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-1

Physics

Multiple Choice Question

Q1 One mole of an ideal gas undergoes a process such that $P \propto \frac{1}{\sqrt{T}}$. The molar heat capacity of this process is 4R, R = universal gas constant.

a) The work done by the gas is 1.5 RΔT where ΔT is the change in temperature

b) Degree of freedom of the gas is 5.

c) On increase of temperature, volume increases

d) On increase of temperature, volume decreases

Q2 A beam of light having frequency ν is incident on an initially neutral metal of work function ϕ ($h\nu > \phi$). Then

a) all emitted photoelectrons have kinetic energy equal to ($h\nu - \phi$).

b) all free electrons in the metal, that absorb photons of energy hν completely, may not be ejected out of the metal.

c) after being emitted out of the metal, the kinetic energy of photoelectrons decreases continuously as long as they are at a finite distance from metal.

d) the emitted photo electrons move with constant speed after escaping from the field of metal.

Q3 A proton and an electron are moving with the same de–Broglie wavelength (consider the non–relativistic case). Then :

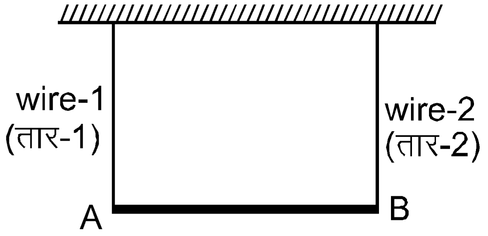
a) in a magnetic field both the particles describe circles of same radius

b) both the particles have the same momentum

c) the speed of the proton and the electron are in the ratio m_e / m_p, where m_e is the electron mass and m_p, the proton mass

d) the product of mass and kinetic energy is the same for both particles

Q4 A rod of length 0.3 m having variable linear mass density from A to B as $\lambda = \lambda_0 x$(x is distance from A in meter), where $\lambda_0 = 100$ kg/m^2 is suspended by two light wires of same length. Ratio of their linear mass density is 2 : 9. Then which of the following is/are correct :



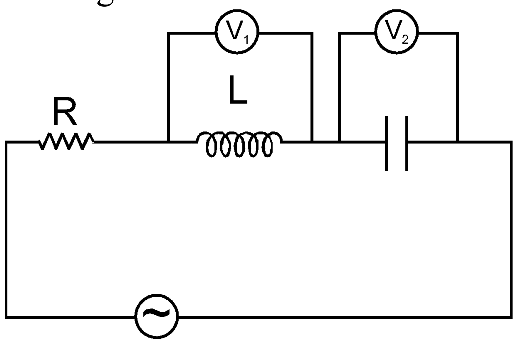
a) Ratio of wave speed in wire–1 to wire–2 is 3 : 2

b) Ratio of wave speed in wire–1 to wire–2 is 3 : 1

c) Second harmonic in wire–1 has same frequency as third harmonic in wire–2

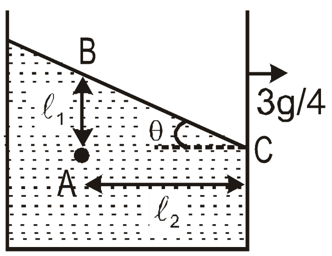
d) Third overtone in wire–1 has same frequency as fifth overtone in wire–2

Q5 In the circuit shown, resistance R = 100 Ω, inductance $L = \frac{2}{\pi}$ H and capacitance C = $\frac{8}{\pi}\mu F$ are connected in series with an ac source of 200 volt and frequency 'f'. If the readings of the hot wire voltmeters V_1 and V_2 are same then :



a) f = 125 Hz **b)** f = 250 π Hz **c)** current through R is 2A **d)** $V_1 = V_2 = 1000$ volt

