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 <u>according to the following marking scheme</u>:

  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   *Among the following molecules, the one that is NOT aromatic is*

(A) naphthalene.   (B) pyridine.
(C) cyclopentadiene.   (D) benzene.

Q.2   *The molecule that contains the most acidic proton is*

(A) benzene.   (B) ethylene.
(C) acetylene.   (D) cyclopentane.

Q.3   *Among the following amines, the one that is NOT a tertiary amine is*

(A) propane-2-amine.   (B) trimethylamine.
(C) *N,N*-diethylisopropylamine.   (D) *N,N*-dimethylethylamine.

Q.4   *If surface tension of water at 25 °C is 72.0 mN m^{-1}, then its surface tension at 90 °C will be*

(A) lower than 72.0 mN m^{-1}.   (B) higher than 72.0 mN m^{-1}.
(C) equal to 72.0 mN m^{-1}.   (D) equal to zero.

Q.5   *Among the ground state electronic configuration of elements, the correct one is*

Q.6   *The process which results in an increase in atomic number is*

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

Q.7   *The INCORRECT statement regarding accuracy and precision, is*

(A) Repeatability of measurements is called precision.
(B) Correctness of measurements is called accuracy.
(C) If a measurement is precise, then it is also accurate.
(D) To get good precision, a scientist tries to repeat the measurement in exactly the same way each time.

Q.8   *The unit of rate constant for a first order reaction is*

(A) $mol\ L^{-1}s^{-1}$
(B) $mol^{-1}L\ s^{-1}$
(C) $mol^{-2}L^2s^{-1}$
(D) s^{-1}

Q.9   *The heat absorbed/released by the system is zero for an*

(A) isothermal process
(B) adiabatic process
(C) isochoric process
(D) isobaric process

Q.10   *The reaction that is accompanied by an increase in entropy is*

(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
(B) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
(C) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
(D) $3C_2H_2(g) \rightarrow C_6H_6(g)$

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 <u>according to the following marking scheme</u>:
  Full Marks : $+4$ If **ONLY** the bubble corresponding to the correct answer is darkened.
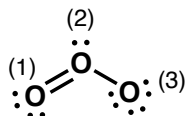 *Zero Marks* :   0 In all other cases.

Q.11   *The maximum number of possible alkenes that can be obtained from acid-catalyzed dehydration of the following molecule is _____.*
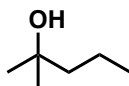
Q.12   *The total number of sp2 hybridized carbon atoms present in the following molecule is _____.*
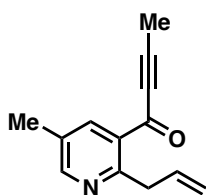
Q.13   *The Lewis dot structure of O_3 is shown below:*

The formal charge on the oxygen atom labelled as (1) is _____.

Q.14   *Consider the following four anions: sulphide, nitrate, sulphite, and carbonate. Among them, the total number of anions that would give colorless gases during their preliminary tests with dilute H_2SO_4 is _____.*

Q.15   *For the reaction $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$ at temperature T, the difference between change in the enthalpy (ΔH) and change in the internal energy (ΔU), "$\Delta H - \Delta U$", is $-x \times RT$. The value of x is _____. (R is the universal gas constant and gases can be considered to be ideal)*

Q.16   *The coefficient of the permanganate ion when the following equation is balanced, is _____.*
$$MnO_4^- + Br^- + H^+ \rightarrow Mn^{2+} + Br_2 + H_2O$$

Q.17   *There are _____ significant figures in 0.06030*

Q.18   *For a reaction, the plot of $\ln k$ versus $1/T$ yields slope equals to –4 (in K). If the activation energy (in J mol^{-1}) of the reaction is $x \times R$, the value of x is _____. (R is the universal gas constant in J K^{-1} mol^{-1})*

Q.19   *At a given temperature, the ratio of root mean square speeds of gaseous H$_2$ and O$_2$, $\frac{v_{rms}(H_2)}{v_{rms}(O_2)}$, is _____. [Molar masses (in g mol^{-1}): H$_2$ = 2, O$_2$ = 32]*

Q.20   *The enthalpy of sublimation and enthalpy of fusion of an element X(s) are 10 kJ mol^{-1} and 3 kJ mol^{-1}, respectively. The enthalpy of vaporization (in kJ mol^{-1}) of X(l) 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 <u>according to the following marking scheme</u>:
  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

