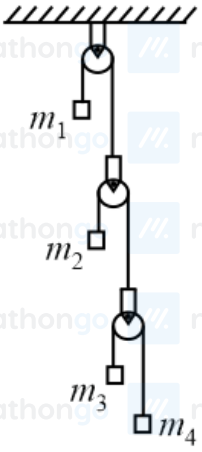
**Q1.** The dimension of mutual inductance is

(1) $\mathrm{ML^2\,T^{-2}A^{-1}}$ (2) $\mathrm{ML^2\,T^{-2}A^{-2}}$

(3) $\mathrm{ML^2\,T^{-3}A^{-1}}$ (4) $\mathrm{ML^2\,T^{-3}A^{-2}}$

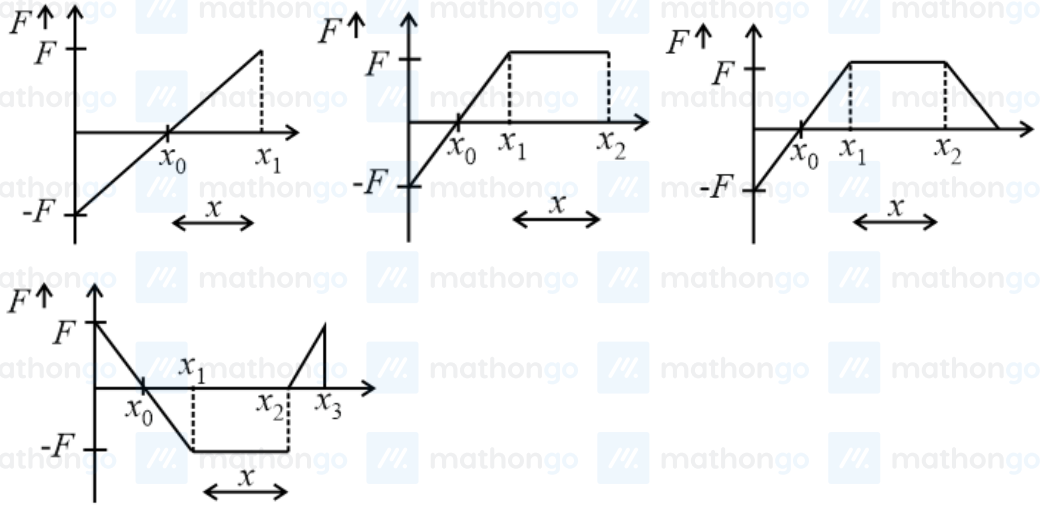
**Q2.** In the arrangement shown in figure $a_1, a_2, a_3$ and $a_4$ are the accelerations of masses $m_1, m_2, m_3$ and $m_4$ respectively. Which of the following relation is true for this arrangement?




(1) $4a_1 + 2a_2 + a_3 + a_4 = 0$ (2) $a_1 + 4a_2 + 3a_3 + a_4 = 0$

(3) $a_1 + 4a_2 + 3a_3 + 2a_4 = 0$ (4) $2a_1 + 2a_2 + 3a_3 + a_4 = 0$

**Q3.** Arrange the four graphs in descending order of total work done; where $W_1, W_2, W_3$ and $W_4$ are the work done corresponding to figure $a, b, c$ and $d$ respectively.




(1) $W_3 > W_2 > W_1 > W_4$ (2) $W_3 > W_2 > W_4 > W_1$

(3) $W_2 > W_3 > W_4 > W_1$ (4) $W_2 > W_3 > W_1 > W_4$

**Q4.** A solid spherical ball is rolling on a frictionless horizontal plane surface about its axis of symmetry. The ratio of rotational kinetic energy of the ball to its total kinetic energy is

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

(3) $\frac{2}{7}$ (4) $\frac{7}{10}$

**Q5.** Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

**Assertion A:** If we move from poles to equator, the direction of acceleration due to gravity of earth always points towards the center of earth without any variation in its magnitude.

**Reason R:** At equator, the direction of acceleration due to the gravity is towards the center of earth.

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

(1) Assertion and reason both are correct and reason is correct explanation of assertion.

(2) Assertion and reason both are correct but reason is not correct explanation of assertion.

(3) Assertion is true but reason is false

(4) Assertion is false but reason is true

**Q6.** If $p$ is the density and $\eta$ is coefficient of viscosity of fluid which flows with a speed $v$ in the pipe of diameter $d$, the correct formula for Reynolds number $R_e$ is

(1) $R_e = \frac{\pi d}{\rho v}$

(2) $R_e = \frac{\rho v}{\eta d}$

(3) $R_e = \frac{\rho v d}{\eta}$

(4) $R_e = \frac{\eta}{\rho v d}$

**Q7.** A flask contains argon and oxygen in the ratio of $3:2$ in mass and the mixture is kept at $27^{\circ}\mathrm{C}$. The ratio of their average kinetic energy per molecule respectively

