CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. In Carius method of estimation of bromine, 1.53 g of an organic compound gave 1 g AgBr. The % of bromine in organic compound is, (Atomic mass of Ag, Br = 108, 80 u respectively)

   (1) 35.23   (2) 43.53

   (3) 27.81   (4) 22.71

Answer (3)

Sol. % of Br $= \dfrac{\dfrac{1}{188} \times 80}{1.53} \times 100$

   = 27.81%

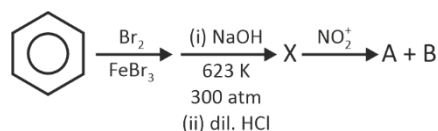2. In period 4 of the periodic table which elements have the highest and lowest atomic radii respectively

   (1) K and Br   (2) Na and Cl

   (3) K and Se   (4) Rb and Br

Answer (1)

Sol. Atomic size generally decreases from left to right in the period.

   (Not including noble gases)

3. Consider the following reaction sequence :

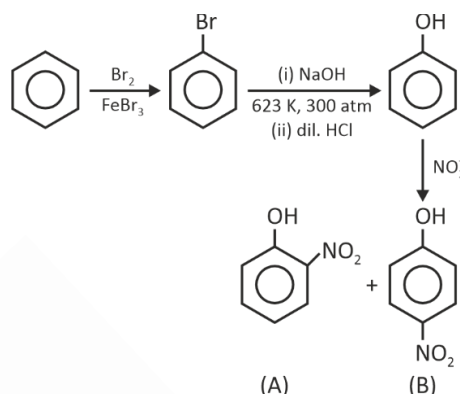   The organic product 'A' and 'B' can be separated by

   (1) Steam distillation

   (2) Fractional distillation

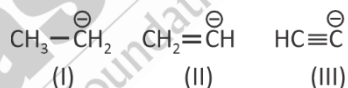   (3) Distillation under reduced pressure

   (4) Azeotropic distillation

Answer (1)

Sol.

   o-nitrophenol is steam volatile due to intramolecular hydrogen bonding.

4. Consider following ions

$$CH_3 - \overset{\ominus}{C}H_2 \qquad CH_2 = \overset{\ominus}{C}H \qquad HC \equiv \overset{\ominus}{C}$$
$$\text{(I)} \qquad\qquad \text{(II)} \qquad\qquad \text{(III)}$$

   Stability of ions is in order

   (1) III > II > I   (2) II > III > I

   (3) I > II > III   (4) I > III > II

Answer (1)

Sol. More is electronegativity of carbon more is stability of carbanion.

5. For equivalence point X ml of 0.02 M HCl is treated with 5 mL of 0.02 M of a weak base. The pK_b of weak base is 5.69 and the pH of the resulting solution is Y at half of the equivalence point. The value of (x + y) is:

   (1) 5   (2) 8.81

   (3) 13.31   (4) 3.81

Answer (3)

Sol. At equivalence point: 0.02 x = 0.02 × 5

x = 5 mL.

For basic buffer: (at half of equivalence point)

$$pOH = pK_b + \log \frac{[Conj.\ acid]}{[Weak\ base]}$$

so, 14 − y = 5.69 + log 1

y = 8.31

x + y = 5 + 8.31 = 13.31

6. For a first order reaction, X → Y + Z, time required for decomposition of $\frac{1}{8}$th and $\frac{1}{10}$th of its initial conc. is $t_{1/8}$ and $t_{1/10}$.

The value of $\left(\dfrac{t_{1/8}}{t_{1/10}}\right) \times 10 = ?$

Take : log8 = 0.90, log7 = 0.84, log9 = 0.95

(1) 9

(2) 10

(3) 12

(4) 8

Answer (3)

Sol. $t_{1/8} = \dfrac{2.303}{k} \log \dfrac{1}{1-\dfrac{1}{8}} = \dfrac{2.303}{k} \log \dfrac{8}{7}$

$$= \frac{2.303}{k}(0.06)$$

$t_{1/10} = \dfrac{2.303}{k} \log \dfrac{1}{1-\dfrac{1}{10}} = \dfrac{2.303}{k} \log \dfrac{10}{9}$

$$= \frac{2.303}{k}(0.05)$$

$\dfrac{t_{1/8}}{t_{1/10}} = \dfrac{\left(\dfrac{2.303}{k}\right)(0.06)}{\left(\dfrac{2.303}{k}\right)(0.05)} = \dfrac{6}{5} = 1.2$

7. Choose the correct statements in respect of hydrides of Group-15.

A. Reducing power increasing down the group.

B. Basic nature increases down the group.

C. Stability decreases down the group.

D. Boiling point decreases regularly down the group.

(1) A, B and C only

(2) A, B and D only

(3) A and C only

(4) B, C and D only

Answer (3)

Sol. A. Down the group bond energy decreases, so release of hydrogen becomes easier and reducing power increases.

