JEE Main February 2021

Question Paper With Text Solution

24 Feb.| Shift-2

CHEMISTRY

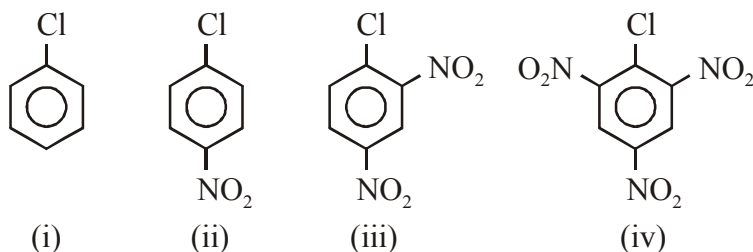## JEE MAIN FEB. 2021 | 24TH FEB SHIFT-2

SECTION – A

1. The correct order of the following compounds showing increasing tendency towards nucleophilic substitution reaction is :

(i)   (ii)   (iii)   (iv)

(1) (iv) < (iii) < (ii) < (i)   (2) (iv) < (i) < (ii) < (iii)

(3) (iv) < (i) < (iii) < (ii)   (4) (i) < (ii) < (iii) < (iv)

Ans. Offical Answer NTA (4)

Sol. NO_2 group at ortho and para position shows –R effect and it facilitates attack of nucleophile so more the number of NO_2 groups more will be the tendency towards aromatic nucleophilic substitution reaction.
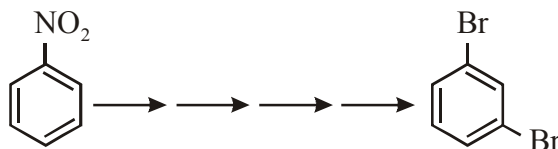
i < ii < iii < iv

2. Most suitable salt which can be used for efficient clotting of blood will be :

(1) $FeCl_3$ (2) $NaHCO_3$ (3) $Mg(HCO_3)_2$ (4) $FeSO_4$
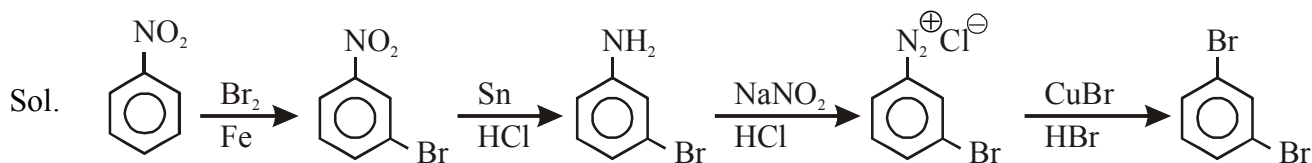
Ans. Offical Answer NTA (1)

Sol. $FeCl_3$ and alums are used for efficient clotting of blood.

3. What is the correct sequence of reagents used for converting nitrobenzene into *m*-dibromobenzene?

(1) $\xrightarrow{Sn/HCl}$ / $\xrightarrow{KBr}$ / $\xrightarrow{Br_2}$ / $\xrightarrow{H^+}$

(2) $\xrightarrow{Sn/HCl}$ / $\xrightarrow{Br_2}$ / $\xrightarrow{NaNO_2}$ / $\xrightarrow{NaBr}$

(3) $\xrightarrow{Br_2/Fe}$ / $\xrightarrow{Sn/HCl}$ / $\xrightarrow{NaNO_2/HCl}$ / $\xrightarrow{CuBr/HBr}$

(4) $\xrightarrow{NaNO_2}$ / $\xrightarrow{HCl}$ / $\xrightarrow{KBr}$ / $\xrightarrow{H^+}$

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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Ans.   Offical Answer NTA (3)

Sol.

