Competishun

52/6, Opposite Metro Mas Hospital, Shipra Path, Mansarovar

Date: 18/11/2024

Time: 3 hours **Max. Marks:** 180

PRAVEEN-2 (24-25)_ACT-4_PAPER-2

Physics

MTC-SCQ

Q1 A gas of hydrogen–like atoms has some atoms at ground level and the rest in an excited level A. These atoms absorb monochromatic light of photon energy 22.95 eV, and subsequently emit radiation of six different photon energies, some of them more than 22.95 eV and some less. Then, match the following :

Column–I	**Column–II**
(a) out of the initial two groups (ground state, and level A) how many absorbed the radiation of 22.95 eV ? (Answer 1 if only one group absorbs, else 2)	(p) 1
(b) principal quantum number of level A	(q) 2
(c) principal quantum number of the level to which atoms are raised by the radiation	(r) 3
(d) the atomic number of the element	(s) 4

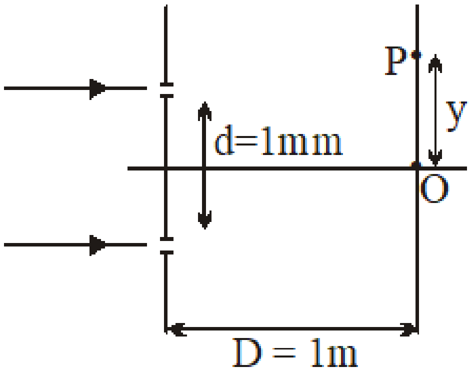
a) (a) – p ; (b) – q ; (c) – r ; (d) – s

b) (a) – r ; (b) – s ; (c) – p ; (d) – q

c) (a) – p ; (b) – q ; (c) – s ; (d) – r

d) (a) – p ; (b) – r ; (c) – s ; (d) – q

Q2 A parallel beam of visible light consisting of wavelengths λ_1 & λ_2 is incident on a standard YDSE apparatus with d = 1mm, D = 1m. P is a point on the screen at a distance y from center of screen O. $y = y_1$ is the nearest point above O where the two maxima coincide. $y = y_2$ is the nearest point above O where the two minima coincide. β_1 & β_2 are fringe width corresponding to wave length λ_1 & λ_2.



Column-I	Column-II
(a) $\beta_1 = 0.3$ mm, $\beta_2 = 0.5$ mm	(p) The 2nd nearest point above O where two maxima coincide is $y = 2y_1$
(b) $\beta_1 = 0.3$ mm, $\beta_2 = 0.4$ mm	(q) y_2 has no finite value
(c) $\beta_1 = 0.2$ mm, $\beta_2 = 0.4$ mm	(r) The 2nd nearest point above O where the two minima coincide is $y = 3y_2$.
(d) $\beta_1 = 0.2$ mm, $\beta_2 = 0.6$ mm	(s) y_1 = LCM of β_1 & β_2
	(t) The 2nd nearest point above O where two minima coincide is $y = 2y_2$.

a) (a) p,q,r; (b) r,s,t; (c) p,q,t; (d) p,r,s

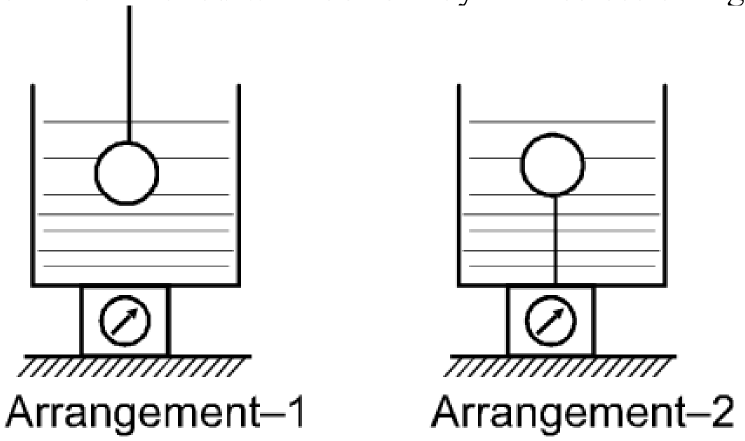
b) (a) p,r,s; (b) p,q,s; (c) p,q,s; (d) p,r,s

c) (a) r,s,t; (b) p,q,s; (c) q,r,s; (d) p,r

d) (a) p,q,r,s; (b) p,q,t; (c) p,r,s; (d) p,r,s

Multiple Choice Question

Q3 A container open from top, filled with water (density ρ_w) upto the top, is placed on a weighing machine and the reading is w. A wooden ball of volume V and mass m is put in the water by the given two arrangements. In arrangement–1, the ball is connected by a rigid rod (of negligible volume) and pushed in the water. In arrangement–2, the ball is attached with bottom by a massless string. The reading of weighing machine :



