

+1

MEGA SCHOLARSHIP TEST (₹ 150000)

TEST - 40

LEVEL - 1 & LEVEL - 2

Topics:

1. Some Basic Concepts in Chemistry
2. Structure of Atom,
3. Periodic & Chemical Bonding
4. States of Matter (Only Gaseous State),
5. Chemical & Ionic Equilibrium
6. Thermodynamics
7. Redox Reactions
8. Organic Chemistry:
 - IUPAC Nomenclature
 - Isomerism
 - Hydrocarbon
 - Analysis of Organic Compounds
 - General Organic Chemistry
9. Inorganic Chemistry:
 - s-block elements
 - Boron family

Test Date: 07.04.2019 (Sunday)

Time: 11:00 AM to 02:00 PM

Empowered By:

TEST SERIES

PCB
QUANTUM⁺Plus

PCM
INTELLIQUEST



Dr. Sangeeta Khanna, Ph.D

S.C.O. 208 (TF) Sector 24-D, Chandigarh. Ph. No. 0172-2713289 (O), 09888007880 (M).

IMPORTANT INSTRUCTIONS

- Test Duration: 11:00 AM to 2:00 PM
- This test consist of 2 Levels.

Level - I

Time: 60 Minutes [11:00 to 12:00 Noon]

45 Qs. \times 4 = 180 Marks

(Single Answer Type) [Negative Marking = - 1]

Level - II

Time: 2 hours [12:00 NOON to 2:00 PM]

43 Qs = 194 Marks

- Assertion & Reason [Negative Marking (-1)] = $10 \times 4 = 40$ Marks
 - Comprehension Type [Negative Marking (-1)] = $10 \times 4 = 40$ Marks
 - More than One Answer [No Negative Marking] = $10 \times 5 = 50$ Marks
 - Matrix Match Type [No Negative Marking] = $3 \times 8 = 24$ Marks
 - Integer Type [No Negative Marking] = $10 \times 4 = 40$ Marks
- Every candidate will get 2 OMR Sheets for answering Level - I and Level - II separately. The candidate will start with Level - I first and return Level I OMR sheet immediately at 12:00 Noon after 60 minutes. So please ensure to fill up OMR on time.
 - OMR sheet for Level - II will be collected immediately after completion of test time at 2:00 pm.
 - Usage of Mobile is strictly prohibited in the examination hall. The mobile must be kept switched off during exam time. Anybody seen using or fiddling with mobile phone will get disqualified for the test.
 - Unfair means of any sort during exam will entail cancellation and disqualification of his/her paper.
 - Answer Key will be given only after completion of paper. Detailed solutions will be uploaded on website.

“BEST OF LUCK”

This Section contains **45 multiple choice questions**. Each question has four choices A), B), C) and D) out of which **ONLY ONE** is correct. (Mark only One choice) **45 x 4 = 180 Marks**

1. What will be the four quantum numbers of last electron of Sc – 21.

(a) $n = 4; \ell = 0; m = 0, s = +\frac{1}{2}$

(b) $n = 3; \ell = 2; m = 0; s = +\frac{1}{2}$

(c) $n = 4; \ell = 1; m = 0; s = +\frac{1}{2}$

(d) $n = 3; \ell = 3; m = 0; s = +\frac{1}{2}$

B

2. Number of waves in a Bohr orbit of H-atom is 3. Its potential energy would be

(a) – 3.4 eV

(b) – 3.02 eV

(c) 3 eV

(d) 0.5 eV

B

Sol. No. of waves = n

$$P.E. = -2 \times E_{\text{Total}} = -\frac{2 \times E_1}{n^2} = -\frac{2 \times 13.6}{3^2} = -3.02 \text{ eV}$$

3. If uncertainty in position and momentum are equal, then uncertainty in velocity is

a. $\sqrt{\frac{h}{\pi}}$

b. $\sqrt{\frac{h}{2\pi}}$

c. $\frac{1}{2m} \sqrt{\frac{h}{\pi}}$

d. None

C

Sol. Heisenberg uncertainty principle is

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

When $\Delta x = \Delta p$, then

$$= (\Delta p)^2$$

$$\Delta p = \sqrt{\frac{h}{4\pi}}$$

$$m\Delta V = \frac{1}{2} \sqrt{\frac{h}{\pi}}$$

$$\Delta V = \frac{1}{2m} \sqrt{\frac{h}{\pi}}$$

4. The ratio of the energy of the electron in ground state of hydrogen to that of the electron in the first excited state of Be^{+3} is:

a. 1 : 4

b. 1 : 8

c. 1 : 16

d. 16 : 1

A

5. If pressure is tripled and temperature (in Kelvin) is halved, the volume of a given mass of an ideal gas becomes:

a. 3/2 times its original volume

b. 2/3rd of its original volume

c. 1/6th of its original volume

d. 6 times its original volume

C

Sol. $P_1 V_1 = nRT_1$... (i)

$$(3P_1)V_2 = nR\left(\frac{T_1}{2}\right) \quad \dots \text{(ii)}$$

$$\frac{V_1}{3V_2} = 2$$

$$V_2 = \frac{1}{6} V_1$$

6. Which of the following statement is not true

- Boiling point of Butanol is higher than diethylether due to presence of H-bonding.
- Order of boiling point of halogen is $F_2 < Cl_2 < Br_2 < I_2$
- Order of Boiling point of hydrohalic acid is $HI < HF < HBr < HCl$
- Heat of vaporization of $H - F$ is less than H_2O

C

7. The B.pt of 2-hydroxybenzaldehyde is lower than that of 4-hydroxybenzaldehyde because:

- 2-hydroxybenzaldehyde has intermolecular H-bonding & p-hydroxybenzaldehyde has intramolecular H-bonding
- Both have intermolecular H - bonding
- Both have intramolecular H - bonding
- 2-hydroxybenzaldehyde has intramolecular H-bonding & p-hydroxybenzaldehyde has intermolecular H - bonding.

D

8. Match column (I) with Column (II)

Column I (Molecule/ion)		Column II (Hybridisation)	
(A)	H_3O^+ ion	(p)	sp
(B)	B_2H_6	(q)	sp^2
(C)	NO_3^- ion	(r)	sp^3
(D)	SF_4	(s)	sp^3d

a. A - r, B - p, C - q, D - s

c. A - r, B - q, C - q, D - s

D

b. A - r, B - p, C - r, D - s

d. A - r, B - r, C - q, D - s

Sol. $H_3O^+ = sp^3$, $B_2H_6 = sp^3$, $NO_3^- = sp^2$, $SF_4 = sp^3d$

9. Which of the following are unstable with respect to their constituent elements at $25^\circ C$?

Species	$\Delta G_f^\circ, kJ/mol$	$\Delta H_f^\circ, kJ/mol$	$S^\circ, J/(K \cdot mol)$
$C_8H_{18}(l)$	-250	+329	+6
$C_2H_2(g)$	+227	+201	+209
$CH_3OH(l)$	-239	+127	-166

a. $C_8H_{18}(l)$, $CH_3OH(l)$

b. $C_8H_{18}(l)$, $C_2H_2(g)$

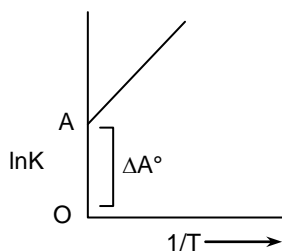
c. $C_2H_2(g)$

d. $CH_3OH(l)$

C

Sol. Its ΔG_f° is positive

10. A graph between $\ln K$ and $\frac{1}{T}$ is of the type



Thus,

a. $\Delta H^\circ > 0$ and $\Delta A^\circ = \frac{\Delta S^\circ}{R}$

b. $\Delta H^\circ < 0$ and $\Delta A^\circ = \frac{\Delta S^\circ}{R}$

c. $\Delta H^\circ > 0$ and $\Delta A^\circ = -\frac{\Delta S^\circ}{R}$

d. $\Delta H^\circ < 0$ and $\Delta A^\circ = -\frac{\Delta S^\circ}{R}$

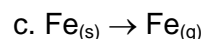
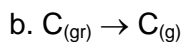
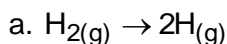
B