B. Basic nature decreases down the group due to decrease of electron density on central atom.

C. Stability decreases down the group due to decrease of bond strength.

D. Hydrides → NH_3 PH_3 AsH_3 SbH_3 BiH_3

B.P. (K) → 238 185 210 254 290

Increasing from PH_3 to BiH_3.

8. Which is correct option.

(A) $[Ni(CN)_4]^{2-}$ is paramagnetic while $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ are diamagnetic.

(B) $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$ are diamagnetic while $[NiCl_4]^{2-}$ is paramagnetic.

(C) $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ are paramagnetic while $[Ni(CN)_4]^{2-}$ is diamagnetic.

(D) $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are paramagnetic while $[Ni(CO)_4]$ is diamagnetic.

(1) A

(2) B

(3) C

(4) D

Answer (2)

Sol. $[Ni(CN)_4]^{2-}$

$\Rightarrow Ni^{2+} \Rightarrow 3d^8$
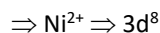
$\Rightarrow CN^-$ is SFL

$\Rightarrow dsp^2$ and diamagnetic (n = 0)

$[NiCl_4]^{2-}$

$\Rightarrow Ni^{2+} \Rightarrow Cl^-$ is WFL ($3d^8$)

$\Rightarrow sp^3$ hybridised and paramagnetic (n = 2)

$[Ni(CO)_4] \Rightarrow Ni \Rightarrow 3d^{10}$

$\Rightarrow sp^3$ hybridised

$\Rightarrow$ diamagnetic (n = 0)

9. The wave number of three spectral lines of H-atom are given. Identify the correct set of spectral lines belonging to Balmer series

(1) $\dfrac{5R}{36}, \dfrac{3R}{16}, \dfrac{21R}{100}$ (2) $\dfrac{3R}{4}, \dfrac{3R}{16}, \dfrac{7R}{144}$

(3) $\dfrac{7R}{144}, \dfrac{3R}{16}, \dfrac{16R}{255}$ (4) $\dfrac{5R}{36}, \dfrac{3R}{16}, \dfrac{21R}{24}$

Answer (1)

Sol. For 1st line $\bar{\nu} = R\left(\dfrac{1}{4} - \dfrac{1}{9}\right) = \dfrac{5R}{36}$

2nd line $\bar{\nu} = R\left(\dfrac{1}{4} - \dfrac{1}{16}\right) = \dfrac{3R}{16}$

3rd line $\bar{\nu} = R\left(\dfrac{1}{4} - \dfrac{1}{25}\right) = \dfrac{21R}{100}$

10. Given below are two statements

Statement I : Among XeF_4, BF_4^- and SF_4, the species having equal M-X bond lengths are XeF_4 and BF_4^-. (M = central atom).

Statement II : Among O_2^{2-}, O_2^-, F_2 and O_2^+, the highest bond order is for F_2 and O_2^{2-}
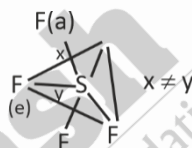
In the light of the above statements, choose the most appropriate option.

(1) Both statement-I and statement-II are correct

(2) Both statement-I and statement-II are incorrect

(3) Statement-I is correct but statement-II is incorrect

(4) Statement-I is incorrect but statement-II is correct.

Answer (3)

Sol.
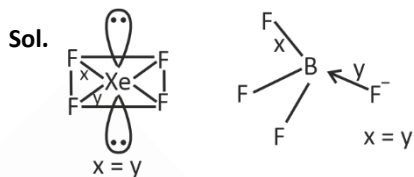
(x, y are bond lengths)

Species	B.O.
O_2	2.0.
O_2^-	1.5.
O_2^+	2.5.
O_2^{2-}	1.0
F_2	1.0

11. Among the following pairs, coloured ions are

(1) Ti^{3+} and V^{3+} (2) Ti^{3+} and Sc^{3+}

(3) Ti^{4+} and V^{3+} (4) V^{2+} and Sc^{3+}

Answer (1)

Sol.

