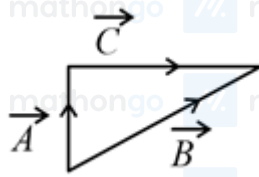**Q1.** Match List I with List II.

List I                     List II
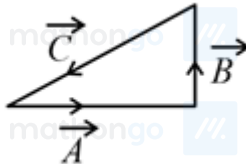
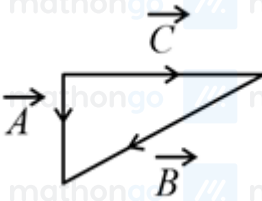(a) $\vec{C} - \vec{A} - \vec{B} = 0$     (i)



(b) $\vec{A} - \vec{C} - \vec{B} = 0$     (ii)
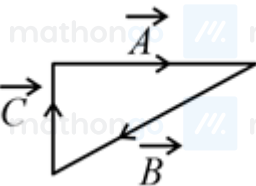


(c) $\vec{B} - \vec{A} - \vec{C} = 0$     (iii)



(d) $\vec{A} + \vec{B} = -\vec{C}$     (iv)



Choose the correct answer from the options given below:

(1) (a) $\rightarrow$ (iv), (b) $\rightarrow$ (i), (c) $\rightarrow$ (iii), (d) $\rightarrow$ (ii)

(2) (a) $\rightarrow$ (iv), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (i), (d) $\rightarrow$ (ii)

(3) (a) $\rightarrow$ (iii), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)

(4) (a) $\rightarrow$ (i), (b) $\rightarrow$ (iv), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (iii)

**Q2.** Water droplets are coming from an open tap at a particular rate. The spacing between a droplet observed at $4^{th}$ second after its fall to the next droplet is $34.3$ m. At what rate the droplets are coming from the tap ? (Take $g = 9.8$ m s$^{-2}$)

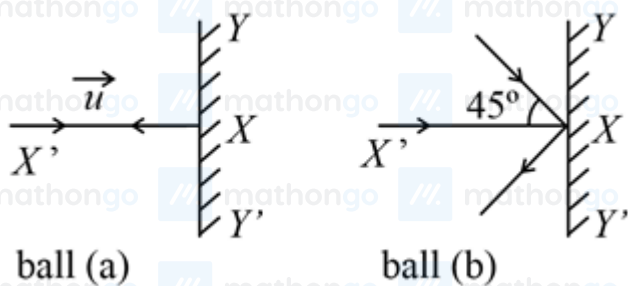(1) 3 drops/2 seconds                    (2) 2 drops/second

(3) 1 drop/second                        (4) 1 drop/7 seconds

**Q3.** Two billiard balls of equal mass 30 g strike a rigid wall with same speed of 108 kmph (as shown) but at different angles. If the balls get reflected with the same speed, then the ratio of the magnitude of impulses imparted to ball $a$ and ball $b$ by the wall along $X$ direction is:

ball (a)     ball (b)

(1) $1:1$

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

(3) $2:1$

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

**Q4.** Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Moment of inertia of a circular disc of mass $M$ and radius $R$ about $X, Y$ axes (passing through its plane) and Z-axis which is perpendicular to its plane were found to be $I_x, I_y$ and $I_z$, respectively. The respective radii of gyration about all the three axes will be the same.

Reason R: A rigid body making rotational motion has fixed mass and shape. In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both A and R are correct but R is not the correct explanation of A.

(2) A is not correct but R is correct.

(3) A is correct but R is not correct.

(4) Both A and R are correct and R is the correct explanation of A.

**Q5.** The minimum and maximum distances of a planet revolving around the Sun are $x_1$ and $x_2$. If the minimum speed of the planet on its trajectory is $v_0$, then its maximum speed will be:

(1) $\frac{v_0 x_1^2}{x_2^2}$

(2) $\frac{v_0 x_2^2}{x_1^2}$

(3) $\frac{v_0 x_1}{x_2}$

(4) $\frac{v_0 x_2}{x_1}$

**Q6.** Two wires of same length and radius are joined end to end and loaded. The Young's moduli of the materials of the two wires are $Y_1$ and $Y_2$. The combination behaves as a single wire then its Young's modulus is:
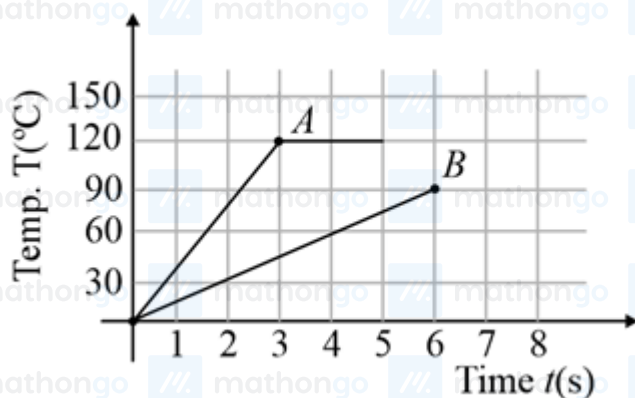
(1) $Y = \frac{2Y_1 Y_2}{3Y_1 + Y_2}$

(2) $Y = \frac{2Y_1 Y_2}{Y_1 + Y_2}$

(3) $Y = \frac{Y_1 Y_2}{2Y_1 + Y_2}$

(4) $Y = \frac{Y_1 Y_2}{Y_1 + Y_2}$

**Q7.** Two different metal bodies $A$ and $B$ of equal mass are heated at a uniform rate under similar conditions. The variation of temperature of the bodies is graphically represented as shown in the figure. The ratio of specific heat capacities is:

