER

2023
24th Jan Shift 2

Section A

Q. 1. Identify the correct statements about alkali metals.

- A. The order of standard reduction potential ($M^+ | M$) for alkali metal ions is $Na > Rb > Li$.
 B. CsI is highly soluble in water.
 C. Lithium carbonate is highly stable to heat.
 D. Potassium dissolved in concentrated liquid ammonia is blue in colour and paramagnetic.
 E. All the alkali metal hydrides are ionic solids.

Choose the correct answer from the options given below:

- (1) C and E only (2) A, B and E only
 (3) A, B, D only (4) A and E only

Q. 2. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R

Assertion A: Beryllium has less negative value of reduction potential compared to the other alkaline earth metals.

Reason: Beryllium has large hydration energy due to small size of Be^{2+} but relatively large value of atomization enthalpy

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

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

Q. 3. A student has studied the decomposition of a gas AB_3 at $25^\circ C$. He obtained the following data.

p(mmHg)	50	100	200	400
relative $t_{1/2}$ (s)	4	2	1	0.5

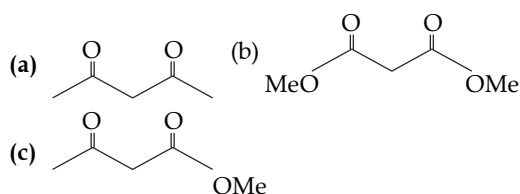
The order of the reaction is

- (1) 0 (zero) (2) 0.5 (3) 1 (4) 2

Q. 4. $K_2Cr_2O_7$ paper acidified with dilute H_2SO_4 turns green when exposed to

- (1) Carbon dioxide (2) Sulphur trioxide
 (3) Sulphur dioxide (4) Hydrogen sulphide

Q. 5. Which will undergo deprotonation most readily in basic medium?

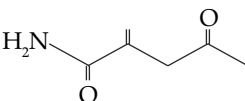


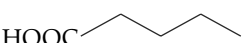
- (1) c only (2) a only
 (3) Both a and c (4) b only

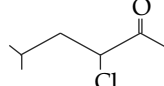
Q. 6. The hybridization and magnetic behaviour of cobalt ion in $[Co(NH_3)_6]^{3+}$ complex, respectively is

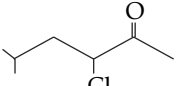
- (1) $d^2 sp^3$ and paramagnetic
 (2) $sp^3 d^2$ and diamagnetic
 (3) $d^2 sp^3$ and diamagnetic
 (4) $sp^3 d^2$ and paramagnetic

Q. 7. Given below are two statements:

Statement 1:  under

Clemmensen reduction conditions will give 

Statement 2:  under Wolff-

Kishner reduction condition will give 

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

- (1) Statement I is false but Statement II is true
 (2) Statement I is true but Statement II is false
 (3) Both Statement I and Statement II are true
 (4) Both Statement I and Statement II are false

Q. 8. Which of the following cannot be explained by crystal field theory?

- (1) The order of spectrochemical series
 (2) Stability of metal complexes
 (3) Magnetic properties of transition metal complexes
 (4) Colour of metal complexes

Q. 9. The number of s-electrons present in an ion with 55 protons in its unipositive state is

- (1) 8 (2) 10 (3) 9 (4) 12

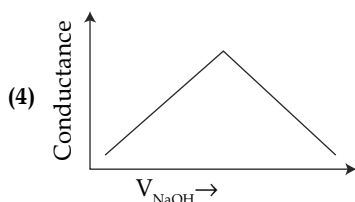
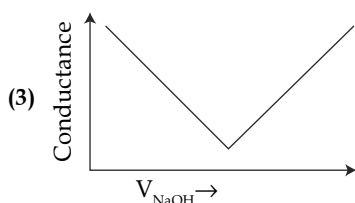
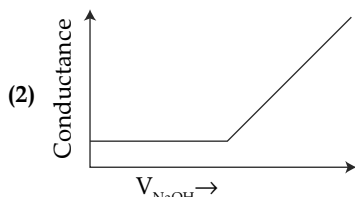
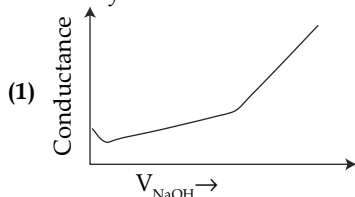
Q. 10. Which one amongst the following are good oxidizing agents?