Ion	Number of unpaired electrons	Colour
Ti^{3+}	1	Purple
V^{3+}	2	Green
Sc^{3+}	0	Colourless
Ti^{4+}	0	
V^{2+}	3	Violet

12. At T(K), 2 moles of liquid A and 3 moles of liquid B are mixed. The vapour pressure of ideal solution so formed is 320 mm Hg. At this stage one mole of A are mixed further, the vapour pressure is found to be 340 mm Hg. The vapour pressure of pure A and B are respectively

    (1) 200 mm Hg

    400 mm Hg

    (2) 440 mm Hg

    240 mm Hg

    (3) 300 mm Hg

    400 mm Hg

    (4) 240 mm Hg

    440 mm Hg

Answer (2)

Sol. $P_S = X_A P_A^o + X_B P_B^o$

$$320 = \frac{P_A^o \times 2}{5} + \frac{P_B^o \times 3}{5}$$

$$1600 = 2P_A^o + 3P_B^o \qquad ...(1)$$

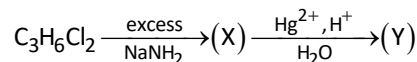After adding 1 mole of A

$$340 = \frac{3P_A^o}{6} + \frac{3P_A^o}{6}$$

$$680 = P_A^o + P_B^o \qquad ...(2)$$

$3 \times (2) - (1)$

$$\boxed{240 \text{ mm Hg} = P_B^o}$$

$$\boxed{440 \text{ mm Hg} = P_A^o}$$

13. Observe the following reaction:

    $$C_3H_6Cl_2 \xrightarrow[NaNH_2]{excess} (X) \xrightarrow[H_2O]{Hg^{2+}, H^+} (Y)$$
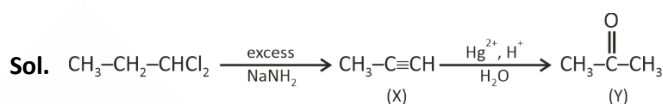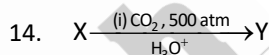
    The product (Y) gives which of the following test?

    (1) Tollen's test   (2) Lucas test

    (3) Iodoform test   (4) Fehling's test

Answer (3)

Sol. $CH_3-CH_2-CHCl_2 \xrightarrow[NaNH_2]{excess} CH_3-C\equiv CH \xrightarrow[H_2O]{Hg^{2+}, H^+} CH_3-\overset{\overset{O}{\|}}{C}-CH_3$
                                                            (X)   (Y)

(Y) gives iodoform test.

14. $X \xrightarrow[H_3O^+]{(i)\, CO_2,\, 500\, atm} Y$
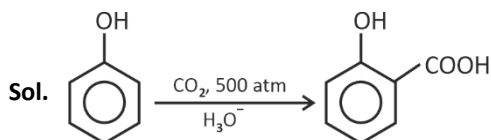
    X react with $FeCl_3$

    X contain C = 76.57% H = 6.43% O = 17%

    V.D. of X = 47

    Incorrect statement among following

    (1) X reacts with $NaHCO_3$

    (2) X is more acidic than Y

    (3) Y is salicylic acid

    (4) Y is product of Kolbe's reaction

Answer (2)

Sol.

15. Consider the following polypeptide :

$$H_2N-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle CHOH}{|}}{C}}-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH-\overset{\overset{\displaystyle CH_2OH}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH-\overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle CH_2SH}{|}}{C}}-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH-\overset{\overset{\displaystyle CH_2}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH-CH_2-COOH$$

(with COOH at top of the CH₂ group)
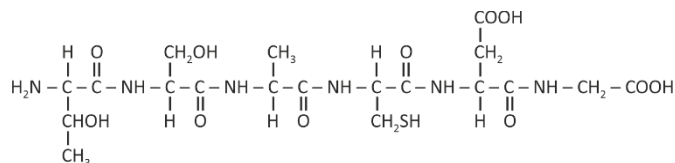
In the given polypeptide, Y is the essential amino acid present. The correct representation of Y and the name of amino acids in the correct sequence in polypeptide is

(1)

Y	Polypeptide (name of amino acid)
Thr	Thr-Ser-Ala-Cys-Asp-Gly

(2)

Y	Polypeptide (name of amino acid)
Ser	Ser-Ala-Thr-Cys-Asp-Gly

(3)

Y	Polypeptide (name of amino acid)
Thr	Thr-Ser-Cys-Asp-Ala-Gly

(4)

Y	Polypeptide (name of amino acid)
Ser	Thr-Ser-Ala-Asp-Cys-Gly

Answer (1)

Sol. Threonine is essential amino acid.