(1) $\frac{8}{3}$

(2) $\frac{3}{8}$

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

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

**Q8.** A monoatomic ideal gas, initially at temperature $T_1$ is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature $T_2$ by releasing the piston suddenly. If $l_1$ and $l_2$ are the lengths of the gas column, before and after the expansion respectively, then the value of $\frac{T_1}{T_2}$ will be:

(1) $\frac{l_1^{\frac{2}{3}}}{l_2}$

(2) $\frac{l_2^{\frac{2}{3}}}{l_1}$

(3) $\frac{l_2}{l_1}$

(4) $\frac{l_1}{l_2}$

**Q9.** For a gas $C_P - C_V = R$ in a state $P$ and $C_P - C_V = 1.10R$ in a state $Q$, $T_P$ and $T_Q$ are the temperatures in two different states $P$ and $Q$, respectively. Then

(1) $T_P = T_Q$

(2) $T_P < T_Q$

(3) $T_P = 0.9T_Q$

(4) $T_P > T_Q$

**Q10.** A parallel plate capacitor with plate area '$A$' and distance of separation '$d$' is filled with a dielectric. What is the capacity of the capacitor when permittivity of the dielectric varies as:

$\varepsilon x = \varepsilon_0 + kx$, for $0 < x \leq \frac{d}{2}$

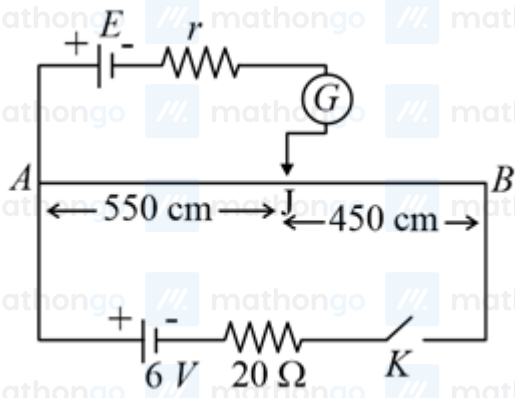$\varepsilon x = \varepsilon_0 + kd - x$, for $\frac{d}{2} \leq x \leq d$

(1) $\varepsilon_0 + \frac{kd^{2/kA}}{2}$

(2) $\frac{kA}{2ln\frac{2\varepsilon_0 + kd}{2\varepsilon_0}}$

(3) $0$

(4) $\frac{kA}{2}ln\frac{2\varepsilon_0}{2\varepsilon_0 - kd}$

**Q11.** In the given figure, there is a circuit of potentiometer of length $AB = 10$ m. The resistance per unit length is $0.1$ $\Omega$ per cm. Across $AB$, a battery of emf $E$ and internal resistance $r$ is connected. The maximum value of emf measured by this potentiometer is:

(1) $5$  V
(2) $2.25$  V
(3) $6$ V
(4) $2.75$  V

**Q12.** A linearly polarised electromagnetic wave in vacuum is $E = 3.1\cos1.8z - 5.4 \times 10^6 t\hat{i}$  N  $C^{-1}$ is incident normally on a perfectly reflecting wall at $z = a$. Choose the correct option.

(1) The wavelength is $5.4$  m.
(2) The frequency of electromagnetic wave is $54 \times 10^4$  Hz.

(3) The transmitted wave will be $3.1\cos1.8z - 5.4 \times 10^6 t\hat{i}$  N $/$ C.
(4) The reflected wave will be $3.1\cos1.8z + 5.4 \times 10^6 t\hat{i}$  N  $C^{-1}$.

**Q13.** A ray of laser of a wavelength $630$  nm is incident at an angle of $30°$ at the diamond-air interface. It is going from diamond to air. The refractive index of diamond is $2.42$ and that of air is $1$. Choose the correct option.

(1) Angle of refraction is $24.41°$.
(2) Angle of refraction is $30°$.
(3) Refraction is not possible.
(4) Angle of refraction is $53.4°$.

**Q14.** In the Young's double slit experiment, the distance between the slits varies in time as $dt = d_0 + a_0$  $\sin\omega t$; where $d_0$,  $\omega$ and $a_0$ are constants. The difference between the largest fringe width and the smallest fringe width obtained over time is given as:

(1) $\dfrac{2\lambda D d_0}{d_0^2 - a_0^2}$
(2) $\dfrac{2\lambda D a_0}{d_0^2 - a_0^2}$
(3) $\dfrac{\lambda D}{d_0^2} a_0$
(4) $\dfrac{\lambda D}{d_0 + a_0}$

**Q15.** What should be the order of arrangement of de-Broglie wavelength of electron $\lambda_e$, an $\alpha$-particle $\lambda_\alpha$ and proton $\lambda_p$ given that all have the same kinetic energy ?

(1) $\lambda_e = \lambda_p = \lambda_\alpha$
(2) $\lambda_e < \lambda_p < \lambda_\alpha$
(3) $\lambda_e > \lambda_p > \lambda_\alpha$
(4) $\lambda_e = \lambda_p > \lambda_\alpha$

**Q16.** A particle of mass $4M$ at rest disintegrates into two particles of mass $M$ and $3M$, respectively, having non zero velocities. The ratio of de-Broglie wavelength of particle of mass $M$ to that of mass $3M$ will be:

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

**Q17.** Some nuclei of a radioactive material are undergoing radioactive decay. The time gap between the instances when a quarter of the nuclei have decayed and when half of the nuclei have decayed is given as: (where $\lambda$ is the decay constant)

