SECTION 1 Multiple Choice Question (MCQ)

- This section contains **TEN (10)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, darken the bubble corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : $+3$ If **ONLY** the bubble corresponding to the correct option is darkened.
Zero Marks : 0 If none of the bubble is darkened (i.e., the question is unanswered).
Negative Marks : -0.75 In all other cases.

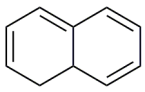
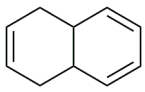
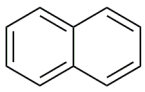
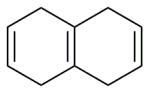
Q.1 *The reaction that is accompanied by increase in the enthalpy is*

(A) $H_2O(l) \rightarrow H_2O(v)$
(B) $H_2O(l) \rightarrow H_2O(s)$
(C) $CO_2(g) \rightarrow CO_2(l)$
(D) $CO_2(g) \rightarrow CO_2(s)$

Q.2 *ΔG for the reaction $P \rightarrow Q$ is 4 kJ mol^{-1} whereas ΔG for the reaction $Q \rightarrow R$ is $-$ 6 kJ mol^{-1}. The correct statement is*

(A) The reaction P → Q is spontaneous, and the reaction Q → R is nonspontaneous.
(B) The reaction P → Q is nonspontaneous, and the reaction P → R is nonspontaneous.
(C) The reaction Q → R is spontaneous, and the reaction P → R is nonspontaneous.
(D) The reaction P → Q is nonspontaneous, and the reaction P → R is spontaneous.

Q.3 *The aromatic compound is*

(A) 
(B) 
(C) 
(D) 

Q.4 *The reaction of ethyl benzoate with aqueous sodium hydroxide (NaOH) gives*

(A) benzyl alcohol and acetic acid
(B) sodium benzoate and ethanol
(C) phenol and acetic acid
(D) benzene and ethyl acetate

Q.5 *The reaction that represents hydrogenation is*

(A)

(B)

(C)

(D)

Q.6 *The highest viscosity would be observed in*

(A) $HOCH_2CH(OH)CH_2OH$
(B) $CH_3CH_2OCH_2CH_3$
(C) CH_3CH_2OH
(D) H_3COCH_3

Q.7 *An example of sublimation is*

(A) the white powder deposited by a CO_2 fire extinguisher
(B) butter that is left out in the sun turning to liquid
(C) moth (naphthalene) balls shrink and disappear
(D) snow melting and then evaporating on a warm winter day

Q.8 *Galvanizing refers to the process of protecting metals from corrosion by coating them with*

(A) chromium
(B) zinc
(C) paint
(D) tin

Q.9 *The Pauli exclusion principle*

(A) describes the size of an orbital
(B) describes the shape of an orbital
(C) describes the orientation of an orbital in space
(D) limits the number of electrons in an orbital to two

Q.10 *If the electronegativity (on Pauling scale) of carbon is 2.5, the electronegativity of boron and nitrogen would*

(A) both be greater than 2.5
(B) be lower and higher than 2.5, respectively
(C) be higher and lower than 2.5, respectively
(D) both be lower than 2.5

SECTION 2 SDI

- This section contains **TEN (10)** questions.
- The answer to each question is a **SINGLE DIGIT NON-NEGATIVE INTEGER (SDI)**.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +4 If **ONLY** the bubble corresponding to the correct answer is darkened.
  Zero Marks : 0 In all other cases.

Q.11 *For a first order reaction R ⟶ P, the concentration of R becomes 1/8th of its initial concentration in 24 hours. The half-life ($t_{1/2}$) of the reaction (in hours) is _____.*

Q.12 *Consider the following reactions and corresponding enthalpy changes (ΔH);*
$A + B \rightarrow 2C;\ \Delta H = 3\ kJ\ mol^{-1}$
$C \rightarrow D;\ \Delta H = 2\ kJ\ mol^{-1}$
The $\Delta H\ (in\ kJ\ mol^{-1})$ for the reaction, $A + B \rightarrow 2D$, under the same conditions is _____.

Q.13 *For a reaction P ⇌ Q taking place in a 1 L vessel, the equilibrium constant (K_c) is 0.5. If the reaction starts with 6 moles of P and no Q, the number of moles of P at equilibrium is _____.*

Q.14 *The total number of isomeric alkanes of the molecular formula C_5H_{12} is _____.*

Q.15 *When one mole of benzene (C_6H_6) is treated with one mole of ethyl chloride (CH_3CH_2Cl) in the presence of anhydrous aluminum chloride ($AlCl_3$), a major product **X** is formed. The total number of sp^3 hybridized carbon atoms in the compound **X** is _____.*

Q.16 *The reaction of one mole of acetophenone ($PhCOCH_3$) with one mole of phenyl magnesium bromide (PhMgBr) followed by treatment with water (acidic) gives product **P**. The total number of phenyl groups in **P** is _____.*

Q.17 *The number of neutrons in an atom of ^{13}C is _____.*

Q.18 *Consider the following unbalanced equation, $HNO_3(aq) \rightarrow NO_2(g) + H_2O(l) + O_2(g)$. The stoichiometric coefficient of O_2 in the balanced chemical equation is _____.*

Q.19 *The number of significant figures in 1400.00650 meter is _____.*

Q.20 *The maximum possible number of electrons in the second shell of an atom is _____.*

SECTION 3: Paragraph based MCQ

- This section contains **FIVE (05)** paragraphs.
- Based on each paragraph, there are **TWO (02)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : $+3$ If **ONLY** the bubble corresponding to the correct answer is darkened.
Zero Marks : 0. If none of the bubble is darkened (i.e., the question is unanswered).
Negative Marks : -0.75 In all other cases.

