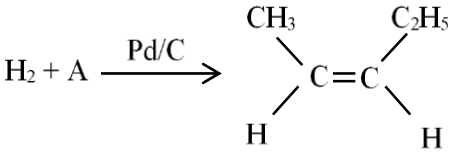
JEE MAIN 2024

Paper with Solution

Chemistry | 01st February 2024 _ Shift-2

SECTION – A

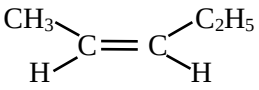
1. In the given reactions identify A and B



$$CH_3 - C \equiv C - CH_3 + H_2 \xrightarrow{Na/Liquid\ NH_3} \text{"B"}$$

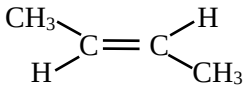
(1) A : n – Pentane B: Cis – 2 – butene
(2) A : 2 – Pentyne B: Cis – 2 – butene
(3) A : n – Pentane B: trans– 2 – butene
(4) A : 2 – Pentyne B: trans – 2 – butene

Ans. **4**

$CH_3–C \equiv C–CH_2–CH_3 + H_2 \xrightarrow[\text{Syn addition}]{\text{Pd-C}}$ 

(A)

2–pentyne

$CH_3–C \equiv C–CH_3 + H_2 \xrightarrow[\text{Birch reduction}]{\text{Na/liq. NH}_3}$ 

trans–2–butene

(B)

2. Solubility of calcium phosphate (molecular mass, M) in water is W_g per 100 mL at 25° C. Its solubility product at 25° C will be approximately.

(1) $10^7\left(\frac{W}{M}\right)^3$ (2) $10^3\left(\frac{W}{M}\right)^5$ (3) $10^7\left(\frac{W}{M}\right)^5$ (4) $10^5\left(\frac{W}{M}\right)^5$

Ans. **3**

At 25°C

$Ca_3(PO_4)_2 \rightarrow 3\,Ca^{+2} + 2\,PO_4^{-3}$

3S 2S

$K_{SP} = [Ca^{+2}]^3\left[PO_4^{-3}\right]^2$

$= [3S]^3[2S]^2$

$\left[\frac{3W}{M}\right]^3\left[\frac{2W}{M}\right]^2$ as per 100 mL but molarity is measured in litre

$\left[\frac{3\times W\times 1000}{M\times 100}\right]^3\left[\frac{2\times W\times 1000}{M\times 100}\right]^2$

$\left[\frac{W}{M}\right]^5 \times 10^5 \times 108$ $108 \cong 10^2$

$= 10^7\left[\frac{W}{M}\right]^5$

3. Given below are two statements:

Statement I: SiO_2 and GeO_2 are acidic while SnO and PbO are amphoteric in nature.

Statement II: Allotropic forms of carbon are due to property of catenation and pπ-dπ bond formation.

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

(1) Statement I is false but statement II is true

(2) Both statement I and statement II are false

(3) Both Statement I and statement II are true

(4) Statement I is true but statement II is false.

Ans. **4**

Statement I : is correct SiO_2 & GeO_2 amphoteric

Statement II : C – do not have de^-

so can't form pπ-dπ bond incorrect.

4. The set of meta directing functional groups from the following sets is :

(1) – CN, – NH_2, – NHR, – OCH_3 (2) – CN, – CHO, – $NHCOCH_3$, – COOR

(3) – NO_2, – NH_2, – COOH, – COOR (4) – NO_2, – CHO, – SO_3H, – COR

Ans. **4**

All deactivating gps are meta directing gp except – X & – NO.

Meta directing gps :- –CN, –CHO, –COOR, –COR, –SO_3H, – NO_2, – COOH

O,P–directing gps :- –NH_2, –NHR, –OCH_3, –$NHCOH_3$

5. $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ are respectively known as :

(1) Inner orbital Complex, Spin paired Complex (2) Spin paired Complex, Spin free Complex

(3) Spin free Complex, Spin paired Complex (4) Outer orbital Complex, Inner orbital Complex

Ans. **2**

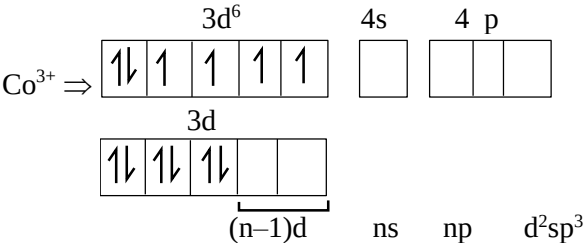
$\rightarrow \left[Co\ NH_3\ _6\right]^{3+}$

O.S of Co = +3

for Co^{+3}, NH_3 act as a strong ligand.