4 moles of P undergo reaction to give 4 moles of Q at equilibrium in a 1 L container according to the reaction (no Q is present in the beginning of the reaction)

$$P(g) \rightleftharpoons 2\,Q(g)$$
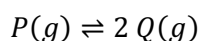
Q.21   *If the rate of consumption of P is 1 mol $L^{-1} s^{-1}$, the rate of formation (in mol $L^{-1} s^{-1}$) of Q is*

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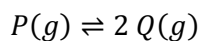

PARAGRAPH I

4 moles of P undergo reaction to give 4 moles of Q at equilibrium in a 1 L container according to the reaction (no Q is present in the beginning of the reaction)

$$P(g) \rightleftharpoons 2\,Q(g)$$

Q.22   *The equilibrium constant (K_c) for the reaction is*

   (A) 2   (B) 4   (C) 8   (D) 16

PARAGRAPH II

*The solubility product constant, K_{sp}, of a sparingly soluble halide salt **MX** is 1×10^{-10} at 300 K.*

Q.23   *At 300 K, the solubility (in mol L^{-1}) of the salt **MX** in the presence of 0.1 M NaX is*

   (A) 1×10^{-5} (B) 1×10^{-6}
   (C) 1×10^{-8} (D) 1×10^{-9}

PARAGRAPH II

*The solubility product constant, K_{sp}, of a sparingly soluble halide salt **MX** is 1×10^{-10} at 300 K.*

Q.24   *The solubility (in mol L^{-1}) of the salt **MX** at 300 K is*

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

PARAGRAPH III

Titration between oxalic acid dihydrate (a diprotic acid, hereafter referred to as OA) and sodium hydroxide is a typical acid-base titration. Phenolphthalein is used as an indicator. The appearance of a permanent light pink color indicates the end point. This titration method helps in determining the unknown concentration of sodium hydroxide using a standard OA solution. (Molar mass of OA = 126 g mol^{-1})

Q.25   *A titration of 20 mL of 0.1 M solution of OA consumed 16 mL of sodium hydroxide solution. The concentration (in M) of this sodium hydroxide solution is*

(A) 0.250   (B) 0.125   (C) 0.0625   (D) 0.160

PARAGRAPH III

Titration between oxalic acid dihydrate (a diprotic acid, hereafter referred to as OA) and sodium hydroxide is a typical acid-base titration. Phenolphthalein is used as an indicator. The appearance of a permanent light pink color indicates the end point. This titration method helps in determining the unknown concentration of sodium hydroxide using a standard OA solution. (Molar mass of OA = 126 g mol^{-1})

Q.26   *The amount (in g) of OA required to make 0.5 L of 0.1 M solution is*

(A) 126   (B) 12.6   (C) 63.0   (D) 6.30

PARAGRAPH IV

*The reaction of 1-bromopropane with concentrated alcoholic KOH gives compound **X**. Reaction of compound **X** with HBr in acetic acid gives 2-bromopropane as the major product.*

Q.27   *1-Bromopropane and 2-bromopropane are*

(A) positional isomers   (B) enantiomers
(C) functional isomers   (D) metamers

PARAGRAPH IV

*The reaction of 1-bromopropane with concentrated alcoholic KOH gives compound **X**. Reaction of compound **X** with HBr in acetic acid gives 2-bromopropane as the major product.*

Q.28   *Compound **X** is an*

(A) aldehyde   (B) alcohol   (C) alkene   (D) alkyne

PARAGRAPH V

The reaction of one equivalent of benzene (molar mass = 78 g mol^{-1}) with one equivalent of acetyl chloride in the presence of anhydrous AlCl$_3$ gave acetophenone (molar mass = 120 g mol^{-1}) as the major product.

Q.29   *If the reaction gave 120 g of the acetophenone from 156 g of the benzene, the yield of the reaction is*

(A) 60%   (B) 50%   (C) 78%   (D) 100%

PARAGRAPH V

The reaction of one equivalent of benzene (molar mass = 78 g mol^{-1}) with one equivalent of acetyl chloride in the presence of anhydrous AlCl$_3$ gave acetophenone (molar mass = 120 g mol^{-1}) as the major product.

Q.30   *This reaction is an example of*

(A) Friedel-Crafts alkylation   (B) Friedel-Crafts acylation
(C) Sandmeyer's reaction   (D) Cannizzaro reaction