(1) 3 : 5

(2) 9 : 4

(3) 2 : 3

(4) 1 : 1

**Q8.** For a specific wavelength $670\ \mathrm{nm}$ of light coming from a galaxy moving with velocity $v$, the observed wavelength is $670.7\ \mathrm{nm}$. The value of $v$ is

(1) $3 \times 10^8\ \mathrm{m\,s^{-1}}$

(2) $3.13 \times 10^5\ \mathrm{m\,s^{-1}}$

(3) $3 \times 10^{10}\ \mathrm{m\,s^{-1}}$

(4) $4.48 \times 10^5\ \mathrm{m\,s^{-1}}$

**Q9.** Sixty four conducting drops each of radius $0.02\ \mathrm{m}$ and each carrying a charge of $5\ \mu\mathrm{C}$ are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be

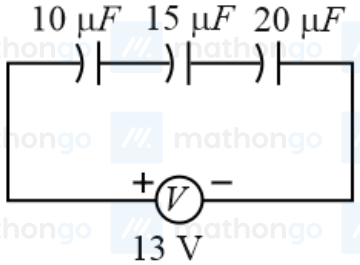
(1) 1 : 4

(2) 4 : 1

(3) 1 : 8

(4) 8 : 1

**Q10.** The charge on capacitor of capacitance $15\mu\mathrm{F}$ in the figure given below is



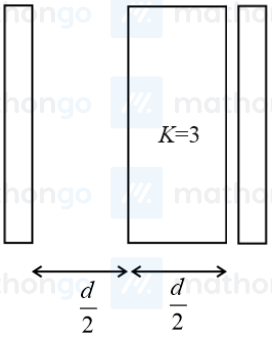

(1) 60 μC

(2) 130 μC

(3) 260 μC

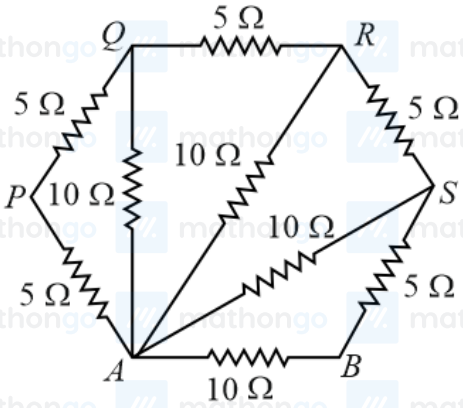
(4) 585 μC

**Q11.** A parallel plate capacitor with plate area $A$ and plate separation $d = 2\ \mathrm{m}$ has a capacitance of 4 μF. The new capacitance of the system if half of the space between them is filled with a dielectric material of dielectric constant $K = 3$ (as shown in figure) will be




(1) 2 μF
(2) 32 μF
(3) 6 μF
(4) 8 μF

**Q12.** Find the equivalent resistance between point $A$ and $B$




(1) 65 Ω
(2) 20 Ω
(3) 5 Ω
(4) 2 Ω

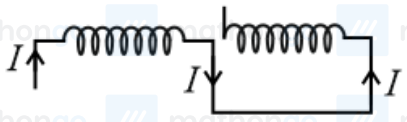
**Q13.** A bar magnet having a magnetic moment of $2.0 \times 10^5$ J $T^{-1}$, is placed along the direction of uniform magnetic field of magnitude $B = 14 \times 10^{-5}$ T. The work done in rotating the magnet slowly through $60^\circ$ from the direction of field is

(1) 14 J
(2) 8 J
(3) 4 J
(4) 1.4 J

**Q14.** A metal surface is illuminated by a radiation of wavelength 4500 Å. The ejected photo-electron enters a constant magnetic field of 2 mT making an angle of $90^\circ$ with the magnetic field. If it starts revolving in a circular path of radius 2 mm, the work function of the metal is approximately

(1) 1.36 eV
(2) 1.69 eV
(3) 2.78 eV
(4) 2.23 eV

**Q15.** Two coils of self inductance $L_1$ and $L_2$ are connected in series combination having mutual inductance of the coils as $M$. The equivalent self inductance of the combination will be




(1) $\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{M}$
(2) $L_1 + L_2 - 2M$
(3) $L_1 + L_2 + M$
(4) $L_1 + L_2 + 2M$

**Q16.** A metallic conductor of length 1 m rotates in a vertical plane parallel to east-west direction about one of its end with angular velocity 5 rad $s^{-1}$. If the horizontal component of earth's magnetic field is $0.2 \times 10^{-4}$ T, then emf induced between the two ends of the conductor is

(1) $5\mu V$ (2) $50\mu$V

(3) 5 m$V$ (4) 50 m$V$

**Q17.** Which is the correct ascending order of wavelengths?

(1) $\lambda_{\text{visible}} < \lambda_{\text{X-ray}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{microwave}}$ (2) $\lambda_{\text{gamma-ray}} < \lambda_{\text{X-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$

(3) $\lambda_{\text{X-ray}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$ (4) $\lambda_{\text{microwave}} < \lambda_{\text{visible}} < \lambda_{\text{gamma-ray}} < \lambda_{\text{X-ray}}$

**Q18.** A radioactive nucleus can decay by two different processes. Half-life for the first process is 3.0 hours while it is 4.5 hours for the second process. The effective halflife of the nucleus will be

(1) 3.75 hours (2) 0.56 hours

(3) 0.26 hours (4) 1.80 hours

**Q19.** The positive feedback is required by an amplifier to act as an oscillator. The feedback here means

(1) External input is necessary to sustain ac signal in output. (2) A portion of the output power is returned back to the input.