$$\underset{\text{NO}_2}{\bigcirc} \xrightarrow[\text{Fe}]{\text{Br}_2} \underset{\text{Br}}{\overset{\text{NO}_2}{\bigcirc}} \xrightarrow[\text{HCl}]{\text{Sn}} \underset{\text{Br}}{\overset{\text{NH}_2}{\bigcirc}} \xrightarrow[\text{HCl}]{\text{NaNO}_2} \underset{\text{Br}}{\overset{\text{N}_2^{\oplus}\text{Cl}^{\ominus}}{\bigcirc}} \xrightarrow[\text{HBr}]{\text{CuBr}} \underset{\text{Br}}{\overset{\text{Br}}{\bigcirc}}$$
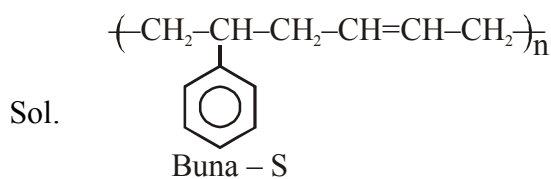
4.   In polymer Buna-S : 'S' stands for :

(1) Sulphur   (2) Styrene   (3) Strength   (4) Sulphonation

Ans.   Offical Answer NTA (2)

Sol.

$$\left(\text{CH}_2\text{–CH–CH}_2\text{–CH=CH–CH}_2\right)_n$$

$$\underset{\text{Buna – S}}{\bigcirc}$$

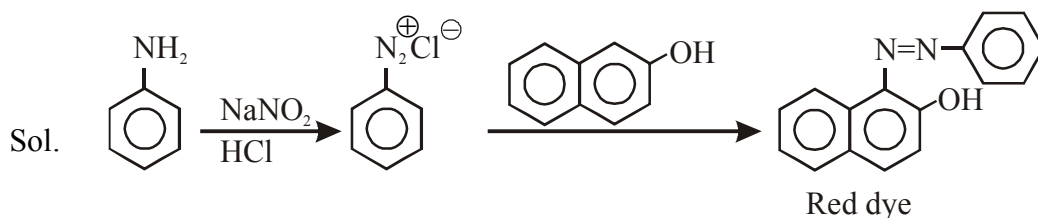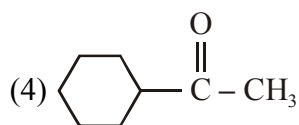S stands for styrene as monomers are Buta–1,3–diene and styrene.
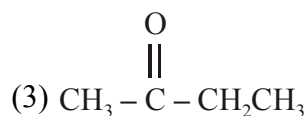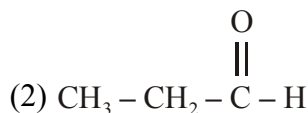
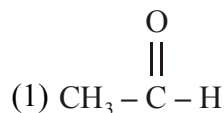5.   The diazonium salt of which of the following compounds will form a coloured dye on reaction with β-Naphthol in NaOH ?

(1) $\underset{\bigcirc}{\overset{\text{CH}_3}{\underset{|}{\text{N} - \text{CH}_3}}}$ (2) $\underset{\bigcirc}{\text{NH}_2}$

(3) $\underset{\bigcirc}{\text{NH – CH}_3}$ (4) $\underset{\bigcirc}{\text{CH}_2\text{NH}_2}$

Ans.   Offical Answer NTA (2)

Sol.

$$\underset{\bigcirc}{\text{NH}_2} \xrightarrow[\text{HCl}]{\text{NaNO}_2} \underset{\bigcirc}{\text{N}_2^{\oplus}\text{Cl}^{\ominus}} \xrightarrow{} \underset{\text{Red dye}}{\bigcirc}$$
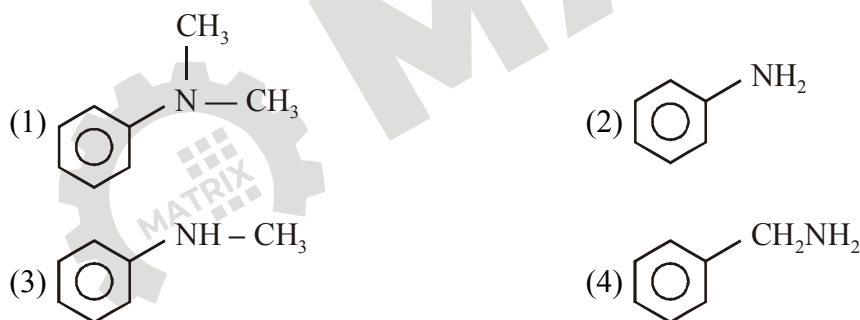
6.   Which one of the following carbonyl compounds cannot be prepared by addition of water on an alkync in the presence of $HgSO_4$ and H_2SO_4 ?