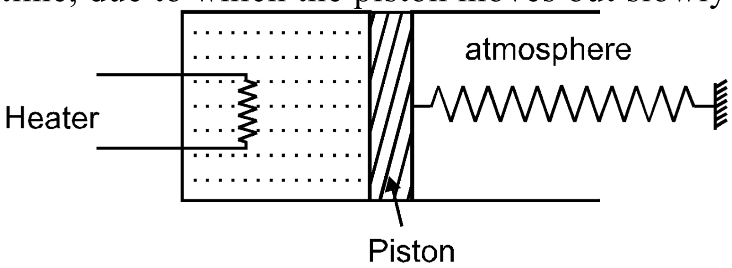
a) In arrangement–1 is W

b) In arrangement–1 is W + ρVg

c) In arrangement–2 is W + mg – ρ_wVg

d) In arrangement–2 is less that in arrangement–1

Q4 An ideal gas is filled in a cylinder as shown in figure. The initial temperature, pressure and volume of the gas are T_0, P_0 and V_0 respectively where P_0 = atmospheric pressure. A light and smooth piston of area A is connected to a spring of spring constant K, which is initially in natural length. Now the gas is heated slowly for some time, due to which the piston moves out slowly by a distance 'x'. Then :



a) Final pressure of the gas is $P_0 + \frac{Kx}{A}$

b) Final temperature of the gas is $\left(1+\frac{Kx}{P_0A}\right)\left(1+\frac{Ax}{V_0}\right) T_0$

c) The gas is undergoing constant pressure process

d) Work done by the gas is $\frac{1}{2}Kx^2$

Q5 Which of the following statements is/are correct for an x-ray tube ?

a) On increasing potential difference between filament and target, photon flux of x-rays increases

b) On increasing potential difference between filament and target, frequency of x-rays increases

c) On increasing filament current, cut–off wavelength increases

d) On increasing filament current, intensity of x-rays increases

Q6 Two radioactive nuclei A and B are present in equal numbers to begin with. Three day later, number of A nuclei are 3 times number of B nuclei. Choose the correct statement.

a) $\lambda_B - \lambda_A = \frac{\ell n3}{3 \text{ days}}$

b) $\lambda_A - \lambda_B = \frac{\ell n3}{3 \text{ days}}$

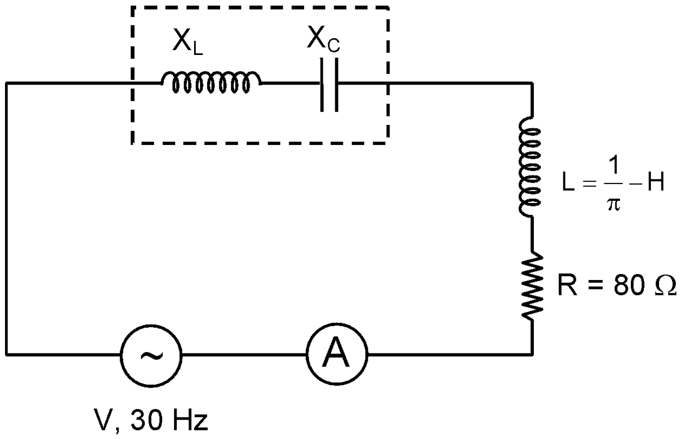
c) the ratio of activity rate of A and B after 3 days is $\frac{3}{1}$

d) the ratio of activity rate of A and B after 3 days is less than $\frac{3}{1}$.