(1) $\frac{1}{2}\frac{ln2}{\lambda}$

(2) $\frac{ln2}{\lambda}$

(3) $\frac{2ln2}{\lambda}$

(4) $\frac{ln\frac{3}{2}}{\lambda}$

**Q18.** The half-life of $^{198}$Au is 3 days. If atomic weight of $^{198}$Au is 198 g mol$^{-1}$, then the activity of 2 mg of $^{198}$Au is [in disintegration second$^{-1}$]:
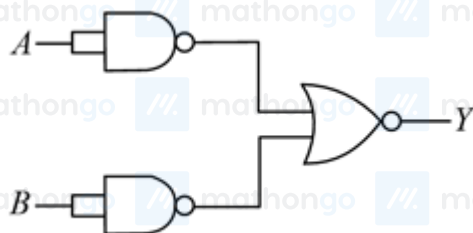
(1) $2.67 \times 10^{12}$

(2) $6.06 \times 10^{18}$

(3) $32.36 \times 10^{12}$

(4) $16.18 \times 10^{12}$

**Q19.** Identify the logic operation carried out.



(1) OR

(2) AND

(3) NOR

(4) NAND

**Q20.** In amplitude modulation, the message signal $V_m(t) = 10\sin2\pi \times 10^5 t$ volts and carrier signal $V_C t = 20\sin2\pi \times 10^7 t$ volts. The modulated signal now contains the message signal with lower side band and upper side band frequency, therefore the bandwidth of modulated signal is $\alpha$ kHz. The value of $\alpha$ is:

(1) 200 kHz

(2) 500 kHz

(3) 100 kHz

(4) 0

**Q21.** A body of mass 2 kg moving with a speed of 4 m s$^{-1}$ makes an elastic collision with another body at rest and continues to move in the original direction but with one fourth of its initial speed. The speed of the two body centre of mass is $x/10$. Find the value of x.

**Q22.** A particle of mass $m$ is moving in time $t$ on a trajectory given by,
$$\vec{r} = 10\alpha t^2 \hat{i} + 5\beta t - 5\hat{j}$$
where $\alpha$ and $\beta$ are dimensional constants.

The angular momentum of the particle becomes the same as it was for $t = 0$ at time $t =$ _____ seconds.

**Q23.** In the reported figure, two bodies $A$ and $B$ of masses 200 g and 800 g are attached with the system of springs. Springs are kept in a stretched position with some extension when the system is released. The horizontal surface is assumed to be frictionless. The angular frequency will be _____ rad s$^{-1}$ when $k = 20$ N m$^{-1}$.
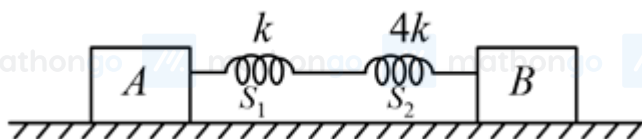


**Q24.** A pendulum bob has a speed of 3 m s$^{-1}$ at its lowest position. The pendulum is 50 cm long. The speed of bob, when the length makes an angle of 60° to the vertical will be $g = 10$ m s$^{-2}$ _____ m s$^{-1}$.

**Q25.** A particle of mass 1 mg and charge $q$ is lying at the mid-point of two stationary particles kept at a distance 2 m when each is carrying same charge $q$. If the free charged particle is displaced from its equilibrium position through distance $x$ $x < < 1$ m. The particle executes SHM. Its angular frequency of oscillation will be _____ $\times 10^5$ rad s$^{-1}$ (if $q^2 = 10C^2$)

**Q26.** An electric bulb rated as 200 W at 100 V is used in a circuit having 200 V supply. The resistance $R$ that must be put in series with the bulb so that the bulb delivers the same power is _____ $\Omega$.

**Q27.** The value of aluminium susceptibility is $2.2 \times 10^{-5}$. The percentage increase in the magnetic field if space within a current carrying toroid is filled with aluminium is $\frac{x}{10^4}$. Then the value of $x$ is

**Q28.** A circular conducting coil of radius 1 m is being heated by the change of magnetic field $\vec{B}$ passing perpendicular to the plane in which the coil is laid. The resistance of the coil is 2 $\mu\Omega$. The magnetic field is slowly switched off such that its magnitude changes in time as
$$B = \frac{4}{\pi} \times 10^{-3} \; T \left(1 - \frac{t}{100}\right)$$
The energy dissipated by the coil before the magnetic field is switched off completely is $E =$ _____ mJ.

**Q29.** An inductor of 10 mH is connected to a 20 V battery through a resistor of 10 k$\Omega$ and a switch. After a long time, when maximum current is set up in the circuit, the current is switched off. The current in the circuit after 1 $\mu$s is $\frac{x}{100}$ mA. Then $x$ is equal to _____ . (Take $e^{-1} = 0.37$)

**Q30.** Student $A$ and student $B$ used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students $A$ and $B$ is _____.
[Figure shows position of reference $O$ when jaws of screw gauge are closed]
Given pitch $= 0.1$ cm.



Screw gauge
(A)

Screw gauge
(B)
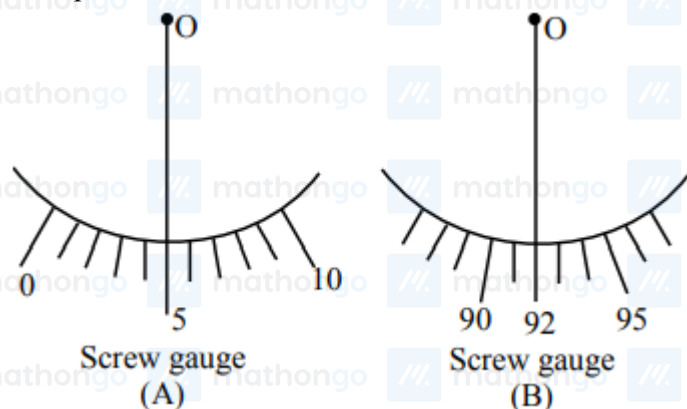
**Q31.** The ionic radii of $K^+, Na^+, Al^{3+}$ and $Mg^{2+}$ are in the order :
(1) $Na^+ < K^+ < Mg^{2+} < Al^{3+}$
(2) $Al^{3+} < Mg^{2+} < K^+ < Na^+$
(3) $Al^{3+} < Mg^{2+} < Na^+ < K^+$
(4) $K^+ < Al^{3+} < Mg^{2+} < Na^+$