- (A) Sm^{2+} (B) Ce^{2+} (C) Ce^{4+} (D) Tb^{4+}

Choose the most appropriate answer from the options given below:

- (1) D only (2) C only
 (3) C and D only (4) A and B only

Q. 11. Choose the correct representation of conductometric titration of benzoic acid vs sodium hydroxide.



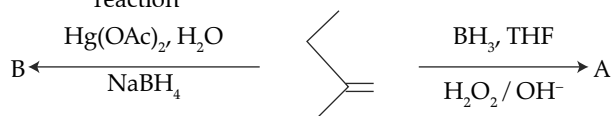
Q.12. Match List I with List II

List I Type		List II Name	
A.	Antifertility drug	I.	Norethindrone
B.	Tranquilizer	II.	Meprobamate
C.	Antihistamine	III.	Seldane
D.	Antibiotic	IV.	Ampicillin

Choose the correct answer from the options given below:

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

Q 13. Find out the major products from the following reaction



- (1) A = , B =
 (2) A = , B =
 (3) A = , B =
 (4) A = , B =

Q. 14. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R
Assertion: Benzene is more stable than hypothetical cyclohexatriene

Reason: The delocalized π electron cloud is attracted more strongly by nuclei of carbon atoms. In the light of the above statements, choose the correct answer from the options given below:

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

Q. 15. In which of the following reactions the hydrogen peroxide acts as a reducing agent?

- (1) $\text{PbS} + 4\text{H}_2\text{O}_2 \rightarrow \text{PbSO}_4 + 4\text{H}_2\text{O}$
 (2) $\text{Mn}^{2+} + \text{H}_2\text{O}_2 \rightarrow \text{Mn}^{4+} + 2\text{OH}^-$
 (3) $\text{HOCl} + \text{H}_2\text{O}_2 \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^- + \text{O}_2$
 (4) $2\text{Fe}^{2+} + \text{H}_2\text{O}_2 \rightarrow 2\text{Fe}^{3+} + 2\text{OH}^-$

Q. 16. Given below are two statements:

Statement I: Pure Aniline and other arylamines are usually colourless.

Statement II: Arylamines get coloured on storage due to atmospheric reduction

In the light of the above statements, 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

Q. 17. Correct statement is:

- (1) An average human being consumes nearly 15 times more air than food
 (2) An average human being consumes 100 times more air than food
 (3) An average human being consumes equal amount of food and air
 (4) An average human being consumes more food than air

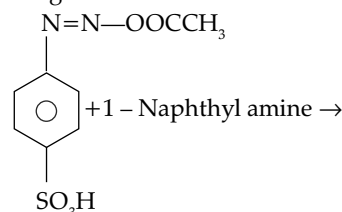
Q. 18. What is the number of unpaired electron(s) in the highest occupied molecular orbital of the following species : $\text{N}_2; \text{N}_2^+; \text{O}_2; \text{O}_2^+$?

- (1) 2,1,0,1 (2) 0, 1, 0, 1
 (3) 0,1,0,1 (4) 2,1,2,1

Q. 19. The metal which is extracted by oxidation and subsequent reduction from its ore is:

- (1) Ag (2) Fe (3) Cu (4) Al

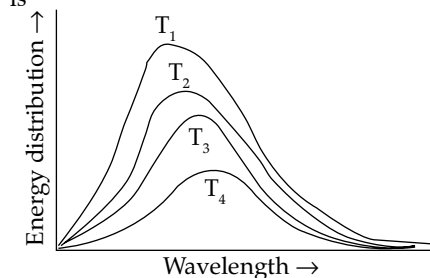
Q. 20. Choose the correct colour of the product for the following reaction.