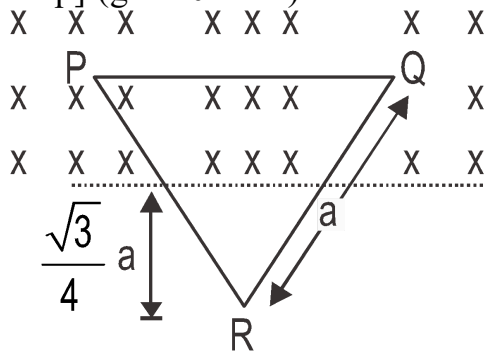
Numerical

Q7 A radioactive sample contains two radio nucleoids A and B having decay constant λ hr^{-1} and 2λ hr^{-1}. Initially 25% of total decay comes from A. How long (in hr) will it take before 75% of total decay comes from A. [Take λ = ln 3]

Q8 In figure below if $X_L = X_C$ and reading of AC ammeter is 1 A. Source voltage is V Volt. Find $\frac{V}{20}$ in Volt.



Q9 An equilateral triangular frame PQR of mass 2kg and side 1m is at rest under the influence of horizontal magnetic field 10T and gravitational field as shown in the figure. The plane of the frame is vertical find the magnitude of current (in ampere) in the frame so that the frame remains at rest [Neglect EMF induced due to motion of the loop] ($g = 10\ m/s^2$)

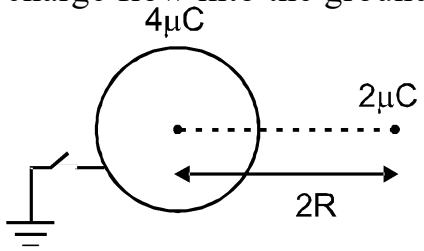


Q10 When equal volumes of two substance are mixed, the specific gravity of the mixture is 8, when equal weights of the same substance are mixed, the specific gravity of the mixture is 6. Find the ratio of specific gravity of denser substance to lighter substance.

Q11 A wire has a length of 2.0 m and a resistance of 3.0 Ω. Find the electric field (in V/m) existing inside the wire if it carries a current of 2 A.

Q12 Two heaters A and B are connected in parallel across the supply voltage 'v'. Heater A generates 400 calories of heat in 20 minutes while B generates 1000 calories of heat in 10 minutes. Resistance of heater A is 10Ω. What will be resistance of heater B.

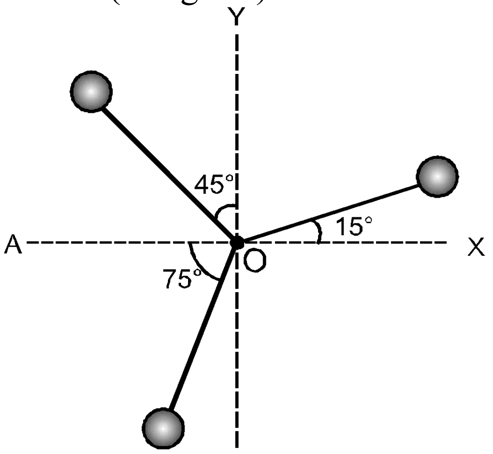
Q13 A solid conducting sphere having charge 4μC is placed on non–conducting stand. A point charge 2μC is placed at a distance from the centre of the sphere, which is double of radius of the sphere as shown in the figure. If conducting sphere is earthed then charge flow into the ground is x μC then calculate x.



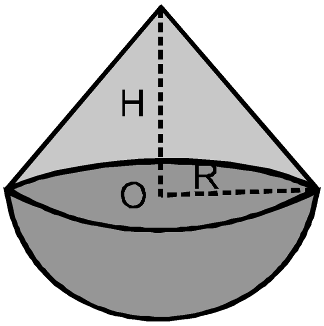
Q14 A binary star system has a time period T = 3 year, while the distance between its components is 2 astronomical units. If mass of the sun is represented by M_s, mass of the binary star in terms of mass of sun is αM_s. Find the value of 9α. (1 Astronomical unit = Distance between earth and sun and 1 year = time period of earth about sun)

Q15 A sphere of solid material of specific gravity 8 has a concentric spherical cavity and just sinks in water. If the ratio of radius of cavity to that of outer radius of the sphere is $\frac{x^{1/3}}{2}$ then what will be the value of x.