(3) Feedback can be achieved by LR network. (4) The base-collector junction must be forward biased.

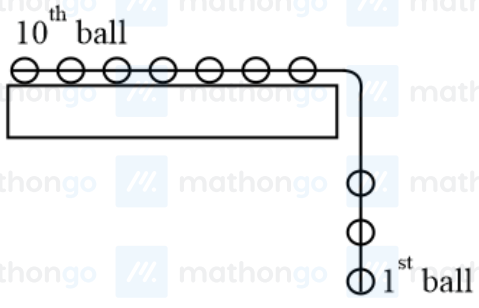
**Q20.** A sinusoidal wave $y(t) = 40\sin\left(10 \times 10^6 \pi t\right)$ is amplitude modulated by another sinusoidal wave $x(t) = 20\sin(1000\pi t)$. The amplitude of minimum frequency component of modulated signal is

(1) 0.5 (2) 0.25

(3) 20 (4) 10

**Q21.** A ball is projected vertically upward with an initial velocity of 50 m $s^{-1}$ at $t = 0$ s. At $t = 2$ s, another ball is projected vertically upward with same velocity. At $t =$____s, second ball will meet the first ball $\left(g = 10 \text{ m s}^{-2}\right)$.

**Q22.** A system to 10 balls each of mass 2 kg are connected via massless and unstretchable string. The system is allowed to slip over the edge of a smooth table as shown in figure. Tension on the string between the $7^{\text{th}}$ and $8^{\text{th}}$ ball is _____ N when $6^{\text{th}}$ ball just leaves the table.




**Q23.** A batsman hits back a ball of mass 0.4 kg straight in the direction of the bowler without changing its initial speed of 15 m $s^{-1}$. The impulse imparted to the ball is _____ N s.

**Q24.** A geyser heats water flowing at a rate of 2.0 kg per minute from 30°C to 70°C. If geyser operates on a gas burner, the rate of combustion of fuel will be _____ g $\text{min}^{-1}$.

[Heat of combustion $= 8 \times 10^3\ \text{Jg}^{-1}$, Specific heat of water $= 4.2\ \text{Jg}^{-1}\ ^\circ\text{C}^{-1}$]

**Q25.** A heat engine operates with the cold reservoir at temperature 324 K. The minimum temperature of the hot reservoir, if the heat engine takes 300 J heat from the hot reservoir and delivers 180 J heat to the cold reservoir per cycle, is _____ $K$.

**Q26.** A set of 20 tuning forks is arranged in a series of increasing frequencies. If each fork gives 4 beats with respect to the preceding fork and the frequency of the last fork is twice the frequency of the first, then the frequency of last fork is _____ Hz.

**Q27.** Two 10 cm long, straight wires, each carrying a current of 5 A are kept parallel to each other. If each wire experienced a force of $10^{-5}$ N, then separation between the wires is _____ cm.

**Q28.** A small bulb is placed at the bottom of a tank containing water to a depth of $\sqrt{7}$ m. The refractive index of water is $\frac{4}{3}$. The area of the surface of water through which light from the bulb can emerge out is $x\pi\ \text{m}^2$. The value of $x$ is _____ .

**Q29.** The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 6630Å is 0.42 V. If the threshold frequency is $x \times 10^{13}$ s, where $x$ is (nearest integer): (Given, speed light $= 3 \times 10^8\ \text{m s}^{-1}$. Planck's constant $= 6.63 \times 10^{-34}$ J s)

**Q30.** A travelling microscope is used to determine the refractive index of a glass slab. If 40 divisions are there in 1 cm on main scale and 50 Vernier scale divisions are equal to 49 main scale divisions, then least count of the travelling microscope is _____ $\times 10^{-6}$ m.

**Q31.** The number of radial and angular nodes in 4 d orbital are, respectively

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

**Q32.** Which of the following is a metalloid?

(1) Sc (2) Pb
(3) Bi (4) Te

**Q33.** The oxide which contains an odd electron at the nitrogen atom is

(1) $N_2O$ (2) $NO_2$
(3) $N_2O_3$ (4) $N_2O_5$

**Q34.** Which one of the following is an example of disproportionation reaction?

(1) $3\,MnO_4^{2-} + 4H^+ \rightarrow 2\,MnO_4^- + MnO_2 + 2H_2O$ (2) $MnO_4^- + 4H^+ + 4e^- \rightarrow MnO_2 + 2H_2O$
(3) $10I^- + 2\,MnO_4^- + 16H^+ \rightarrow 2\,Mn^2 + +8H_2O + 5I_2$ (4) $8\,MnO_4^- + 3\,S_2O_3^{2-} + H_2O \rightarrow 8\,MnO_2 + 6\,SO_4^{2-} + 2\,OH$

