**Q1.** In an expression $a \times 10^{b}$;

(1) $b$ is order of magnitude for $a \geq 5$

(2) $b$ is order of magnitude for $a \leq 5$

(3) $a$ is order of magnitude for $b \leq 5$

(4) $b$ is order of magnitude for $5 < a \leq 10$

**Q2.** Young's modulus is determined by the equation given by $\mathrm{Y} = 49000 \frac{\mathrm{m}}{\mathrm{l}} \frac{\mathrm{dyn}}{\mathrm{cm}^2}$ where $M$ is the mass and $l$ is the extension of wire used in the experiment. Now error in Young modules $(Y)$ is estimated by taking data from $M - l$ plot in graph paper. The smallest scale divisions are 5 g and 0.02 cm along load axis and extension axis respectively. If the value of $M$ and $l$ are 500 g and 2 cm respectively then percentage error of $Y$ is :

(1) $0.5\%$

(2) $2\%$

(3) $0.02\%$

(4) $0.2\%$

**Q3.** A clock has $75\ \mathrm{cm}, 60\ \mathrm{cm}$ long second hand and minute hand respectively. In 30 minutes duration the tip of second hand will travel $x$ distance more than the tip of minute hand. The value of $x$ in meter is nearly (Take $\pi = 3.14$ ) :

(1) 140.5

(2) 118.9

(3) 139.4

(4) 220.0

**Q4.** A stationary particle breaks into two parts of masses $m_A$ and $m_B$ which move with velocities $v_A$ and $v_B$ respectively. The ratio of their kinetic energies $(K_B : K_A)$ is :

(1) $v_B : v_A$

(2) $m_B : m_A$

(3) $m_B v_B : m_A v_A$

(4) $1 : 1$

**Q5.** Three bodies A, B and C have equal kinetic energies and their masses are 400 g. 1.2 kg and 1.6 kg respectively. The ratio of their linear momenta is :

(1) $\sqrt{2}; \sqrt{3}; 1$

(2) $1 : \sqrt{3} : 2$

(3) $1 : \sqrt{3} : \sqrt{2}$

(4) $\sqrt{3} : \sqrt{2} : 1$

**Q6.** A player caught a cricket ball of mass 150 g moving at a speed of 20 m/s. If the catching process is completed in 0.1 s, the magnitude of force exerted by the ball on the hand of the player is:

(1) 3 N

(2) 300 N

(3) 150 N

(4) 30 N

**Q7.** Two planets $A$ and $B$ having masses $m_1$ and $m_2$ move around the sun in circular orbits of $r_1$ and $r_2$ radii respectively. If angular momentum of $A$ is $L$ and that of $B$ is 3 L, the ratio of time period $\left(\frac{T_A}{T_B}\right)$ is:

(1) $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$

(2) $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$

(3) $27\left(\frac{m_1}{m_2}\right)^3$

(4) $\left(\frac{r_1}{r_2}\right)^3$

**Q8.** Correct Bernoulli's equation is (symbols have their usual meaning) :

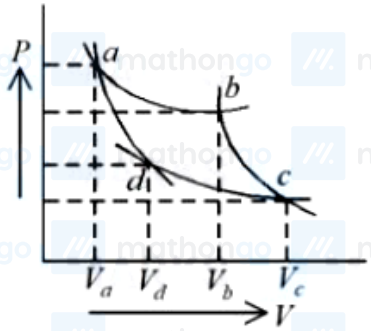
(1) $P + mgh + \frac{1}{2}mv^2 = \text{constant}$

(2) $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$

(3) $P + \rho gh + \rho v^2 = \text{constant}$

(4) $P + \frac{1}{2}\rho gh + \frac{1}{2}\rho v^2 = \text{constant}$

**Q9.** Two different adiabatic paths for the same gas intersect two isothermal curves as shown in P-V diagram. The




relation between the ratio $\frac{V_a}{V_d}$ and the ratio $\frac{V_b}{V_c}$ is:

(1) $\frac{V_a}{V_d} \neq \frac{V_b}{V_c}$ (2) $\frac{V_a}{V_d} = \frac{V_b}{V_c}$

(3) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{-1}$ (4) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{2}$

**Q10.** A mixture of one mole of monoatomic gas and one mole of a diatomic gas (rigid) are kept at room temperature $(27^\circ\text{C})$. The ratio of specific heat of gases at constant volume respectively is:

(1) $\frac{7}{5}$ (2) $\frac{3}{5}$

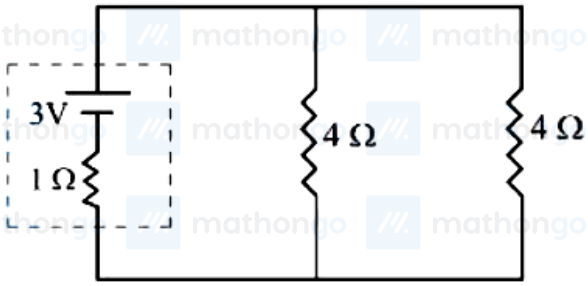
(3) $\frac{5}{3}$ (4) $\frac{3}{2}$

**Q11.** Two charged conducting spheres of radii $a$ and $b$ are connected to each other by a conducting wire. The ratio of charges of the two spheres respectively is:

(1) $\frac{a}{b}\ v$ (2) $\sqrt{ab}$

(3) $\frac{b}{a}$ (4) $ab$

**Q12.** In the given circuit, the terminal potential difference of the cell is :




(1) 2 V (2) 3 V

(3) 4 V (4) 1.5 V

**Q13.** Paramagnetic substances: A. align themselves along the directions of external magnetic field. B. attract strongly towards external magnetic field. C. has susceptibility little more than zero. D. move from a region of strong magnetic field to weak magnetic field. Choose the most appropriate answer from the options given below:

(1) A, B, C Only (2) A, B, C, D

(3) A, C Only (4) B, D Only

**Q14.** A LCR circuit is at resonance for a capacitor $C$, inductance $L$ and resistance $R$. Now the value of resistance is halved keeping all other parameters same. The current amplitude at resonance will be now:

(1) Zero (2) same
(3) halved (4) double

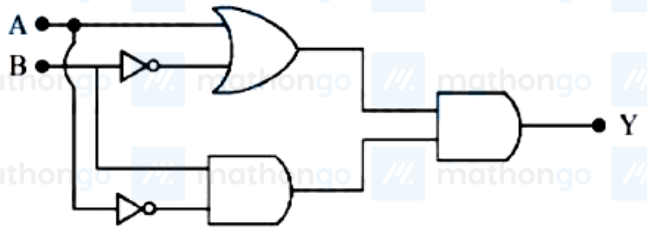
**Q15.** Critical angle of incidence for a pair of optical media is $45^{\circ}$. The refractive indices of first and second media are in the ratio:
(1) $1:\sqrt{2}$ (2) $\sqrt{2}:1$
(3) $2:1$ (4) $1:2$

**Q16.** A proton and an electron are associated with same de-Broglie wavelength. The ratio of their kinetic energies is: (Assume h=6.63 $\times 10^{-34}$ J s, $m_e = 9.0 \times 10^{-31}$ kg and $m_p = 1836$ times $m_e$ )
(1) $1:\sqrt{1836}$ (2) $1:\frac{1}{1836}$
(3) $1:\frac{1}{\sqrt{1836}}$ (4) 1: 1836

**Q17.** Average force exerted on a non-reflecting surface at normal incidence is $2.4 \times 10^{-4}$ N. If 360 $W/cm^2$ is the light energy flux during span of 1 hour 30 minutes, Then the area of the surface is:
(1) 0.2 $m^2$ (2) 20 $m^2$
(3) 0.1 $m^2$ (4) 0.02 $m^2$

**Q18.** Binding energy of a certain nucleus is $18 \times 10^8$ J. How much is the difference between total mass of all the nucleons and nuclear mass of the given nucleus:
(1) 10$\mu$g (2) 20$\mu$g
(3) 0.2$\mu$g (4) 2$\mu$g

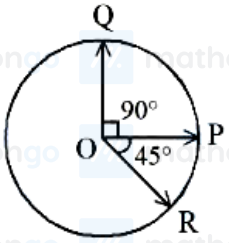
**Q19.** The output Y of following circuit for given inputs is :




(1) $\Lambda \cdot B(\Lambda + B)$ (2) 0
(3) $\overline{\mathrm{A}} \cdot \mathrm{B}$ (4) $A \cdot B$

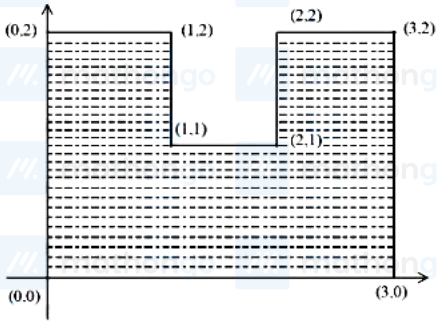
**Q20.** The diameter of a sphere is measured using a vernier caliper whose 9 divisions of main scale are equal to 10 divisions of vernier scale. The shortest division on the main scale is equal to 1 mm. The main scale reading is 2 cm and second division of vernier scale coincides with a division on main scale. If mass of the sphere is 8.635 g, the density of the sphere is:
(1) 2.0 $g/cm^3$ (2) 1.7 $g/cm^3$
(3) 2.2 $g/cm^3$ (4) 2.5 $g/cm^3$

**Q21.** Three vectors $\overrightarrow{OP}, \overrightarrow{OQ}$ and $\overrightarrow{OR}$ each of magnitude A are acting as shown in figure. The resultant of the three




vectors is $A\sqrt{x}$. The value of $x$ is _____ .

**Q22.** A uniform thin metal plate of mass 10 kg with dimensions is shown. The ratio of x and y coordinates of center




of mass of plate in $\frac{n}{9}$. The value of $n$ is _____

**Q23.** A liquid column of height $0.04$ cm balances excess pressure of a soap bubble of certain radius. If density of liquid is $8 \times 10^3$ kg $m^{-3}$ and surface tension of soap solution is $0.28 Nm^{-1}$, then diameter of the soap bubble is _____ cm. (if $g = 10$ m $s^{-2}$ )

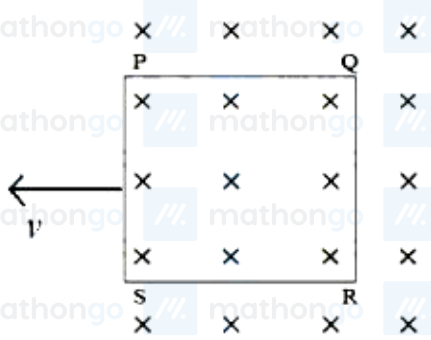
**Q24.** A closed and an open organ pipe have same lengths. If the ratio of frequencies of their seventh overtones is $\left(\frac{a-1}{a}\right)$ then the value of a is _____

**Q25.** An electric field, $\vec{E} = \frac{2\hat{i}+6\hat{j}+8\hat{k}}{\sqrt{6}}$ passes through the surface of 4 $m^2$ area having unit vector $\hat{n} = \left(\frac{2\hat{i}+\hat{j}+\hat{k}}{\sqrt{6}}\right)$. The electric flux for that surface is _____ Vm.