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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(1) $CH_3 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - H$

(2) $CH_3 - CH_2 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - H$

(3) $CH_3 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - CH_2CH_3$

(4) $\overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - CH_3$

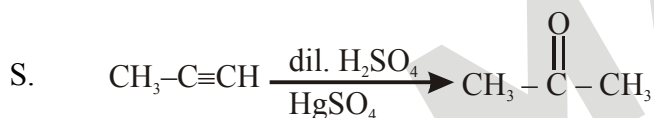Question Type : MCQ

Question ID : 70819116367

Option 1 ID : 70819154263

Option 2 ID : 70819154266

Option 3 ID : 70819154264

Option 4 ID : 70819154265

Ans.   Offical Answer NTA (2)

Ans.   (2)

S. $CH_3-C\equiv CH \xrightarrow[\text{HgSO}_4]{\text{dil. H}_2\text{SO}_4} CH_3 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - CH_3$

This alkyne will not produce $CH_3 - CH_2 - \overset{\displaystyle O}{\overset{\displaystyle \|}{C}} - H$.

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

        Assertion A   :   Hydrogen is the most abundant element in the Universe, but it is not the most

                            abundant gas in the troposphere.

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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Reason R : Hydrogen is the lightest element.

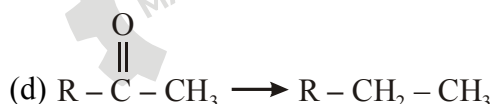In the light of the above statements, choose the correct answer from the options given below :
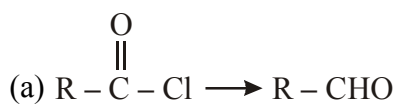
(1) A is false but R is true

(2) A is true but R is false

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

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

Ans. Offical Answer NTA (3)

Sol. Troposphere is lowest part of atmosphere and since it is a light gas so it won't be present in sufficient amount.

8. Match List - I and List - II.

List - I

(a) $R - \overset{\overset{O}{\|}}{C} - Cl \longrightarrow R - CHO$

(b) $R - CH_2 - COOH \longrightarrow R - \underset{\underset{Cl}{|}}{CH} - COOH$

(c) $R - \overset{\overset{O}{\|}}{C} - NH_2 \longrightarrow R - NH_2$

(d) $R - \overset{\overset{O}{\|}}{C} - CH_3 \longrightarrow R - CH_2 - CH_3$

List - II

(i) $Br_2/NaOH$

(ii) $H_2/Pd - BaSO_4$

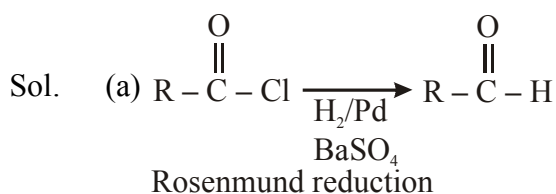(iii) $Zn(Hg)/Conc. HCl$

(iv) $Cl_2/Red P, H_2O$

(1) (a) - (iii), (b) - (i), (c) - (iv), (d) - (ii)

(2) (a) - (ii), (b) - (iv), (c) - (i), (d) - (iii)

(3) (a) - (iii), (b) - (iv), (c) - (i), (d) - (ii)

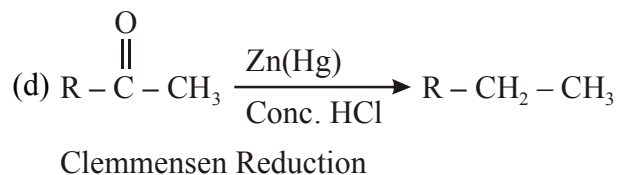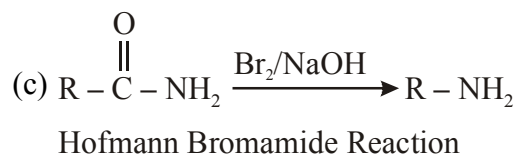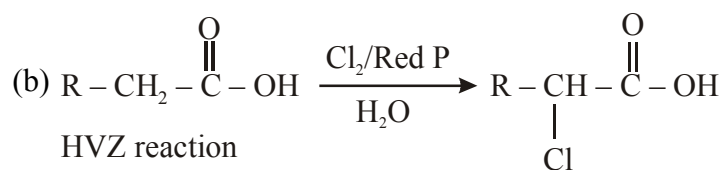(4) (a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)