**Q35.** Boiling of hard water is helpful in removing the temporary hardness by converting calcium hydrogen carbonate and magnesium hydrogen carbonate to

(1) $CaCO_3$ and $Mg(OH)_2$ (2) $CaCO_3$ and $MgCO_3$
(3) $Ca(OH)_2$ and $MgCO_3$ (4) $Ca(OH)_2$ and $Mg(OH)_2$

**Q36.** s-block element which cannot be qualitatively confirmed by the flame test is

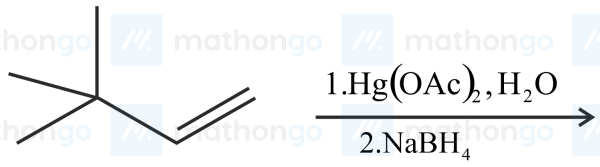
(1) Li (2) Na
(3) Rb (4) Be

**Q37.** The correct order of nucleophilicity is

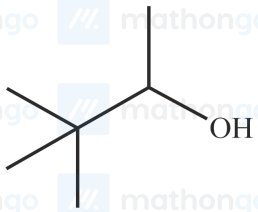
(1) $F^- > OH^-$ (2) $H_2\ddot{O} > OH^-$

(3) $ROH > RO^-$ (4) $NH_2^- > NH_3$

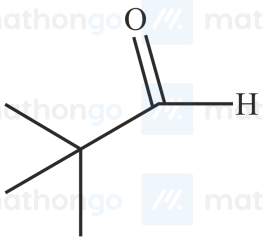
**Q38.**



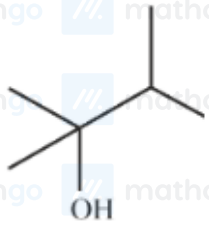

(1)



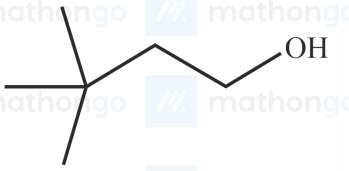

(2)




(3)

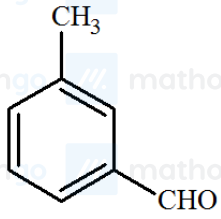



(4)

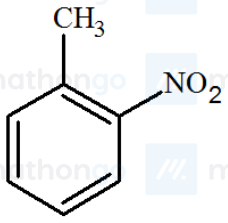



**Q39.** Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product?

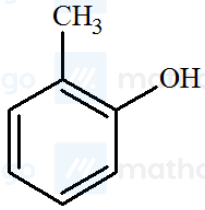
(1)



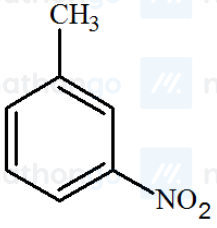

(2)




(3)




(4)




**Q40.** The measured BOD values tor four difterent water samples $(A - D)$ are as tollows: $A = 3$ ppm; $B = 18$ ppm; $C = 21$ ppm; $D = 4$ ppm. The water samples which can be called as highly polluted with organic wastes, are

(1) A&B (2) A&D

(3) B&C (4) B&D

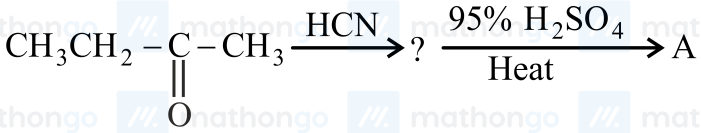
**Q41.** The role of depressants in 'Froth Floation method' is to

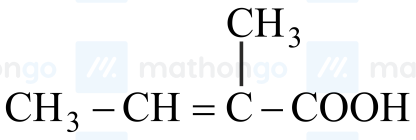
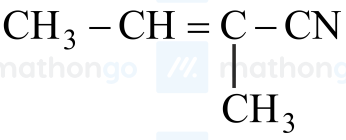
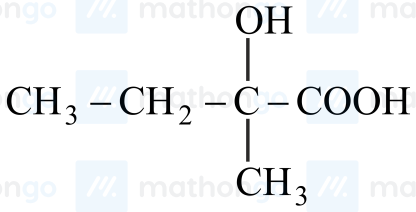
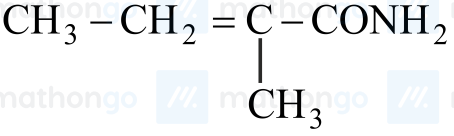
(1) selectively prevent one component of the ore from coming to the froth.
(2) reduce the consumption of oil for froth formation.
(3) stabilize the froth.
(4) enhance non-wettability of the mineral particles.