Sol. As $\frac{1}{T}$ increase (T decreases) log K or K increases. Thus, given reaction is exothermic, i.e., $\Delta H^\circ < 0$

$$\ln K = \frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$$

Thus, slope is $\frac{\Delta H^\circ}{R}$ and $\Delta A^\circ = \frac{\Delta S^\circ}{R}$

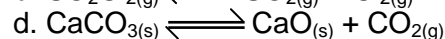
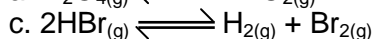
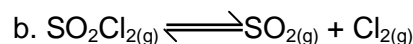
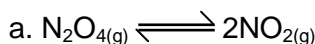
11. For which of the following reaction is the enthalpy change is the standard enthalpy of atomization?



d. all three

D

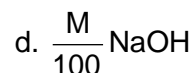
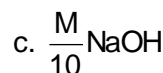
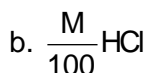
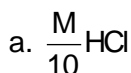
12. For which of the following reactions, the degree of dissociation cannot be calculated from the vapour density data



C

Sol. A reaction with no change in gaseous no. of moles

13. Which of the following will have largest pH?



C

Sol. (c) is basic solution with highest concentration Hence its pH is largest.

14. At 1000 K a vessel contain CO_2 at a pressure of 0.5 atm. When graphite is added to vessel CO is formed and total pressure become 0.8 atm. Calculate K_p .

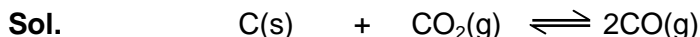
a. 1.8

b. 2.8

c. 1.0

d. 2.5

A



Initial

0.5

0

At equi.

$(0.5 - x)$

$2x$

$0.5 - 3 = 0.2$

$2 \times 0.3 = 0.6$

$P_{Total} = 0.5 - x + 2x$ $0.8 = 0.5 + x$ $x = 0.3$
--

$$K_p = \frac{P_{CO}^2}{P_{CO_2}} = \frac{0.6 \times 0.6}{0.2} = 1.8$$

15. For the reaction $2A_{(g)} + 3B_{(g)} \rightleftharpoons 4C_{(g)}$ at $127^\circ C$. The value of $K_p = 2$. Find K_c

a. 70.6

b. 65.6

c. 6.56

d. 5.12

B

Sol. $K_p = K_c (RT)^{\Delta n}$

$$\Delta n = 4 - 5 = -1$$

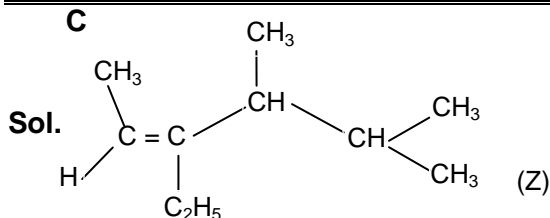
$$T = 273 + 127 = 400K$$

$$K_p = K_c (RT)^{\Delta n}$$

$$2 = K_c (0.082 \times 400)^{-1}$$

$$2 = K_c \left(\frac{1}{32.8} \right)$$

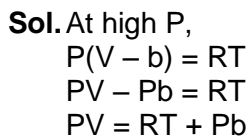
$$K_c = 65.6$$



21. For a real gas obeying Vander Waal's equation at high pressure, a graph is plotted between PV_m (y-axis) and P (axis) where V_m is molar volume. y-intercept of the graph is:

- a. RT b. $\left(P + \frac{a}{V^2}\right)$ c. $\frac{RT}{V-b}$ d. $\left(P - \frac{a}{V^2}\right)$

A



22. Which of the following reagent is used to identify sulphide ion.

- (i) Lead Acetate test (ii) Sodium nitro prusside test
 (iii) Belistein Test (iv) Sodalime test
- a. i & ii b. i,ii,iii c. ii & iv d. iii & iv

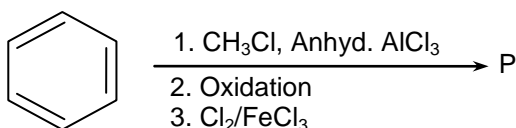
A

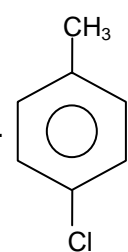
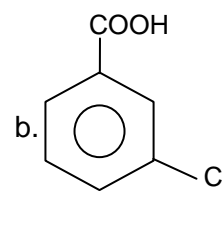
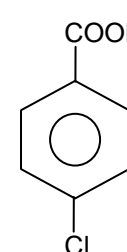
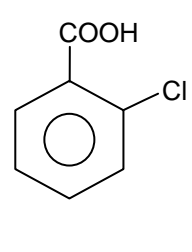
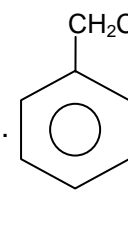
23. The groups which can exert both + M and - M effect

- a. nitro b. cyano c. ester d. All

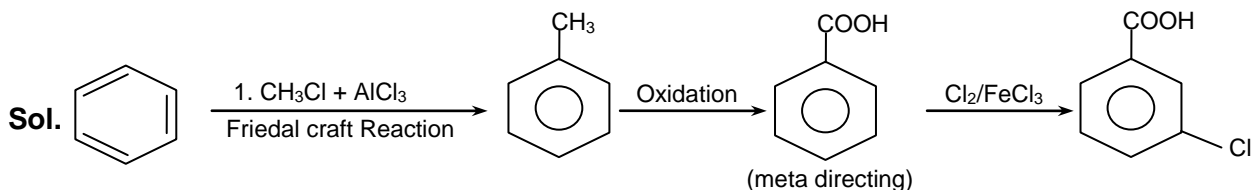
C

24. Which is the major product (P) in the following reaction:



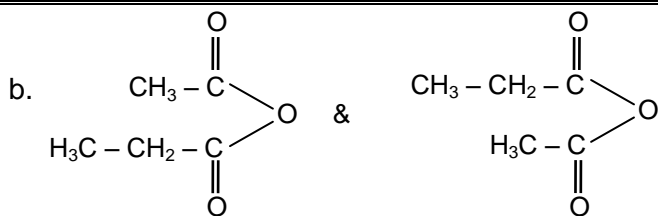
- a.  b.  c.  +  d. 

B



25. Which of the following is a correct match

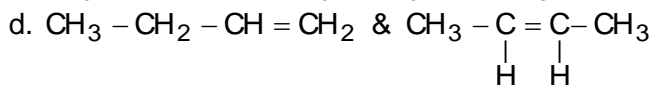
- a. $CH_3 - \overset{O}{\parallel} C - CH_2 - CH_2 - CH_3$ & $H - \overset{O}{\parallel} C - CH_2CH_2 - CH_2CH_3$ Functional Isomer