**Q26.** Resistance of a wire at $0°C, 100°C$ and $t°C$ is found to be $10\Omega, 10.2\Omega$ and $10.95\Omega$ respectively. The temperature $t$ in Kelvin scale is _____

**Q27.** An electron with kinetic energy 5eV enters a region of uniform magnetic field of 3 $\mu$T perpendicular to its direction. An electric field E is applied perpendicular to the direction of velocity and magnetic field. The value of $E$, so that electron moves along the same path, is _____ $NC^{-1}$. ( Given, mass of electron $= 9 \times 10^{-31}$ kg , electric charge $= 1.6 \times 10^{-19}$C)

**Q28.** A square loop PQRS having 10 turns, area $3.6 \times 10^{-3}$ $m^2$ and resistance $100\Omega$ is slowly and uniformly being pulled out of a uniform magnetic field of magnitude $B = 0.5$ T as shown. Work done in pulling the loop out of




the field in 1.0 s is _____ $\times 10^{-6}$ J.

**Q29.** A parallel beam of monochromatic light of wavelength 600 nm passes through single slit of 0.4 mm width. Angular divergence corresponding to second order minima would be _____ $\times 10^{-3}$rad.

**Q30.** In an alpha particle scattering experiment distance of closest approach for the $\alpha$ particle is $4.5 \times 10^{-14}$ m. If target nucleus has atomic number 80 , then maximum velocity of $\alpha$ - particle is _____ $\times 10^{5}$ m/s approximately. $\left(\frac{1}{4\pi\epsilon_0} = 9 \times 10^{9}\right.$ SI unit, mass of $\alpha$ particle $\left. = 6.72 \times 10^{-27}\ \text{kg}\right)$

**Q31.** Combustion of glucose $(C_6H_{12}O_6)$ produces $CO_2$ and water. The amount of oxygen (in g) required for the complete combustion of 900 g of glucose is : [Molar mass of glucose in $\text{gmol}^{-1} = 180$ ]

(1) 480 (2) 800

(3) 960 (4) 32

**Q32.**

| | List - I | | List - II |
|---|---|---|---|
| | (Elements) | | (Properties in their respective groups) |
| A. | Cl, S | I. | Elements with highest electronegativity |
| B. | Ge, As | II. | Elements with largest atomic size |
| C. | Fr, Ra | III. | Elements which show properties of both metals and non-metal |
| D. | F, O | IV. | Elements with highest negative electron gain enthalpy |

Match List I with List II Choose the correct answer from the options given below:

(1) A-II, B-I, C-IV, D-III (2) A-III, B-II, C-I, D-IV

(3) A-IV, B-III, C-II, D-I (4) A-II, B-III, C-IV, D-I

**Q33.**

| | List-I | | List-II |
|---|---|---|---|
| | (Molecule) | | (Shape) |
| A. | $NH_3$ | I. | Square pyramid |
| B. | $BrF_5$ | II. | Tetrahedral |
| C. | $PCl_5$ | III. | Trigonal pyramidal |
| D. | $CH_4$ | IV. | Trigonal bipyramidal |

Match List I with List II Choose the correct answer from the options given below:

(1) A-II, B-IV, C-I, D-III (2) A-III, B-I, C-IV, D-II

(3) A-IV, B-III, C-I, D-II (4) A-III, B-IV, C-I, D-II

**Q34.** Match List I with List II

| | List-I | | List-II |
|---|---|---|---|
| | (Molecule) | | (Shape) |
| A. | $Fe_4[Fe(CN)_6]_3 \cdot xH_2O$ | I. | Violet |
| B. | $[Fe(CN)_5NOS^{4-}$ | II. | Blood Red $A$ |
| C. | $[Fe(SCN)]^{2+}$ | III. | Prussian Blue |
| D. | $(NH_4)_3PO_4 \cdot 12MoO_3$ | IV. | Yellow |

Choose the correct answer from the options given below:

(1) A-III, B-I, C-II, D-IV
(2) A-I, B-II, C-III, D-IV
(3) A-IV, B-I, C-II, D-III
(4) A-II, B-III, C-IV, D-I

**Q35.** Given below are two statements: Statement I: $N(CH_3)_3$ and $P(CH_3)_3$ can act as ligands to form transition metal complexes. Statement II: As N and P are from same group, the nature of bonding of $N(CH_3)_3$ and $P(CH_3)_3$ is always same with transition metals. In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect.
(2) Statement I is incorrect but Statement II is correct.
(3) Both Statement I and Statement II are correct.
(4) Both Statement I and Statement II are incorrect.

**Q36.** For the given hypothetical reactions, the equilibrium constants are as follows : $X \rightleftharpoons Y; K_1 = 1.0$ $Y \rightleftharpoons Z; K_2 = 2.0$ $Z \rightleftharpoons W; K_3 = 4.0$ The equilibrium constant for the reaction $X \rightleftharpoons W$ is

(1) 6.0
(2) 12.0
(3) 7.0
(4) 8.0

**Q37.** Among the following halogens $F_2, Cl_2, Br_2$ and $I_2$ Which can undergo disproportionation reactions?

(1) $F_2, Cl_2$ and $Br_2$
(2) $F_2$ and $Cl_2$
(3) Only $I_2$
(4) $Cl_2, Br_2$ and $I_2$

**Q38.** Thiosulphate reacts differently with iodine and bromine in the reactions given below:

$2\,S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$

$S_2O_3^{2-} + 5Br_2 + 5H_2O \rightarrow 2SO_4^{2-} + 4Br^- + 10H^+$

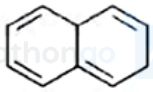
Which of the following statement justifies the above dual behaviour of thiosulphate?