**Q42.** The most common oxidation state of Lanthanoid elements is $+3$. Which of the following is likely to deviate easily from $+3$ oxidation state?
(1) $Ce(At.\ No, 58)$
(2) $La(At.\ No, 57)$
(3) $Lu(At.\ No, 71)$
(4) $Gd(At.\ No, 64)$

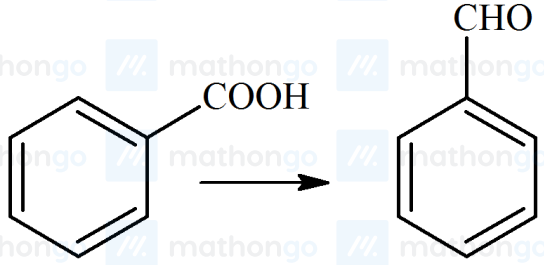
**Q43.** Toluene can be easily converted into benzaldehyde by which of the following reagents?
(1) $CrO_3$ /acetic acid, $H_3O^+$
(2) $CrO_3$ /acetic anhydride, $H_3O^+$
(3) $KMnO_4 / HCl, H_3O^+$
(4) $CO,\ HCl,\ Anhyd.\ AlCl_3$

**Q44.** The final product 'A' in the following reaction sequence



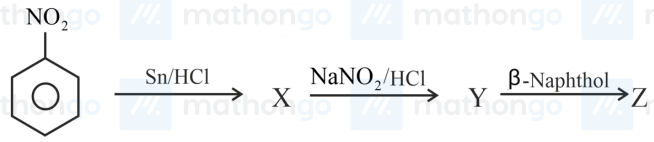
(1) 
(2) 
(3) 
(4) 

**Q45.** The reagent, from the following, which converts benzoic acid to benzaldehyde in one step is

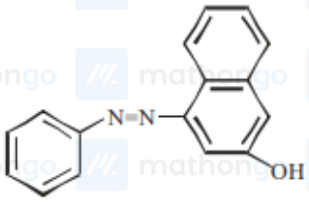


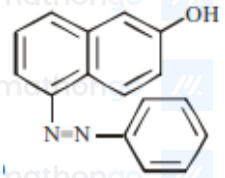
(1) $LiAlH_4$
(2) $KMnO_4$
(3) $MnO$
(4) $NaBH_4$

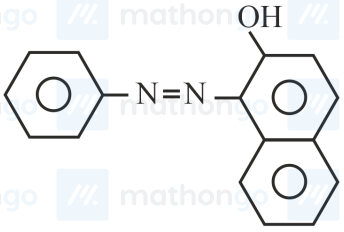
**Q46.** Which statement is NOT correct for p-toluenesulphonyl chloride?
(1) It is hinsberg's reagent
(2) It is used to distinguish primary and secondary amines.
(3) On treatment with secondary amine, it leads to a product, that is soluble in alkali.
(4) It does not react with tertiary amine.

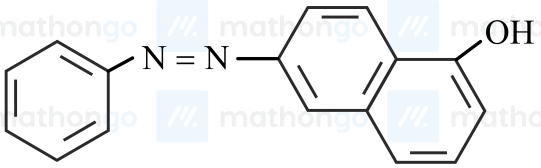
**Q47.** 


Identify 'Z' among the following

(1) 


(2) 


(3) 


(4) 


**Q48.** Match List I with List II.

| | **List-I Enzyme** | | **List-II Conversion of** |
|---|---|---|---|
| A. | Invertase | I. | Starch into maltose |
| B. | Zymase | II. | Maltose into glucose |
| C. | Diastase | III. | Glucose into ethanol |
| D. | Maltase | IV. | Cane sugar into glucose |

Choose the most appropriate answer from the options given below

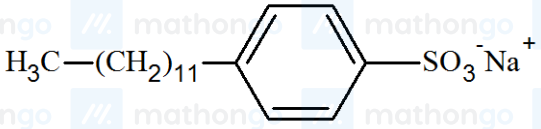
(1) A – III, B – IV, C – II, D – I

(2) A – III, B – II, C – I, D – IV

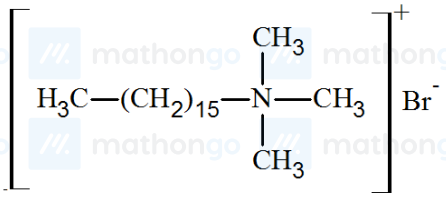
(3) A – IV, B – III, C – I, D – II

(4) A – IV, B – II, C – III, D – I

**Q49.** Which of the following is NOT an example of synthetic detergent?

(1) 


(2) $CH_3 - (CH_2)_{16} - COO^- Na^+$

(3) 


(4) $CH_3\,(CH_2)_{16}\,COO\,(CH_2\,CH_2\,O)_n\,CH_2\,CH_2\,OH$

**Q50.** Which one of the following is a water soluble vitamin, that is not excreted easily?

(1) Vitamin $B_2$

(2) Vitamin $B_1$

(3) Vitamin $B_6$

(4) Vitamin $B_{12}$

**Q51.** CNG is an important transportation fuel. When 100 gCNG is mixed with 208 g oxygen in vehicles, it leads to the formation of $CO_2$ and $H_2O$ and produces large quantity of heat during this combustion, then the amount of carbon dioxide, produced in grams is [nearest integer] [Assume CNG to be methane]