Ans. Offical Answer NTA (2)

Sol. (a) $R - \overset{\overset{O}{\|}}{C} - Cl \xrightarrow[\text{BaSO}_4]{\text{H}_2/\text{Pd}} R - \overset{\overset{O}{\|}}{C} - H$

Rosenmund reduction

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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(b) $R - CH_2 - \overset{\overset{\displaystyle O}{\|}}{C} - OH \xrightarrow[\text{H}_2\text{O}]{\text{Cl}_2/\text{Red P}} R - \underset{\underset{\displaystyle Cl}{|}}{CH} - \overset{\overset{\displaystyle O}{\|}}{C} - OH$

HVZ reaction

(c) $R - \overset{\overset{\displaystyle O}{\|}}{C} - NH_2 \xrightarrow{\text{Br}_2/\text{NaOH}} R - NH_2$

Hofmann Bromamide Reaction

(d) $R - \overset{\overset{\displaystyle O}{\|}}{C} - CH_3 \xrightarrow[\text{Conc. HCl}]{\text{Zn(Hg)}} R - CH_2 - CH_3$

Clemmensen Reduction

9. What is the correct order of the following elements with respect to their density ?

(1) $Cr < Fe < Co < Cu < Zn$

(2) $Zn < Cr < Fe < Co < Cu$

(3) $Zn < Cu < Co < Fe < Cr$

(4) $Cr < Zn < Co < Cu < Fe$

Ans. Offical Answer NTA (2)

Sol.

Metal	density
Cr	7.19 g/cm³
Fe	7.8 g/cm³
Co	8.7 g/cm³
Cu	8.9 g/cm³
Zn	7.1 g/cm³

$Zn < Cr < Fe < Co < Cu$

10. The incorrect statement among the following is :

(1) Cr_2O_3 is an amphoteric oxide

(2) RuO_4 is an oxidizing agent

(3) $VOSO_4$ is a reducing agent

(4) Red colour of ruby is due to the presence of Co^{3+}

Ans. Offical Answer NTA (4)

Sol. Cr_2O_3 is an amphoteric oxide.

Ru in RuO_4 is in +8 oxidation state so it is an oxidising agent.

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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$VOSO_4$ has VO^{2+} ion so it is in +4 state therefore it can act as reducing agent.

Red colour of ruby is due to presence of Cr^{3+}.

11. Match List - I with List - II.

List - I	List - II
(Salt)	(Flame colour wavelength)
(a) LiCl	(i) 455.5 nm
(b) NaCl	(ii) 670.8 nm
(c) RbCl	(iii) 780.0 nm
(d) CsCl	(iv) 589.2 nm

(1) (a) - (ii), (b) - (iv), (c) - (iii), (d) - (i)

(2) (a) - (i), (b) - (iv), (c) - (ii), (d) - (iii)

(3) (a) - (iv), (b) - (ii), (c) - (iii), (d) - (i)

(4) (a) - (ii), (b) - (i), (c) - (iv), (d) - (iii)

Ans. Offical Answer NTA (1)

Sol. LiCl has crimson red flame (670.8 nm)

NaCl has yellow flame (589.2 nm)

RbCl has red violet flame (780 nm)

CsCl has Blue flame (455.5 nm)

12. The calculated magnetic moments (spin only value) for species $[FeCl_4]^{2-}$, $[Co(C_2O_4)_3]^{3-}$ and MnO_4^{2-} respectively are :

(1) 4.90, 0 and 1.73 BM

(2) 5.92, 4.90 and 0 BM

(3) 4.90, 0 and 2.83 BM

(4) 5.82, 0 and 0 BM

Ans. Offical Answer NTA (1)

Sol. $[FeCl_4]^{2-}$ has Fe in +2 state.

So Fe^{+2} has $3d^6\ 4s^0$ configuration

Magnetic moment = $\sqrt{4(4+2)}$ = 4.9 BM

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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$[Co(C_2O_4)_3]^{3-}$ has Co in +3 state.

So Co^{+3} has $3d^6 4s^0$ but it e^- will get paired up by oxalato ion.

Magnetic moment = 0 BM

MnO_4^{2-} has Mn in +6 state.