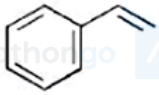
(1) Bromine is a stronger oxidant than iodine
(2) Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reaction
(3) Bromine is a weaker oxidant than iodine
(4) Bromine undergoes oxidation and iodine undergoes reduction in these reactions

**Q39.** Give below are two statements: One is labelled as Assertion A and the other is labelled as Reason R: Assertion A: The stability order of +1 oxidation state of Ga, In and T1 is Ga < In < T1. Reason R: The inert pair effect stabilizes the lower oxidation state down the group. In the light of the above statements, choose the correct answer from the options given below:

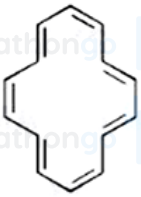
(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is NOT the correct explanation of A.

**Q40.**

A. 

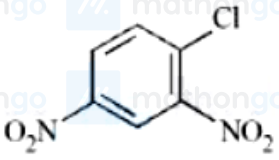
B. 

C. 

D. 

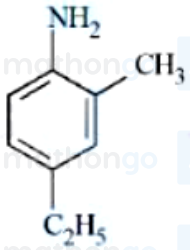
Which of the following are aromatic?
(1) A and C only
(2) B and D only
(3) C and D only
(4) A and B only

**Q41.**



Compound A

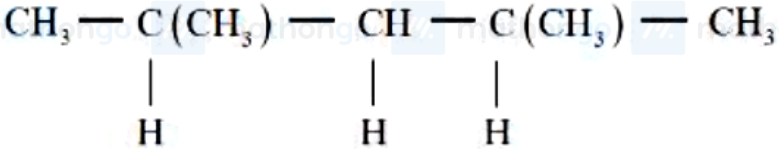
Given below are two statements: Statements I:



Compound B

IUPAC name of Compound $A$ is 4-chloro-1,3-dinitrobenzene. Statements II:
IUPAC name of Compound B is 4-ethyl-2-methylaniline. In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Both Statement I and Statement II are incorrect.
(2) Both Statement I and Statement II are correct.
(3) Statement I is correct but Statement II is incorrect.
(4) Statement I is incorrect but Statement II is correct.

**Q42.** In the given compound, the number of 2° carbon atom /s is _____.




(1) Four
(2) Two
(3) One
(4) Three

**Q43.** Iron (III) catalyses the reaction between iodide and persulphate ions, in which A. $Fe^{3+}$ oxidises the iodide ion B. $Fe^{3+}$ oxidises the persulphate ion C. $Fe^{2+}$ reduces the iodide ion D. $Fe^{2+}$ reduces the persulphate ion
Choose the most appropriate answer from the options given below:

(1) B only (2) A only

(3) B and C only (4) A and D only

**Q44.** Number of Complexes with even number of electrons in $t_{2g}$ orbitals is -
$[Fe(H_2O)_6]^{2+}, [Co(H_2O)_6]^{2+}, [Co(H_2O)_6]^{3+}, [Cu(H_2O)_6]^{2+}, [Cr(H_2O)_6]^{2+}$

(1) 2 (2) 3

(3) 1 (4) 5

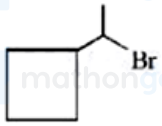
**Q45.** An octahedral complex with the formula $CoCl_3 \cdot nNH_3$ upon reaction with excess of $AgNO_3$ solution gives 2 moles of AgCl. Consider the oxidation state of Co in the complex is ' $x$ '. The value of " $x + n$ " is _____

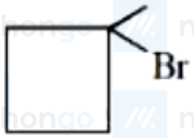
(1) 6 (2) 8

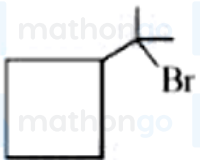
(3) 3 (4) 5

**Q46.** Which among the following compounds will undergo fastest $S_N2$ reaction.

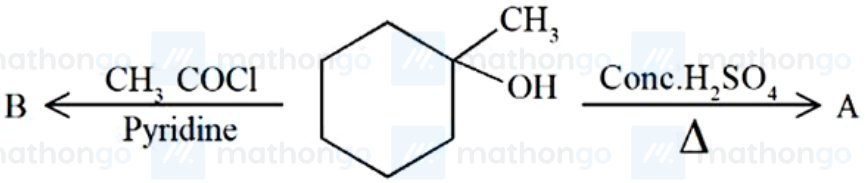
(1) 

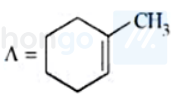
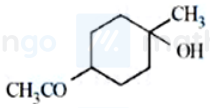
(2) 

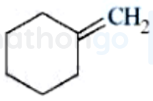
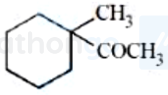
(3) 

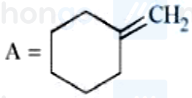
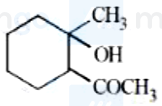
(4) 

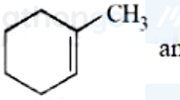
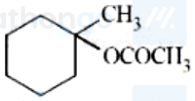
**Q47.** Identify the major products A and B respectively in the following set of reactions.