Metamers



Positional isomer



Stereoisomer

A

Sol. In B, both are identical

26. When but-1-yne is treated with excess of HBr, the expected product is:

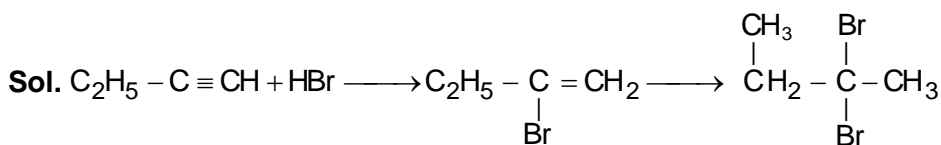
a. 1, 2 - Dibromobutane

b. 2, 2 - Dibromobutane

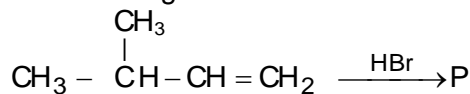
c. 1, 1 - Dibromobutane

d. All the above

B



27. Which of the following is incorrect for following reaction



a. This reaction follows Markovnikoff's rule

b. Carbocation intermediate is formed

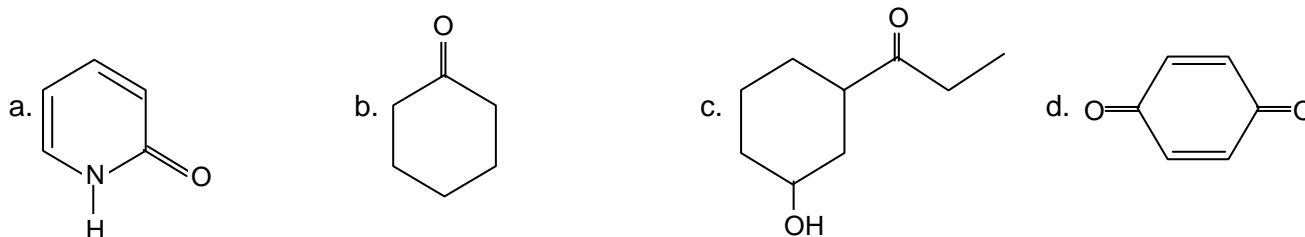
c. Methyl shift is preferred

d. Product is 2-Bromo-2-methylbutane

C

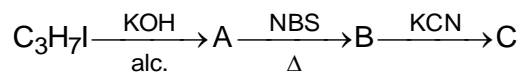
Sol. H^- shift is preferred

28. In which of the following the enol form is dominant over keto form?



A

29. Identify C in the following series



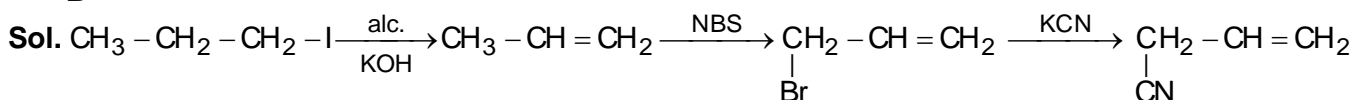
a. $(\text{CH}_3)_2\text{CH} - \text{CN}$

b. $\text{CH}_2 = \text{CH} - \text{CH}_2\text{CN}$

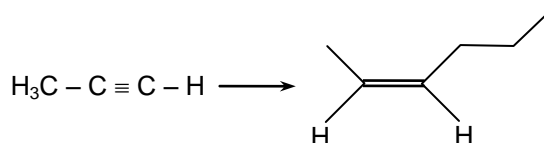
c. $\text{Br} - \text{CH} = \text{CH} - \text{CN}$

d. $\begin{array}{c} \text{CH}_2 = \text{CH} - \text{CHCN} \\ | \\ \text{Br} \end{array}$

B

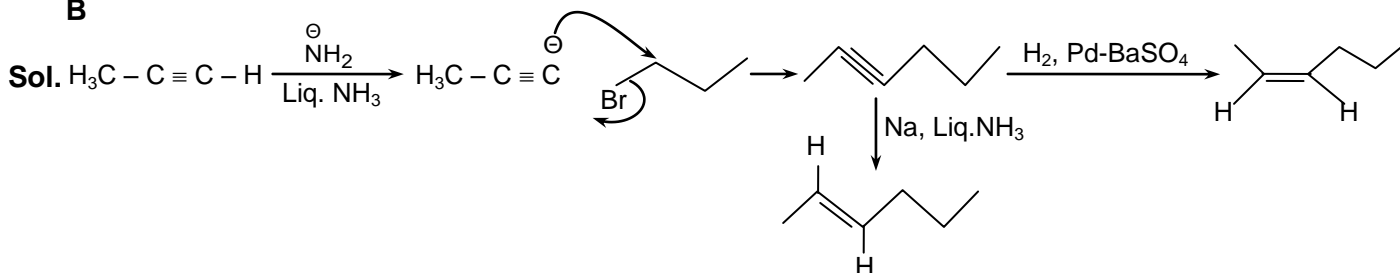


30. Choose the best reagent to carry out the following transformations:



- a. Lindlar catalyst; $\text{NaNH}_2/\text{NH}_3 (\ell)$, 1-bromopropane
 b. $\text{NaNH}_2/\text{NH}_3 (\ell)$, 1-bromopropane; Lindlar catalyst
 c. $\text{NaNH}_2/\text{NH}_3 (\ell)$, 1-bromopropane; $\text{Li}/\text{NH}_3 (\ell)$
 d. All of the above

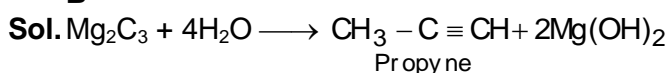
B



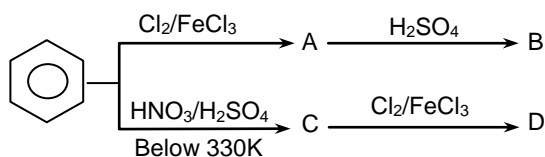
31. Which of the following gives propyne on hydrolysis ?

- a. Al_4C_3 b. Mg_2C_3 c. B_4C d. La_4C_3

B



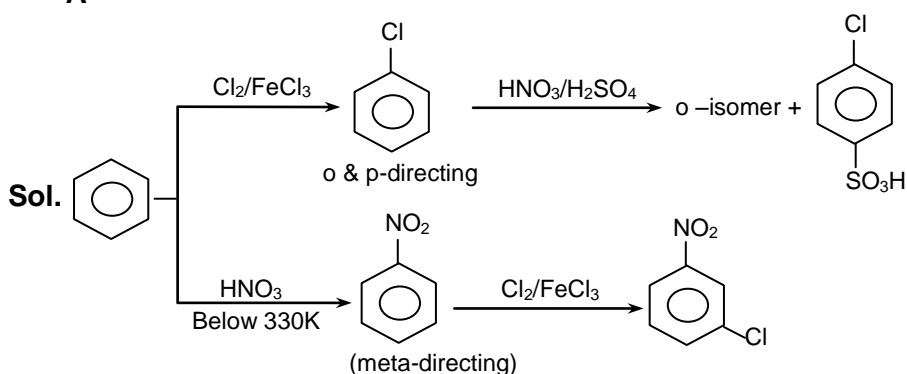
32. Consider the following reaction sequence



In this B and D respectively are

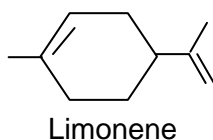
- a. and
- b. and
- c. and
- d. and

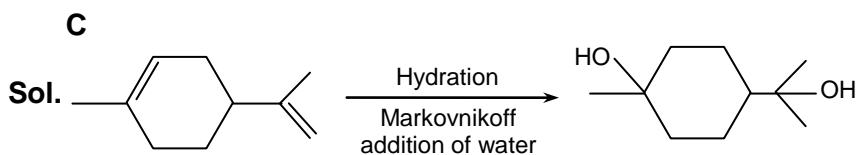
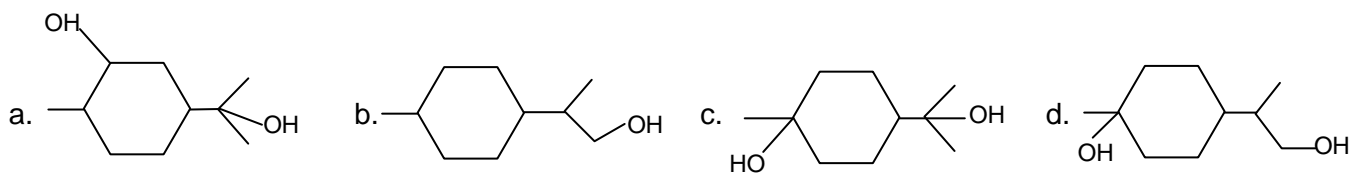
A



Remember : - Cl is o, p-directing while $-\text{NO}_2$ is meta directing group.