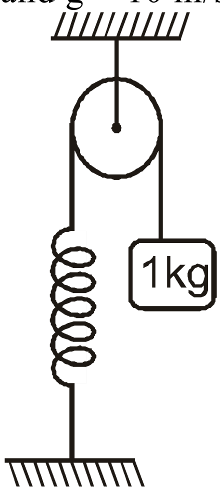
Q16 Each point mass 2 kg is connected at the end of each uniform rod of length 1 m and mass 1 kg. All the masses are in XY plane. Find the moment of inertia of system about Z-axis (in kg-m^2).



Q17 A homogenous body consists of right circular conical portion attached to a hemispherical portion of radius $R = \sqrt{3}$ m. Determine the height h of cone if the centre of gravity of the composite body coincides with the centre O of the circular base of the wire.



Q18 The pulley shown in figure has radius 20 cm and moment of inertia 0.2 kg m^2. Spring used has force constant 50 N/m. The system is released from rest and spring at its natural length initially. If the velocity of 1kg block when it has descended by 10cm is $\frac{1}{x}$ (in m/s), then calculate x. (Assume there is no sliding between pulley and string and $g = 10\ m/s^2$)



Chemistry

MTC-SCQ

Q19

Column I	**Column II**
(A) A process carried out infinitesimally slowly	(p) Adiabatic
(B) A process in which no heat enters or leaves the system	(q) $\Delta E = 0, \Delta H = 0$
(C) A process carried out at constant temperature	(r) Reversible
(D) Cyclic process	(s) Isothermal

a) (A – r) ; (B – p) ; (C – s) ; (D – q)
b) (A – r) ; (B – s) ; (C – p) ; (D – q)
c) (A – r) ; (B – p) ; (C – q) ; (D – s)
d) (A – q) ; (B – p) ; (C – s) ; (D – r)

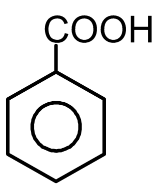
Q20

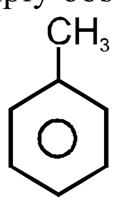
Column-I Compounds	**Column-II pKa values**
(A) $H_3C-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{C}}-OEt$	**(P)** 3.5
(B) $H_3C-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{C}}-CH_3$	**(Q)** 10.7
(C) $H-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{C}}-H$	**(R)** 8.9
(D) $H-\overset{O}{\overset{\parallel}{C}}-CH_2-\overset{O}{\overset{\parallel}{N}}\rightarrow O$	**(S)** 0.4

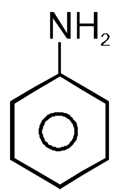
a) [A → Q; B → R; C → S; D → P]
b) [A → R; B → Q; C → S; D → P]
c) [A → Q; B → S; C → R; D → P]
d) [A → Q; B → R; C → P; D → S]

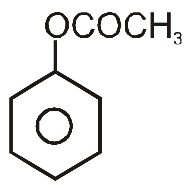
Multiple Choice Question

Q21 Friedel craft acylation is simply observed in :

a) 

b) 

c) 

d) 

Q22 In electrolysis of Al_2O_3 by Hall-Heroultprocess :

a) cryolite $Na_3[AlF_6]$ lowers the melting point of Al_2O_3 and increases its electrical conductivity.

b) Al is obtained at cathode and probably CO_2 at anode

c) electrolysis is carried out in aqueous medium **d)** anode consists of graphite

Q23 Which of the following is/are correctly matched with respect to the processes involved in the extractivemetallurgy of the respective metal ?

a) Bauxite $\rightarrow$Al : Leaching, precipitation, calcination and electrolytic reduction (molten state).

b) Ag_2S $\rightarrow$Ag : Leaching and displacement method.

c) PbS$\rightarrow$Pb : Froth flotation process, roasting and self reduction.

d) $KCl.MgCl_2.6H_2O$ $\rightarrow$Mg : Dehydration by simple heating and electrolytic reduction (molten state).