(1) A =  and B = 

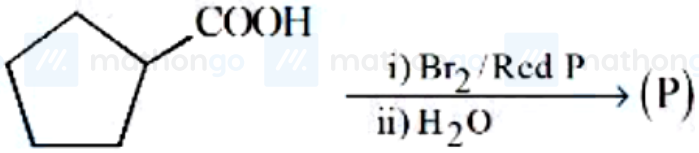
(2) A =  and B = 

(3) A =  and B = 

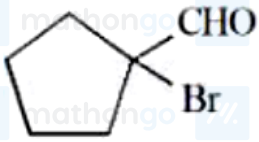
(4) A =  and B = 

**Q48.**

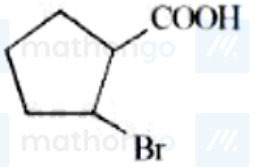
Identify the product (P) in the following reaction:



(1) 


(2) 


(3) 


(4) 


**Q49.** Match List I with List II

| | List-I (Name of the test) | | List-II (Reaction sequence involved) [M is metal] |
|---|---|---|---|
| A. | Borax bead test | I. | $MCO_3 \rightarrow MO \xrightarrow{Co(NO_3)_2} CoO \cdot MO$ |
| B. | Charcoal cavity test | II. | $MCO_3 \rightarrow MCl_2 \rightarrow M^{2+}$ |
| C | Cobalt nitrate test | III | $MSO_4 \xrightarrow[\Delta]{Na_2B_4O_7} M(BO_2)_2 \rightarrow MBO_2 \rightarrow M$ |
| D. | Flame test | IV | $MSO_4 \xrightarrow[\Delta]{Na_2CO_3} MCO_3 \rightarrow MO \rightarrow M$ |

Choose the correct answer from the options given below:

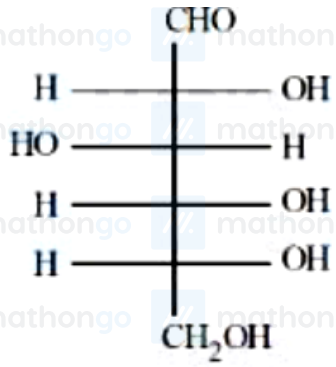
(1) A-III, B-II, C-IV, D-I

(2) A-III, B-IV, C-I, D-II

(3) A-III, B-I, C-II, D-IV

(4) A-III, B-I, C-IV, D-II

**Q50.**




The incorrect statement regarding the given structure is

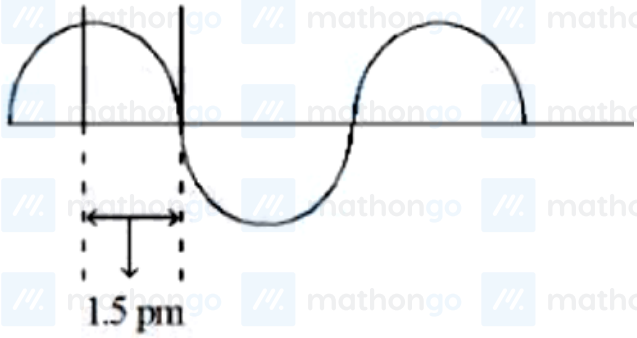
(1) can be oxidized to a dicarboxylic acid with $Br_2$ water

(2) will coexist in equilibrium with 2 other cyclic structure

(3) despite the presence of - CHO does not give Schiff's test

(4) has 4 asymmetric carbon atom

**Q51.**



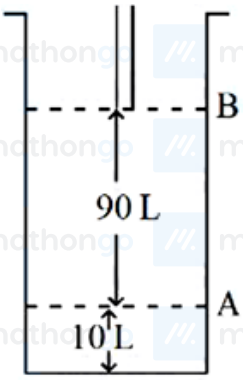

A hypothetical electromagnetic wave is show below.

The frequency of the wave is $x \times 10^{19}$ Hz. $x =$ _____ (nearest integer)

**Q52.** Number of molecules from the following which are exceptions to octet rule is _____

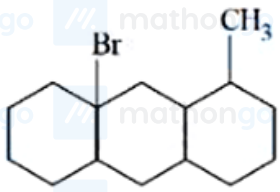
$CO_2, NO_2, H_2SO_4, BF_3, CH_4, SiF_4, ClO_2, PCl_5, BeF_2, C_2H_6, CHCl_3, CBr_4$

**Q53.**




Consider the figure provided. 1 mol of an ideal gas is kept in a cylinder, fitted with a piston, at the position A, at 18°C. If the piston is moved to position B, keeping the temperature unchanged, then ' $x$ ' $L$ atm work is done in this reversible process. $x =$ _____ L atm. (nearest integer) [Given : Absolute temperature $= °C + 273.15, R = 0.08206$ L atm $mol^{-1}$ $K^{-1}$ ]

**Q54.**




The number of optical isomers in following compound is: _____

**Q55.** A solution containing 10 g of an electrolyte $AB_2$ in 100 g of water boils at 100.52°C. The degree of ionization of the electrolyte $(\alpha)$ is _____ $\times 10^{-1}$. (nearest integer) [Given : Molar mass of $AB_2 = 200$ g $mol^{-1}$, $K_b$ (molal boiling point elevation const. of water) $= 0.52$ K kg $mol^{-1}$, boiling point of water $= 100°C$; $AB_2$ ionises as $AB_2 \rightarrow A^{2+} + 2B^-$]

**Q56.** Consider the following reaction

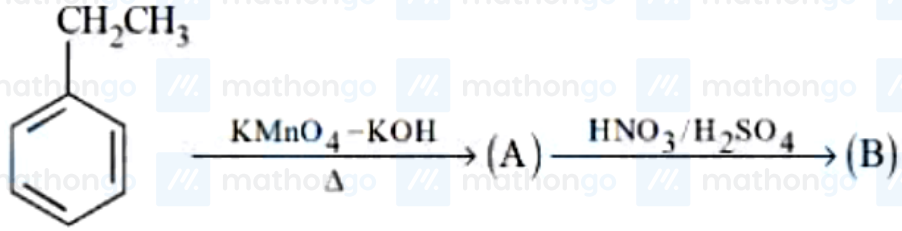
$$A + B \rightarrow C$$

The time taken for A to become $1/4^{th}$ of its initial concentration is twice the time taken to become $1/2$ of the same. Also, when the change of concentration of $B$ is plotted against time, the resulting graph gives a straight

line with a negative slope and a positive intercept on the concentration axis. The overall order of the reaction is _____

