JEE MAIN 2024

Paper with Solution

Chemistry | 30th January 2024 _ Shift-2

SECTION – A

1. Which among the following purification methods is based on the principle of "Solubility" in two different solvents?

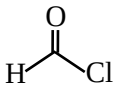
(1) Column Chromatography (2) Sublimation

(3) Distillation (4) Differential Extraction

Ans. **4**

Different layers are formed which can be separated in funnel. (Theory based).

2. Salicylaldehyde is synthesized from phenol, when reacted with

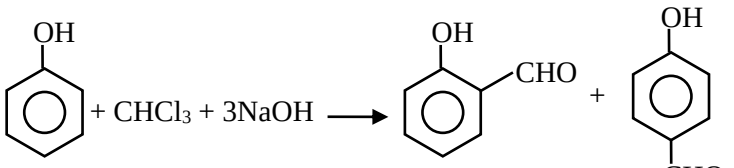
(1)  , NaOH

(2) CO_2, NaOH

(3) CCl_4, NaOH

(4) $HCCl_3$, NaOH

Ans. **4**



(Major) (Minor)

o-salicylaldehyde

Reimer Tiemann Reaction

3. Given below are two statements:

Statement – I : High concentration of strong nucleophilic reagent with secondary alkyl halides which do not have bulky substituents will follow S_N^2 mechanism.

Statement – II : A secondary alkyl halide when treated with a large excess of ethanol follows S_N^1 mechanism.

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

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

(2) Statement I is false but Statement II is true.

(3) Both Statement I and Statement II are false.

(4) Both Statement I and Statement II are true.

Ans. **4**

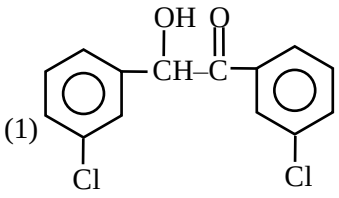
Statement 1 : High conc^n. of strong nu$^-$ reagent with 2^o Alkyl Halide which do not have bulky substituents will follow S_N^2 mechanism.

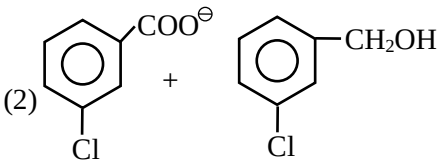
Hence statement I is true.

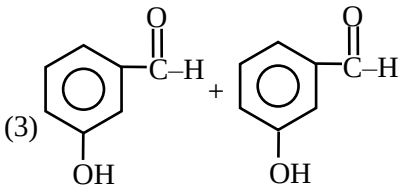
Statement 2 : 2^o Alkyl Halide reacts with excess of ethanol undergo S_N^1 reaction.

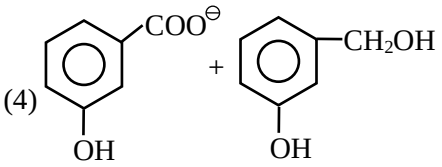
Hence statement 2 is true

4. m-chlorobenzaldehyde on treatment with 50% KOH solution yields

(1) 

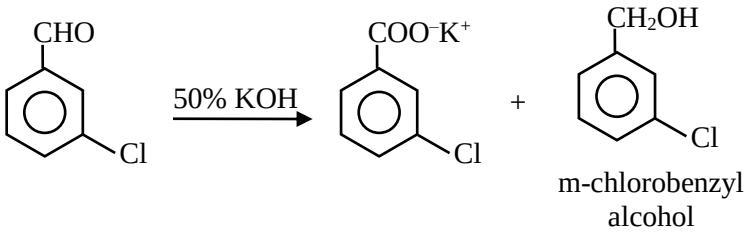
(2) 

(3) 

(4) 

Ans. **2**

Cannizaro reaction (Disproportionation reaction)



m-chlorobenzyl alcohol

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

Assertion A: H_2Te is more acidic than H_2S.

Reason R: Bond dissociation enthalpy of H_2Te is lower than H_2S.