**Q32.** At 298.2 K the relationship between enthalpy of bond dissociation (in kJ mol$^{-1}$) for hydrogen $E_H$ and its isotope, deuterium $E_D$, is best described by:
(1) $E_H = \frac{1}{2}E_D$
(2) $E_H = E_D$
(3) $E_H = E_D - 7.5$
(4) $E_H = 2E_D$

**Q33.** Given below are two statements:

Statement I : None of the alkaline earth metal hydroxides dissolve in alkali.

Srtatement II : Solubility of alkaline earth metal hydroxides in water increases down the group.

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) Statement I and Statement II both are incorrect.

(4) Statement I and Statement II both are correct.

**Q34.** Which one of the following compounds of Group-14 elements is not known?

(1) $GeCl_6^{2-}$

(2) $SnOH_6^{2-}$

(3) $SiCl_6^{2-}$

(4) $SiF_6^{2-}$

**Q35.** Which one among the following resonating structures is not correct?

(1)

(2)

(3)

(4)
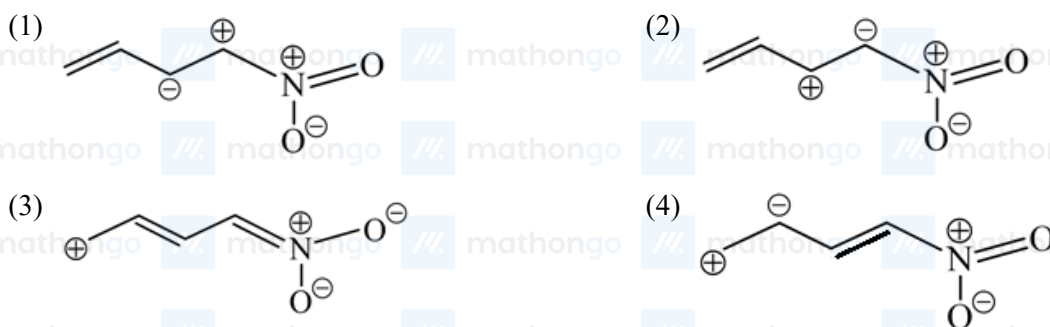
**Q36.** An organic compound 'A' $C_4H_8$ on treatment with $KMnO_4 / H^+$ yields compound 'B' $C_3H_6O$. Compound 'A' also yields compound 'B' an ozonolysis. Compound 'A' is :

(1) 2-Methylpropene

(2) 1-Methylcyclopropane

(3) But-2-ene

(4) Cyclobutane

**Q37.** Which one of the following chemical agent is not being used for dry-cleaning of clothes?

(1) $H_2O_2$

(2) $CCl_4$

(3) Liquid $CO_2$

(4) $Cl_2C = CCl_2$

**Q38.** For the following graphs,
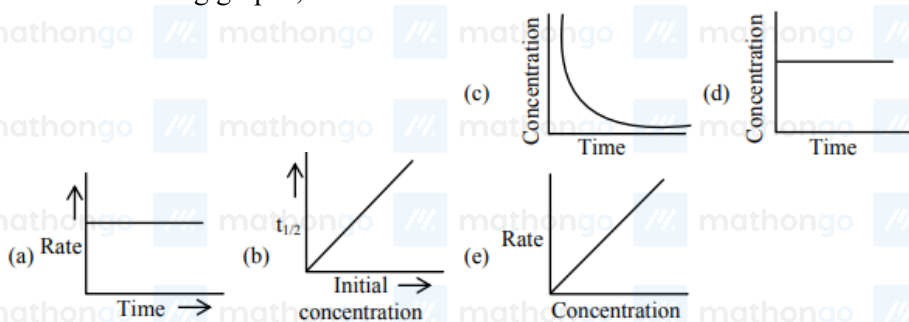
Choose from the options given below, the correct one regarding order of reaction is :

(1) (b) zero order (c) and (e) First order

(2) (a) and (b) Zero order (e) First order

(3) (b) and (d) Zero order (e) First order

(4) (a) and (b) Zero order (c) and (e) First order

**Q39.** In the leaching of alumina from bauxite, the ore expected to leach out in the process by reacting with NaOH is :

(1) $TiO_2$

(2) $Fe_2O_3$

(3) ZnO

(4) $SiO_2$

**Q40.** The correct order of following 3d metal oxides, according to their oxidation numbers is :
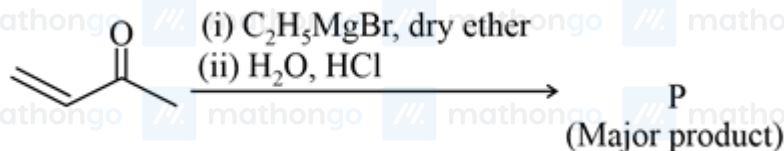
(a) $CrO_3$

(b) $Fe_2O_3$

(c) $MnO_2$

(d) $V_2O_5$

(e) $Cu_2O$

(1) ( d ) > ( a ) > ( b ) > ( c ) > ( e )

(2) ( a ) > ( c ) > ( d ) > ( b ) > ( e )

(3) ( a ) > ( d ) > ( c ) > ( b ) > ( e )

(4) ( c ) > ( a ) > ( d ) > ( e ) > ( b )