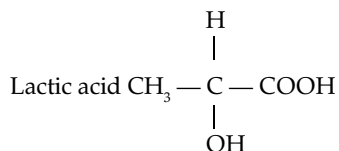
- (1) White (2) Red (3) Blue (4) Yellow

Section B

- Q. 21. Following figure shows spectrum of an ideal black body at four different temperatures. The number of correct statement/s from the following is

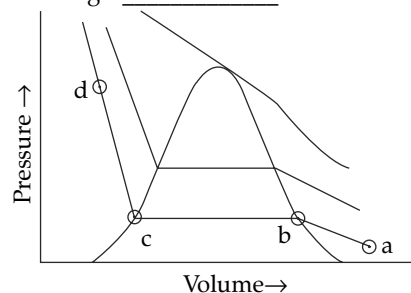


- A. $T_4 > T_3 > T_2 > T_1$
 B. The black body consists of particles performing simple harmonic motion.
 C. The peak of the spectrum shifts to shorter wavelength as temperature increases.
 D. $\frac{T_1}{v_1} = \frac{T_2}{v_2} = \frac{T_3}{v_3} \neq \text{constant}$
 E. The given spectrum could be explained using quantisation of energy.
- Q. 22. The number of units, which are used to express concentration of solutions from the following is ____ Mass percent, Mole, Mole fraction, Molarity, ppm, Molality
- Q. 23. The number of statement/s which are the characteristics of physisorption is ____
 A. It is highly specific in nature
 B. Enthalpy of adsorption is high
 C. It decreases with increase in temperature
 D. It results into unimolecular layer
 E. No activation energy is needed
- Q. 24. Sum of π - bonds present in peroxodisulphuric acid and py3rosulphuric acid is:
- Q. 25. If the pKa of lactic acid is 5, then the pH of 0.005M calcium lactate solution at 25°C is ____ $\times 10^{-1}$ (Nearest integer)

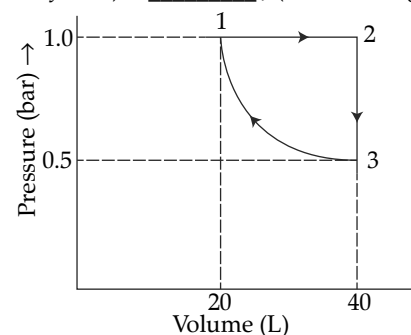


- Q. 26. The total pressure observed by mixing two liquids A and B is 350 mmHg when their mole fractions are 0.7 and 0.3 respectively. The total pressure become 410 mmHg if the mole fractions are changed to 0.2 and 0.8 respectively for A and B. The vapour pressure of pure A is ____ mm Hg. (Nearest integer) Consider the liquids and solutions behave ideally.

- Q. 27. The number of statement/s, which are correct with respect to the compression of carbon dioxide from point (a) in the Andrews isotherm from the following is



- A. Carbon dioxide remains as a gas upto point (b)
 B. Liquid carbon dioxide appears at point (c)
 C. Liquid and gaseous carbon dioxide coexist between points (b) and (c)
 D. As the volume decreases from (b) to (c), the amount of liquid decreases
- Q. 28. Maximum number of isomeric monochloro derivatives which can be obtained from 2, 2, 5, 5 tetramethylhexane by chlorination is ____.
- Q. 29. Total number of tripeptides possible by mixing of valine and proline is ____.
- Q. 30. One mole of an ideal monoatomic gas is subjected to changes as shown in the graph. The magnitude of the work done (by the system or on the system) is ____ J (nearest integer)



Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	(4)	Properties of s-Block	s-Block
2	(3)	Reduction Potential of s-Block	s-Block
3	(4)	Order of Reaction	Chemical Kinetics
4	(3)	Properties of potassium dichromate	d & f Block
5	(2)	Deprotonation reaction in carbonyl compounds	Aldehyde and Ketone
6	(3)	Hybridisation and magnetic behaviour of transition metal complexes	Coordination chemistry