In the light of the above statements, choose the most appropriate 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.

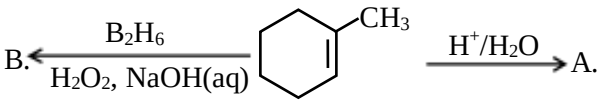
(3) A is false but R is true.

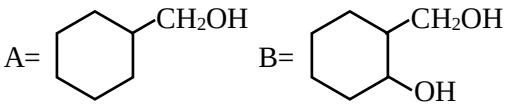
(4) A is true but R is false.

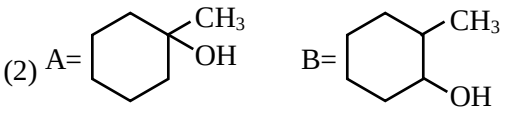
Ans. **2**

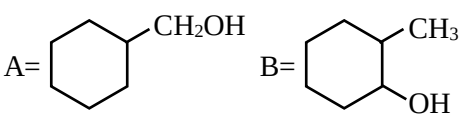
Due to lower bond dissociation energy of H_2Te it ionizes to give H^+ more easily as compare to H_2S

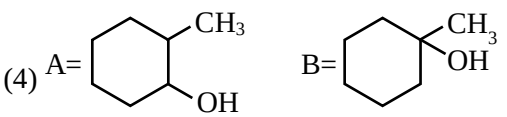
6. Products A and B formed in the following set of reactions are



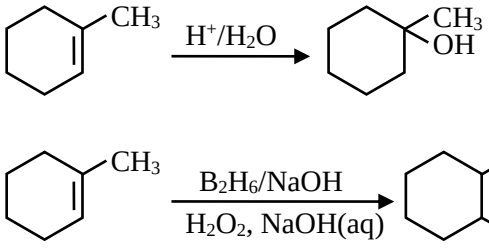
(1) 

(2) 

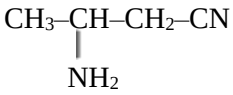
(3) 

(4) 

Ans. **2**



7. IUPAC name of following compound is :



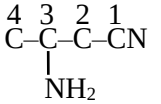
(1) 2-Aminopentanenitrile

(2) 2-Aminobutanenitrile

(3) 3-Aminobutanenitrile

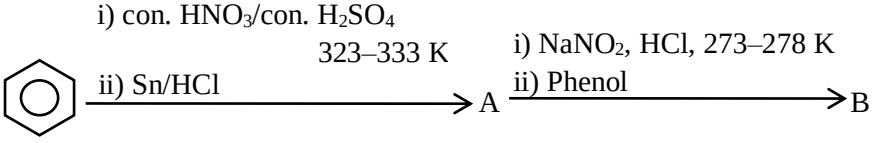
(4) 3-Aminopropanenitrile

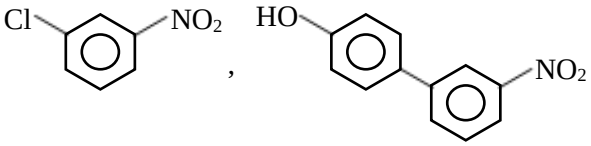
Ans. **3**

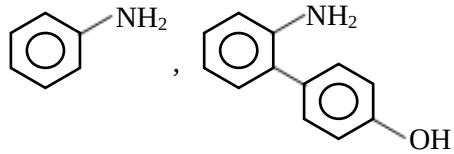


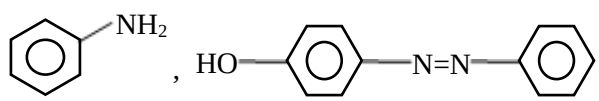
3-Amino butanenitrile

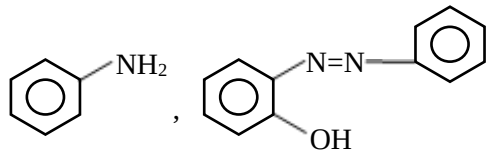
8. The products A and B formed in the following reaction scheme are respectively