**Q41.** Which one of the following species responds to an external magnetic field?

(1) $FeH_2O_6^{3+}$
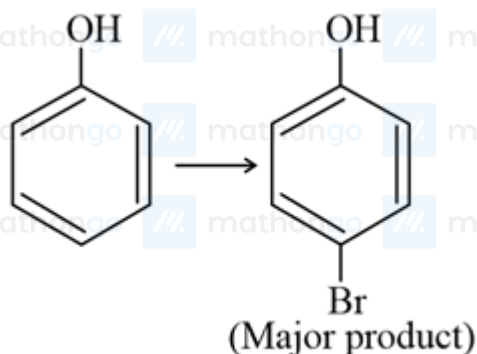
(2) $NiCN_4^{2-}$

(3) $CoCN_6^{3-}$

(4) $NiCO_4$

**Q42.**



Consider the above reaction, the major product 'P' is:
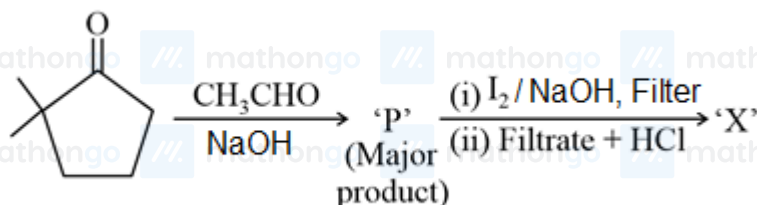
(1)



(2)



(3)



(4)



**Q43.**



(Major product)

The given reaction can occur in the presence of :

(a) Bromine water

(b) $Br_2$ in $CS_2$, 273 K

(c) $Br_2$ / $FeBr_3$

(d) $Br_2$ in $CHCl_3$, 273 K

Choose the correct answer from the options given below:

(1) (b) and (d) only

(2) (a) and (c) only

(3) (b), (c) and (d) only

(4) (a), (b) and (d) only

**Q44.**



Consider the given reaction, the product 'X' is:

(1)



(2)



(3)



(4)



**Q45.** Given below are two statements, one is labelled as Assertion (A) and other is labelled as Reason (R).

Assertion (R) : Gabriel phthalimide synthesis cannot be used to prepare aromatic primary amines.

Reason : Aryl halides do not undergo nucleophilic substitution reaction.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both (A) and (R) true but (R) is not the correct explanation of (A).

(2) (A) is false but ( R) is true.

(3) Both (A) and (R) true and (R) is correct explanation of (A).

(4) (A) is true but (R) is false.

**Q46.** Which one of the products of the following reactions does not react with Hinsberg reagent to form sulphonamide?

(1) 

$+Na/Hg \xrightarrow{C_2H_5OH}$

(2) 

$+SnCl_2 + HCl \longrightarrow$
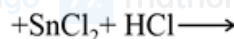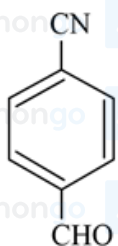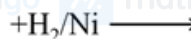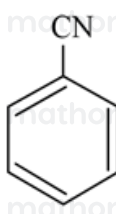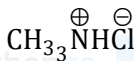
(3) 

$+LiAlH_4 \xrightarrow{H_3O^{\oplus}}$

(4) 

$+H_2/Ni \longrightarrow$
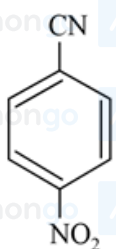
**Q47.** Which one of the following compounds will liberate $CO_2$, when treated with $NaHCO_3$ ?

(1) $CH_{3_3}\overset{\oplus}{N}H\overset{\ominus}{Cl}$

(2) $CH_{3_4}\overset{\oplus}{N}\overset{\ominus}{O}H$

(3)

$$CH_3 - \overset{\overset{O}{\|}}{C} - NH_2$$

(4) $CH_3NH_2$
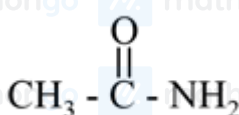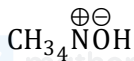
**Q48.**
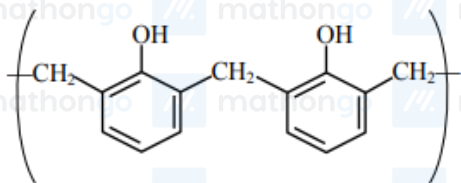


is a repeating unit for :

(1) Novolac

(2) Buna-N

(3) Acrilan

(4) Neoprene

**Q49.** Sodium stearate $CH_3CH_{2_{16}}COO^-Na^+$ is an anionic surfactant which forms micelles in oil. Choose the correct statement for it from the following :

(1) It forms spherical micelles with $CH_3CH_{2_{16}}$ - group pointing towards the centre of sphere.

(2) It forms non-spherical micelles with $-COO^-$ group pointing outwards on the surface.

(3) It forms spherical micelles with $CH_3CH_{2_{16}}$ - group pointing outwards on the surface of sphere

(4) It forms non-spherical micelles with $CH_3CH_{2_{16}}$ - group pointing towards the centre.