So Mn^{+6} has $3d^1 4s^0$ configuration

Magnetic moment = $\sqrt{1 \times (1+2)}$ = 1.73 BM

13. The correct set from the following in which both pairs are in correct order of melting point is :

(1) LiCl > LiF ; NaCl > MgO

(2) LiF > LiCl ; NaCl > MgO

(3) LiCl > LiF ; MgO > NaCl

(4) LiF > LiCl ; MgO > NaCl

Ans. Offical Answer NTA (4)

Sol. LiCl has less melting point than LiF due to more polarisation (Fajan's Rule)

MgO has more melting point than NaCl due to greater lattice energy.

LiF > LiCl ; MgO > NaCl

14. Given below are two statements :

Statement I : The value of the parameter "Biochemical Oxygen Demand (BOD)" is important for the survival of aquatic life.

Statement II : The optimum value of BOD is 6.5 ppm.

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

(1) Both statements I and statement II are false

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

(3) Both statement I and statement II are true

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

Ans. Offical Answer NTA (2)

Sol. BOD is important for survival of aquatic life but optimum value of BOD is 6 ppm.

15. According to Bohr's atomic theory :

(A) Kinetic energy of electron is $\propto \dfrac{Z^2}{n^2}$

(B) The product of velocity (v) of electron and principal quantum number (n), 'vn' $\propto Z^2$.

(C) Frequency of revolution of electron in an orbit is $\propto \dfrac{Z^3}{n^3}$

(D) Coulombic force of attraction on the electron is $\propto \dfrac{Z^3}{n^4}$

Choose the most appropriate answer from the options given below.

(1) (A) only

(2) (C) only

(3) (A), (C) and (D) only

(4) (A) and (D) only

Ans.   Offical Answer NTA (3)

Answer by MATRIX JEE ACADEMY is 4.

Sol.   KE of $e^- \propto \dfrac{Z^2}{n^2}$

Velocity of $e^- \propto \dfrac{Z}{n}$

So $vn \propto Z$

Frequency of revolution of $e^- \propto \dfrac{Z^2}{n^3}$

Coulombic force of attraction on $e^- \propto \dfrac{Z}{r^2}$

and $r \propto \dfrac{n^2}{Z}$ so force $\propto \dfrac{Z^3}{n^4}$

16.   Match List - I and List - II.

List - I	List - II
(a) Valium	(i) Antifertility drug
(b) Morphine	(ii) *Pernicious anaemia
(c) Norethindrone	(iii) Analgesic
(d) Vitamin B_{12}	(iv) Tranquilizer

(1) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

(2) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

(3) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

(4) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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Ans.   Offical Answer NTA (3)

Sol.   Valium is tranquilizer

Norethindrone is anti fertility drug.

Morphine is analgesic.

Deficiency of Vitamin B_{12} leads to pernicious **anaemia**.

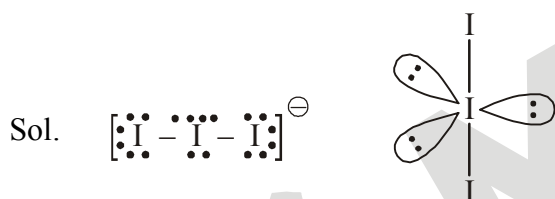17.   The correct shape and I – I – I bond angles respectively in I_3^- ion are :

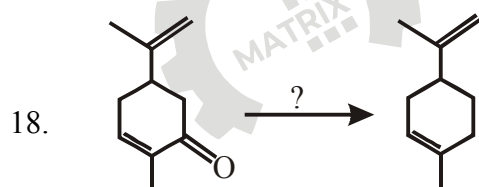(1) Distorted trigonal planar; 135° and 90°

(2) Linear; 180°

(3) Trigonal planar; 120°

(4) T-shaped; 180° and 90°

Ans.   Offical Answer NTA (2)

Sol. $\left[\ddot{\underset{\cdot\cdot}{I}} - \dot{\underset{\cdot}{I}} - \ddot{\underset{\cdot\cdot}{I}} \right]^{\ominus}$

Shape is linear and bond angle is 180°.

18.