7	(2)	reduction of carbonyl compounds	Aldehyde and Ketone
8	(1)	Crystal field theory	Coordination chemistry
9	(2)	Calculation of number of s electron	Periodic classification of elements
10	(3)	Oxidising nature of f Block	d & f Block
11	(1)	Conductometric titration	Electrochemistry
12	(3)	Classification of drugs	Chemistry in everyday life
13	(2)	Hydration of alkene	Hydrocarbons
14	(1)	Stability of benzene ring	Aromatic hydrocarbon
15	(3)	Properties of hydrogen peroxide	Hydrogen
16	(3)	Properties of nitrogen containing compounds	Amines
17	(1)	Introduction of balanced diet	Chemistry in everyday life
18	(2)	Molecular orbital theory	Chemical bonding and molecular structure
19	(1)	Extraction of metal	Metallurgy
20	(2)	Properties of aromatic amines	Amines
21	[2]	Black body radiation	Structure of atom
22	[5]	Concentration terms	Liquid solution
23	[2]	Properties of physical adsorption	Surface chemistry
24	[8]	Calculation of number of pie bonds in oxyacid of phosphorus	p-Block elements
25	[85]	pH of salt solution	Ionic Equilibrium
26	[314]	Vapour pressure of solution	Liquid solution
27	[2]	Andrews isotherm	States of matter
28	[3]	Calculation of number of isomers	Isomerism
29	[8]	Calculation of number of tripeptides	Biomolecules
30	[620]	Calculation of work done	Thermodynamics and Thermochemistry

Solutions

Section A

1. Option (4) is correct.

Statement (A) is correct

The standard reduction potential of the elements are –

Li	Na	Rb
–3.237	–2.898	–3.079

From the above data, the order of standard reduction potential (M^+/M) for

Alkali: metals is $Na > Rb > Li$

Statement (D) is correct

In conc. liquid ammonia solution, potassium get dissolved to form blue colour and

Paramagnetic solution.

Statement (E) is correct

All alkali metal hydrides are ionic solids with high melting point. This is due to their large size and very low ionisation enthalpy.

From the given option, option (4) is correct.

A and E only.

2. Option (3) is correct.

Assertion is correct

The standard reduction potential of alkaline earth metal are as follows-

SRP	Be	Mg	Ca	Sr	Ba	Ra
V	–1.97	–2.36	–2.84	–2.89	–2.92	–2.92

From the above data it is clear that the beryllium has less negative value of reduction potential compared to the other alkaline earth metals.

Reason is correct –

Due to small size of beryllium ion, the value of hydration energy is very high and similarly due to the small size of beryllium ion, the enthalpy of atomisation is also very high

3. Option (4) is correct.

The relation between half life of the reaction and the pressure is given as follows

$$t_{\frac{1}{2}} \propto (P_0)^{1-n}$$

For two condition –

$$\frac{\left(\frac{t_1}{2}\right)_1}{\left(\frac{t_1}{2}\right)_2} = \frac{(P_0)_1^{1-n}}{(P_0)_2^{1-n}}$$

Given : $\left(\frac{t_1}{2}\right)_1 = 4s$ $\left(\frac{t_1}{2}\right)_2 = 2s$

$$(P_0)_1 = 50 \text{ mmHg} \quad (P_0)_2 = 100 \text{ mmHg}$$

By putting these values in the formula

$$\left(\frac{4}{2}\right) = \left(\frac{50}{100}\right)^{1-n} \quad \text{or} \quad 2 = \left(\frac{1}{2}\right)^{1-n}$$

or $(2)^1 = (2)^{n-1}$ or $n - 1 = 1$ or $n = 2$

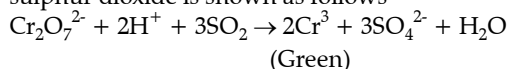
The order of the reaction is 2.

4. Option (3) is correct.

The reaction of potassium dichromate ($K_2Cr_2O_7$) with sulphur dioxide (SO_2) in the presence of dilute acid gives green colour of chromic sulphate and sulphate ion.

In this reaction, potassium dichromate act as an oxidizing agent which oxidises sulphur dioxide into sulphate ion and itself get reduced to chromic sulphate, which has green colour.