**Q50.** The water soluble protein is:

(1) Fibrin

(2) Albumin

(3) Myosin

(4) Collagen

**Q51.** Consider the complete combustion of butane, the amount of butane utilized to produce $72.0$ g of water is _____ $\times 10^{-1}$ g. (in nearest integer)

**Q52.** A source of monochromatic radiation wavelength 400 nm provides 1000 J of energy in 10 seconds. When this radiation falls on the surface of sodium, $x \times 10^{20}$ electrons are ejected per second. Assume that wavelength 400 nm is sufficient for ejection of electron from the surface of sodium metal. The value of x is _____. (Nearest integer)

$h = 6.626 \times 10^{-34}$ Js

**Q53.** A home owner uses $4.00 \times 10^3$ m$^3$ of methane CH$_4$ gas, (assume CH$_4$ is an ideal gas) in a year to heat his home. Under the pressure of 1.0 atm and 300 K, mass of gas used is $x \times 10^5$ g. The value of x is _____. (Nearest integer)

(Given R = 0.083 L atm K$^{-1}$ mol$^{-1}$)

**Q54.** At 298 K, the enthalpy of fusion of a solid X is 2.8 kJ mol$^{-1}$ and the enthalpy of vaporisation of the liquid X is 98.2 kJ mol$^{-1}$. The enthalpy of sublimation of the substance X in kJ mol$^{-1}$ is _____. (in nearest integer)

**Q55.** For the reaction

$A + B \rightleftharpoons 2C$
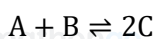
the value of equilibrium constant is 100 at 298 K. If the initial concentration of all the three species is 1 M each, then the equilibrium concentration of C is $x \times 10^{-1}$ M. The value of x is _____. (Nearest integer)

**Q56.** When 10 mL of an aqueous solution of Fe$^{2+}$ ions was titrated in the presence of dil H$_2$SO$_4$ using diphenylamine indicator, 15 mL of 0.02 M solution of K$_2$Cr$_2$O$_7$ was required to get the end point. The molarity of the solution containing Fe$^{2+}$ ions is $x \times 10^{-2}$ M. The value of x is _____. (Nearest integer)

**Q57.**

$$H_3C - \underset{\underset{H}{|}}{C} = CH - C \equiv C - H$$
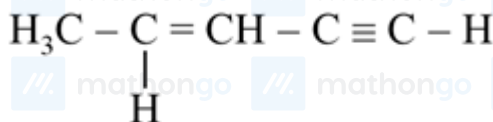
The number of sigma bonds in is _____.

**Q58.** CO$_2$ gas is bubbled through water during a soft drink manufacturing process at 298 K. If CO$_2$ exerts a partial pressure of 0.835 bar then x m mol of CO$_2$ would dissolve in 0.9 L of water. The value of x is _____. (Nearest integer)

(Henry's law constant for CO$_2$ at 298 K is $1.67 \times 10^3$ bar)

**Q59.** Consider the cell at 25°C

$Zn Zn^{2+}$ aq, 1 M $\|$ Fe$^{3+}$ (aq), Fe$^{2+}$ aq Pts
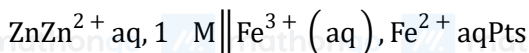
The fraction of total iron present as Fe$^{3+}$ ion at the cell potential of 1.500 V is $x \times 10^{-2}$. The value of x is _____. (Nearest integer)

Given: $E^{\circ}_{Fe^{3+} | Fe^{2+}} = 0.77V$, $E^{\circ}_{Zn^{2+} | Zn} = -0.76V$

**Q60.** Three moles of AgCl get precipitated when one mole of an octahedral co-ordination compound with empirical formula CrCl$_3$.3NH$_3$.3H$_2$O reacts with excess of silver nitrate. The number of chloride ions satisfying the secondary valency of the metal ion is _____.

**Q61.** Let $S_n$ be the sum of the first $n$ terms of an arithmetic progression. If $S_{3n} = 3S_{2n}$, then the value of $\frac{S_{4n}}{S_{2n}}$ is :

(1) 6        (2) 4

(3) 2        (4) 8

**Q62.** If $b$ is very small as compared to the value of $a$, so that the cube and other higher powers of $\frac{b}{a}$ can be neglected in the identity

$$\frac{1}{a-b} + \frac{1}{a-2b} + \frac{1}{a-3b} + \ldots + \frac{1}{a-nb} = \alpha n + \beta n^2 + \gamma n^3$$

then the value of $\gamma$ is :

(1) $\frac{a^2 + b}{3a^3}$        (2) $\frac{a+b}{3a^2}$

(3) $\frac{b^2}{3a^3}$        (4) $\frac{a+b^2}{3a^3}$

**Q63.** The sum of all values of $x$ in $[0, 2\pi]$, for which $\sin x + \sin 2x + \sin 3x + \sin 4x = 0$, is equal to :

(1) $8\pi$        (2) $11\pi$

(3) $12\pi$        (4) $9\pi$

**Q64.** Let a parabola $P$ be such that its vertex and focus lie on the positive $x$-axis at a distance 2 and 4 units from the origin, respectively. If tangents are drawn from $O(0,0)$ to the parabola $P$ which meet $P$ at $S$ and $R$, then the area (in sq. units) of $\Delta SOR$ is equal to :

(1) $16\sqrt{2}$        (2) 16

(3) 32        (4) $8\sqrt{2}$

**Q65.** Let an ellipse $E: \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, a^2 > b^2$, passes through $\sqrt{\frac{3}{2}}, 1$ and has eccentricity $\frac{1}{\sqrt{3}}$. If a circle, centered at focus $F(\alpha, 0), \alpha > 0$, of $E$ and radius $\frac{2}{\sqrt{3}}$, intersects $E$ at two points $P$ and $Q$, then $PQ^2$ is equal to :

(1) $\frac{8}{3}$        (2) $\frac{4}{3}$

(3) $\frac{16}{3}$        (4) 3

**Q66.** The locus of the centroid of the triangle formed by any point $P$ on the hyperbola

$16x^2 - 9y^2 + 32x + 36y - 164 = 0$ and its foci is

(1) $16x^2 - 9y^2 + 32x + 36y - 36 = 0$        (2) $9x^2 - 16y^2 + 36x + 32y - 144 = 0$

(3) $16x^2 - 9y^2 + 32x + 36y - 144 = 0$        (4) $9x^2 - 16y^2 + 36x + 32y - 36 = 0$