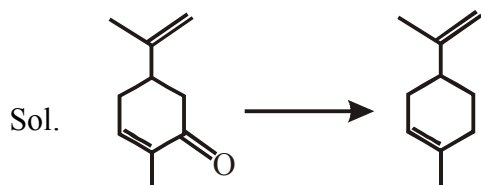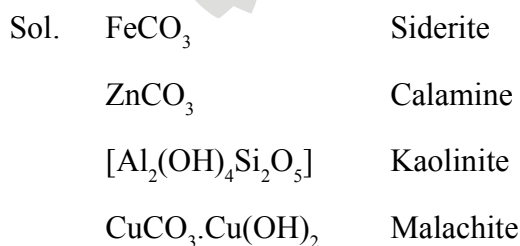Which of the following reagent is suitable for the preparation of the product in the above reaction?

(1) Red P + Cl_2

(2) $NH_2-NH_2 / C_2H_5O^{\ominus}Na^{\oplus}$

(3) $NaBH_4$

(4) Ni/H_2

Ans.   Offical Answer NTA (2)

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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Sol.

This reaction is done in presence of $N_2H_4/C_2H_5O^-Na^+$ and it is known as Wolf Kishner reduction.

19.   Match List - I with List - II.

List - I	**List - II**
(Metal)	**(Ores)**
(a) Aluminium	(i) Siderite
(b) Iron	(ii) Calamine
(c) Copper	(iii) Kaolinite
(d) Zinc	(iv) Malachite

Choose the correct answer from the options given below :

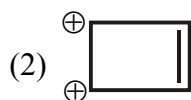(1) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)
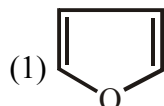
(2) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

(3) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

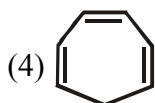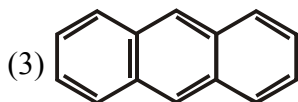(4) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

Ans.   Offical Answer NTA (4)

Sol. $FeCO_3$ Siderite

$ZnCO_3$ Calamine

$[Al_2(OH)_4Si_2O_5]$ Kaolinite

$CuCO_3.Cu(OH)_2$ Malachite

20.   Which one of the following compounds is non–aromatic?
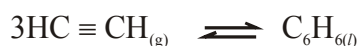
(1)

(2)

(3)

(4)

Ans. Offical Answer NTA (4)

Sol. does not have complete delocalisation in ring so it is non aromatic.

SECTION – B

1. Assuming ideal behaviour, the magnitude of log K for the following reaction at 25°C is $x \times 10^{-1}$. The value of x is...........(Integer answer)

$$3HC \equiv CH_{(g)} \rightleftharpoons C_6H_{6(l)}$$
[Given : $\Delta_f G°$ (HC ≡ CH) = $- 2.04 \times 10^5$ J mol^{-1} ; $\Delta_f G°(C_6H_6)$ = $- 1.24 \times 10^5$ J mol^{-1} ;
R = 8.314 J K^{-1} mol^{-1}]

Given ......

Ans. Offical Answer NTA (855)

Sol. $\Delta G°_{rxn} = \Delta G°_{Pro.} - \Delta G°_{Rea}$
    $= (-1.24 \times 10^5) - 3 (-2.04 \times 10^5)$
    $= 4.88 \times 10^5$ J mol^{-1}

$\Delta G° = -RT \ln K$

$4.88 \times 10^5 = - 2.303 \times 8.314 \times 298 \log K$

$\log K = - 85.5$

$\log K = - 855 \times 10^{-1}$

x = 855

2. C_6H_6 freezes at 5.5°C. The temperature at which a solution of 10 g of C_4H_{10} in 200 g of C_6H_6 freeze is............ °C. (The molal freezing point depression constant of C_6H_6 is 5.12°C/m.)

Given 1.09

Ans. Offical Answer NTA (1)

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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Sol. $\Delta T_f = K_f m$

$\Delta T_f = 5.12 \times \dfrac{\dfrac{10}{58}}{200} \times 1000$

$\Delta T_f = 4.4$

$(T_f)_{Solvent} - (T_f)_{Solution} = \Delta T_f$

$(T_f)_{Solution} = (T_f)_{Solvent} - \Delta T_f$

$= 278.5 - 4.4$

$= 274.1\ K$

$= 1.1\ °C$
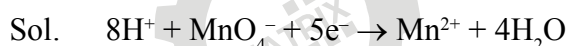
3.   The magnitude of the change in oxidising power of the MnO_4^-/Mn^{2+} couple is $x \times 10^{-4}$ V, if the H^+ concentration is decreased from 1 M to 10^{-4} M at 25°C. (Assume concentration of MnO_4^- and Mn^{2+} to be same on change in H^+ concentration). The value of x is............