The reaction between potassium dichromate and sulphur dioxide is shown as follows

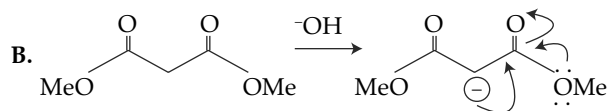
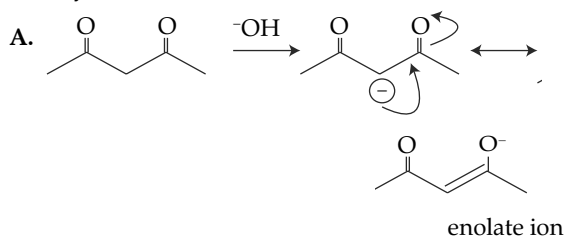


5. Option (2) is correct.

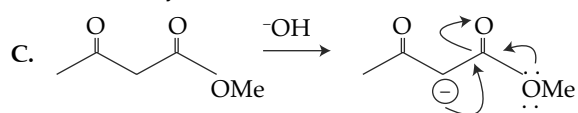
Among the given compounds, that compound will undergo deprotonation in basic medium which forms a stable carbanion.

The stability of carbanion can be increased by an electron withdrawing group.

Here compound A contains electron withdrawing group while compounds B and C are surrounded with electron donating groups which decreases the stability of carbanion by donating their electron density



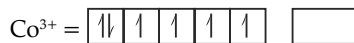
Here, cross conjugation takes place which decrease the stability of carbanion



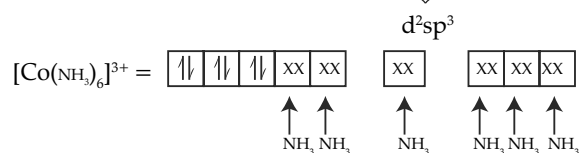
Here, cross conjugation takes place which decrease the stability of carbanion. As the carbanion is stabilised only A compound, thus it will undergo deprotonation most readily in basic medium.

6. Option (3) is correct.

In the complex $[Co(NH_3)_6]^{3+}$ the oxidation state of Co is +3, electronic configuration of $Co^{3+} = [Ar] 3d^6 4s^0$



Being a strong ligand NH_3 pair the unpaired e^- and vacant the d- orbital for it.

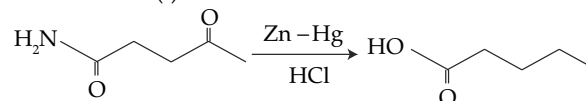


From above it is clear that no unpaired e^- is present in the complex

Therefore it is diamagnetic in nature and $\mu = 0$.

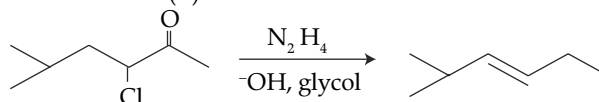
7. Option (2) is correct.

Statement (I) is correct



The hydrolysis of an amide in presence of an acid gives carboxylic acid, therefore this reaction is correct.

Statement (II) is not correct



In the Wolf Kishner reduction along with carbonyl group, halogen will also get eliminated to form a double bond. Therefore, the statement (II) is not correct.

8. Option (1) is correct.

By the help of experimental value of Δ ,

Crystal field theory introduces spectrochemical series but unable to explain its order. Because as per CFT, anionic ligands should exert greatest splitting effect. However they lie lower on lower end of the spectrochemical series.

Similarly crystal field theory explain the stability, colour and magnetic properties of transition metal complexes.

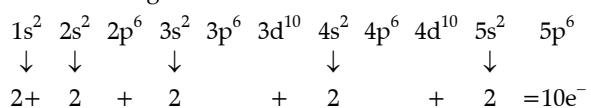
9. Option (2) is correct.

An ion which contains 55 proton in its unipositive state is Cs.

The electronic configuration of Cs $\Rightarrow [Xe]6s^1$

On losing one electron it become Cs^+

The configuration of Cs^+ will be



The number of s-electron present in Cs^+ ion = $10e^-$.