Q6 A container is filled with a liquid of density ρ. Container is accelerating on a horizontal surface with acceleration $\frac{3g}{4}$ towards right hand side and liquid is at rest with respect to container as shown in figure. If there is a point A in liquid then, which of the following is **correct** : (assume atmospheric pressure is zero and AB is vertical and AC is horizontal line)



a) Pressure at A is $\rho g \ell_1$

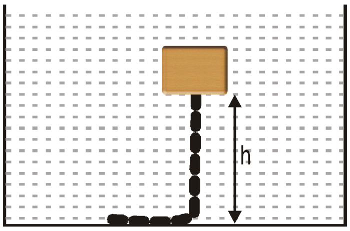
b) Pressure at A is $\rho \frac{3g}{4} \ell_2$

c) $\theta = \tan^{-1}\left(\frac{3}{4}\right)$

d) $\rho g \ell_1 = \rho g \ell_2$

Numerical

Q7 One end of a very long chain of linear mass density λ is fixed to a cube of mass m and specific density $\frac{2}{3}$ while the other end of chain is free. The cube attached with chain is immersed in deep water container. If specific density of chain is 6, then find the height h (in mtres) above the surface of container at which cube will float in equilibrium. (Given $\frac{m}{\lambda} = 50$ metre)

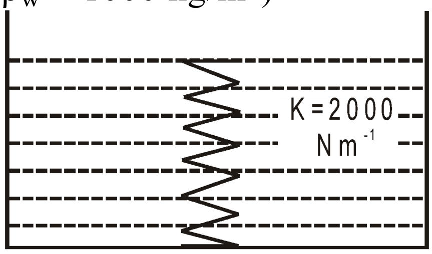


Q8 An engine takes in 5 moles of air at 20°C and 1 atm, and compresses it adiabatically to $1/10^{th}$ of the original volume. Assuming air to be a diatomic ideal gas made up of rigid molecules, the change in its internal energy during this process comes out to be X kJ. The value of X to the nearest integer is________.

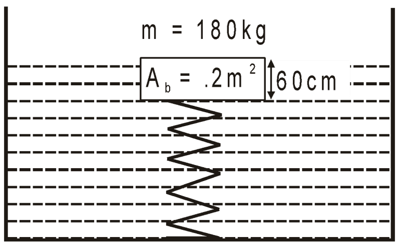
Q9 Two identical containers A and B with frictionless pistons contain the same ideal gas at the same temperature and the same volume V. The mass of the gas in A is m_A and that in the B is m_B. The gas in each cylinder is now allowed to expand isothermally to the same final volume 2V. The changes in the pressure in A and B are found to be ΔP and $1.5\Delta P$ respectively. Then find $\frac{14m_B}{m_A}$.

Q10 Intensity v/s wavelength of x-rays graphs are given for two different target elements. If number of protons in an atom of target element-1 is 37 then number of protons in an atom of target element-2 will be :

Q11 In a tank of horizontal cross-sectional area $1m^2$, a spring with force constant 2000 Nm^{-1} is fixed in vertical position upto the height of the water as shown in figure 1. A block of mass 180 kg is gently placed over the spring and it attains the equilibrium position as shown in figure 2. If base area of the block is $0.2m^2$ and height 60 cm, then find compression in the spring in cm in equilibrium position. (take $g = 10\ m/s^2$; $\rho_W = 1000\ kg/m^3$)



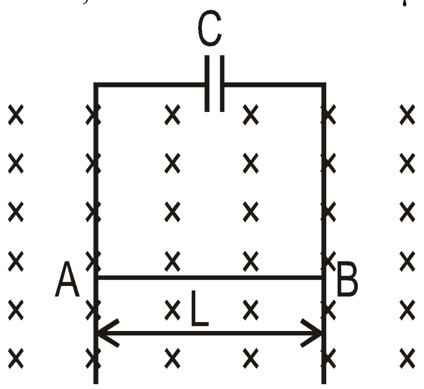
(Fig.1)