∴ Natural amino acids general form

$$H_2N-\overset{\overset{\displaystyle COOH}{|}}{\underset{\underset{\displaystyle R}{|}}{C}}-H$$
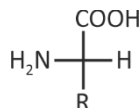
∴ R $\Rightarrow$ H₃C − CHOH − (Threonine) (essential Amino acid)

R $\Rightarrow$ HO − CH₂ − (Serine)

R $\Rightarrow$ CH₃ − (Alanine)
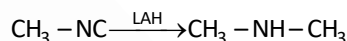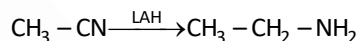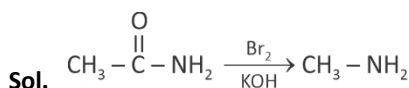
R $\Rightarrow$ HS − CH₂ − (Cysteine)

R $\Rightarrow$ HOOC − CH₂ − (Aspartic acid)

R $\Rightarrow$ H − (Glycine)

16. Which of the following reaction is correctly matched with the product formed?

(1) $CH_3-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH_2 + Br_2 + KOH \longrightarrow CH_3NH_2$

(2) $CH_3-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH_2 + Br_2 + KOH \longrightarrow CH_3-CH_2-NH_2$

(3) $CH_3-CN \xrightarrow{\text{LiAlH}_4} CH_3-NH_2$

(4) $CH_3-NC \xrightarrow{\text{LiAlH}_4} CH_3-CH_2-NH_2$

Answer (1)

Sol. $CH_3-\overset{\overset{\displaystyle O}{\parallel}}{C}-NH_2 \xrightarrow[\text{KOH}]{Br_2} CH_3-NH_2$

$CH_3-CN \xrightarrow{\text{LAH}} CH_3-CH_2-NH_2$

$CH_3-NC \xrightarrow{\text{LAH}} CH_3-NH-CH_3$
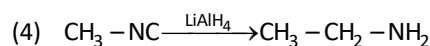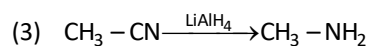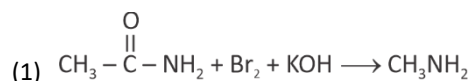
17. Match the column-I showing compounds with column-II showing suitable test for that compound

	Column-I		Column-II
(P)	$C_6H_5COCH_2CH_3$	a	Iodoform test
(Q)	C_6H_5CHO	b	2, 4-DNP test
(R)	$C_6H_5CH_2CHO$	c	Tollens test
(S)	$C_6H_5COCH_3$	d	Fehling test

(1) P – b

Q – b, c

R – b, c, d,

S – a, b

(2) P – b

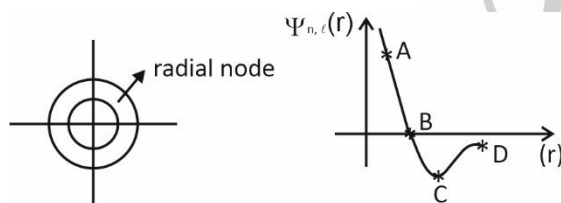Q – b, c, d

R – b, c, d

S – a, b, c

(3) P – a, b

Q – b, c, d

R – b, c, d

S – a, b, d

(4) P – b

Q – b, c, d

R – b, c

S – a, b

Answer (1)

Sol. a. Iodoform test is given by aldehydes and ketones having CH_3CO – group

b. 2, 4-DNP test is given by aldehydes and ketones.

c. Tollen test is given by aldehydes, but not ketones.

d. Fehling test is given by only aliphatic aldehydes.

18. Consider the diagram

Radial node is shown by

(1) A

(2) B

(3) C

(4) D

Answer (2)

Sol. At radial node, $\psi(r)$ vs r curve touches r-axis.