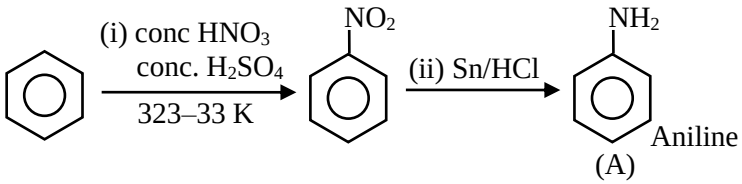
(1) 

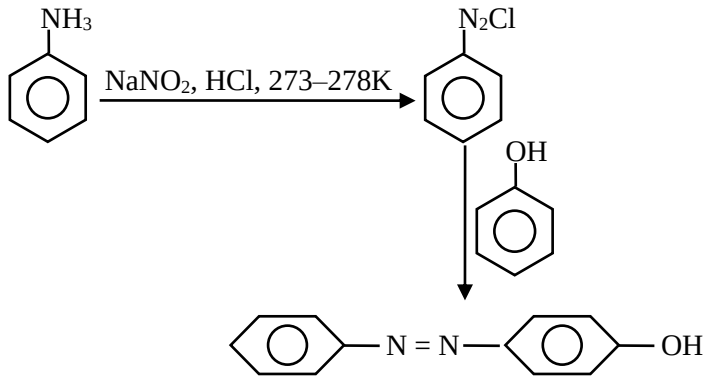
(2) 

(3) 

(4) 

Ans. **3**

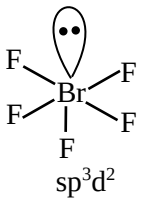




9. The molecule / ion with square pyramidal shape is

(1) $[Ni(CN)_4]^{2-}$ (2) PCl_5 (3) BrF_5 (4) PF_5

Ans. **3**



sp^3d^2

square pyramidal

10. The orange colour of $K_2Cr_2O_7$ and purple colour of $KMnO_4$ is due to

(1) Charge transfer transition in both.

(2) $d \rightarrow d$ transitions in $KMnO_4$ and charge transfer transitions in $K_2Cr_2O_7$.

(3) $d \rightarrow d$ transitions in $K_2Cr_2O_7$ and charge transfer transitions in $KMnO_4$.

(4) $d \rightarrow d$ transitions in both

Ans. **1**

orange colour of $K_2Cr_2O_7$ and purple colour of $KMnO_4$ is due to ligand to metal charge transfer (LMCT)

11. Alkaline oxidative fusion of MnO_2 gives "A" which on electrolytic oxidation in alkaline solution produces B. A and B respectively are

(1) Mn_2O_7 and MnO_4^- (2) MnO_4^{2-} and MnO_4^-

(3) Mn_2O_3 and MnO_4^{2-} (4) MnO_4^{2-} and Mn_2O_7

Ans. **2**

Alkaline oxidative fusion of MnO_2 gives MnO_4^{2-}

$2MnO_2+4OH^-+O_2 \rightarrow 2\ MnO_4^{2-}+2H_2O$

electrolytic oxidation of MnO_4^{2-} in alkaline solution gives MnO_4^-

$MnO_4^{2-} \rightarrow MnO_4^- + e^-$

12. If a substance 'A' dissolves in solution of a mixture of 'B ' and 'C' with their respective number of moles as n_A, n_B and n_C. Mole fraction of C in the solution is

(1) $\frac{n_C}{n_A \times n_B \times n_C}$ (2) $\frac{n_C}{n_A + n_B + n_C}$ (3) $\frac{n_C}{n_A - n_B - n_C}$ (4) $\frac{n_B}{n_A + n_B}$

Ans. **(2)**

mole fraction of C(X_c) = $\frac{n_C}{n_A + n_B + n_C}$

13. Given below are two statements:

Statement – I : Along the period, the chemical reactivity of the elements gradually increases from group 1 to group 18 .