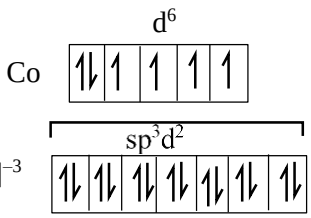
$Co = 4s^2 3d^7$

$Co^{+3} = 3d^6$



Low spin complex and spin paired that is inner orbital complex (IOC)

$[CoF_6]^{3-} \rightarrow sp^3d^2$ as F is weak field ligand



High spin and spin free, outer orbital complex (OOC)

6. The transition metal having highest 3rd ionization enthalpy is :

(1) Mn (2) Fe (3) Cr (4) V

Ans. **1**

Mn has Highest 3rd IE

IE_3 kJ/mol

$V \rightarrow 2833$ $Mn \rightarrow 3260$

$Cr \rightarrow 2990$ $Fe \rightarrow 2962$

7. Match list I with list II.

List I Compound		**List II Use**	
A.	Carbon tetrachloride	I.	Paint remover
B.	Methylene chloride	II.	Refrigerators and air conditioners
C.	DDT	III.	Fire extinguisher
D.	Freons	IV.	Non-Biodegradable insecticide

Choose the correct answer from the options given below:

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

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

Ans. **2**

Freons are used in refrigerators & air conditioners.

DDT is used as Nonbiodegrable insectisides

CCl_4 is used on Fire Extinguisher.

Methylene chloride is used as a solvent as paint remover.

8. Match list I with list II.

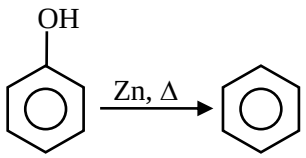
List I Reactants		**List II Product**	
A.	Phenol, Zn/Δ	I.	Salicylaldehyde
B.	Phenol, $CHCl_3$, NaOH, HCl	II.	Salicylic acid
C.	Phenol, CO_2, NaOH, HCl	III.	Benzene
D.	Phenol, Conc. HNO_3	IV.	Picric acid

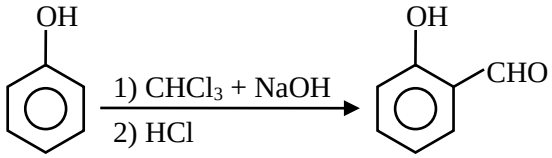
Choose the correct answer from the options given below:

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

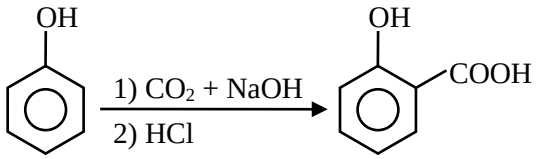
(3) A-(IV), B-(II), C-(I), D-(III) (4) A-(III), B-(IV), C-(I), D-(II)

Ans. **2**

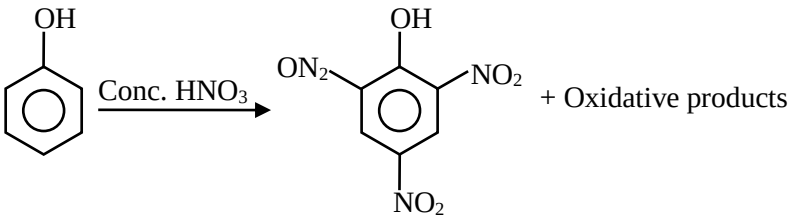
(A) 

(B) 

(Reimer-Tiemann Rx^n)

(C) 

(Kolbe's Rx^n)

(D) 

+ Oxidative products

9. Given below are two statements:

Statement I: Dimethyl glyoxime forms a six-membered covalent chelate when treated with $NiCl_2$ solution in presence of NH_4OH.

Statement II: Prussian blue precipitate contains iron both in (+2) and (+3) oxidation states.