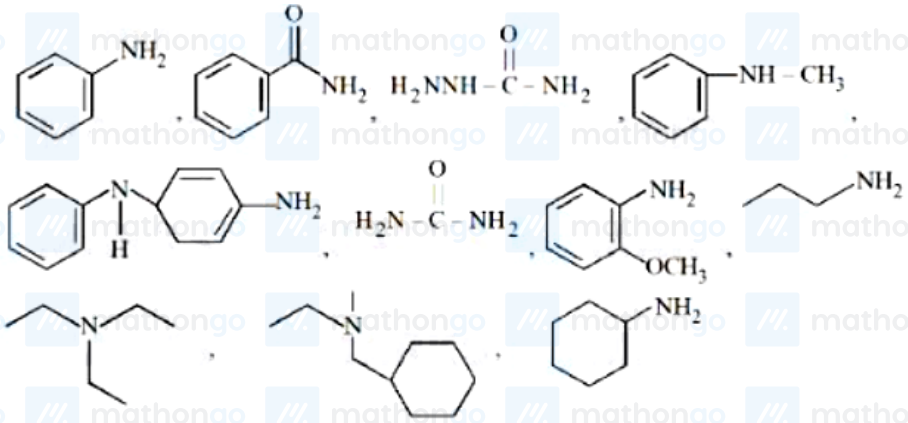
**Q57.** The 'spin only' magnetic moment value of $MO_4^{2-}$ is _____ BM. (Where M is a metal having least metallic radii. among Sc, Ti, V, Cr, Mn and Zn ). (Given atomic number: Sc = 21, Ti = 22, V = 23, Cr = 24, Mn = 25 and Zn = 30)

**Q58.** Major product $B$ of the following reaction has _____ $\pi$-bond.




**Q59.** If 279 g of aniline is reacted with one equivalent of benzenediazonium chloride, the maximum amount of aniline yellow formed will be _____ g. (nearest integer) (consider complete conversion).

**Q60.** Number of amine compounds from the following giving solids which are soluble in NaOH upon reaction with Hinsberg's reagent is _____



**Q61.** The sum of all the solutions of the equation $(8)^{2x} - 16 \cdot (8)^x + 48 = 0$ is :

(1) $1 + \log_8(6)$ (2) $1 + \log_6(8)$

(3) $\log_8(6)$ (4) $\log_8(4)$

**Q62.** Let $z$ be a complex number such that $|z + 2| = 1$ and $\text{Im}\left(\frac{z+1}{z+2}\right) = \frac{1}{5}$. Then the value of $|\text{Re}(\overline{z+2})|$ is

(1) $\frac{2\sqrt{6}}{5}$ (2) $\frac{24}{5}$

(3) $\frac{1+\sqrt{6}}{5}$ (4) $\frac{\sqrt{6}}{5}$

**Q63.** If the set $R = \{(a, b) : a + 5b = 42, a, b \in \mathbb{N}\}$ has $m$ elements and $\sum_{n=1}^{m}\left(1 - i^{n!}\right) = x + iy$, where $i = \sqrt{-1}$, then the value of $m + x + y$ is

(1) 12 (2) 4

(3) 8 (4) 5

**Q64.** If $\sin x = -\frac{3}{5}$, where $\pi < x < \frac{3\pi}{2}$, then $80\left(\tan^2 x - \cos x\right)$ is equal to

(1) 108 (2) 109

(3) 18 (4) 19

**Q65.** The equations of two sides AB and AC of a triangle ABC are $4x + y = 14$ and $3x - 2y = 5$, respectively. The point $\left(2, -\frac{4}{3}\right)$ divides the third side BC internally in the ratio $2 : 1$. the equation of the side BC is

(1) $x + 3y + 2 = 0$
(2) $x - 6y - 10 = 0$
(3) $x - 3y - 6 = 0$
(4) $x + 6y + 6 = 0$

**Q66.** Let the circles $C_1 : (x-\alpha)^2 + (y-\beta)^2 = r_1^2$ and $C_2 : (x-8)^2 + \left(y - \frac{15}{2}\right)^2 = r_2^2$ touch each other externally at the point $(6, 6)$. If the point $(6, 6)$ divides the line segment joining the centres of the circles $C_1$ and $C_2$ internally in the ratio $2 : 1$, then $(\alpha + \beta) + 4\left(r_1^2 + r_2^2\right)$ equals

(1) 125
(2) 130
(3) 110
(4) 145

**Q67.** Let $H : \frac{-x^2}{a^2} + \frac{y^2}{b^2} = 1$ be the hyperbola, whose eccentricity is $\sqrt{3}$ and the length of the latus rectum is $4\sqrt{3}$. Suppose the point $(\alpha, 6), \alpha > 0$ lies on $H$. If $\beta$ is the product of the focal distances of the point $(\alpha, 6)$, then $\alpha^2 + \beta$ is equal to

(1) 172
(2) 171
(3) 169
(4) 170

**Q68.** Let $A = \begin{bmatrix} 2 & a & 0 \\ 1 & 3 & 1 \\ 0 & 5 & b \end{bmatrix}$. If $A^3 = 4A^2 - A - 21I$, where $I$ is the identity matrix of order $3 \times 3$, then $2a + 3b$ is equal to

(1) -9
(2) -13
(3) -10
(4) -12

**Q69.** Let $[t]$ be the greatest integer less than or equal to $t$. Let $A$ be the set of all prime factors of 2310 and $f : A \to \mathbb{Z}$ be the function $f(x) = \left[\log_2\left(x^2 + \left[\frac{x^3}{5}\right]\right)\right]$. The number of one-to-one functions from $A$ to the range of $f$ is

(1) 25
(2) 24
(3) 20
(4) 120

**Q70.** For the function $f(x) = (\cos x) - x + 1, x \in \mathbb{R}$, between the following two statements (S1) $f(x) = 0$ for only one value of $x$ in $[0, \pi]$. (S2) $f(x)$ is decreasing in $\left[0, \frac{\pi}{2}\right]$ and increasing in $\left[\frac{\pi}{2}, \pi\right]$.