33. What product results from the complete Hydration of limonene, (in acidic medium) the structure of which is given below:





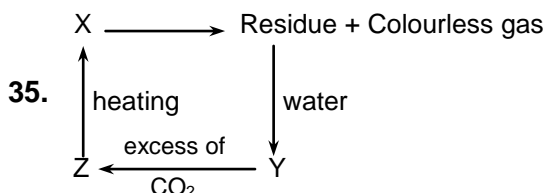
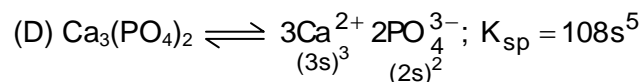
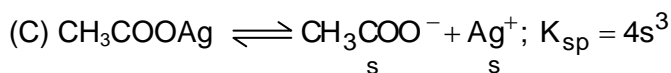
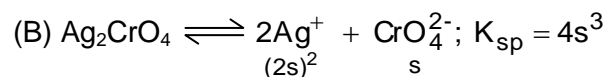
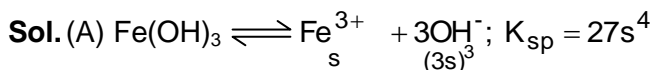
34. Match the column I with column II and mark the appropriate choice.

Column - I		Column - II	
(A)	$\text{Fe}(\text{OH})_3$	(i)	$K_{sp} = s^2$
(B)	Ag_2CrO_4	(ii)	$K_{sp} = 27s^4$
(C)	CH_3COOAg	(iii)	$K_{sp} = 108s^5$
(D)	$\text{Ca}_3(\text{PO}_4)_2$	(iv)	$K_{sp} = 4s^3$

a. (A) \rightarrow (iii), (B) \rightarrow (ii), (C) \rightarrow (iv), (D) \rightarrow (i)
 c. (A) \rightarrow (i), (B) \rightarrow (iii), (C) \rightarrow (ii), (D) \rightarrow (iv)

b. (A) \rightarrow (ii), (B) \rightarrow (iv), (C) \rightarrow (i), (D) \rightarrow (iii)
 d. (A) \rightarrow (iv), (B) \rightarrow (i), (C) \rightarrow (iii), (D) \rightarrow (ii)

B

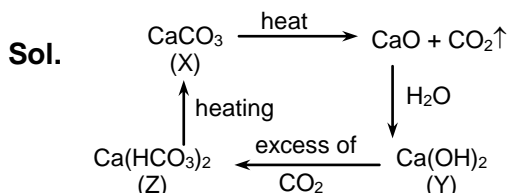


Identify X, Y and Z

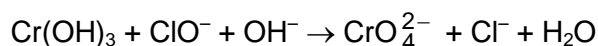
X **Y** **Z**
 a. $\text{Ca}(\text{HCO}_3)_2$ CaCO_3 $\text{Ca}(\text{OH})_2$
 c. CaCO_3 CaO $\text{Ca}(\text{OH})_2$

X **Y** **Z**
 b. CaCO_3 $\text{Ca}(\text{OH})_2$ $\text{Ca}(\text{HCO}_3)_2$
 d. CaCO_3 CaO $\text{Ca}(\text{HCO}_3)_2$

B

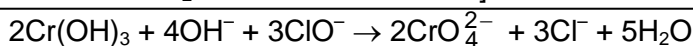
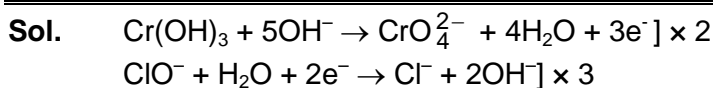


36. The values of coefficients to balance the following reaction are



Cr(OH)₃ **ClO⁻** **CrO₄²⁻** **Cl⁻**
 a. 2 3 3 3
 b. 2 4 3 2
 c. 2 4 4 2
 d. 2 3 2 3

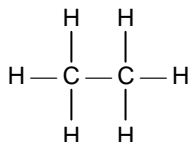
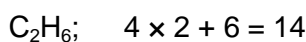
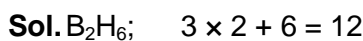
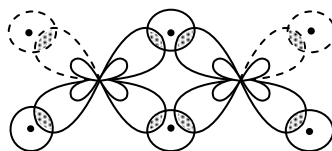
D



37. Select correct statement about B_2H_6 (diborane) and C_2H_6 (ethane)

- B_2H_6 has total 12 valence electrons but C_2H_6 has total 18 valence electrons
- Each compound contains four identical M-H bonds (M = B or C)
- Every sp^3 orbital of central atom in B_2H_6 is associated with H but not so in C_2H_6
- Free rotation around central atoms is possible in both

C



38. Which of the following is an incorrect order of Nucleophilicity?

- $\text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$
- $\text{OH}^- > \text{SH}^- > \text{SeH}^-$
- $\text{OH}^- > \text{H}_2\text{O}$
- $\text{NH}_2^- > \text{NH}_3$

B

39. Which of the following species has $\text{p}\pi - \text{d}\pi$ bonding?

- NO_3^-
- SO_3^{2-}
- BO_3^{3-}
- CO_3^{2-}

B

40. Which of the following orbital will have maximum number of nodes:

- 3s
- 3d
- 4d
- 5s

D

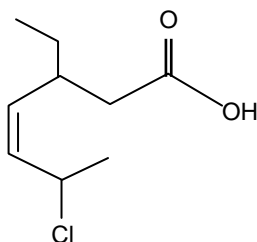
41. In i.e. pyridine.

- lone pair of electron is in conjugation with double bond.
- lone pair of electron is not localized on N – atom
- lone pair of electron is localized on N – atom
- all the double bonds are not in conjugation with each other

C

Sol. In conjugation π bond is given preference over ℓp , +ve charge, -ve charge or odd electron.

42. Which of the following is correct IUPAC naming of given compound?



- 6-Chloro-3-ethylhept-4-enoic acid
- 2-Chloro-5-ethylheptanamide
- 6-Chloro-3-ethylheptane-carboxylic acid
- 1-Hydroxy-6-Chloro-3-ethyl-heptanone

A

43. Elemental analysis of a gaseous hydrocarbon gave the following results: C = 85.6% and H = 14.4%. The weight of 224 mL of the gas at STP was found to be 0.56 g. The molecular formula of the hydrocarbon is

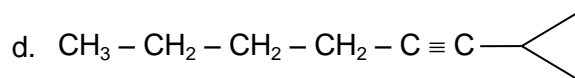
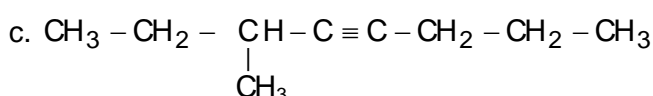
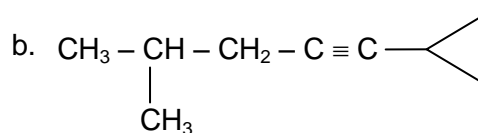
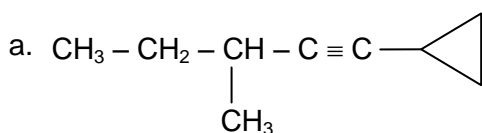
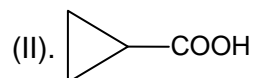
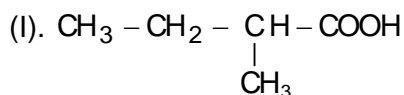
- a. C₄H₈ b. CH₄ c. C₂H₆ d. C₄H₁₀