**Q67.** The Boolean expression $(p \Rightarrow q) \wedge (q \Rightarrow \sim p)$ is equivalent to :

(1) $\sim q$        (2) $q$

(3) $p$        (4) $\sim p$

**Q68.** A spherical gas balloon of radius 16 meter subtends an angle 60° at the eye of the observer $A$ while the angle of elevation of its center from the eye of $A$ is 75°. Then the height (in meter) of the top most point of the balloon from the level of the observer's eye is :

(1) $8(2 + 2\sqrt{3} + \sqrt{2})$        (2) $8(\sqrt{6} + \sqrt{2} + 2)$

(3) $8(\sqrt{2} + 2 + \sqrt{3})$        (4) $8(\sqrt{6} - \sqrt{2} + 2)$

**Q69.** The values of $a$ and $b$, for which the system of equations

$2x + 3y + 6z = 8$

$x + 2y + az = 5$

$3x + 5y + 9z = b$

has no solution, are :

(1) $a = 3, b \neq 13$

(2) $a \neq 3, b \neq 13$

(3) $a \neq 3, b = 3$

(4) $a = 3, b = 13$

**Q70.** Let $g: N \to N$ be defined as

$g(3n + 1) = 3n + 2$

$g(3n + 2) = 3n + 3$

$g(3n + 3) = 3n + 1$, for all $n \geq 0$

Then which of the following statements is true ?

(1) There exists an onto function $f: N \to N$ such that $f o g = f$

(2) There exists a one-one function $f: N \to N$ such that $f o g = f$

(3) $g o g o g = g$

(4) There exists a function $f: N \to N$ such that $g o f = f$

**Q71.** Let $f: R \to R$ be defined as

$$fx = \begin{cases} \dfrac{\lambda x^2 - 5x + 6}{\mu 5x - x^2 - 6} & x < 2 \\[2mm] e^{\frac{\tan(x-2)}{x - [x]}} & x > 2 \\[2mm] \mu & x = 2 \end{cases}$$

where $x$ is the greatest integer less than or equal to $x$. If $f$ is continuous at $x = 2$, then $\lambda + \mu$ is equal to :

(1) $e(-e + 1)$

(2) $e(e - 2)$

(3) $1$

(4) $2e - 1$

**Q72.** Let $f: [0, \infty) \to [0, \infty)$ be defined as $fx = \int_0^x ydy$ where $[x]$ is the greatest integer less than or equal to $x$. Which of the following is true?

(1) $f$ is continuous at every point in $[0, \infty)$ and differentiable except at the integer points.

(2) $f$ is both continuous and differentiable except at the integer points in $[0, \infty)$.

(3) $f$ is continuous everywhere except at the integer points in $[0, \infty)$.

(4) $f$ is differentiable at every point in $[0, \infty)$.

**Q73.** Let $fx = 3\sin^4 x + 10\sin^3 x + 6\sin^2 x - 3, x \in -\dfrac{\pi}{6}, \dfrac{\pi}{2}$. Then, $f$ is :

(1) increasing in $-\dfrac{\pi}{6}, \dfrac{\pi}{2}$

(2) decreasing in $0, \dfrac{\pi}{2}$

(3) increasing in $-\dfrac{\pi}{6}, 0$

(4) decreasing in $-\dfrac{\pi}{6}, 0$

**Q74.** The number of real roots of the equation $e^{6x} - e^{4x} - 2e^{3x} - 12e^{2x} + e^x + 1 = 0$ is:

(1) $2$

(2) $4$

(3) $6$

(4) $1$

**Q75.** The value of the definite integral $\int_{\pi/24}^{5\pi/24} \dfrac{dx}{1 + \sqrt[3]{\tan 2x}}$ is

(1) $\dfrac{\pi}{3}$

(2) $\dfrac{\pi}{6}$

(3) $\dfrac{\pi}{12}$

(4) $\dfrac{\pi}{18}$

**Q76.** The area (in sq. units) of the region, given by the set $x, y \in R \times R \mid x \geq 0, 2x^2 \leq y \leq 4 - 2x$ is :

(1) $\frac{8}{3}$  (2) $\frac{17}{3}$

(3) $\frac{13}{3}$  (4) $\frac{7}{3}$

**Q77.** Let $y = y(x)$ be the solution of the differential equation $\frac{dy}{dx} = 1 + xe^{y-x}$, $-\sqrt{2} < x < \sqrt{2}$, $y0 = 0$, then the minimum value of $yx$, $x \in -\sqrt{2}, \sqrt{2}$ is equal to :

(1) $2 - \sqrt{3} - \log_e 2$  (2) $2 + \sqrt{3} + \log_e 2$

(3) $1 + \sqrt{3} - \log_e \sqrt{3} - 1$  (4) $1 - \sqrt{3} - \log_e \sqrt{3} - 1$

**Q78.** Let the vectors $2 + a + b\hat{i} + a + 2b + c\hat{j} - b + c\hat{k}$, $1 + b\hat{i} + 2b\hat{j} - b\hat{k}$ and $2 + b\hat{i} + 2b\hat{j} + 1 - b\hat{k}$, $\forall a, b, c \in R$ be co-planar. Then which of the following is true?

(1) $2b = a + c$  (2) $3c = a + b$

(3) $a = b + 2c$  (4) $2a = b + c$

**Q79.** Let the foot of perpendicular from a point $P(1, 2, -1)$ to the straight line $L: \frac{x}{1} = \frac{y}{0} = \frac{z}{-1}$ be $N$. Let a line be drawn from $P$ parallel to the plane $x + y + 2z = 0$ which meets $L$ at point $Q$. If $\alpha$ is the acute angle between the lines $PN$ and $PQ$, then $\cos\alpha$ is equal to _____.