PARAGRAPH I

When 2 moles of $AgNO_3$ are mixed with 0.5 mole of NaCl, the reaction goes to completion and a precipitate of AgCl is formed.

Q.21 *The amount of AgCl (in mole) formed is*

(A) 1 (B) 0.5
(C) 2 (D) 2.5

PARAGRAPH I

When 2 moles of $AgNO_3$ are mixed with 0.5 mole of NaCl, the reaction goes to completion and a precipitate of AgCl is formed.

Q.22 *In water, the solubility of AgCl (in mol L^{-1}) is close to*
[$The\ solubility\ product\ constant\ (K_{sp})\ of\ AgCl\ is\ 1.8 \times 10^{-10}$]

(A) 1.3×10^{-5} (B) 1.8×10^{-10}
(C) 1.4×10^{-2} (D) 5×10^{-1}

PARAGRAPH II

Among other nuclear reactions, the two types of spontaneous decays are
(i) *emission of alpha particles that are He^{2+} ions and*
(ii) *emission of beta particles that are electrons.*

Q.23 *The alpha decay of $^{234}_{92}U$ gives*

(A) $^{230}_{90}U$ (B) $^{238}_{94}Pu$
(C) $^{232}_{88}Ra$ (D) $^{230}_{90}Th$

PARAGRAPH II

Among other nuclear reactions, the two types of spontaneous decays are
(i) *emission of alpha particles that are He^{2+} ions and*
(ii) *emission of beta particles that are electrons.*

Q.24 *A nuclear reaction that results in the decrease in the neutron-to-proton ratio is*

(A) alpha emission
(B) beta emission
(C) gamma emission
(D) positron emission

PARAGRAPH III

Towards the end of the 19th century, a Swiss high school teacher, Johann Balmer, found an empirical equation that describes the spectrum of the hydrogen atom in the visible region

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{2^2} - \frac{1}{n^2}\right) m^{-1}$$

where λ is the transition wavelength and n = 3, 4, 5, …

Q.25 *The wavelength (in nm) of the line in the spectrum of the hydrogen atom for which n = 3, is closest to*

(A) 656
(B) 378
(C) 518
(D) 434

PARAGRAPH III

Towards the end of the 19th century, a Swiss high school teacher, Johann Balmer, found an empirical equation that describes the spectrum of the hydrogen atom in the visible region

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{2^2} - \frac{1}{n^2}\right) m^{-1}$$

where λ is the transition wavelength and n = 3, 4, 5, …

Q.26 *The green line at 486 nm results from the electron falling from the energy level having n equal to*

(A) 7
(B) 4
(C) 5
(D) 6

PARAGRAPH IV

A solution that has same concentration of hydrogen ions and hydroxide ions as pure water is called a neutral solution. A solution that has higher concentration of hydrogen ions (lower concentration of hydroxide ions) than pure water is called an acidic solution. A solution that has lower concentration of hydrogen ions (higher concentration of hydroxide ions) than pure water is called a basic solution.

Q.27 *When 50 mL of 0.1 M aqueous HCl is titrated with 0.2 M aqueous solution of NaOH, the volume (in mL) of aqueous NaOH needed to achieve neutral solution is*

(A) 50
(B) 25
(C) 75
(D) 100

PARAGRAPH IV

A solution that has same concentration of hydrogen ions and hydroxide ions as pure water is called a neutral solution. A solution that has higher concentration of hydrogen ions (lower concentration of hydroxide ions) than pure water is called an acidic solution. A solution that has lower concentration of hydrogen ions (higher concentration of hydroxide ions) than pure water is called a basic solution.

Q.28 *When a weak acid is titrated with a strong base, the solution at the equivalence point is*

(A) neutral
(B) acidic
(C) basic
(D) depends on acid dissociation constant (K_a) of the acid

PARAGRAPH V

*Propene reacts with water in the presence of few drops of sulphuric acid and gives 2-propanol. The reaction of 2-propanol with chromium trioxide (CrO_3) gives product **P** having molecular formula C_3H_6O.*

Q.29 *The formation of 2-propanol from propene is*

(A) addition reaction
(B) elimination reaction
(C) substitution reaction
(D) condensation reaction

PARAGRAPH V

*Propene reacts with water in the presence of few drops of sulphuric acid and gives 2-propanol. The reaction of 2-propanol with chromium trioxide (CrO_3) gives product **P** having molecular formula C_3H_6O.*

Q.30 *The functional group present in product **P** is*

(A) alcohol
(B) ether
(C) aldehyde
(D) ketone