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

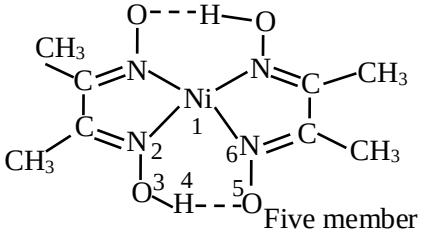
(2) Both statement I and statement II are true

(3) Statement I is true but statement II is false

(4) Both Statement I and statement II are false

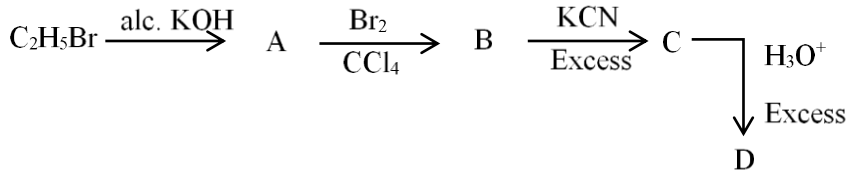
Ans. **1**

$2(DMG) + NiCl_2 \rightarrow Ni(DMG)_2$



Five member ring

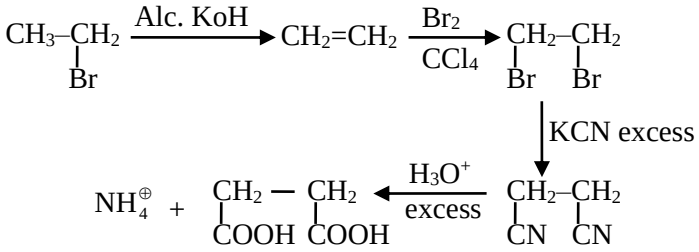
10.



Acid D formed in above reaction is:

(1) Malonic acid (2) Oxalic acid (3) Succinic acid (4) Gluconic acid

Ans. **3**



Succinic acid

11. Lassaigne's test is used for detection of :

(1) Phosphorous and halogens only

(2) Nitrogen, Sulphur and Phosphorous only

(3) Nitrogen, Sulpher, Phosphorous and halogens

(4) Nitrogen and Sulpur only

Ans. **3**

Lassaigne's test is used for detection of N, S, P and halogen.

12. The strongest reducing agent among the following is :

(1) SbH_3 (2) NH_3 (3) BiH_3 (4) PH_3

Ans. **3**

Fact

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

Assertion (A): In aqueous solutions Cr^{2+} is reducing while Mn^{3+} is oxidizing in nature.

Reason (R): Extra stability to half filled electronic configuration is observed than incompletely filled electronic configuration.

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

(1) (A) is true but (R) is false

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

(3) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(4) (A) is false but (R) is true.

Ans. **2**

$Cr^{2+} \rightarrow Cr^{3+}$ $Mn^{+3} \rightarrow Mn^{2+}$

$d^4 \rightarrow d^3$ $d^4 \rightarrow d^5$

14. The functional group that shows negative resonance effect is :

(1) – OH (2) – OR (3) – COOH (4) – NH_2

Ans. **3**

–COOH gp shows – R or – M effect

–OR, –OH, –NH_2 show + R or + M effects

15. The number of radial node/s for 3p orbital is:

(1) 3 (2) 2 (3) 1 (4) 4

Ans. **3**

Radial Node : $n - \ell - 1$

$\Rightarrow n = 3, \ \ell = 1$, for 3p

$= 3 - 1 - 1$

$= 1$

16. Which among the following has highest boiling point ?

(1) $CH_3CH_2CH_2CH_2 - OH$ (2) $CH_3CH_2CH_2CH_3$

(3) $CH_3CH_2CH_2CHO$ (4) $H_5C_2 - O - C_2H_5$

Ans. **1**

$CH_3CH_2CH_2CH_2$–OH has highest boiling point due to H-bonding.

17. Given below are two statements:

Statement I: A π bonding MO has lower electron density above and below the inter-nuclear axis.

Statement II: The π* antibonding MO has a node between the nuclei.

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

(1) Both statement I and statement II are true

(2) Both statement I and statement II are false

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

Ans. **4**

I : π BMO has larger e^- density above and below inter-nuclear axis due to overlapping & interference of atomic orbital.

hence statement I is false.

II : π* (ABMO) has nodal plane between nuclei. True

18. Given below are two statements:

Statement I: Both metals and non-metals exist in p and d-block elements.

Statement II: Non-metals have higher ionization enthalpy and higher electronegativity then the metals.

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

(1) Both statement I and statement II are false (2) Both statement I and statement II are true

(3) Statement I is false but statement II is true (4) Statement I is true but statement II is false

Ans. **3**

Statement I : p-block has Metal as well non metals.

while d-block has only metal. hence Ist is incorrect.

Statement II : Non-Metal has high I.E. & E.N.

F $\rightarrow$ highest E.N.

He $\rightarrow$ Highest I.E.