19. In reversible isothermal process at 600 K, pressure changes from 0.5 MPa to 0.2 MPa, then find ΔU, w and q. Given moles of gas in container is 1 mol. ($R = 8.3\ JK^{-1}\ mol^{-1}$)

(1) $\Delta U = 0$

q = –4.587 kJ

w = +4.587 kJ

(2) $\Delta U = 0$

q = 0

w = 0

(3) $\Delta U = 0$

q = 0

w = –4.587 kJ

(4) $\Delta U = 0$

q = +4.587 kJ

w = –4.587

Answer (4)

Sol. For reversible isothermal process,

$$w = -nRT\ln\frac{V_2}{V_1}$$

$$w = nRT\ln\frac{P_2}{P_1}$$

$$= 1 \times 8.3 \times 2.303 \times 600\log\frac{0.2}{0.5}$$

= –4.587 kJ

For isothermal process, $\Delta U = 0$

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.
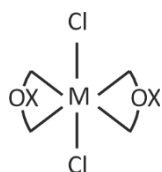
21. Calculate the sum of number of geometrical isomers of $[MClBrNO_2CN]$, number of optically inactive isomers of $[M(OX)_2Cl_2]$ and number of geometrical isomers of $[MCl_3Br_3]$
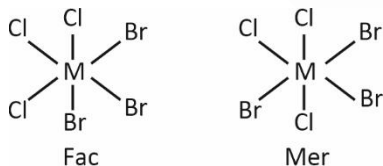
Answer (15)

Sol. $[M\,Cl\,BrNO_2CN]$
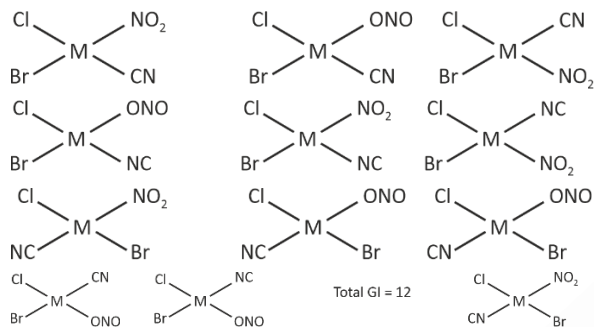
Total GI = 12

$[M(OX)_2Cl_2]$

Total optically inactive isomer = 1

Fac   Mer

Total GI = 2

Sum = 15

22. Find out the ratio of de Broglie wavelengths of deuteron with kinetic energy E and α particle having kinetic energy 2E.
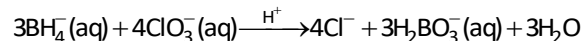
Answer (2)

Sol. $\lambda = \dfrac{h}{\sqrt{2.m.KE}}$

$$\frac{\lambda_D}{\lambda_\alpha} = \left(\frac{m_\alpha \times (KE)_\alpha}{m_D \times (KE)_D} \right)^{1/2}$$

$$= \left(\frac{2m_D \times 2E}{m_D \times E} \right)^{1/2} = 2$$
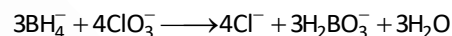
23. Consider a galvanic cell reaction :

$$3BH_4^-(aq) + 4ClO_3^-(aq) \xrightarrow{H^+} 4Cl^- + 3H_2BO_3^-(aq) + 3H_2O$$

EMF of cell is given by,

$$E_{cell} = E_{cell}^o - \frac{RT}{nF}\ln[Q]$$

Here 'Q' is reaction quotient for the given cell reaction. Find 'n'.

Answer (24)

Sol. $\overset{+5}{ClO_3^-} \longrightarrow \overset{-1}{Cl^-} \quad \Delta \text{Oxidation number} = 6\,\text{units}$

$$3BH_4^- + 4ClO_3^- \longrightarrow 4Cl^- + 3H_2BO_3^- + 3H_2O$$

Number of electrons exchanged in balanced reaction = $(5 - (-1)) \times 4 = 24$

24. 500 ml of 1.2 M KI solution is reacting with 500 ml of 0.2 M $KMnO_4$ solution in acidic medium, and product iodine is further reacting with 0.1 M $Na_2S_2O_3$ solution. The volume of $Na_2S_2O_3$ solution required for complete reaction is _____ ml.

Answer (5000)
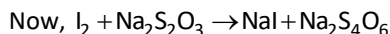
Sol. $KI + KMnO_4 \rightarrow I_2 + Mn^{2+}$
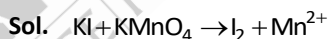
m equivalent of KI = $500 \times 1.2 \times 1 = 600$

m equivalent of $KMnO_4 = 500 \times 0.2 \times 5 = 500$ (limiting reagent)

So, m equivalent of I_2 formed = 500,

m mol of $I_2 = \dfrac{500}{2} = 250$

Now, $I_2 + Na_2S_2O_3 \rightarrow NaI + Na_2S_4O_6$

m equivalent of $I_2 = 250 \times 2 = 500$,

so, m equivalent of $Na_2S_2O_3 \Rightarrow 500 = 0.1 \times V$

V = 5000 ml

25.