**Q52.** The moles of methane required to produce 81 g of water after complete combustion is____$\times 10^{-2}$ mol. [nearest integer]

**Q53.** Amongst $SF_4$, $XeF_4$, $CF_4$ and $H_2O$, the number of species with two lone pairs of electrons is

**Q54.** A fish swimming in water body when taken out from the water body is covered with a film of water of weight 36 g. When it is subjected to cooking at 100 °C, then the internal energy for vaporization in $kJmol^{-1}$ is integer]
[Assume steam to be an ideal gas. Given $\Delta_{vap}H^{\ominus}$ for water at 373 K and 1 bar is 41.1 kJ $mol^{-1}$ : R = 8.31 J $K^{-1}$ $mol^{-1}$]

**Q55.** 40% of HI undergoes decomposition to $H_2$ and $I_2$ at 300 K. $\Delta G^{\Theta}$ for this decompostion reaction at one atmopsphere pressure is____$Jmol^{-1}$-[nearest integer]
(Use R = 8.31 $JK^{-1}$ $mol^{-1}$; log 2 = 0.3010, ln 10 = 2.3, log 3 = 0.477)

**Q56.** In a solid AB, A atoms are in ccp arrangement and B atoms occupy all the octahedral sites. If two atoms from the opposite faces are removed, then the resultant stoichiometry of the compound is $A_xB_y$. The value of x is [nearest integer]

**Q57.** The osmotic pressure exerted by a solution prepared by dissolving 2.0 g of protein of molar mass 60 kg $mol^{-1}$ in 200 mL of water at 27 °C is____Pa. [integer value] (use R = 0.083 L bar $mol^{-1}$ $K^{-1}$)

**Q58.** $Cu(s) + Sn^{2+}(0.001M) \rightarrow Cu^{2+}(0.01M) + Sn(s)$
The Gibbs free energy change for the above reaction at 298 K is $x \times 10^{-1}$ kJ $mol^{-1}$. The value of x is____[nearest integer]
[Given : $E^{\ominus}_{Cu^{2+}/Cu} = 0.34$ V; $E^{\ominus}_{Sn^{2+}/Sn} = -0.14$ V; F = 96500 $Cmol^{-1}$]

**Q59.** Catalyst A reduces the activation energy for a reaction by 10 kJ $mol^{-1}$ at 300 K. The ratio of rate constants, $\frac{k_{T,\ Catalysed}}{k_{T,\ Uncatalysed}}$ is $e^x$. The value of x is____[nearest integer] [Assume that the pre-exponential factor is same in both the cases. Given R = 8.31 J $K^{-1}$ $mol^{-1}$]

**Q60.** Reaction of $[Co(H_2O)_6]^{2+}$ with excess ammonia and in the presence of oxygen results into a diamagnetic product. Number of electrons present in $t_{2g}$-orbitals of the product is

**Q61.** If $A = \sum_{n=1}^{\infty} \frac{1}{(3+(-1)^n)^n}$ and $B = \sum_{n=1}^{\infty} \frac{(-1)^n}{(3+(-1)^n)^n}$, then $\frac{A}{B}$ is equal to
(1) $\frac{11}{9}$ (2) 1
(3) $-\frac{11}{9}$ (4) $-\frac{11}{3}$

**Q62.** $16\sin(20^\circ)\sin(40^\circ)\sin(80^\circ)$ is equal to
(1) $\sqrt{3}$ (2) $2\sqrt{3}$
(3) 3 (4) $4\sqrt{3}$

**Q63.** If $m$ is the slope of a common tangent to the curves $\frac{x^2}{16} + \frac{y^2}{9} = 1$ and $x^2 + y^2 = 12$, then $12m^2$ is equal to

(1) 6 (2) 9
(3) 10 (4) 12

**Q64.** The locus of the mid-point of the line segment joining the point $(4,3)$ and the points on the ellipse $x^2+2y^2=4$ is an ellipse with eccentricity
(1) $\frac{\sqrt{3}}{2}$ (2) $\frac{1}{2\sqrt{2}}$
(3) $\frac{1}{\sqrt{2}}$ (4) $\frac{1}{2}$

**Q65.** The normal to the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{9}=1$ at the point $\left(8,3\sqrt{3}\right)$ on it passes through the point
(1) $\left(15,-2\sqrt{3}\right)$ (2) $\left(9,2\sqrt{3}\right)$
(3) $\left(-1,9\sqrt{3}\right)$ (4) $\left(-1,6\sqrt{3}\right)$

**Q66.** $\lim\limits_{x\to 0}\frac{\cos(\sin x)-\cos x}{x^4}$ is equal to
(1) $\frac{1}{3}$ (2) $\frac{1}{6}$
(3) $\frac{1}{4}$ (4) $\frac{1}{12}$

**Q67.** Let $r\in(P,q,\sim p,\sim q)$ be such that the logical statement $r\vee(\sim p)\Rightarrow(p\wedge q)\vee r$ is a tautology. Then $r$ is equal to
(1) $p$ (2) $q$
(3) $\sim p$ (4) $\sim q$