Q24 ΔG^o vs T plot in the Ellingham's diagram slopes upward for the reaction :

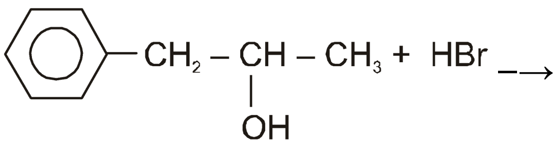
a) $Mg + O_2 \rightarrow MgO$ **b)** $2Ag + O_2 \rightarrow Ag_2O$ **c)** $C + O_2 \rightarrow CO$ **d)** $CO + O_2 \rightarrow CO$

Numerical

Q25 The number of hexagonal faces that are present in a truncated octahedron is :

Q26 At 300 K, 40 mL of O_3 (g) dissolves in 100 g of water at 1.0 atm. What mass of ozone (in gram) dissolved in 1600 g of water at a pressure of 4.0 atm at 300 K ?

Q27



Number of possible isomeric products including stereoisomers will be:

Q28 An ideal aqueous solution containing liquid A(M.Wt. = 128) 64% by weight has a vapour pressure of 145 mm Hg. If the vapour pressure of A is x mm of Hg and that of water is 155 mm Hg at the same temperature. Then find x/15. The solutions is ideal.

Q29 Total number of paramagnetic complexes which are inner orbital complexes :
$[Cr(NH_3)_6]Cl_3$, $[Co(NH_3)_6](NO_3)_2$, $[Ni(NH_3)_6]SO_4$, $K_2[PtCl_6]$, $[V(H_2O)_6]SO_4$, $[Mn(NH_3)_6]SO_4$, $[Fe(H_2O)_5 (NO)]SO_4$, $K_3[CuCl_4]$, $Na_4[Fe(CN)_5 (NOS)]$

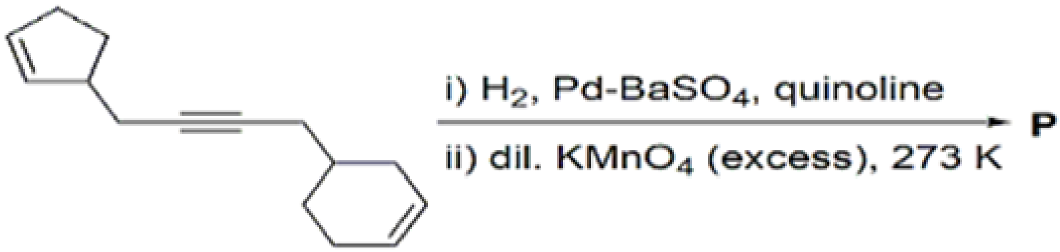
Q30 Find the sum of number of geometrical isomers for following complexes.
(a) $[CoCl_2Br_2]^{2-}$ (b) $[Rh(en)_3]^{3+}$ (c) $[Cr(en)_2 Br_2]^+$
(d) $[Pt\ en\ Cl_2]$ (e) $[Co(NH_3)_3(NO_2)_3]$

Q31 A transition metal 'M' among Sc, Ti, V, Cr, Mn and Fe has the highest second ionisation enthalpy. The spin only magnetic moment value of M^+ ion is BM (Near integer)
(Given atomic number Sc : 21, Ti : 22, V:23, Cr : 24, Mn : 25, Fe : 26)

Q32 Total number of acidic oxides among N_2O_3, NO_2, N_2O, Cl_2O_7, SO_2, CO, CaO, Na_2O and NO is__________.

Q33 The number of alkali metal(s), from Li, K, Cs, Rb having ionization enthalpy greater than 400 kJ mol^{-1} and forming stable super oxide is___.

Q34 Total number of hydroxyl groups present in a molecule of the major product P is



Q35 The number of chiral alcohol(s) with molecular formula $C_4H_{10}O$ is______.

Q36 The total number of intensive properties from the following is ______
Volume, Molar heat capacity, Molarity, E^{θ} cell, Gibbs free energy change, Molar mass, Mole

Mathematics

MTC-SCQ

Q37 If x, y, z ∈ R satisfies the system of equations $x + [y] + \{z\} = 12.7$, $[x] + \{y\} + z = 4.1$ and $\{x\} + y + [z] = 2$
(where $\{\cdot\}$ and $[\cdot]$ denotes the fractional and integral parts respectively), then match the following :

	Column-I		Column-II
(A)	$\{x\} + \{y\} =$	(P)	7.7
(B)	$[z] + [x] =$	(Q)	1.1
(C)	$x + \{z\} =$	(R)	1
(D)	$z + [y] - \{x\} =$	(S)	3
		(T)	4

a) $A \to P; B \to Q; C \to S; D \to T$
b) $A \to R; B \to S; C \to P; D \to Q$
c) $A \to R; B \to S; C \to T; D \to P$
d) $A \to R; B \to S; C \to Q; D \to T$