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

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

**Q80.** Let 9 distinct balls be distributed among 4 boxes, $B_1$, $B_2$, $B_3$ and $B_4$. If the probability that $B_3$ contains exactly 3 balls is $k\frac{3}{4}^9$ then $k$ lies in the set :

(1) $\{x \in R: |x - 3| < 1\}$  (2) $\{x \in R: |x - 2| \leq 1\}$

(3) $\{x \in R: |x - 1| < 1\}$  (4) $\{x \in R: |x - 5| \leq 1\}$

**Q81.** If $\alpha, \beta$ are roots of the equation $x^2 + 5\sqrt{2}x + 10 = 0, \alpha > \beta$ and $P_n = \alpha^n - \beta^n$ for each positive integer $n$, then the value of $\frac{P_{17}P_{20} + 5\sqrt{2}P_{17}P_{19}}{P_{18}P_{19} + 5\sqrt{2}P_{18}^2}$ is equal to

**Q82.** There are 5 students in class 10, 6 students in class 11 and 8 students in class 12. If the number of ways, in which 10 students can be selected from them so as to include at least 2 students from each class and at most 5 students from the total 11 students of class 10 and 11 is $100k$, then $k$ is equal to

**Q83.** If the value of $1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \ldots$ upto $\infty^{\log_{0.25}\frac{1}{3} + \frac{1}{3^2} + \frac{1}{3^3} + \ldots \cdot \text{ upto } \infty}$ is $l$, then $l^2$ is equal to _____

**Q84.** The ratio of the coefficient of the middle term in the expansion of $(1 + x)^{20}$ and the sum of the coefficients of two middle terms in expansion of $(1 + x)^{19}$ is _____.

**Q85.** The term independent of $x$ in the expansion of $\frac{x + 1}{x^{2/3} - x^{1/3} + 1} - \frac{x - 1}{x - x^{1/2}}^{10}$, where $x \neq 0, 1$ is equal to

**Q86.** Consider the following frequency distribution :

| class | 10 - 20 | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 |
|---|---|---|---|---|---|
| Frequency | $\alpha$ | 110 | 54 | 30 | $\beta$ |

If the sum of all frequencies is 584 and median is 45, then $|\alpha - \beta|$ is equal to _____.

**Q87.** Let $M = A = \begin{pmatrix} a & b \\ c & d \end{pmatrix} : a, b, c, d \in \pm 3, \pm 2, \pm 1, 0$. Define $f: M \to Z$, as $f A = \det A$, for all $A \in M$ where $Z$ is set of all integers. Then the number of $A \in M$ such that $f A = 15$ is equal to _____.

**Q88.** Let $S = n \in N, \begin{pmatrix} 0 & i \\ 1 & 0 \end{pmatrix}^n \begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \forall a, b, c, d \in R$, where $i = \sqrt{-1}$. Then the number of 2 - digit numbers in the set $S$ is

**Q89.** Let $y = y(x)$ be solution of the following differential equation
$e^y \frac{dy}{dx} - 2e^y \sin x + \sin x \cos^2 x = 0, \quad y\frac{\pi}{2} = 0.$
If $y0 = \log_e \alpha + \beta e^{-2}$, then $4(\alpha + \beta)$ is equal to _____.

**Q90.** Let $\vec{p} = 2\hat{i} + 3\hat{j} + \hat{k}$ and $\vec{q} = \hat{i} + 2\hat{j} + \hat{k}$ be two vectors. If a vector $\vec{r} = \alpha \hat{i} + \beta \hat{j} + \gamma \hat{k}$ is perpendicular to each of the vectors $(\vec{p} + \vec{q})$ and $(\vec{p} - \vec{q})$, and $|\vec{r}| = \sqrt{3}$, then $|\alpha| + |\beta| + |\gamma|$ is equal to _____

# ANSWER KEYS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** (2) | **2.** (3) | **3.** (2) | **4.** (2) | **5.** (4) | **6.** (2) | **7.** (2) | **8.** (2) |
| **9.** (4) | **10.** (2) | **11.** (1) | **12.** (4) | **13.** (3) | **14.** (2) | **15.** (3) | **16.** (4) |
| **17.** (4) | **18.** (4) | **19.** (2) | **20.** (1) | **21.** (25) | **22.** (10) | **23.** (10) | **24.** (2) |
| **25.** (6000) | **26.** (50) | **27.** (22) | **28.** (80) | **29.** (74) | **30.** (13) | **31.** (3) | **32.** (3) |
| **33.** (2) | **34.** (3) | **35.** (1) | **36.** (1) | **37.** (1) | **38.** (2) | **39.** (4) | **40.** (3) |
| **41.** (1) | **42.** (3) | **43.** (3) | **44.** (4) | **45.** (3) | **46.** (2) | **47.** (1) | **48.** (1) |
| **49.** (1) | **50.** (2) | **51.** (464) | **52.** (2) | **53.** (26) | **54.** (101) | **55.** (25) | **56.** (18) |
| **57.** (10) | **58.** (25) | **59.** (24) | **60.** (0) | **61.** (1) | **62.** (3) | **63.** (4) | **64.** (2) |
| **65.** (3) | **66.** (1) | **67.** (4) | **68.** (2) | **69.** (1) | **70.** (1) | **71.** (1) | **72.** (1) |
| **73.** (4) | **74.** (1) | **75.** (3) | **76.** (4) | **77.** (4) | **78.** (1) | **79.** (3) | **80.** (1) |
| **81.** (1) | **82.** (238) | **83.** (3) | **84.** (1) | **85.** (210) | **86.** (164) | **87.** (16) | **88.** (11) |
| **89.** (1) | **90.** (3) | | | | | | |