19. Which of the following compounds show color due to d-d transition ?

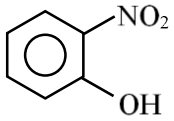
(1) K_2Cr_2O7 (2) $CuSO_4.5H_2O$ (3) $KMnO_4$ (4) K_2CrO_4

Ans. **2**

The water molecule in $CuSO_4.5H_2O$ causes d-orbital splitting in $CuSO_4$.

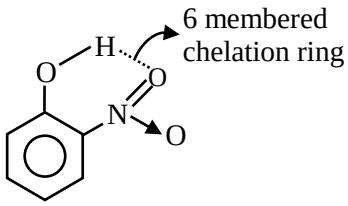
Hence d-d transition occurs therefore it shows blue colour

20. Select the compound from the following that will show intramolecular hydrogen bonding.

(1) 

(2) H_2O (3) C_2H_5OH (4) NH_3

Ans. 1

→ 

Intra molecular
H-bonding

→ H_2O, EtOH & NH_3 form intermolecular H-bonding.

SECTION – B

21. The number of tripeptides formed by three different amino acids using each amino acid once is-

Ans. 6

Suppose we have 3 amino acids glycine, Alanine & valine.

Possible Tripeptides are

Gly – Ala – Val

Gly – Val– Ala

Val – Gly – Ala

Val – Ala – Gly

Ala – Gly – Val

Ala – Val – Gly

22. Mass of ethylene glycol (antifreeze) to be added to 18.6 kg of water to protect the freezing point at –24°C is _____ kg (Molar mass in g mol^{-1} for ethylene glycol 62, K_f of water = 1.86 K kg mol^{-1})

Ans. **15**

$\Delta Tf = K_f \times$ molality

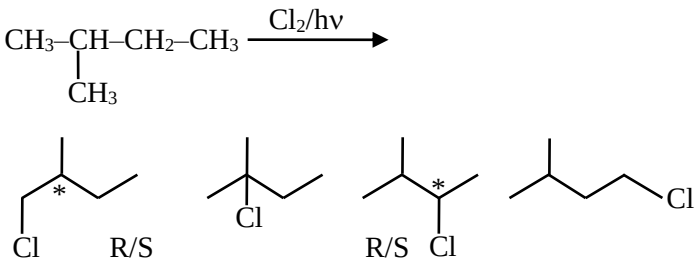
$$0 - (-24) = 1.86 \times \frac{w}{62 \times 18.6}$$

$$\Rightarrow w = \frac{62 \times 24 \times 18.6}{1.86} = 14880\,gm$$

$= 14.88 \approx 15$ Kg

23. Total number of isomeric compounds (including stereoisomers) formed by monochlorination of 2-methylbutane is _____ .

Ans. **6**



24. The following data were obtained during the first order thermal decomposition of a gas A at constant volume:

$A(g) \rightarrow 2B(g) + C(g)$

S. No.	**Time/s**	**Total pressure/(atm)**
1.	0	0.1
2.	115	0.28

The rate constant of the reaction is _____ $\times 10^{-2}$ s^{-1} (nearest integer)

Ans. **2**

	$A(g)$	$\rightarrow 2B(g)$	$+ C(g)$
t=0	0.1	–	–
t=115sec	0.1–x	2x	x

Total Pressure = 0.1+2x=0.28

x=0.09

$$K = \frac{2.303}{115} \log \frac{0.1}{0.1 - 0.09}$$

K = 0.020

$K = 2 \times 10^{-2}$

25. For a certain reaction at 300K, K = 10, then $\Delta G°$ for the same reaction is _____ $\times 10^{-1}$ kJ mol^{-1}.
(Given R = 8.314 JK^{-1} mol^{-1})

Ans. **57**

$\Delta G° = -2.303\ RT \log K_{eq}$

$= -2.303 \times 8.314 \times 300 \log 10$

$= -5744.17$ J/mol

$= -5.744$ kJ/mol

$= -57.44 \times 10^{-1}$ kJ/mol

$= 57$

26. The amount of electricity in Coulomb required for the oxidation of 1 mol of H_2O to O_2 is _____ $\times 10^5$C.

Ans. **2**

$$H_2O \longrightarrow 2H^+ + \frac{1}{2}O_2 + 2e^-$$

oxidation of 1 mole of water req. 96500 × 2C

= 96500×2

= 19300

= 1.93×10^5C ≈ 2×10^5C

27. Following Kjeldahl's method, 1g of organic compound released ammonia, that neutralized 10 mL of 2M H_2SO_4. The percentage of nitrogen in the compound is _____ %.