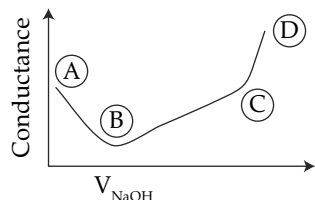
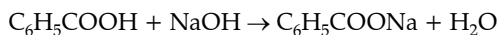
10. Option (3) is correct.

The electronic configuration of the ions are as follows:

- A. Sm^{2+} : $[\text{Xe}] 4f^6$
 B. Ce^{2+} : $[\text{Xe}] 4f^2$
 C. Ce^{4+} : $[\text{Xe}] 4f^0$
 D. Tb^{4+} : $[\text{Xe}] 4f^7$
- Out of the following ions Ce^{4+} and Tb^{4+} act as good oxidizing agent. Because they can be readily converted to their +3 oxidation states.

11. Option (1) is correct.

The reaction of benzoic acid with sodium hydroxide is shown as follows-



From point A \rightarrow B

Free H^+ ions are replaced by Na^+ which decreases conductance.

From point B \rightarrow C

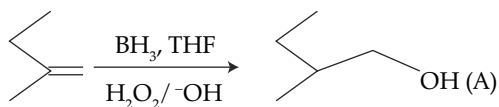
Undissociated benzoic acid reacts with strong base, NaOH and forms a salt, CH_3COONa which is a strong electrolyte and helps in the increment of conductance.

From point C \rightarrow D

Once the equivalence point is reached, the excess NaOH will further increase the conductance.

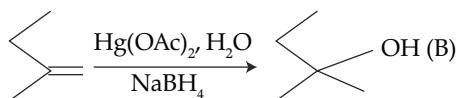
12. Option (3) is correct.

- | | |
|-----------------------|------------------|
| A. Antifertility drug | i. Norethindrone |
| B. Tranquilizer | ii. Meprobamate |
| C. Antihistamine | iii. Seldane |
| D. Anti-biotic | iv. Ampicillin |

13. Option (2) is correct.


The above reaction addition of water takes place according to anti-Markonikov's Rule

Where the negative part of the reagent attached to that carbon where number of hydrogen atom are more and forms primary alcohol.



In the above reaction addition of water takes place according to Markonikov's Rule where the negative part of the reagent attached to that carbon where number of hydrogen atom are less and forms secondary alcohol.

14. Option (1) is correct.

Assertion is true -

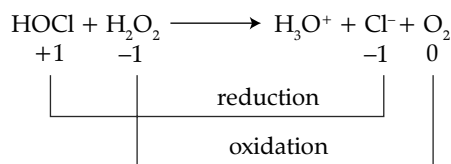
Benzene is more stable than hypothetical cyclohexatriene because in benzene. This is due to delocalisation of πe^- resulting in extra stability.

The delocalised πe^- cloud in bonding molecular orbital of carbon atom which increases the attraction of πe^- towards the nuclei of carbon atoms.

15. Option (3) is correct.

Reducing agent is the reagent in which the element itself gets oxidised and reduces other by losing electron.

Here in option (3), H_2O_2 oxidises itself into O_2 and acts as a reducing agent.


16. Option (3) is correct.

Statement (I) is correct

Pure aniline and other arylamines are usually colourless so it is a correct statement.

Statement (II) is incorrect.

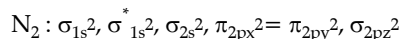
Arylamine or aniline gets coloured or storage due to action of air and light i.e; when oxidation of these compounds occur.

17. Option (1) is correct.

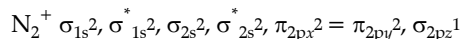
An average human being requires nearly 12-15 times more air than the food.