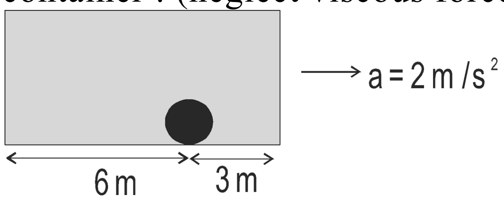
(Fig. 2)

Q12 An inductor of inductive reactance 30 Ω and a resistor of resistance 40 Ω are connected in series with an ac source of voltage 100V. Find the value of $\frac{Z(V_L + V_R)\sin\phi}{100}$ where Z is the impedance of the circuit, V_L is the voltage across inductor, V_R is the voltage across the resistor and ϕ is the phase angle between source voltage and current. All voltages refer to rms voltages.

Q13 Two metal bars are fixed vertically and are connected on the top by a capacitor C. A sliding conductor AB of length L slides with its ends in contact with the bars. The arrangement is placed in a uniform horizontal magnetic field directed normal to the plane of the figure. The conductor is released from rest. Find the displacement (x) in meter of the conductor at time 't' = 2 sec. [Given m = 100gm, g = 10m/s^2, B = 100 Tesla, L = 1m and C = 10 μF]

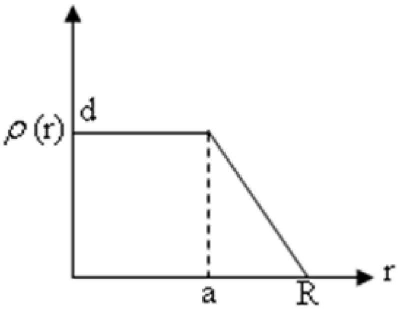


Q14 A small metallic ball is placed in a liquid filled in a closed container as shown. Initially ball is rest with respect container. Now the container is accelerated with an acceleration 2 m/s^2 towards right. The density of the ball is thrice that of the liquid. Find the time (in seconds) after which the ball will collide with the wall of the container : (neglect viscous forces and assume the floor of the container to be smooth)



Single Choice Question

Q15 The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density ρ (r) (charge per unit volume) is dependent only on the radial distance r from the centre of the nucleus, as shown. The electric field is only along radial direction

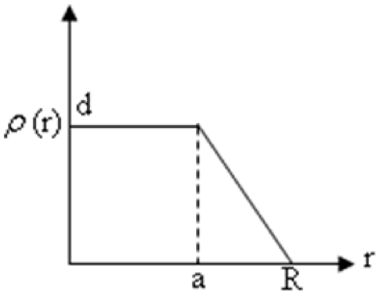


The electric field at r = R is :

a) independent of a **b)** directly proportional to a **c)** directly proportional to a^2

d) inversely proportional to a

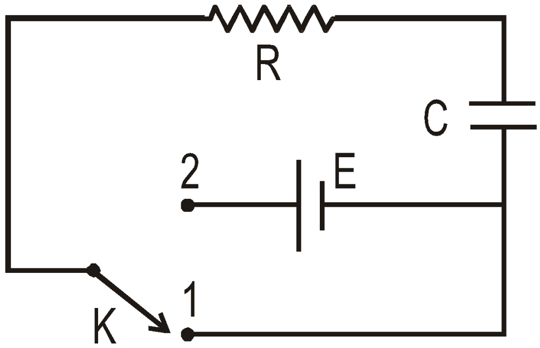
Q16 The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density ρ (r) (charge per unit volume) is dependent only on the radial distance r from the centre of the nucleus, as shown. The electric field is only along radial direction



For a = 0, the value of d(maximum value of ρ as shown in the figure) is :

a) $\frac{3Ze}{4\pi R^3}$ **b)** $\frac{3Ze}{\pi R^3}$ **c)** $\frac{4Ze}{3\pi R^3}$ **d)** $\frac{Ze}{3\pi R^3}$