(Rounded off to the nearest integer)

$\left[\text{Given}: \dfrac{2.303\,RT}{F} = 0.059 \right]$

Given ....

Ans.   (3776)

Sol. $8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O$

$E_{MnO_4^-/Mn^{2+}} = E^{\circ}_{MnO_4^-/Mn^{2+}} - \dfrac{0.059}{n} \log \dfrac{\left[Mn^{2+} \right]}{\left[MnO_4^- \right]\left(H^+ \right)^8}$

Since $[MnO_4^-] = [Mn^{2+}]$ n = 5

$E_{MnO_4^-/Mn^{2+}} = E^{\circ}_{MnO_4^-/Mn^{2+}} - \dfrac{0.059}{5} \log \dfrac{1}{\left[H^+ \right]^8}$

Oxidising power of MnO_4^- / Mn^{2+} depends on reduction potential.
Putting $[H^+] = 1$ M $[H^+] = 10^{-4}$ M

$E_{MnO_4^-/Mn^{2+}} = E^{\circ}_{MnO_4^-/Mn^{2+}} - \dfrac{0.059}{5} \log \dfrac{1}{\left[1 \right]^8}$ .... (1)

$E_{MnO_4^-/Mn^{2+}} = E^{\circ}_{MnO_4^-/Mn^{2+}} - \dfrac{0.059}{5} \log \dfrac{1}{\left[10^{-4} \right]^8}$ .... (2)

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) \| Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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(1) – (2)

For 2 different conditions

$$x \times 10^{-4} = -\frac{0.059}{5} \log \frac{1}{1^8} - \left(-\frac{0.059}{5}\right) \log \frac{1}{\left(10^{-4}\right)^8}$$

$$x \times 10^{-4} = \frac{0.059}{5} \log 10^{32}$$

$$x \times 10^{-4} = 0.3776$$

$$= 3776 \times 10^{-4}$$

$$x = 3776$$

4.   Sucrose hydrolyses in acid solution into glucose and fructose following first order rate law with a half-life of 3.33 h at 25°C. After 9 h, the fraction of sucrose remaining is f. The value of $\log_{10}\left(\dfrac{1}{f}\right)$ is

_____ $\times 10^{-2}$. (Rounded off to the nearest integer)

[Assume : ln 10 = 2.303, ln 2 = 0.693]

Ans.   Offical Answer NTA (81)

Sol. $$K = \frac{0.693}{t_{1/2}}$$

$$K = \frac{0.693}{3.33}$$

$$K = \frac{2.303}{t} \log \frac{1}{1-x}$$

Sucrose $\rightarrow$ fructose + glucose

1

1 – x   x   x

1 – x = f

$$\frac{0.693}{3.33} = \frac{2.303}{9} \log \frac{1}{f}$$

$$\log \frac{1}{f} = \frac{0.693 \times 9}{3.33 \times 2.303}$$

$$\log \frac{1}{f} = 0.813$$

$$= 81.3 \times 10^{-2}$$

5.   The volume occupied by 4.75 g of acetylene gas at 50°C and 740 mmHg pressure is _____ L.

(Rounded off to the nearest integer)

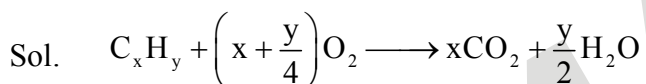[Given R = 0.0826 L atm K⁻¹ mol⁻¹]

Ans.   Offical Answer NTA (5)

Sol.   PV = nRT

$$\frac{740}{760} \times V = \frac{4.75}{26} \times 0.0821 \times 323$$
V = 4.975 L

$V \simeq 5L$

6.   The formula of a gaseous hydrocarbon which requires 6 times of its own volume of O_2 for complete oxidation and produces 4 times its own volume of CO_2 is C_xH_y. The value of y is

Ans.   Offical Answer NTA (8)