A

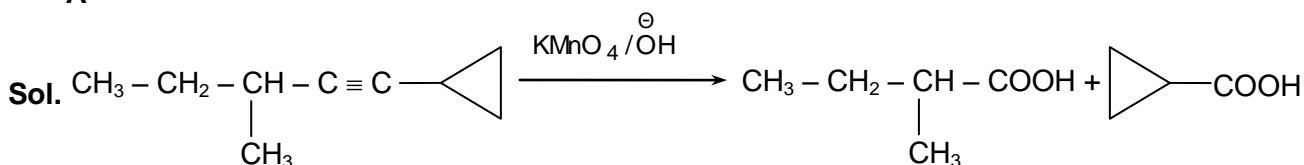
Sol. Empirical formula is CH₂; M.Wt. = $\frac{0.56}{224} \times 22400 = 56$ gm

Molecular formula = (CH₂)₄ = C₄H₈

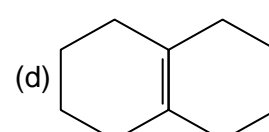
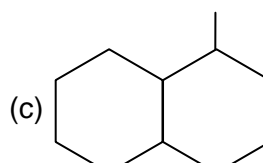
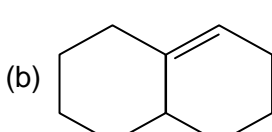
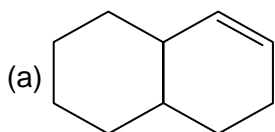
44. Which of the following alkynes will give following two products (I) and (II) on oxidative cleavage with hot $\text{KMnO}_4/\text{OH}^-$?



A



45. Which of the following has the lowest heat of hydrogenation?



D

Sol. Heat of hydrogenation $\propto \frac{1}{\text{stability of alkene}} \propto \frac{1}{\text{hyperconjugation}}$

SECTION – B (Assertion and Reason) Negative Marking [-1]

This Section contains **10 multiple choice questions**. Each question has four choices A), B), C) and D) out of which **ONLY ONE** is correct. **10 × 4 = 40 Marks)**

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true and reason is not correct explanation of assertion
 (c) If assertion is correct but reason is incorrect
 (d) If assertion is incorrect but reason is correct

1. **Assertion:** 3° carbocation $[(\text{CH}_3)_3\text{C}^\oplus]$ is more stable than 2° carbocation $[(\text{CH}_3)_2\text{CH}^\oplus]$ and 2° carbocation is more stable than the 1° carbocation $(\text{CH}_3\text{CH}_2)^\oplus$.

Reason: Greater the number of hyperconjugative structures, more is the stability of carbocation.

- a. (a) b. (b) c. (c) d. (d)

A

Sol. Both assertion and reason are correct and reason is the correct explanation of assertion.

2. **Assertion (A):** In Duma's method, organic compound is heated with CuO and then with Cu.

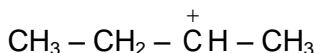
Reason (R) : It is done to avoid the oxidation of organic nitrogen into nitrogen oxides.

- a. (a) b. (b) c. (c) d. (d)

A

Sol. It is method of estimation of nitrogen. Cu is used to convert nitrogen oxide to N_2

3. **Assertion (A):** The intermediate formed in the addition of HCl on 1-butene in the presence of benzoyl peroxide is:



Reason (R) : The H – Cl bond strength is higher than H – Br (which shows peroxide effect) and also H – Cl bond is heterolytically broken & have no peroxide effect

- a. (a) b. (b) c. (c) d. (d)

A

4. **Assertion:** $^\oplus\text{CF}_3$ carbocation is more stable than $\text{F}_3\text{C}-\overset{\oplus}{\text{C}}\text{H}_2$ carbocation.

Reason: $^\oplus\text{CF}_3$ carbocation is more stable due to inductive effect.

- a. (A) b. (B) c. (C) d. (D)

C

5. **Statement – 1:** The hydrogen gas warms up during the joule-Thomson Expansion.

Statement–2: The temperature at which the joule – Thomson co – efficient becomes negative is called joule- Thomson inversion temperature

- a. (A) b. (B) c. (C) d. (D)

C

Sol. The temperature at which the joule – Thomson coefficient becomes zero is called joule – Thomson inversion temperature.

6. **Statement – 1:** Decrease of free energy during the process under constant temperature and pressure provides a measure of its spontaneity.

Statement – 2: A spontaneous change must have +ve sign of ΔS_{system} .

- a. (A) b. (B) c. (C) d. (D)

C

7. **Statement – 1:-** Although PF_5 , PCl_5 and PBr_5 are known, the pentahalides of nitrogen have not been observed.

Statement – 2:- Phosphorus has lower electronegativity than nitrogen.

- a. (A) b. (B) c. (C) d. (D)

B

Sol. Correct explanation: Nitrogen does not form a pentahalide due to non-availability of 2d-subshell in its valency shell.

8. **Statement – 1:-** In change from $\text{PCl}_3 \rightarrow \text{POCl}_3$, the hybrid state of P remains same.

Statement – 2:- d-orbitals are not available for P to expand its octet.

- a. (A) b. (B) c. (C) d. (D)

C

Sol. Hybridisation is same from PCl_3 (sp^3) to POCl_3 (sp^3) and d-orbitals are available for P.

9. **Statement – 1:-** Shielding effect increases as we go down the group.

Statement – 2:- More is the number of electrons in the penultimate shell, more is shielding.

- a. (A) b. (B) c. (C) d. (D)

A

Sol. The phenomenon in which the penultimate shell ($n - 1$) electrons act as screen or shield in between nucleus and valence shell electrons thereby reducing the effective nuclear charge is known as shielding effect.

10. **Assertion:** The ψ_{640} represents an orbital.

Reason: The orbital will be 6 g as its $\ell = 4$

- a. (A) b. (B) c. (C) d. (D)

A

Sol. ψ represents an orbital ψ_{640} means $n = 6$, $\ell = 4$, $m = 0$, i.e., 6 g orbital

SECTION – C (Paragraph Type) Negative Marking [-1]

This Section contains **4 paragraphs**. Each of these questions has four choices A), B), C) and D) out of which **ONLY ONE** is correct. **10 × 4 = 40 Marks**

Comprehension – 1

Intermixing of two or more gases in available space is called diffusion. Diffusion of gas from high pressure to low pressure through an orifice is called effusion.

Effusion time of a gas is directly proportional to the square root of molar mass. Atmolysis is based on difference in rate of effusion of the two gases or isotopes

Rate of diffusion/effusion is experimentally measured

$$\begin{aligned} r &= \frac{\text{Number of moles of gas diffused}}{\text{Time taken}} \\ &= \frac{\text{Volume of gas diffused}}{\text{Time taken}} \\ &= \frac{\text{Decrease in pressure of cylinder}}{\text{Time taken}} \\ &= \frac{\text{Distance travelled by the gas}}{\text{Time taken}} \end{aligned}$$

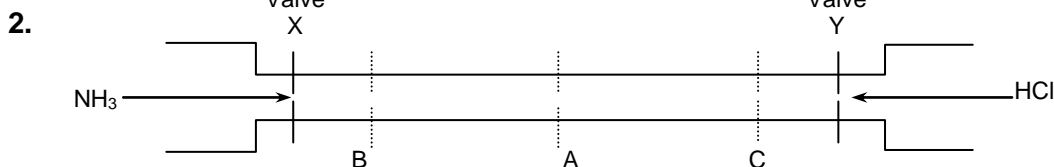
1. 500 mL of methane (CH_4) effusion through a small hole in 48 sec. How much time will be taken by same volume of helium to effuse out of the same orifice?

- a. 192 sec. b. 24 sec c. 12 sec d. 96 sec

B

Sol. $\frac{t_{\text{effuse CH}_4}}{t_{\text{effuse He}}} = \sqrt{\frac{m_{\text{CH}_4}}{m_{\text{He}}}}$

$$\frac{48}{T} = \sqrt{\frac{16}{4}}; T = 24 \text{ sec}$$



In above figure, the valves X and Y are opened simultaneously then white fumes of NH_4Cl will be formed at:

- a. A
b. B
c. C
d. A, B and C simultaneously

C

Sol. $r \propto \frac{1}{\sqrt{m}}$; NH_3 will diffuse faster than HCl hence, fumes of NH_4Cl will be formed near C.