(1) Both (S1) and (S2) are correct.
(2) Both (S1) and (S2) are incorrect.
(3) Only (S2) is correct.
(4) Only (S1) is correct.

**Q71.** Let $f(x) = 4\cos^3 x + 3\sqrt{3}\cos^2 x - 10$. The number of points of local maxima of $f$ in interval $(0, 2\pi)$ is

(1) 3
(2) 4
(3) 1
(4) 2

**Q72.** The number of critical points of the function $f(x) = (x-2)^{2/3}(2x+1)$ is

(1) 1
(2) 2
(3) 0
(4) 3

**Q73.** Let $I(x) = \int \frac{6}{\sin^2 x(1-\cot x)^2} dx$. If $I(0) = 3$, then $I\left(\frac{\pi}{12}\right)$ is equal to

(1) $2\sqrt{3}$ (2) $\sqrt{3}$
(3) $3\sqrt{3}$ (4) $6\sqrt{3}$

**Q74.** The value of $k \in \mathrm{N}$ for which the integral $I_n = \int_0^1 \left(1-x^k\right)^n dx, n \in \mathbb{N}$, satisfies $147I_{20} = 148I_{21}$ is
(1) 14 (2) 8
(3) 10 (4) 7

**Q75.** Let $f(x)$ be a positive function such that the area bounded by $y = f(x), y = 0$ from $x = 0$ to $x = a > 0$ is $e^{-a} + 4a^2 + a - 1$. Then the differential equation, whose general solution is $y = c_1 f(x) + c_2$, where $c_1$ and $c_2$ are arbitrary constants, is
(1) $(8e^x - 1)\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$ (2) $(8e^x - 1)\frac{d^2y}{dx^2} - \frac{dy}{dx} = 0$
(3) $(8e^x + 1)\frac{d^2y}{dx^2} - \frac{dy}{dx} = 0$ (4) $(8e^x + 1)\frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$

**Q76.** Let $y = y(x)$ be the solution of the differential equation $\left(1+y^2\right)e^{\tan x}dx + \cos^2 x\left(1+e^{2\tan x}\right)dy = 0, y(0) = 1$. Then $y\left(\frac{\pi}{4}\right)$ is equal to
(1) $\frac{2}{e}$ (2) $\frac{2}{e^2}$
(3) $\frac{1}{e}$ (4) $\frac{1}{e^2}$

**Q77.** The set of all $\alpha$, for which the vectors $\vec{a} = \alpha t\hat{i} + 6\hat{j} - 3\hat{k}$ and $\vec{b} = t\hat{i} - 2\hat{j} - 2\alpha t\hat{k}$ are inclined at an obtuse angle for all $t \in \mathbb{R}$, is
(1) $\left(-\frac{4}{3}, 1\right)$ (2) $[0, 1)$
(3) $\left(-\frac{4}{3}, 0\right]$ (4) $(-2, 0]$

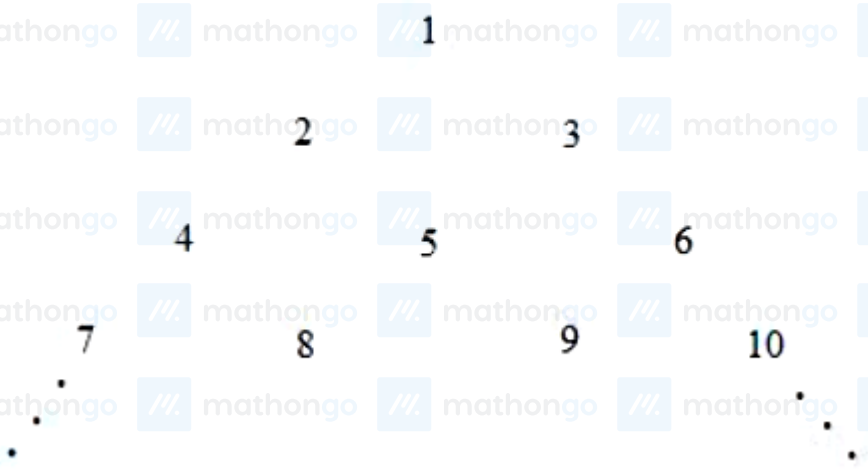
**Q78.** If the shortest distance between the lines $L_1 : \vec{r} = (2+\lambda)\hat{i} + (1-3\lambda)\hat{j} + (3+4\lambda)\hat{k}, \quad \lambda \in \mathbb{R}$
$L_2 : \vec{r} = 2(1+\mu)\hat{i} + 3(1+\mu)\hat{j} + (5+\mu)\hat{k}, \quad \mu \in \mathbb{R}$ is $\frac{m}{\sqrt{n}}$, where $\gcd(m, n) = 1$, then the value of $m + n$ equals
(1) 390 (2) 384
(3) 377 (4) 387