Statement – II : The nature of oxides formed by group 1 elements is basic while that of group 17 elements is acidic.

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

(1) Both Statement I and Statement II are True

(2) Statement I is True But Statement II is False

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

(4) Both Statement I and Statement II are False

Ans. **3**

Chemical reactivity along the period decreases

So, statement-I is wrong

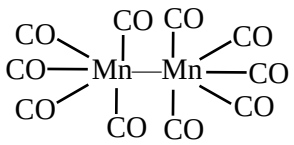
Group-I elements form basic nature oxide while group 17 elements form acidic nature oxide

14. The coordination geometry around the manganese in decacarbonyldimanganese (0) is

(1) Octahedral (2) Trigonal bipyramidal

(3) Square pyramidal (4) Square planar

Ans. **1**



Octahedral around Mn

15. Given below are two statements:

Statement – I : Since Fluorine is more electronegative than nitrogen, the net dipole moment of NF_3 is greater than NH_3.

Statement – II : In NH_3, the orbital dipole due to lone pair and the dipole moment of NH bonds are in opposite direction, but in NF_3 the orbital dipole due to lone pair and dipole moments of N-F bonds are in same direction.

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

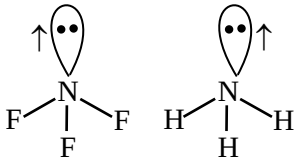
(1) Statement I is true but Statement II is false.

(2) Both Statement I and Statement II are false.

(3) Both Statement I and Statement II are true.

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

Ans. **2**



Both statement are false

16. The correct stability order of carbocations is

(1) $(CH_3)_3C^+ > CH_3-\overset{+}{C}H_2 > (CH_3)_2\overset{+}{C}H > \overset{+}{C}H_3$

(2) $\overset{+}{C}H_3 > (CH_3)_2\overset{+}{C}H > CH_3-\overset{+}{C}H_2 > (CH_3)_3\overset{+}{C}$

(3) $(CH_3)_3\overset{+}{C} > (CH_3)_2\overset{+}{C}H > CH_3-\overset{+}{C}H_2 > \overset{+}{C}H_3$

(4) $\overset{+}{C}H_3 > CH_3-\overset{+}{C}H_2 > CH_3-\underset{\underset{CH_3}{|}}{\overset{+}{C}H} > (CH_3)_3C^+$

Ans. **3**

Stability order carbocation

$$CH_3-\underset{\underset{CH_3}{|}}{\overset{+}{C}}-CH_3 > CH_3-\overset{+}{C}H-CH_3 > \overset{+}{C}H-CH_3 > \overset{+}{C}H_3$$

(9 α–H) (6 α–H) (3 α–H)

17. The solution from the following with highest depression in freezing point/lowest freezing point is

(1) 180 g of acetic acid dissolved in water

(2) 180 g of acetic acid dissolved in benzene

(3) 180 g of benzoic acid dissolved in benzene

(4) 180 g of glucose dissolved in water

Ans. **1**

Highest depression in freezing point (Colligative Properties) is inversely proportional to experimentally molar mass of non volatile solute

* on dissociation exp. Molar mass dec.

* On association exp. Molar mass Inc.

18. A and B formed in the following reactions are:

$CrO_2Cl_2 + 4NaOH \rightarrow A + 2NaCl + 2H_2O$

$A + 2HCl + 2H_2O_2 \rightarrow B + 3H_2O$

(1) $A = Na_2CrO_4, B = CrO_5$

(2) $A = Na_2Cr_2O_4, B = CrO_4$

(3) $A = Na_2Cr_2O_7, B = CrO_3$

(4) $A = Na_2Cr_2O_7, B = CrO_5$

Ans. **1**

$CrO_2Cl_2 + 4NaOH \rightarrow Na_2CrO_4 + 2NaCl + 2H_2O$

(A)

$Na_2CrO_4 + 2HCl + 2H_2O_2 \rightarrow CrO_5 + 3H_2O + 2NaCl$

(B)