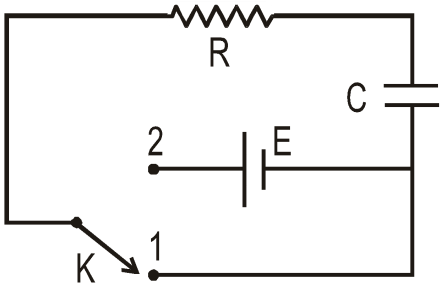
Q17 In the shown circuit involving a resistor of resistance R Ω, capacitor of capacitance C farad and an ideal cell of emf E volts, the capacitor is initially uncharged and the key is in position 1. At t = 0 second the key is pushed to position 2 for t_0 = RC seconds and then key is pushed back to position 1 for t_0 = RC seconds. This process is repeated again and again. Assume the time taken to push key from position 1 to 2 and vice versa to be negligible.



The charge on capacitor at t = 2RC second is

a) CE b) $CE\left(1-\frac{1}{e}\right)$ c) $CE\left(\frac{1}{e}-\frac{1}{e^2}\right)$ d) $CE\left(1-\frac{1}{e}+\frac{1}{e^2}\right)$

Q18 In the shown circuit involving a resistor of resistance R Ω, capacitor of capacitance C farad and an ideal cell of emf E volts, the capacitor is initially uncharged and the key is in position 1. At t = 0 second the key is pushed to position 2 for t_0 = RC seconds and then key is pushed back to position 1 for t_0 = RC seconds. This process is repeated again and again. Assume the time taken to push key from position 1 to 2 and vice versa to be negligible.



The current through the resistance at t = 1.5 RC seconds is

a) $\frac{E}{e^2R}(1-\frac{1}{e})$ b) $\frac{E}{eR}(1-\frac{1}{e})$ c) $\frac{E}{R}(1-\frac{1}{e})$ d) $\frac{E}{\sqrt{e}R}(1-\frac{1}{e})$

Chemistry

Multiple Choice Question

Q19 The function(s) of salt bridge in a cell is/ are

a) It maintains standard electrode potential of cell constant which depends on several factors.

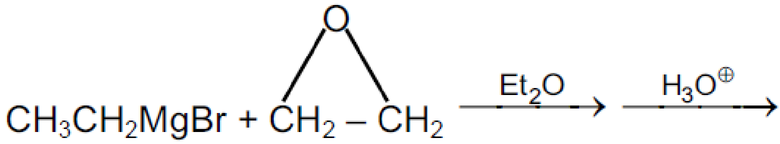
b) It completes the electrical circuit.

c) It departs both the solutions from each other.

d) It maintains the electrical neutrality of both electrolytic solutions.

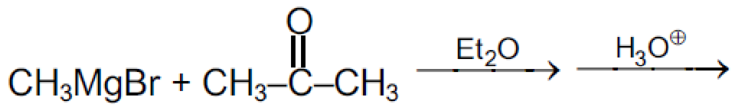
Q20 Which of the following reaction sequences would be the best for synthesis of t-butyl alcohol?

a)



b) $COCl_2 + CH_3MgBr \xrightarrow{Et_2O} \xrightarrow{H_3O^{\oplus}}$

c)



d) $(CH_3)_3C{-}MgBr + O_2 \xrightarrow{Et_2O} \xrightarrow{H_3O^{\oplus}}$

Q21 In which of following silicate(s), the number of corners shared per tetrahedron is ≥ 2?

a) Four membered cylic silicate **b)** Pyrosilicate **c)** Chain silicate **d)** 2-D silicate