Comprehension – 2

The electrons in an atom occupy atomic orbitals which are represented as the regions around the nuclei where there is a high probability of finding the electrons. Molecular orbital theory is based on the linear combination of atomic orbitals (LCAO) of the atoms constituting the molecule or ion and hence is also called LCAO –MO theory. In this theory; atomic orbitals of the combining atoms get mixed and rearrange themselves to form molecular orbitals. Two atomic orbitals can overlap to form two molecular orbitals; one of which lies at a lower energy level, called bonding molecular orbitals (MBO) and the other at a higher energy level, called antibonding molecular orbital (ABMO). The sequence of the rearrangement of molecular orbitals is determined by the two nuclei and the filling of electron in them follow the Aufbau principle. Each molecular orbital can hold one or two electrons in accordance with Pauli's exclusion principle. The bond order of a molecule or ion is half the number of bonding electrons minus the number of antibonding electrons. Molecular orbital theory can explain the bond length, bond dissociation energy, bond stability and paramagnetism/ diamagnetism of molecules.

3. On the basis of MO theory which one of the following species does not exist?

- a. He_2^{2+} b. Be_2 c. He_2^+ d. Li_2^+

B

4. Which of the following statement is not true for NO & NO^+ ?

- a. NO is paramagnetic & NO^+ is diamagnetic
b. NO^+ is more stable than NO
c. Bond order of NO^+ is 3 but Bond order of NO is 2.5
d. NO has tendency to get reduced

D

5. Which of the following statement is/are correct?

- (i) The peroxide ion has a bond order of 1 while the oxygen molecule has a bond order of 2
(ii) The peroxide ion has a weaker bond than the dioxygen molecule has
(iii) The peroxide ion as well as the dioxygen molecule are paramagnetic
(iv) The bond length of the peroxide ion is greater than that of the dioxygen molecule

Correct option is:

- a. i, ii, iii b. i, ii, iv c. i, iii, iv d. all

B

6. Match the ionization processes listed in column-I with the changes observed as listed in column-II. For this use the codes given below:

Column – I

- a. $N_2 \longrightarrow N_2^+$
 b. $O_2^+ \longrightarrow O_2^{2+}$
 c. $B_2 \longrightarrow B_2^+$
 d. $NO^- \longrightarrow NO$

Column – II

- (p) Bond order increases and magnetic property is changed
 (q) Bond order decreases and magnetic property is not changed
 (r) Bond order increases and magnetic property is not changed
 (s) Bond order decreases and magnetic property is changed

Note: Here change in magnetic property refers to change from diamagnetic to paramagnetic or paramagnetic to diamagnetic.

- a b c d**
 a. s p r q
 c. r q s p

- a b c d**
 b. s p q r
 d. p s q r

B

Sol. (a) $N_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$

B.O. = $\frac{10-4}{2} = 3$; $n = 0$ (D)

$N_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^1$

B.O. = $\frac{9-4}{2} = 2.5$; $n = 1$ (P)

(b) $O_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^0$

B.O. = $\frac{10-5}{2} = 2.5$; $N = 1$ (p)

$O_2^{2+} = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^0 = \pi^* 2p_y^0$

B.O. = $\frac{10-4}{2} = 3$; $n = 0$ (D)

(c) $B_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^1 = \pi 2p_y^1$

B.O. = $\frac{6-4}{2} = 1$; $n = 2$ (P)

$B_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^1 \sigma 2p_z^0$

B.O. = $\frac{5-4}{2} = 1/2$; $n = 1$ (P)

(d) $NO^- = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^1$

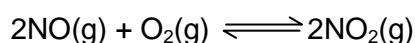
B.O. = $\frac{10-6}{2} = 1.0$; $n = 2$ (P)

$NO = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2s_x^1 = \pi^* 2p_y^0$

B.O. = $\frac{10-5}{2} = 2.5$; $n = 1$ (P)

Comprehension – 3

Question 7 and 8 should both be answered with reference to this reaction, for which ΔH° is negative.



7. Which would increase the partial pressure of $NO_2(g)$ at equilibrium?

- (a) Decreasing the volume of the system
 (b) Adding a noble gas to increase the pressure of the system
 (c) Removing some $NO(g)$ from the system
 (d) Adding an appropriate catalyst

A

8. At a certain temperature the equilibrium concentration for this system are :
 $[NO] = 0.52M$; $[O_2] = 0.24M$; $[NO_2] = 0.18M$.
 What is the value of K_C at this temperature?

- (a) 0.063 (b) 0.50 (c) 1.4 (d) 2.0
B

Sol. $K_C = \frac{0.18^2}{0.24 \times 0.52^2} = 0.50$

Comprehension – 4

Estimation of halogens :

Carius method : A known mass of compound is heated with conc. HNO_3 in the presence of $AgNO_3$ contained in a hard glass tube known as Carius tube in a furnace. C and H are oxidised to CO_2 and H_2O . The halogen forms the corresponding AgX . It is filtered, dried and weighed.

Estimation of sulphur : A known mass of compound is heated with fuming HNO_3 or sodium peroxide (Na_2O_2) in the presence of $BaCl_2$ solution in Carius tube. Sulphur is oxidised to H_2SO_4 precipitated as $BaSO_4$. It is filtered, dried and weighted.

$$\text{Percentage of S} = \frac{\text{Atomic mass of S}}{\text{Molecular mass of BaSO}_4} \times \frac{\text{Mass of BaSO}_4 \times 100}{\text{Mass of compound}}$$

9. 0.15 gm of an organic compound gave 0.12 gm of silver bromide by the Carius method. Find the percentage of bromine in the compound. [A.Wt. of Ag = 108; A.wt of Br = 80]
 a. 34.0 b. 40 c. 17 d. 68

A

Sol. $\frac{0.12}{188} \times \frac{80}{0.15} \times 100 = 34\%$

10. 0.2595 gm of an organic substance when treated by Carius method gave 0.35gm of $BaSO_4$. Calculate the percentage of sulphur in the compound. [M.Wt. of $BaSO_4 = 233$]

- a. 9 b. 30.4 c. 18.52 d.40.52

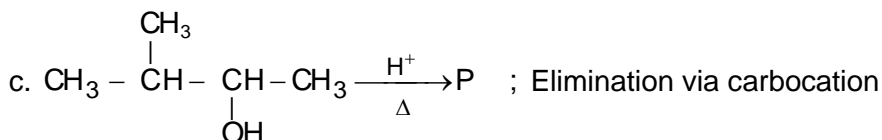
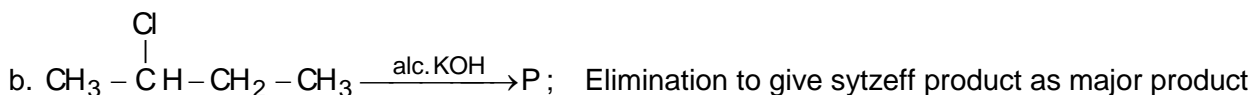
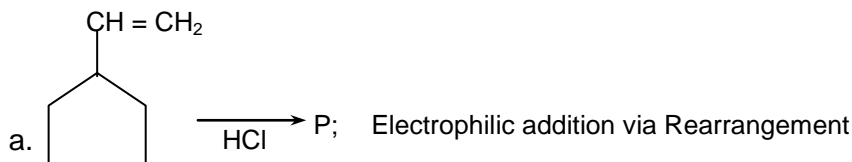
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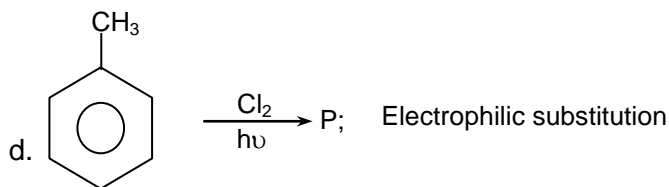
Sol. $\frac{0.35}{233} \times \frac{32}{0.2595} \times 100 = 18.52\%$