**Q79.** Let $P(x, y, z)$ be a point in the first octant, whose projection in the $xy$-plane is the point $Q$. Let $OP = \gamma$; the angle between $OQ$ and the positive $x$-axis be $\theta$; and the angle between $OP$ and the positive $z$-axis be $\phi$, where $O$ is the origin. Then the distance of $P$ from the $x$-axis is
(1) $\gamma\sqrt{1 - \sin^2\phi\cos^2\theta}$ (2) $\gamma\sqrt{1 - \sin^2\theta\cos^2\phi}$
(3) $\gamma\sqrt{1 + \cos^2\phi\sin^2\theta}$ (4) $\gamma\sqrt{1 + \cos^2\theta\sin^2\phi}$

**Q80.** Let the sum of two positive integers be 24 . If the probability, that their product is not less than $\frac{3}{4}$ times their greatest possible product, is $\frac{m}{n}$, where $\gcd(m, n) = 1$, then $n - m$ equals
(1) 10 (2) 9
(3) 11 (4) 8

**Q81.** The number of 3-digit numbers, formed using the digits $2, 3, 4, 5$ and 7 , when the repetition of digits is not allowed, and which are not divisible by 3 , is equal to_____

**Q82.** Let the positive integers be written in the form :




If the $k^{\text{th}}$ row contains exactly $k$ numbers for every natural number $k$, then the row in which the number 5310 will be, is _____

**Q83.** Let $\alpha = \sum_{r=0}^{n} \left(4r^2 + 2r + 1\right) {}^{n}C_r$ and $\beta = \left(\sum_{r=0}^{n} \frac{{}^{n}C_r}{r+1}\right) + \frac{1}{n+1}$. If $140 < \frac{2\alpha}{\beta} < 281$, then the value of $n$ is _____

**Q84.** If the orthocentre of the triangle formed by the lines $2x + 3y - 1 = 0, x + 2y - 1 = 0$ and $ax + by - 1 = 0$, is the centroid of another triangle, whose circumcentre and orthocentre respectively are $(3, 4)$ and $(-6, -8)$, then the value of $|a - b|$ is_____

**Q85.** The value of $\lim_{x \to 0} 2 \left( \frac{1 - \cos x \sqrt{\cos 2x} \sqrt[3]{\cos 3x} \ldots\ldots \sqrt[10]{\cos 10x}}{x^2} \right)$ is

**Q86.** Let $A = \begin{bmatrix} 2 & -1 \\ 1 & 1 \end{bmatrix}$. If the sum of the diagonal elements of $A^{13}$ is $3^n$, then $n$ is equal to_____

**Q87.** If the range of $f(\theta) = \frac{\sin^4\theta + 3\cos^2\theta}{\sin^4\theta + \cos^2\theta}, \theta \in \mathbb{R}$ is $[\alpha, \beta]$, then the sum of the infinite G.P., whose first term is 64 and the common ratio is $\frac{\alpha}{\beta}$, is equal to_____

**Q88.** Let the area of the region enclosed by the curve $y = \min\{\sin x, \cos x\}$ and the $x$ axis between $x = -\pi$ to $x = \pi$ be $A$. Then $A^2$ is equal to _____

**Q89.** Let $\vec{a} = 9\hat{i} - 13\hat{j} + 25\hat{k}, \vec{b} = 3\hat{i} + 7\hat{j} - 13\hat{k}$ and $\vec{c} = 17\hat{i} - 2\hat{j} + \hat{k}$ be three given vectors. If $\vec{r}$ is a vector such that $\vec{r} \times \vec{a} = (\vec{b} + \vec{c}) \times \vec{a}$ and $\vec{r} \cdot (\vec{b} - \vec{c}) = 0$, then $\frac{|593\vec{r} + 67\vec{a}|^2}{(593)^2}$ is equal to_____

**Q90.** Three balls are drawn at random from a bag containing 5 blue and 4 yellow balls. Let the random variables $X$ and $Y$ respectively denote the number of blue and yellow balls. If $\bar{X}$ and $\bar{Y}$ are the means of $X$ and $Y$ respectively, then $7\bar{X} + 4\bar{Y}$ is equal to_____

## ANSWER KEYS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** (2) | **2.** (2) | **3.** (3) | **4.** (1) | **5.** (2) | **6.** (4) | **7.** (2) | **8.** (2) |
| **9.** (2) | **10.** (2) | **11.** (1) | **12.** (1) | **13.** (3) | **14.** (4) | **15.** (2) | **16.** (4) |
| **17.** (4) | **18.** (2) | **19.** (2) | **20.** (1) | **21.** (3) | **22.** (15) | **23.** (7) | **24.** (16) |
| **25.** (12) | **26.** (748) | **27.** (4) | **28.** (3) | **29.** (6) | **30.** (156) | **31.** (3) | **32.** (3) |
| **33.** (2) | **34.** (1) | **35.** (1) | **36.** (4) | **37.** (4) | **38.** (1) | **39.** (3) | **40.** (2) |
| **41.** (4) | **42.** (3) | **43.** (4) | **44.** (2) | **45.** (2) | **46.** (1) | **47.** (4) | **48.** (1) |
| **49.** (2) | **50.** (1) | **51.** (5) | **52.** (6) | **53.** (55) | **54.** (32) | **55.** (5) | **56.** (1) |
| **57.** (0) | **58.** (5) | **59.** (591) | **60.** (5) | **61.** (1) | **62.** (1) | **63.** (1) | **64.** (2) |
| **65.** (1) | **66.** (2) | **67.** (2) | **68.** (2) | **69.** (4) | **70.** (4) | **71.** (4) | **72.** (2) |
| **73.** (3) | **74.** (4) | **75.** (4) | **76.** (3) | **77.** (3) | **78.** (4) | **79.** (1) | **80.** (1) |
| **81.** (36) | **82.** (103) | **83.** (5) | **84.** (16) | **85.** (55) | **86.** (7) | **87.** (96) | **88.** (16) |
| **89.** (569) | **90.** (17) | | | | | | |