Q38 **Match the column :**

	Column-I		Column-II
(A)	The ratio of altitude to the radius of the cylinder of maximum volume that can be inscribed in a given sphere is	(P)	$\frac{1}{\sqrt{2}}$
(B)	The ratio of radius to the altitude of the cone of the greatest volume which can be inscribed in a given sphere is	(Q)	$\sqrt{2}$
(C)	The cone circumscribing the sphere of radius 'r' has the minimum volume if its semi vertical angle is θ, then 33 sin θ =	(R)	$\frac{32}{3}$
(D)	The greatest value of x^3y^4 if $2x + 3y = 7$, $x > 0$, $y \geq 0$ is	(S)	11

a) $A \to Q; B \to P; C \to S; D \to R$
b) $A \to P; B \to Q; C \to R; D \to S$
c) $A \to Q; B \to S; C \to P; D \to R$
d) $A \to S; B \to P; C \to Q; D \to R$

Multiple Choice Question

Q39 $\int \frac{dx}{(1+\sqrt{x})^8} = -\frac{1}{3(1+\sqrt{x})^{k_1}} + \frac{2}{7(1+\sqrt{x})^{k_2}} + C$, then:

a) $k_1 = 5$
b) $k_1 = 6$
c) $k_2 = 7$
d) $k_2 = 8$

Q40 If $f(\theta)=\lim_{n\to\infty}\sum_{r=0}^{n\theta}\frac{2r}{n\sqrt{(3\theta n-2r)(n\theta+2r)}}$ then:

a) $f(1)=\frac{\pi}{6}$

b) $f(\theta)=\frac{\theta}{2}\int_0^{\theta}\frac{dx}{\sqrt{\theta^2-\left(x-\frac{\theta}{2}\right)^2}}$

c) $f(\theta)$ is a constant function

d) $y = f(\theta)$ is invertible

Q41 Let $f(\theta)=\left(\cos\theta-\cos\frac{\pi}{8}\right)\left(\cos\theta-\cos\frac{3\pi}{8}\right)\left(\cos\theta-\cos\frac{5\pi}{8}\right)\left(\cos\theta-\cos\frac{7\pi}{8}\right)$ then :

a) Maximum value of $f(\theta)$ $\forall\theta\in R$ is $\frac{1}{4}$

b) Maximum value of $f(\theta)$ $\forall\theta\in R$ is $\frac{1}{8}$

c) $f(0) = \frac{1}{8}$

d) Number of principle solutions of $f(\theta) = 0$ is 8

Q42 If $(\vec{a}\times\vec{b})\times(\vec{c}\times\vec{d}) = h\vec{a}+k\vec{b} = r\vec{c}+s\vec{d}$, where $\vec{a},\vec{b}$ are non-collinear and $\vec{c},\vec{d}$ are also non-collinear then :

a) $h = [\vec{b}\ \vec{c}\ \vec{d}]$

b) $k = [\vec{a}\ \vec{c}\ \vec{d}]$

c) $r = [\vec{a}\ \vec{b}\ \vec{d}]$

d) $r = [\vec{a}\ \vec{b}\ \vec{c}]$

Numerical

Q43 If complete solution set of $e^{-x}\le 4-x$ is $[\alpha,\beta]$, then $[\alpha]+[\beta]$ is equal to :
(where $[\cdot]$ denotes greatest integer function)

Q44 If $\frac{z-\alpha}{z+\alpha}(a\in R)$ is a purely imaginary number and $|z| = 2$, then a value of α is

Q45 Let 'θ' be the angle in radians between the curves $\frac{x^2}{36}+\frac{y^2}{4}=1$ and $x + y = 12$. If $\theta = \tan^{-1}\left(\frac{a}{\sqrt{3}}\right)$; Find the value of a.

Q46 Let $f(x) = \int_0^x((a-1)(t^2+t+1)^2-(a+1)(t^4+t^2+1))dt$. Then the total number of integral values of 'a' for which $f'(x) = 0$ has no real roots is

Q47 Consider three boxes, each containing 10 balls labelled 1, 2, ...,10. Suppose one ball is randomly drawn from each of the boxes. Denote by n_i, the label of the ball drawn from the i^{th} box, $(i = 1, 2, 3)$. Then, the number of ways in which the balls can be chosen such that $n_1 < n_2 < n_3$ is N then find N/24.