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

$x + \frac{y}{4} = 6$ and $x = 4$
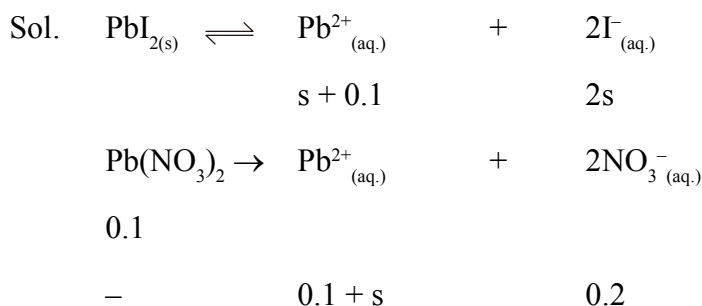
So y = 8

C_4H_8

7.   The solubility product of PbI_2 is 8.0×10^{-9}. The solubility of lead iodide in 0.1 molar solution of lead nitrate is $x \times 10^{-6}$ mol/L. The value of x is _____. (Rounded off to the nearest integer)

[Given $\sqrt{2}$ = 1.41]

Ans.   Offical Answer NTA (141)

Sol. $PbI_{2(s)} \rightleftharpoons Pb^{2+}_{(aq.)} + 2I^-_{(aq.)}$

s + 0.1   2s

$Pb(NO_3)_2 \rightarrow Pb^{2+}_{(aq.)} + 2NO_3^-_{(aq.)}$

0.1

–   0.1 + s   0.2

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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$(2s)^2 (0.1 + s) = 8 \times 10^{-9}$

$4s^2 \times 0.1 = 8 \times 10^{-9}$

$s^2 = 2 \times 10^{-8}$

$s = \sqrt{2} \times 10^{-4}$

$s = 1.41 \times 10^{-4}$

$s = 141 \times 10^{-6}$

$x = 141$

8. Among the following allotropic forms of sulphur, the number of allotropic forms, which will show paramagnetism is _____.

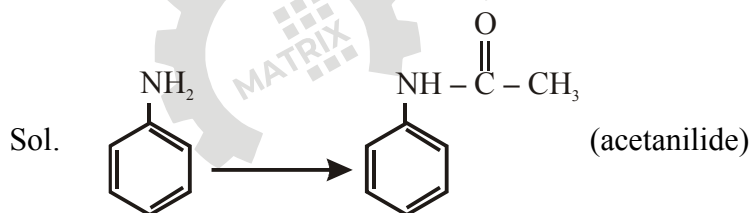(A) α-sulphur   (B) β-sulphur   (C) S_2-form

Ans. Offical Answer NTA (1)

Sol. S_2 has unpaired e^- in π^* – orbital at high temperature so it will be paramagnetic.

9. 1.86 g of aniline completely reacts to form acetanilide. 10% of the product is lost during purification. Amount of acetanilide obtained after purification (in g) is _____ $\times 10^{-2}$.

Ans. Offical Answer NTA (243)

Sol.

   (acetanilide)

Moles of aniline $= \dfrac{1.86}{93} = 0.02$

So moles of acetanilide $= 0.02$
Mass of acetanilide $= 0.02 \times 135 = 2.7$ g

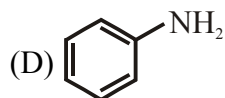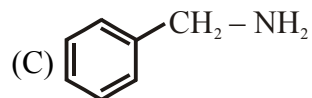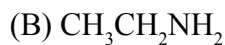Mass left $= 2.7 - 2.7 \times \dfrac{10}{100}$

$= 2.43$

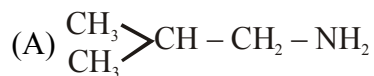$= 243 \times 10^{-2}$

MATRIX JEE ACADEMY
Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911
Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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10. The total number of amines among the following which can be synthesized by Gabriel synthesis is

_____.

(A) $\begin{matrix} CH_3 \\ CH_3 \end{matrix} > CH - CH_2 - NH_2$

(B) $CH_3CH_2NH_2$

(C) $CH_2 - NH_2$

(D) NH_2

Ans. Offical Answer NTA (3)

Sol. 1° amines are prepared from Gabriel synthesis but it should not be aryl amines.

Aniline can not be prepared.

MATRIX JEE ACADEMY
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Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

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