Ans. **56**

Normality of H_2SO_4 = Molarity × n factor

= 2 × 2 = 4

$$\%\ \text{of Nitrogen} = \frac{1.4\times N_{H_2SO_4}\times V_{H_2SO_4}}{\text{wt.of organic compd.}}$$

$$= \frac{1.4\times4\times10}{1} = 56\%$$

28. Consider the following redox reaction:

$$MnO_4^- + H^+ + H_2C_2O_4 \rightleftharpoons Mn^{2+} + H_2O + CO_2$$

The standard reduction potentials are given as below: (E_{red}):

$$E^\circ_{MnO_4^-/Mn^{2+}} = +1.51V$$

$$E^\circ_{CO_2/H_2C_2O_4} = -0.49V$$

If the equilibrium constant of the above reaction is given as $K_{eq} = 10^x$, then the value of x = _____ (nearest integer)

Ans. **338**

$$MnO_4^- + H^+ + H_2C_2O_4 \rightleftharpoons Mn^{2+} + H_2O + CO_2$$

$$E^\circ_{Mn^{7+}/Mn^{+2}} = 1.51V$$

$$E^\circ_{C^{+4}/C^{+3}} = -0.49V$$

$$E^\circ_{cell} = E^\circ_{Oxi.} + E^\circ_{red}$$

= 1.51 + (–0.49)

= 2V

balance

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

$$\boxed{n = 10}$$

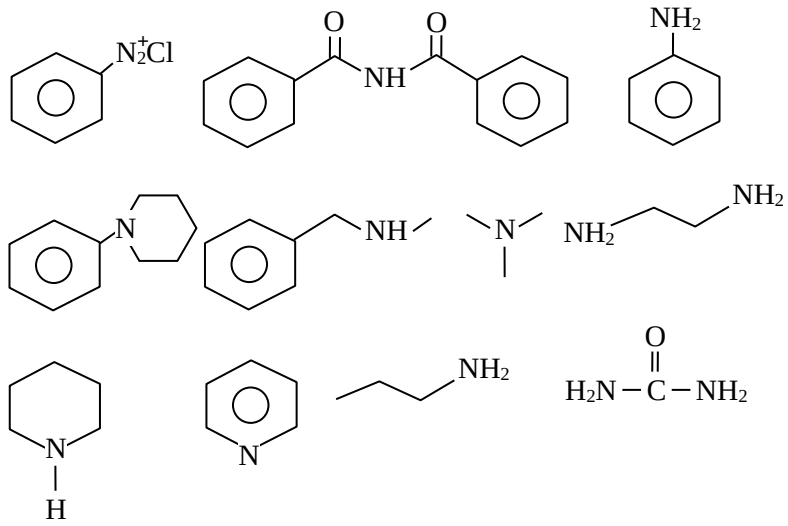
$$E^\circ_{cell} = \frac{0.059}{n}\log K_{eq}$$

$$2 = \frac{0.059}{10}\log K_{eq}$$

$$\log K_{eq} = \frac{2\times10}{0.059} = 338 \Rightarrow K_{eq} = 10^{338}$$

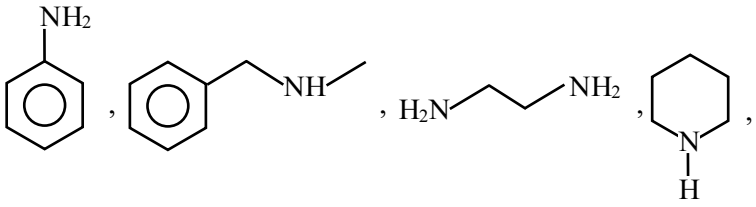
$$= Keq = 10^{338}$$

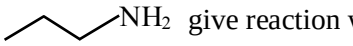
29. Number of compounds which give reaction with Hinsberg's reagent is _____ .



Ans. **5**

1° Amines & 2° Amines give rx^n with Hinsberg's reagent.



 give reaction with Hinsberg's reagent (Ph–SO_2Cl)

30. 10 mL of gaseous hydrocarbon on combustion gives 40mL of $CO_2(g)$ and 50 mL of water vapour. Total number of carbon and hydrogen atoms in the hydrocarbon is _____ .

Ans. **14**

general balancing of Hydrocarbon

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

10 ml $\left(x + \frac{y}{4}\right)$ 40 ml 50ml

On applying POAC on carbon

$10 \times x = 40$

$x = 4$

On applying POAC on hydrogen

$10 \times y = 50 \times 2$

$y = 10$

Hence C_4H_{10}

$10+4=14$

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