18. Option (2) is correct.

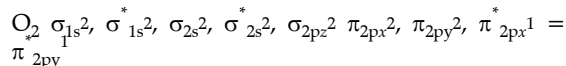
The electronic e^- configuration of species given are as follows:



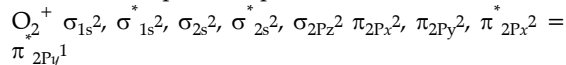
number of unpaired e^- present in HOMO = 0



Number of unpaired e^- present in HOMO = 1



Number of unpaired e^- present in HOMO = 2



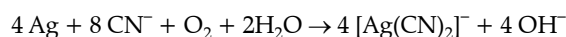
Number of unpaired e^- present in HOMO = 1

The number of unpaired e^- in HOMO of the following species : $\text{N}_2, \text{N}_2^+, \text{O}_2, \text{O}_2^+ \Rightarrow 0, 1, 2, 1$

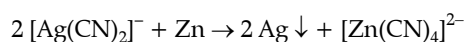
19. Option (1) is correct.

The metal which is extracted by oxidation & then subsequent reduction from its ore is silver (Ag).

Oxidation reaction :

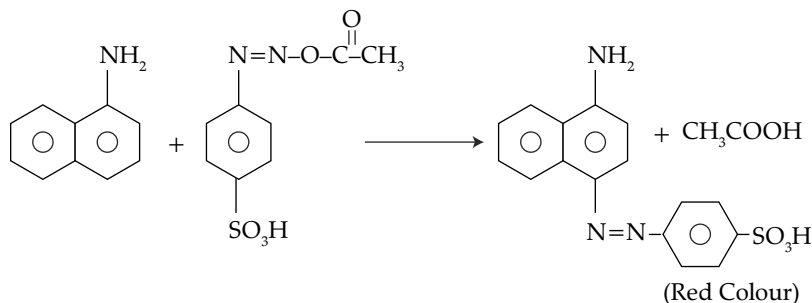


Reduction reaction :



20. Option (2) is correct.

It gives Red colour complex



Section B

21. The correct answer is [2]

The spectrum of black body radiation is explained using quantization of energy. With increase in temperature, peak of spectrum shifts to shorter wavelength or higher frequency.

So statements. C and E are correct.

22. The correct answer is [5]

The number of units which are used to express concentration of solution are –

Mass percentage, mole fraction, molarity, ppm, molality.

23. The correct answer is [2]

The characteristic of physical adsorption are

It is not specific in nature. The enthalpy of adsorption is low.

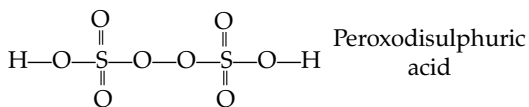
It decreases with increase in temperature.

It forms multi-layers, less or no activation energy is required.

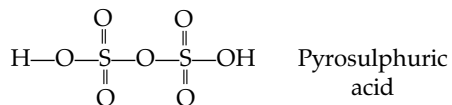
Out of the given statements only C and E are correct.

24. The correct answer is [8]

The structure of peroxodisulphuric acid and pyrosulphuric acid are as follows



No. of π -bonds = 4

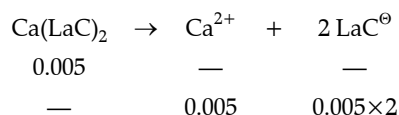


No. of π -bond = 4

Total no. of π -bonds = 4+4 = 8

25. The correct answer is [85]

Given [calcium lactate] = 0.005M



[lactate ion] = $0.005 \times 2 = 0.010 \text{ M}$

Calcium lactate is a salt of weak acid and strong base Therefore, it under go anionic hydrolysis.

The pH of the weak acid and strong base salt solution can be calculated as follows