Q22 The reactions taking place in the dry cell are :
Anode: $Zn \rightarrow Zn^{2+} + 2e^-$
Cathode: $2MnO_2 + 2NH_4^+ + 2e^- \rightarrow Mn_2O_3 + 2NH_3 + H_2O$
The minimum mass of reactants, if a dry cell is to generate 0.25A for 9.65 h, are (Mn = 55, Zn = 65.4) (neglect any other chemical reactions occurring in the cell)

a) 2.943 g Zn **b)** 7.83 g MnO_2 **c)** 1.62 g NH_4^+ **d)** 3.915 g MnO_2

Q23 Consider the 1st order reactions :

$$A \xrightarrow[E_1]{k_1} B;\ 2A \xrightarrow[E_4]{k_4} D;\ B \xrightarrow[E_2]{k_2} C;\ D \xrightarrow[E_3]{k_3} 2C.$$

E_1, E_2, E_3 and E_4 are respective activation energies and k_1, k_2, k_3 and k_4 are respective rate constants. Which of the following is/are correct ?

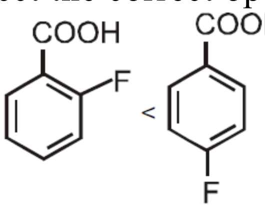
a) $\frac{d[B]}{dt} = k_1[A] - k_2[B]$

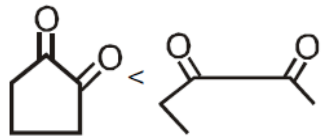
b) $\frac{d[C]}{dt} = k_2[B] + 2k_3[D]$

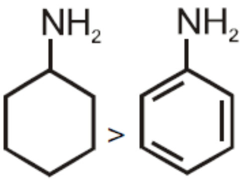
c) Average activation energy of $A = \frac{k_1E_1 + k_4E_4}{k_1 + k_4}$

d) None of these

Q24 Select the correct options:

a)  (pKa order)

b)  (% enol content)

c)  (K_b order))

d) Both the C – O bond lengths in HCOOK are equal

Numerical

Q25 Consider the following reversible reaction,

$A(g) + B(g) \rightleftharpoons AB(g)$

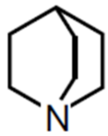
The activation energy of the backward reaction exceeds that of the forward reaction by 2RT (in J mol^{-1}). If the pre-exponential factor of the forward reaction is 4 times that of the reverse reaction, the absolute value of ΔG^{θ} (in J mol^{-1}) for the reaction at 300 K is , if your answer is x J mol^{-1} than what will be the value of x/100.

(Given; ln(2) = 0.7, RT = 2500 J mol^{-1} at 300 K and G is the Gibbs energy)

Q26 How many following order's are correct for Nucleophicity as well as basicity.

(a) $HO^{\ominus} >> H_2O$ (b) $NH_2^{\ominus} >> NH_3$ (c) $I^{\ominus} > Br^{\ominus} > Cl^{\ominus} > F^{\ominus}$

(d) $MeO^{\ominus} > HO^{\ominus} > MeCOO^{\ominus}$ (e) $HOO^{\ominus} > HO^{\ominus}$ (f) $\ddot{N}H_2-\ddot{N}H_2 > \ddot{N}H_3$

(g) $HS^{\ominus} > OH^{\ominus}$ (h) $(CH_3 - CH_2)_3N <$  (i) $\overset{\ominus}{C}H_3 > \overset{\ominus}{N}H_2 > \overset{\ominus}{O}H > F^{\ominus}$

Q27 The maximum number of electrons that can have principal quantum number, n = 3, and spin quantum number, $m_s = -1/2$, is

Q28 100 g of propane is completely reacted with 1000 g of oxygen. The mole fraction of carbon dioxide in the resulting mixture is $x \times 10^{-2}$. The value of x is ________.