19. Choose the correct statements about the hydrides of group 15 elements.

A. The stability of the hydrides decreases in the order $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$.

B. The reducing ability of the hydride increases in the order $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$.

C. Among the hydrides, NH_3 is strong reducing agent while BiH_3 is mild reducing agent.

D. The basicity of the hydrides increases in the order $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$.

Choose the most appropriate from the options given below:

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

Ans. **3**

NH_3 M-H bond length ↑
PH_3 Thermal stability ↓
ASH_3 Reducing nature ↑
SbH_3
BiH_3

20. Reduction potential of ions are given below:

ClO_4^-	IO_4^-	BrO_4^-
$E^\circ = 1.19\,V$	$E^\circ = 1.65\,V$	$E^\circ = 1.74\,V$

The correct order of their oxidizing power is.

(1) $ClO_4^- > IO_4^- > BrO_4^-$ (2) $BrO_4^- > IO_4^- > ClO_4^-$

(3) $BrO_4^- > ClO_4^- > IO_4^-$ (4) $IO_4^- > BrO_4^- > ClO_4^-$

Ans. **2**

Oxidizing power $\propto$ Reduction potential

	ClO_4^-	IO_4^-	BrO_4^-
E^o_{red}	1.19 V	1.65 V	1.74 V

order of standard reduction potential

E^o $ClO_4^- < IO_4^- < BrO_4^-$

Thus order of oxidizing power

$ClO_4^- < IO_4^- < BrO_4^-$

SECTION – B

21. Number of complexes which show optical isomerism among the following is

$cis-[Cr(ox)_2Cl_2]^{3-}$, $[Co(en)_3]^{3+}$, $cis-[Pt(en)_2Cl_2]^{2+}$, $cis-[Co(en)_2Cl_2]^{+}$,

$trans-[Pt(en)_2Cl_2]^{2+}$, $trans-[Cr(ox)_2Cl_2]^{3-}$

Ans. **4**

Those complex which has no COS and POS areoptically active

Cis–$[Cr(ox)_2Cl_2]^{3-}$, $[Co(en)_3]^{3+}$, Cis-$[Pt(en)_2Cl_2]^{+2}$, $[Co(en)_2Cl_2]^{+}$

22. NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation

$2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$

The initial concetration. of N_2O_5 is $3 mol L^{-1}$ and it is $2.75 mol L^{-1}$ after 30 minutes.

The rate of formation of NO_2 is $x \times 10^{-3} mol L^{-1} min^{-1}$, value of x is (nearest integer) _____.

Ans. **17**

$$\frac{1}{2}\frac{d[N_2O_5]}{dt} = -\frac{1}{4}\frac{d[NO_2]}{dt}$$

$$\frac{d[NO_2]}{dt} = -2\frac{d[N_2O_5]}{dt}$$

$$\frac{d[NO_2]}{dt} = -2\frac{(3-2.75)}{30}$$

$$\frac{d[NO_2]}{dt} = \frac{2\times 0.25}{30}$$

$= 1.667\times10^{-2}$

$= 16.67\times10^{-3}$

$x \approx 17\times10^{-3}$

23. Two reactions are given below:

$$2Fe_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Fe_2O_{3(s)}, \Delta H^\circ = -822 kJ/mol$$

$$C_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)}, \Delta H^\circ = -110 kJ/mol$$

Then enthalpy change for following reaction $3C_{(s)} + Fe_2O_{3(s)} \rightarrow 2Fe_{(s)} + 3CO_{(g)}$ is _____ kJ/mol.