Q48 Let $I_n = \int_{-1}^{1} |x|\left(1 + x + \frac{x^2}{2} + \frac{x^3}{3} + \ldots\ldots + \frac{x^{2n}}{2n}\right)dx$. If $\lim_{n\to\infty} I_n$ can be expressed as rational $\frac{p}{q}$ in its lowest form, then find the value of $\frac{pq(p+q)}{10}$

Q49 Find the number of solutions of the equation $2\sin^2 x + \sin^2 2x = 2$; $\sin 2x + \cos 2x = \tan x$ in $[0, 4\pi]$ satisfying the condition $2\cos^2 x + \sin x \le 2$.

Q50 Let $\vec{r} = (\vec{a} \times \vec{b}) sin\ x(\vec{b} \times \vec{c}) cos\ y + 2(\vec{c} \times \vec{a})$, where $\vec{a}, \vec{b}, \vec{c}$ are non-zero and non-coplanar vectors. If $\vec{r}$ is orthogonal to $\vec{a} + \vec{b} + \vec{c}$, then find the minimum value of $\frac{4}{\pi^2}(x^2 + y^2)$.

Q51 If $y^2 = 3\cos^2 x + 2\sin^2 x$, then the value of $y^4 + y^3 \frac{d^2y}{dx^2}$ is

Q52 For the parabola $y = -x^2$, let $a < 0$ and $b > 0$; $P(a, -a^2)$ and $Q(b, -b^2)$. Let M be the mid-point of PQ and R be the point of intersection of the vertical line through M, with the parabola. If the ratio of the area of the region bounded by the parabola and the line segment PQ to the area of the triangle PQR be $\frac{\lambda}{\mu}$; where λ and μ are relatively prime positive integers, then find the value $(\lambda + \mu)$

Q53 If $A^{-1} = \begin{bmatrix} sin^2\alpha & 0 & 0 \\ 0 & sin^2\beta & 0 \\ 0 & 0 & sin^2\gamma \end{bmatrix}$ and $B^{-1} = \begin{bmatrix} cos^2\alpha & 0 & 0 \\ 0 & cos^2\beta & 0 \\ 0 & 0 & cos^2\gamma \end{bmatrix}$ where α, β, γ are any real numbers and $C = (A^{-5} + B^{-5}) + 5A^{-1}B^{-1}(A^{-3} + B^{-3}) + 10A^{-2}B^{-2}(A^{-1} + B^{-1})$ then find $|C|$

Q54 Let A_n and B_n be square matrices of order 3, which are defined as :
$A_n = [a_{ij}]$ and $B_n = [b_{ij}]$ where $a_{ij} = \frac{2i+j}{3^{2n}}$ and $b_{ij} = \frac{3i-j}{2^{2n}}$ for all i and j, $1 \le i, j \le 3$.
If $\ell = \lim_{n\to\infty} Tr.(3A_1 + 3^2A_2 + 3^3A_3 + \ldots\ldots + 3^nA_n)$ and
$m = \lim_{n\to\infty} Tr.(2B_1 + 2^2B_2 + 2^3B_3 + \ldots\ldots + 2^nB_n)$, then find the value of $\frac{(\ell+m)}{3}$
[Note : Tr. (P) denotes the trace of matrix P.]

Answer Key

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**C**	**B**	**A, C, D**	**A, B**	**B, D**	**A, D**	**2**	**5**	**4**	**3**
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	**3**	**2**	**5**	**8**	**7**	**7**	**3**	**2**	**A**	**A**
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	**B, D**	**A, B, D**	**A, B, C**	**A, B, D**	**8**	**5**	**4**	**7**	**3**	**4**
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	**6**	**4**	**2**	**6**	**1**	**4**	**B**	**A**	**B, C**	**A, B, D**
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	**B, C, D**	**B, C, D**	**1**	**2**	**2**	**3**	**5**	**3**	**8**	**5**
Que.	51	52	53	54						
Ans.	**6**	**7**	**1**	**7**						