(Nearest integer)

[Atomic weight : H = 1.008; C = 12.00; O = 16.00]

Q29 200 mL of 0.1 M aqueous solution of acetic acid is mixed with equal volume of equimolar HCl solution at 27°C. If 1 g of NaOH is added to this, then the $[H^+]$ in final solution is $x \times 10^{-y}$ (represented in scientific notation). Find x + y. K_a of acetic acid = 2×10^{-5}

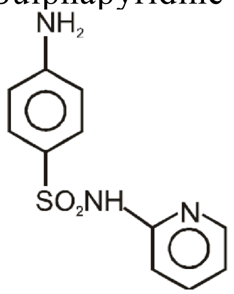
Q30 Number of oxygen atoms present in chemical formula of fuming sulphuric acid is ________

Q31 During the preparation of $H_2S_2O_8$ (peroxydisulphuric acid) using H_2SO_4 electrolytically, O_2 gas also releases at anode as by product. When 10.304 L of H_2 releases at cathode and 2.24 L O_2 at anode at STP, the weight of $H_2S_2O_8$ produced in gram is : (Round it off to nearest whole number)

Q32 Equilibrium constant for the given reaction is $K = 10^{20}$ at temperature 300 K
$A(s) + 2B\ (aq.) \rightleftharpoons 2C\ (s) + D\ (aq.)\ K = 10^{20}$
Calculate the equilibrium concentration of B (in mol/L) starting with mixture of 1 mole of A and 1/2
mole/litre of B in a container of volume 1L at 300 K
(Give your answer by multiplying it with 10^{12})

Single Choice Question

Q33 Sulphur forms numerous compounds and show variety of oxidation states. It also exhibit a good tendency of catenation. It forms variety of oxoacids and oxoanions also. Sulphur also occur in several biomolecules and is also used in chemotherapy as sulphadrugs.
Sulphapyridine was shown to be effective drug against pneumonia



(Sulphapyridine)

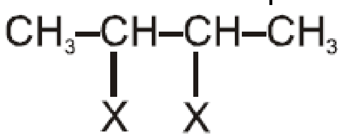
What is the hybridization of 'S' in this compound.

a) sp^2 **b)** sp^3d **c)** sp^3 **d)** sp^3d^2

Q34 Sulphur forms numerous compounds and show variety of oxidation states. It also exhibit a good tendency of catenation. It forms variety of oxoacids and oxoanions also. Sulphur also occur in several biomolecules and is also used in chemotherapy as sulphadrugs.
Among the following compounds of sulphur, which contain sulphur–sulphur bond?

a) $H_2S_2O_5$ **b)** $H_2S_2O_3$ **c)** $Na_2S_4O_6$ **d)** CaS_2O_7

Q35 The compound shows below in the diagram, on treatment with acid catalyst isomerizes and equilibrium is established among the stereoisomers.

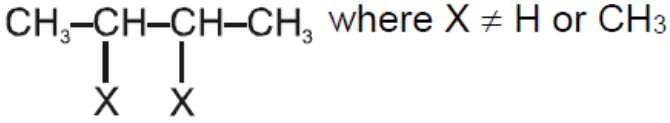


where X ≠ H or CH_3

The equilibrium mixture contains all the three stereoisomers of this compound. Specific rotation of pure dextro isomer is +62° while the specific rotation of the equilibrium mixture is + 22°. Also the equilibrium mixture contains 20% of the meso isomers. Answer the following three qeustions based on the above information.
The percentage purity of the equilibrium mixture is :

a) 28% **b)** 35% **c)** 46% **d)** 54%

Q36 The compound shows below in the diagram, on treatment with acid catalyst isomerizes and equilibrium is established among the stereoisomers.



The equilibrium mixture contains all the three stereoisomers of this compound. Specific rotation of pure dextro isomer is +62° while the specific rotation of the equilibrium mixture is + 22°. Also the equilibrium mixture contains 20% of the meso isomers. Answer the following three qeustions based on the above information.
The percentage of racemic mixture present in the equilibrium mixture is :

a) 35% **b)** 45% **c)** 65% **d)** 80%

Mathematics

Multiple Choice Question

Q37 Let f(x) = $\cos^{-1}\left(\frac{1-tan^2(x/2)}{1+tan^2(x/2)}\right)$
Which of the following statement(s) is/are correct about f(x) ?
a) Domain is R **b)** Range is $[0, \pi]$ **c)** f(x) is even **d)** f(x) is derivable in $(\pi, 2\pi)$