$$\text{pH} = \left(\frac{14 + \text{pka} + \log C}{2} \right)$$

$$= \frac{14 + 5 + \log 0.01}{2}$$

$$\text{pH} = 8.5$$

$$= 85 \times 10^{-1}$$

26. The correct answer is [314]

Let vapour pressure of pure liquid A = P_A^0

Let vapour pressure of pure liquid B = P_B^0

For case 1

$$X_A = 0.7 \text{ and } X_B = 0.3$$

$$P_{\text{solution}} = 350 \text{ mmHg}$$

$$\text{So } P_A^0 \times 0.7 + P_B^0 \times 0.3 = 350 \quad \dots(1)$$

For case 2

$$X_A = 0.2 \text{ and } X_B = 0.8$$

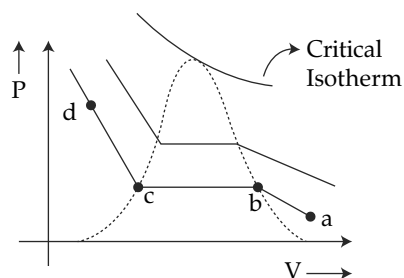
$$P_{\text{solution}} = 410 \text{ mmHg}$$

$$\text{So } P_A^0 \times 0.2 + P_B^0 \times 0.8 = 410 \quad \dots(2)$$

On solving (1) & (2)

$$P_A^0 = 314 \text{ mmHg } P_B^0 = 434 \text{ mmHg}$$

27. The correct answer is [2]



At point (a) CO_2 exits as a gas.

At point (b) due to increase in pressure, the volume decreases and at point b liquefaction of CO_2 starts.

The liquification starts from point b and continuous till point C. At point b the first particle of gas will be converted to liquid. At point c, all the particles will convert into liquid. Thus liquid and gaseous carbon dioxide coexist between points (b) and (c)

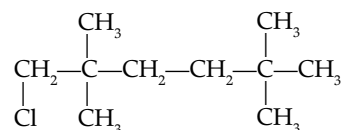
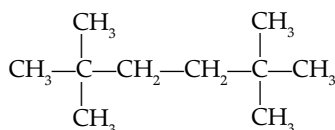
As the liquification starts from point b, therefore the volume of liquid increases from pt b to c.

So from above point (A) and (C) are correct.

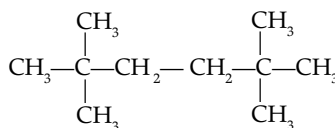
28. The correct answer is [3]

The number of isomeric monochloro derivatives which can be obtained from 2,2,5,5-tetramethyl hexane by chlorination are (3)

Structure of 2,2,5,5-tetramethyl hexane



No Chiral carbon. So only only 1 product is obtained.



One chiral carbon is there. So two enantiomers would be obtained.

Total number of products including isomers = 3

29. The correct answer is [8]

Number of tripeptides = 8

Number of amino acid = 2

Possible products = 3 (tripeptide)

No. of products = $2^3 = 8$

(1) Val - val - val

(2) Pro - pro - pro

(3) Val - pro - pro

(4) Pro - val - pro

(5) Val - val - pro

(6) Val - pro - val

(7) Pro - pro - val

(8) Pro - val - val

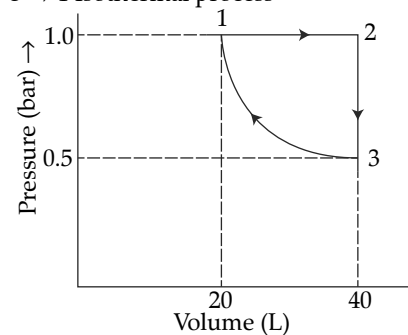
30. The correct answer is [620]

The process

1 → 2 Isobaric process

2 → 3 Isochoric process

3 → 1 Isothermal process



In Isochoric process work done = 0

Thus Total work done For a process

$$W = W_{1 \rightarrow 2} + W_{2 \rightarrow 3} + W_{3 \rightarrow 1}$$

$$= \left[-p(V_2 - V_1) + 0 + \left(-PV_1 \ln \left(\frac{V_2}{V_1} \right) \right) \right]$$

$$= \left[-1 \times (40 - 20) + 0 + \left[-1 \times 20 \ln \left(\frac{20}{40} \right) \right] \right]$$

$$= -20 + 20 \ln 2$$

$$= -20 + 20 \times 2.303 \times 0.3$$

$$= -6.2 \text{ bar L}$$

$$1 \text{ L bar} = 100 \text{ J approx}$$

$$|W| = 6.2 \times 100 \text{ J} = 620 \text{ J}$$