Ans. **492**

By Hess law

$2\,Fe + \frac{3}{2}O_2 \rightarrow Fe_2O_3$ $\quad \Delta H^o = -822$ KJ ……..(1)

$C + \frac{1}{2}O_2 \rightarrow CO$ $\quad \Delta H^o = -110$ KJ/mol …..(2)

$Fe_2O_3 \rightarrow 2\,Fe + 3/2O_2$ $\quad \Delta H^o = 822$ KJ …..(3)

eq. (2) multiply by 3

$3C + \frac{3}{2}O_2 \rightarrow 3\,CO$ $\quad \Delta H^o = -330$ KJ …..(4)

eq. (3)+(4)

$3C + Fe_2O_3 \rightarrow 2Fe + 3CO$ $\quad \Delta H = 492$ KJ/mol

24. The total number of correct statements, regarding the nucleic acids is

A. RNA is regarded as the reserve of genetic information

B. DNA molecule self-duplicates during cell division

C. DNA synthesizes proteins in the cell

D. The message for the synthesis of particular proteins is present in DNA

E. Identical DNA strands are transferred to daughter cells.

Ans. **3**

A	B	C	D	E
(False)	(True)	(False)	(True)	(True)

25. The pH of an aqueous solution containing 1 M benzoic acid $\left(pK_a = 4.20\right)$ and 1 M sodium benzoate is 4.5 . The volume of benzoic acid solution in 300 mL of this buffer solution is _____ mL.

(given : log 2 = 0.3)

Ans. **100**

$$pH = pK_a + \log \frac{(V_{salt})}{(V_{acid})}$$

$$4.5 = 4.2 + \log \frac{(V_{salt})}{(V_{acid})}$$

$$\log \frac{(V_{salt})}{(V_{acid})} = 0.3$$

$$\frac{(V_{salt})}{(V_{acid})} = 2 \qquad \ldots\ldots \text{(Eq. 1)}$$

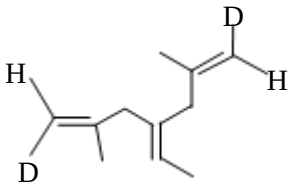
$V_{salt} + V_{acid} = 300$ ml $\qquad \ldots\ldots$ (Eq. 2)

By Eq. (1) & (2)

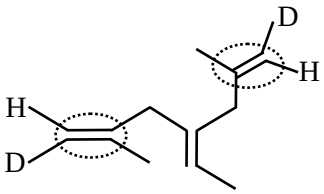
$V_{salt} = 200$ ml

$V_{acid} = 100$ ml

26. Number. of geometrical isomers possible for the given structure is/are _____.



Ans. **4**



(E, E) (E, Z) (Z, Z) (Z, E)

27. Total number of species from the following which can undergo disproportionation reaction is _____.

$H_2O_2, ClO_3^-, P_4, Cl_2, Ag, Cu^{+1}, F_2, NO_2, K^+$

Ans. **6**

Intermediate oxidation state of element can undergo disproportionation reaction

H_2O_2, ClO_3^-, P_4, Cl_2, Cu^+, NO_2

28. Number of metal ions characterized by flame test among the following is _____ .

$Sr^{2+}, Ba^{2+}, Ca^{2+}, Cu^{2+}, Zn^{2+}, Co^{2+}, Fe^{2+}$

Ans. **4**

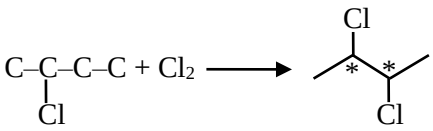
Metal ions (Ca^{2+}, Sr^{2+}, $Ba^{2+}Cu^{2+}$)

responds flame test

29. 2-chlorobutane $+Cl_2 \rightarrow C_4H_8Cl_2$ (isomers)

Total number of optically active isomers shown by $C_4H_8Cl_2$, obtained in the above reaction is _____.

Ans. **3**



(1 meso + d and ℓ)

(3)

30. Number of spectral lines obtained in He^+ spectra, when an electron makes transition from fifth excited state to first excited state will be

Ans. **10**

Fifth excited state $n_2=6$

first excited state $n_1=2$

Number of spectra line $\frac{\left[\left(n_2-n_1\right)\right]\left[\left(n_2-n_1\right)+1\right]}{2}$

$=\frac{(6-2)(6-2+1)}{2}$

$=\frac{4\times5}{2}=\frac{20}{2}=10$

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