Q38 For x ∈ R^+, if x, [x], {x} are in harmonic progression then the value of x can not be equal to : (where [·] denotes greatest integer function, {·} denotes fractional part function)
a) $\frac{1}{\sqrt{2}}\tan\frac{\pi}{8}$ **b)** $\frac{1}{\sqrt{2}}\cot\frac{\pi}{8}$ **c)** $\frac{1}{\sqrt{2}}\tan\frac{\pi}{12}$ **d)** $\frac{1}{\sqrt{2}}\cot\frac{\pi}{12}$

Q39 If $f(x)=\begin{cases}\sin^{-1}(\sin x) & x>0\\ \frac{\pi}{2} & x=0\\ \cos^{-1}(\cos x) & x<0\end{cases}$, then
a) x = 0 is a point of maxima **b)** f(x) is continuous ∀ x ∈ R
c) Global maximum value of f(x) ∀ x ∈ R is π
d) Global minimum value of f(x) ∀ x ∈ R is 0

Q40 The function f(x) = 1 + x ln $\left(x+\sqrt{1+x^2}\right)-\sqrt{1-x^2}$ is :
a) Strictly increasing ∀ x ∈ (0, 1) **b)** Strictly increasing ∀ x ∈ (–1, 0)
c) Strictly decreasing for x ∈ (–1, 0) **d)** Strictly decreasing for x ∈ (0, 1)

Q41 The straight line which is both tangent and normal to the curve x = $3t^2$, y = $2t^3$ is :
a) $y+\sqrt{3}(x-1)=0$ **b)** $y-\sqrt{3}(x-1)=0$ **c)** $y+\sqrt{2}(x-2)=0$
d) $y-\sqrt{2}(x-2)=0$

Q42 PQ is a double ordinate of the parabola $y^2 = 4ax$. If the normal at P intersect the line passing through Q and parallel to x-axis at G; then locus of G is a parabola with :
a) Vertex at (4a, 0) **b)** focus at (5a, 0) **c)** Directrix as the line x = 3a – 0
d) length of latus rectum equal to 4a

Numerical

Q43 Let f(x) = $x^3 - 3x + 1$. Find the number of different real solution of the equation f(f(x)) = 0.

Q44 The number of solutions of the equation $\cos^{-1}\left(\frac{1-x^2-2x}{(x+1)^2}\right) = \pi(1-\{x\})$, for x ∈ [0, 76) is equal to. (where {·} denote fraction part function)

Q45 $\int \frac{x+(acrc\ cos3x)^2}{\sqrt{1-9x^2}}dx = \frac{1}{k_1}\left(\sqrt{1-9x^2} + (cos^{-1}3x)^{k_2}\right)+ C$, then $k_1^2 + k_2^2 =$
(Where C is an arbitrary constant.)

Q46 The Director circle of the parabola $(y-2)^2 = 16(x+7)$ touches the circle $(x-1)^2 + (y+1)^2 = r^2$, then r is equal to :

Q47 If area of the ellipse $\frac{x^2}{16} + \frac{y^2}{b^2} = 1$ inscribed in a square of side length $5\sqrt{2}$ is A, then $\frac{A}{\pi}$ equals to:

Q48 If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors, then the value of $|\vec{a} - 2\vec{b}|^2 + |\vec{b} - 2\vec{c}|^2 + |\vec{c} - 2\vec{a}|^2$ does not exceed to:

Q49 If $\vec{a}, \vec{b}$ and $\vec{c}$ are three non-zero non-coplanar vectors and $\vec{p} = \vec{a} + \vec{b} - 2\vec{c}$; $\vec{q} = 3\vec{a} - 2\vec{b} + \vec{c}$ and $\vec{r} = \vec{a} - 4\vec{b} + 2\vec{c}$ are three vectors such that the volumes of the parallelepiped formed by $\vec{a}, \vec{b}, \vec{c}$ and $\vec{p}, \vec{q}, \vec{r}$ as their coterminous edges are V_1 and V_2 respectively. Then $\frac{V_2}{V_1}$ is equal to:

