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 an increase in entropy is

(A) \( \text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g) \)
(B) \( 2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g) \)
(C) \( \text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g) \)
(D) \( 3\text{C}_2\text{H}_2(g) \rightarrow \text{C}_6\text{H}_6(g) \)

Q.2  The heat absorbed/released by the system is zero for an

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

Q.3  The unit of rate constant for a first order reaction is

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

Q.4  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.5  The process which results in an increase in atomic number is

(A) gamma emission.  (B) positron emission.
(C) beta emission.  (D) alpha emission.
Q.6 Among the ground state electronic configuration of elements, the correct one is

(A) Carbon

(B) Nitrogen

(C) Oxygen

(D) Boron

Q.7 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.8 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.9 The molecule that contains the most acidic proton is

(A) benzene.

(B) ethylene.

(C) acetylene.

(D) cyclopentane.

Q.10 Among the following molecules, the one that is NOT aromatic is

(A) naphthalene.

(B) pyridine.

(C) cyclopentadiene.

(D) benzene.
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.

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Q.11  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 ______.

Q.12  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.13  For a reaction, the plot of \(\ln k\) versus \(\frac{1}{T}\) 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.14  There are ______ significant figures in 0.06030

Q.15  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.16  For the reaction 2C\(_2\)H\(_6\)(g) + 7O\(_2\)(g) \(\rightarrow\) 4CO\(_2\)(g) + 6H\(_2\)O(l) at temperature \(T\), the difference between change in the enthalpy (\(\Delta H\)) and change in the internal energy (\(\Delta U\)), \(\Delta H - \Delta U\), is \(-x \times RT\). The value of \(x\) is ______. (\(R\) is the universal gas constant and gases can be considered to be ideal)

Q.17  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\(_2\)SO\(_4\) is ______.

Q.18  The Lewis dot structure of O\(_3\) is shown below:

![Lewis structure of O\(_3\)](image)

The formal charge on the oxygen atom labelled as (1) is ______.
Q.19  The total number of \( sp^2 \) hybridized carbon atoms present in the following molecule is _____.

\[
\begin{align*}
\text{Me} & \quad \text{Me} \\
\text{N} & \quad \text{O} \\
\text{Me} & \quad \text{OH}
\end{align*}
\]

Q.20  The maximum number of possible alkenes that can be obtained from acid-catalyzed dehydration of the following molecule is _____.

\[
\begin{align*}
\text{OH} & \\
\text{CH}_3 & \quad \text{CH}_3
\end{align*}
\]
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 The equilibrium constant ($K_c$) for the reaction is

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

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 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 II

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

Q.23 The solubility (in mol L$^{-1}$) of the salt $MX$ at 300 K is

(A) $1 \times 10^{-5}$  (B) $2 \times 10^{-5}$
(C) $1 \times 10^{-10}$  (D) $2 \times 10^{-10}$
PARAGRAPHS

PARAGRAPH II

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

Q.24 At 300 K, the solubility (in mol L$^{-1}$) of the salt $MX$ in the presence of 0.1 M NaX is

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

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 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 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 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 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 Compound X is an

(A) aldehyde  
(B) alcohol  
(C) alkene  
(D) alkyne
**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 1-Bromopropane and 2-bromopropane are

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

**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 This reaction is an example of

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

**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 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%