**Q68.** Let the mean of 50 observations is 15 and the standard deviation is 2. However, one observation was wrongly recorded. The sum of the correct and incorrect observations is 70. If the mean of the correct set of observations is 16, then the variance of the correct set is equal to
(1) 10 (2) 36
(3) 43 (4) 60

**Q69.** If the system of equations $\alpha x+y+z=5, x+2y+3z=4, x+3y+5z=\beta$. Has infinitely many solutions, then the ordered pair $(\alpha,\beta)$ is equal to
(1) $(1,-3)$ (2) $(-1,3)$
(3) $(1,3)$ (4) $(-1,-3)$

**Q70.** If the inverse trigonometric functions take principal values, then $\cos^{-1}\left(\frac{3}{10}\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right)+\frac{2}{5}\sin\left(\tan^{-1}\left(\frac{4}{3}\right)\right)\right)$ is equal to
(1) 0 (2) $\frac{\pi}{4}$
(3) $\frac{\pi}{3}$ (4) $\frac{\pi}{6}$

**Q71.** Let $f:\mathbb{R}\to\mathbb{R}$ be defined as $f(x)=x-1$ and $g:R\to\{1,-1\}\to\mathbb{R}$ be defined as $g(x)=\frac{x^2}{x^2-1}$. Then the function $fog$ is:
(1) One-one but not onto (2) onto but not one-one
(3) Both one-one and onto (4) Neither one-one nor onto

**Q72.** Let $f(x)=\min\{1,1+x\sin x\}, 0\le x\le 2\pi$. If $m$ is the number of points, where $f$ is not differentiable and $n$ is the number of points, where $f$ is not continuous, then the ordered pair $(m,n)$ is equal to
(1) $(2,0)$ (2) $(1,0)$
(3) $(1,1)$ (4) $(2,1)$

**Q73.** Consider a cuboid of sides $2x, 4x$ and $5x$ and a closed hemisphere of radius $r$. If the sum of their surface areas is constant $k$, then the ratio $x : r$, for which the sum of their volumes is maximum, is

(1) $2 : 5$ (2) $19 : 45$

(3) $3 : 8$ (4) $19 : 15$

**Q74.** If $\int \frac{1}{x}\sqrt{\frac{1-x}{1+x}}dx = g(x) + c, g(1) = 0$, then $g\left(\frac{1}{2}\right)$ is equal to

(1) $\log_e\left(\frac{\sqrt{3}-1}{\sqrt{3}+1}\right) + \frac{\pi}{3}$ (2) $\log_e\left(\frac{\sqrt{3}+1}{\sqrt{3}-1}\right) + \frac{\pi}{3}$

(3) $\log_e\left(\frac{\sqrt{3}+1}{\sqrt{3}-1}\right) - \frac{\pi}{3}$ (4) $\frac{1}{3}\log_e\left(\frac{\sqrt{3}-1}{\sqrt{3}+1}\right) - \frac{\pi}{6}$

**Q75.** The area of the region bounded by $y^2 = 8x$ and $y^2 = 16(3 - x)$ is equal to

(1) $\frac{32}{3}$ (2) $\frac{40}{3}$

(3) 16 (4) 9

**Q76.** If $y = y(x)$ is the solution of the differential equation $x\frac{dy}{dx} + 2y = xe^x, y(1) = 0$ then the local maximum value of the function $z(x) = x^2y(x) - e^x, x \in R$ is

(1) $1 - e$ (2) 0

(3) $\frac{1}{2}$ (4) $\frac{4}{e} - e$

**Q77.** If $\frac{dy}{dx} + e^x(x^2 - 2)y = (x^2 - 2x)(x^2 - 2)e^{2x}$ and $y(0) = 0$, then the value of $y(2)$ is

(1) $-1$ (2) 1

(3) 0 (4) $e$

**Q78.** Let $\vec{a} = \hat{i} + \hat{j} + 2\hat{k}, \vec{b} = 2\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} + \hat{k}$ be the three given vectors. Let $\vec{v}$ be a vector in the plane of $\vec{a}$ and $\vec{b}$ whose projection on $\vec{c}$ is $\frac{2}{\sqrt{3}}$. If $\vec{v}, \hat{j} = 7$, then $\vec{v} \cdot \left(\hat{i} + \hat{k}\right)$ is equal to

(1) 6 (2) 7

(3) 8 (4) 9

**Q79.** If the plane $2x + y - 5z = 0$ is rotated about its line of intersection with the plane $3x - y + 4z - 7 = 0$ by an angle of $\frac{\pi}{2}$, then the plane after the rotation passes through the point

(1) $(2, -2, 0)$ (2) $(-2, 2, 0)$

(3) $(1, 0, 2)$ (4) $(-1, 0, -2)$

**Q80.** If the lines $\vec{r} = \left(\hat{i} - \hat{j} + \hat{k}\right) + \lambda\left(3\hat{j} - \hat{k}\right)$ and $\vec{r} = \left(\alpha\hat{i} - \hat{j}\right) + \mu\left(2\hat{i} - 3\hat{k}\right)$ are co-planar, the the distance of the plane containing these two lines from the point $(\alpha, 0, 0)$ is

(1) $\frac{2}{9}$ (2) $\frac{2}{11}$

(3) $\frac{4}{11}$ (4) 2

**Q81.** If $p$ and $q$ are real number such that $p + q = 3,\ p^4 + q^4 = 369$, then the value of $\left(\frac{1}{p} + \frac{1}{q}\right)^{-2}$ is equal to

**Q82.** If $z^2 + z + 1 = 0, z \in C$, then $\left|\sum_{n=1}^{15}\left(z^n + (-1)^a\frac{1}{z^n}\right)^2\right|$ is equal to _____.