SECTION – D (More than One Answer) No Negative Marking

This Section contains **10 questions**. Each question has four choices A), B), C) and D) out of which **ONE OR MORE** may be correct. **(10 × 5 = 50 Marks)**

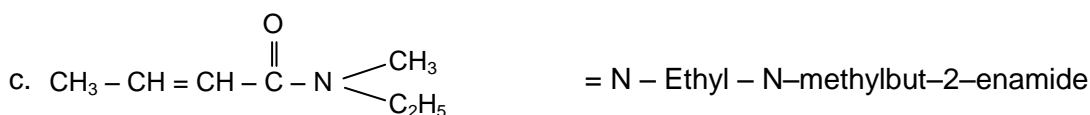
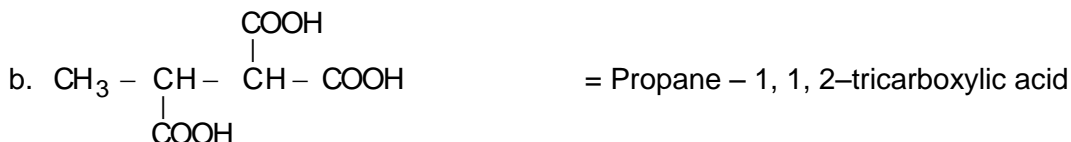
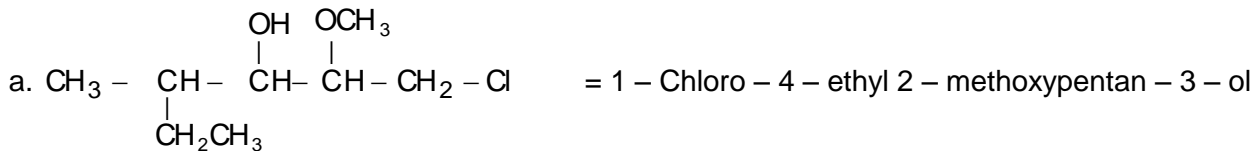
1. Which of the following is a correct match.





A,B,C

2. How many are not correctly matched:



A,D

Sol. (a) 1-chloro-2-methoxy-4-methylhexan-3-ol

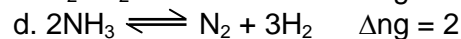
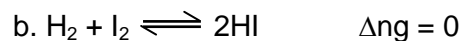
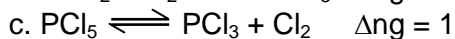
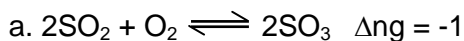
(d) 2-methyl-4-oxopentane nitrile

3. Which are heavier than dry air:

- a. Moist air b. Sulphur dioxide c. Chlorine d. Oxygen

B,C,D

4. $\log \frac{K_p}{K_c} + \log \frac{1}{RT} = 0$ is not possible for



A,B,D

Sol. $\log \frac{K_p}{K_c} + \log \frac{1}{RT} = 0$

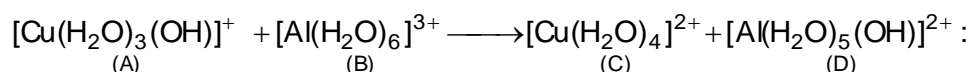
$$\log \frac{K_p}{K_c} = -\log \frac{1}{RT}$$

$$\log \frac{K_p}{K_c} = \log RT$$

$$\frac{K_p}{K_c} = (RT)^1$$

$$\Delta n_g = 1$$

5. In the following reaction,



- a. (A) is an acid and (B) is a base
- b. (A) is a base and (B) is an acid
- c. (C) is conjugate acid of (A) and (D) is the conjugate base of (B)
- d. (C) is the conjugate base of (A) and (D) is the conjugate acid of (B)

B,C

6. Which of the following will act as Buffer:

- a. 100 ml 0.1 M H_3PO_4 + 50 ml 0.1 M NaOH
- b. Borax in water
- c. 20 ml 0.1 M HCN + 10 ml 0.1 M CH_3COOH
- d. 10 mole NH_3 + 2 mole HCl in a solution

A,B,D

7. When ice melts at 1°C :

- a. an increase in entropy
- b. a decrease in enthalpy
- c. a decrease in free energy
- d. process is spontaneous

A,C,D

8. Which of the following is the correct order as indicated.

- a. $\text{XeF}_6 < \text{XeF}_4 < \text{XeF}_2$ [increasing number of lone pair on central atom]
- b. $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$ [increasing Acidic strength]
- c. $\text{SO}_3 < \text{SO}_2 < \text{CO}_2$ [increasing Bond angle]
- d. $\text{XeF}_2 < \text{XeO}_2\text{F}_2 < \text{XeO}_3$ [increasing number of hybrid orbitals on central atom]

A,B

Sol. Bond angle of SO_3 is more than SO_2

9. Which of the following set of quantum numbers are correct

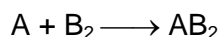
- a. $n = 2, \ell = 1, m = 0, s = +1/2$
- b. $n = 4, \ell = 3, m = -2, s = -1/2$
- c. $n = 3, \ell = 2, m = -3, s = +1/2$
- d. $n = 4, \ell = 3, m = -3, s = +1/2$

A,B,D

Sol. A = 2p; B = 4d; D = 4f

C is not correct as m can't have value more than 2

10. In the reaction:



Find out in which option(s) B_2 is limiting reagent.

[Molar mass: $M_A = 10 \text{ g mole}^{-1}$, $M_B = 20 \text{ g mol}^{-1}$]

- a. 300 atoms of A + 200 molecules of B_2
- b. 2 mole A + 3 gram-atom of B
- c. 100 mole A atoms + 100 mole B atoms
- d. 5 gram-atom of A + 12.5 gram molecule of B_2

A,B,C

Sol. $\text{A} + \text{B}_2 \rightarrow \text{AB}_2$

(a) 100 atom of A will be left unused

(b) 2 mole A & 1.5 mol B_2 (c) 100 mole A & 50 mol B_2 (d) 5 mol A & 12.5 mol B

SECTION – E (Matrix Type) No Negative Marking

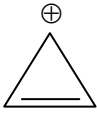
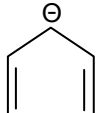
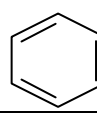
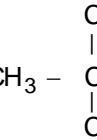
This Section contains **3 questions**. Each question has four choices (A, B, C and D) given in **Column I** and five statements (p, q, r, and s) in **Column II**. **(3 × 8 = 24 Marks)**

1. Match Column – I with Column – II. [More than one Match]

Column – I		Column – II	
(A)	Expansion of Ideal gas at Isothermal condition	(p)	$\Delta H = 0$ [enthalpy change of system]
(B)	Adiabatic expansion of a gas	(q)	$\Delta S = 0$ [entropy change]
(C)	Cyclic process	(r)	$\Delta H \neq 0$
(D)	In a chemical reaction	(s)	$\Delta U = 0$ [internal energy change]

Sol. A → p, s; B → q, r; C → p, q, s; D → r

2. Match column – I with Column – II

Column – I		Column - II	
(A)		(P)	Maximum +I effect
(B)		(Q)	All carbon atoms are sp ² -hybridised
(C)		(R)	Aromatic
(D)		(S)	Diamagnetic