Q50 If O (origin) is a point inside the triangle PQR such that $\overrightarrow{OP} + k_1\overrightarrow{OQ} + k_2\overrightarrow{OR} = 0$, where k_1, k_2 are constants such that $\frac{Area\ (\Delta PQR)}{Area\ (\Delta OQR)} = 4$, then the value of $k_1 + k_2$ is :

Single Choice Question

Q51 Let f(x) be a continuous function (define for all x) which satisfies
$f^3(x) - 5f^2(x) + 10f(x) - 12 \geq 0$, $f^2(x) - 4f(x) + 3 \geq 0$ and $f^2(x) - 5f(x) + 6 \leq 0$

If distinct positive number b_1, b_2 and b_3 are in G.P. then $f(1) + \text{In } b_1$, $f(2) + \text{In } b_2$, $f(3) + \text{In } b_3$ are in :

a) A.P. **b)** G.P. **c)** H.P. **d)** A.G.P.

Q52 Let f(x) be a continuous function (define for all x) which satisfies
$f^3(x) - 5f^2(x) + 10f(x) - 12 \geq 0$, $f^2(x) - 4f(x) + 3 \geq 0$ and $f^2(x) - 5f(x) + 6 \leq 0$

The equation of tangent that can be drawn from (2, 0) on the curve $y = x^2f(\sin x)$ is:

a) $y = 24(x+2)$ **b)** $y = 12(x+2)$ **c)** $y = 24(x-2)$ **d)** $y = 12(x-2)$

Q53

Let $f(x) = \begin{cases} 1-x & ; \ 0 \le x \le 1 \\ 0 & ; \ 1 < x \le 2 \\ (2-x)^2 & ; \ 2 < x \le 3 \end{cases}$ and $g(x) = \int_0^x f(t)dt$

Let the tangent to the curve y = g(x) at point P whose abscissa is $\frac{5}{2}$ cuts x-axis in point Q.
Let the perpendicular from point Q on x – axis meets the curve y=g(x) in point R.

g(1) =

a) 0 **b)** $\frac{1}{2}$ **c)** 1 **d)** 2

Q54

Let $f(x) = \begin{cases} 1-x & ; \ 0 \le x \le 1 \\ 0 & ; \ 1 < x \le 2 \\ (2-x)^2 & ; \ 2 < x \le 3 \end{cases}$ and $g(x) = \int_0^x f(t)dt$

Let the tangent to the curve y = g(x) at point P whose abscissa is $\frac{5}{2}$ cuts x-axis in point Q.
Let the perpendicular from point Q on x – axis meets the curve y=g(x) in point R.

Equation of tangent to the curve y = g(x) at P is :

a) 3y = 12x + 1 **b)** 3y = 12x – 1 **c)** 12y = 3x – 1 **d)** 12y = 3x + 1

Answer Key

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**A, B, C**	**B, C**	**A, B, C, D**	**A, C, D**	**A, C, D**	**A, B, C**	**30**	**46**	**21**	**19**
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	**40**	**42**	**10**	**03**	**A**	**B**	**C**	**D**	**B, C, D**	**B, C, D**
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	**A, C, D**	**A, B, C**	**A, B**	**A, C, D**	**85**	**05**	**09**	**19**	**11**	**07**
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	**50**	**50**	**C**	**C**	**B**	**B**	**C, D**	**A, C, D**	**A, C**	**Bonus**
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	**C, D**	**A, B, C, D**	**07**	**76**	**90**	**12**	**12**	**21**	**15**	**03**
Que.	51	52	53	54						
Ans.	**A**	**C**	**B**	**C**						