**Q83.** The total number of 3-digit numbers, whose greatest common divisor with 36 is 2, is _____.

**Q84.** If $a_1(> 0), a_2, a_3, a_4, a_5$ are in a G.P. , $a_2 + a_4 = 2a_3 + 1$ and $3a_2 + a_3 = 2a_4$, then $a_2 + a_4 + 2a_5$ is equal to _____.

**Q85.** If ${}^{40}C_0 + {}^{41}C_1 + {}^{42}C_2 + \cdots + {}^{60}C_{20} = \frac{m}{n} \times {}^{60}C_{20}$ where $m$ & $n$ are co-prime, then $m + n$ is equal to

**Q86.** Let a line $L_1$ be tangent to the hyperbola $\frac{x^2}{16} - \frac{y^2}{4} = 1$ and let $L_2$ be the line passing through the origin and perpendicular to $L_1$. If the locus of the point of intersection of $L_1$ and $L_2$ is $\left(x^2 + y^2\right)^2 = \alpha x^2 + \beta y^2$, then $\alpha + \beta$ is equal to _____.

**Q87.** Let $X = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$, $Y = \alpha I + \beta X + \gamma X^2$ and $Z = \alpha^2 I - \alpha\beta X + \left(\beta^2 - \alpha\gamma\right) X^2, \alpha, \beta, \gamma \in \mathbb{R}$.

If $Y^{-1} = \begin{bmatrix} \frac{1}{5} & \frac{-2}{5} & \frac{1}{5} \\ 0 & \frac{1}{5} & \frac{-2}{5} \\ 0 & 0 & \frac{1}{5} \end{bmatrix}$, then $(\alpha - \beta + \gamma)^2$ is equal to _____.

**Q88.** Let $f : \mathbb{R} \to \mathbb{R}$ satisfy $f(x + y) = 2^x f(y) + 4^y (f(x), \forall x, y \in \mathbb{R}$. If $f(2) = 3$, then $14 \cdot \frac{f'(4)}{f'(2)}$ is equal to _____.

**Q89.** The integral $\frac{24}{\pi} \int_0^{\sqrt{2}} \frac{(2 - x^2)\,dx}{(2 + x^2)\sqrt{4 + x^4}}$ is equal to _____.

**Q90.** If the probability that a randomly chosen 6-digit number formed by using digits 1 and 8 only is a multiple of 21 is $p$, then $96p$ is equal to _____.

## ANSWER KEYS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** (2) | **2.** (1) | **3.** (1) | **4.** (3) | **5.** (4) | **6.** (3) | **7.** (1) | **8.** (2) |
| **9.** (2) | **10.** (1) | **11.** (3) | **12.** (3) | **13.** (1) | **14.** (1) | **15.** (2) | **16.** (2) |
| **17.** (2) | **18.** (4) | **19.** (2) | **20.** (4) | **21.** (6) | **22.** (36) | **23.** (12) | **24.** (42) |
| **25.** (540) | **26.** (152) | **27.** (5) | **28.** (9) | **29.** (35) | **30.** (5) | **31.** (1) | **32.** (4) |
| **33.** (2) | **34.** (1) | **35.** (1) | **36.** (4) | **37.** (4) | **38.** (1) | **39.** (3) | **40.** (3) |
| **41.** (1) | **42.** (1) | **43.** (2) | **44.** (1) | **45.** (3) | **46.** (3) | **47.** (3) | **48.** (3) |
| **49.** (2) | **50.** (4) | **51.** (143) | **52.** (225) | **53.** (2) | **54.** (38) | **55.** (2735) | **56.** (3) |
| **57.** (415) | **58.** (983) | **59.** (4) | **60.** (6) | **61.** (3) | **62.** (2) | **63.** (2) | **64.** (3) |
| **65.** (3) | **66.** (2) | **67.** (3) | **68.** (3) | **69.** (3) | **70.** (3) | **71.** (4) | **72.** (2) |
| **73.** (2) | **74.** (1) | **75.** (3) | **76.** (4) | **77.** (3) | **78.** (4) | **79.** (3) | **80.** (2) |
| **81.** (4) | **82.** (2) | **83.** (150) | **84.** (40) | **85.** (102) | **86.** (12) | **87.** (100) | **88.** (248) |
| **89.** (3) | **90.** (33) | | | | | | |