Sol. A → Q, R, S; B → Q, R, S; C → Q, R, S; D → P, S

3. Match the following columns:

Column – I		Column – II	
(a)	3 mole of $\text{Co}(\text{NH}_3)_4\text{SO}_4$	(p)	3 mole of S atom
(b)	1 mole $\text{FeKCo}(\text{NO}_2)_6$	(q)	1 mole Fe
(c)	1.5 mole $[\text{Fe}(\text{H}_2\text{O})_5\text{SCN}]\text{SO}_3$	(r)	12 mole O atoms
(d)	0.75 mole $\text{K}_2\text{Cu}(\text{SCN})_4$	(s)	6 mole N atoms
		(t)	1.5 mole K atoms

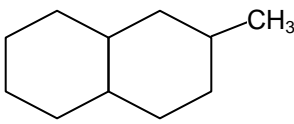
Sol. A → p, r; B → q, r, s; C → p, r; D → p, t

1 mole	Fe	K	Co	$(\text{NO}_2)_6$
	↓	↓	↓	↓ ↓
	1	1	1	6 12

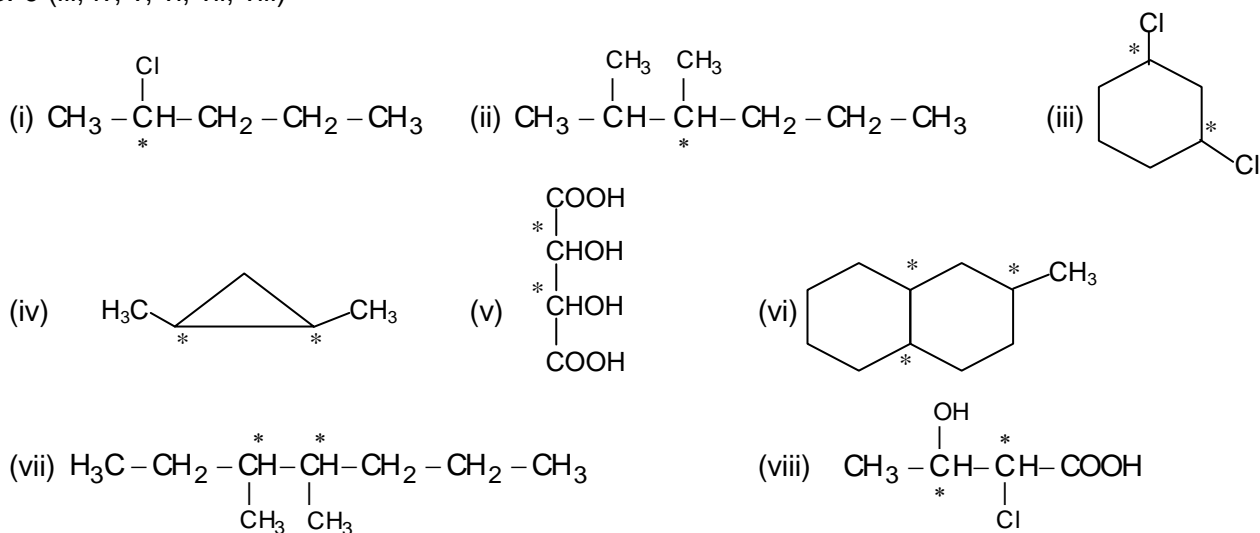
SECTION – F (Integer Type) No Negative Marking

This Section contains **10 Questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 10. **10 × 4 = 40 Marks**

1. How many of the following have more than one chiral carbon.

1.	2 – Chlorohexane
2.	1,2 – Dimethylhexane
3.	1, 3 – Dichlorocyclohexane
4.	2,3 – Dimethyl cyclopropane
5.	Tartaric Acid
6.	
7.	3, 4-Dimethyl heptane
8.	2-Chloro -3-hydroxybutanoic acid

Ans. 6 (iii, iv, v, vi, vii, viii)



2. A system undergoes a process in which $\Delta E = +300 \text{ J}$ while absorbing 400 J of heat energy and undergoing an expansion against 0.5 bar . What is the change (approximate) in the volume (in L)?

Sol. 2

$$\Delta E = q + w; 300 = 400 + W;$$

$$\begin{aligned} W &= -100 \text{ J} \\ &= \frac{-100}{101.3} \text{ lit. atm} \end{aligned}$$

$$P\Delta V = -W; \Delta V = \frac{W}{P} = \frac{100}{0.5 \times 101.3} \approx 2$$

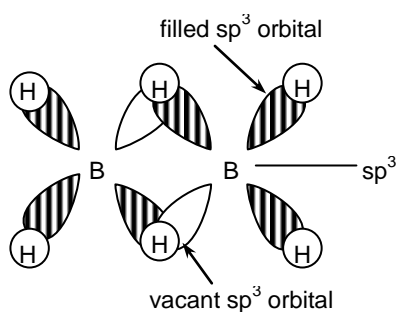
3. The percentage hydrolysis of $M/160 \text{ KCN}$ solution at 25°C will be (Given for HCN , $K_a = 6.4 \times 10^{-10}$)

Sol. 5

$$\begin{aligned} h &= \sqrt{\frac{K_w}{K_a c}} = \sqrt{\frac{10^{-14}}{6.4 \times 10^{-10} \times 1/160}} \\ &= \sqrt{\frac{10^{-14} \times 160}{6.4 \times 10^{-10}}} = \sqrt{25 \times 10^{-4}} = 5 \times 10^{-2} \\ &= 0.05 = 5\% \end{aligned}$$

4. The number of vacant hybrid orbitals which participate in the formation of 3-centre 2 electron bonds (banana bonds) in diborane structure is:

Sol.2

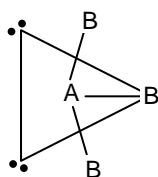


No of vacant sp^3 hybrid orbitals participating in the formation of banana bonds are 2.

5. A σ bonded molecule AB_3 has T-shaped geometry. The number of lone pair of electrons on the central atom A is:

Sol.2

If the central atom in AB_3 molecule has 2 lone pairs of electrons, it will have T-shaped geometry



6. The number of B – O – B bonds in borax is

Sol.5

7. Which of the following statement is not correct for Lithium

- Lithium has highest oxidation potential
- Lithium always form ionic compound
- Lithium form stable peroxide & superoxide
- $LiNO_3$ on heating give Brown gas NO_2
- Lithium carbonate is thermally stable
- Lithium does not show photoelectric effect
- Lithium give yellow colour in flame
- Lithium has lowest density in its group
- Lithium form both oxide and nitride when burn in air like Mg.
- Lithium ion has highest hydration energy in its gp

Sol.4 (b, c, e, g)

- Li form ionic as well as covalent compound
- Li form stable oxide
- Li carbonate is thermally unstable
- Li give red colour in flame

8. Choose the number of correct order according to indicated property

- $Na^+ < K^+ < Rb^+ < Cs^+$ Hydration energy
- $NaCl < KCl < RbCl < CsCl$ Conductance of salt solution
- $HI < HBr < HCl < HF$ Bond strengths

- (d) Cs < Rb < Na < K < Li M.pt.
(e) Li < Na < K < Rb < Cs Softness
(f) NaOH < KOH < RbOH < CsOH Basic strength
(g) BeO < MgO < CaO < BaO Solubility
(h) Li < Na < K < Rb < Cs I.E.

Sol. 5 (b, c, e, f, g)

9. In how many of the following compound one of the atom is present in highest oxidation state. Excluding (hydrogen; oxygen)

H₂SO₄; H₃PO₄; HNO₃; HCl; NH₃; SF₆; N₂O₅

Sol. 5 (H₂SO₄; H₃PO₄; HNO₃; SF₆; N₂O₅)
 (+6) (+5) (+5) (+6) (+5)

10. What is the degeneracy of the level of the hydrogen atom that has the energy $-\frac{R_H}{9}$

Sol. 9

Degeneracy is the No. of orbital with same energy. In H-like system, energy of all orbital of same shell is same. It is 3rd shell.