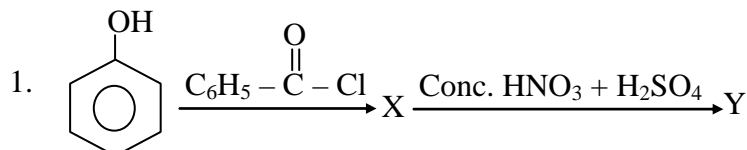
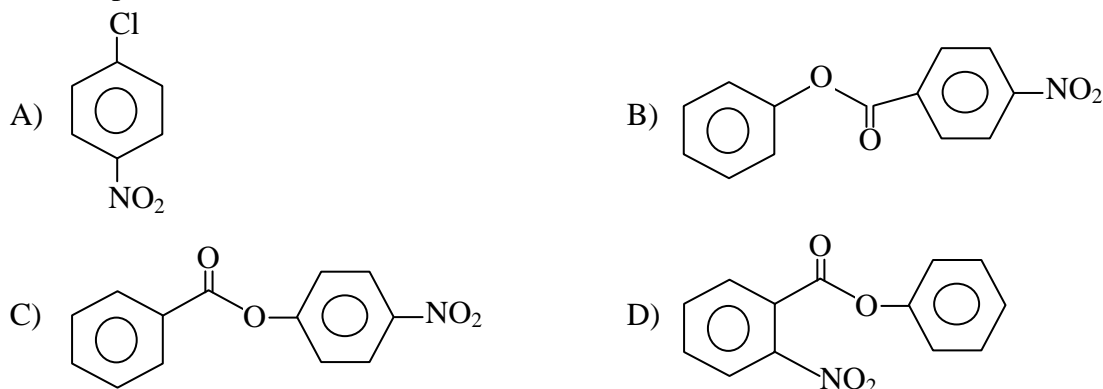


PART I :CHEMISTRY
SECTION – I (Total Marks:21)
(Single answer type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.



The compound Y is



2. The hybridization of boron in B_2H_6 is

- A) sp^2 B) sp^3 C) sp D) sp^3d

3. If the mass of an electron equal to uncertainty in position, then uncertainty in velocity equal to

- A) $\frac{h}{4\pi m}$ B) $\frac{h}{4\pi m^2}$ C) $\frac{h}{4\pi}$ D) $\frac{4\pi m^2}{h}$

4. The volume occupied by atoms in a two dimensional square unit cell is

- A) πl^2 B) $\frac{\pi l^2}{2}$ C) $\frac{\pi l^2}{3}$ D) $\frac{\pi l^2}{4}$

5. Adsorption of gases on solids is accompanied with

- A) increase in enthalpy B) increase in entropy
C) decrease in entropy D) increase in free energy

6. Silica reacts with fused aqueous NaOH to form

- A) SiO_2 B) SiO_2^{2-} C) SiO_3^{2-} D) SiO

7. The synthesis of 3-octyne is achieved by adding a bromo alkane into a mixture of sodium amide and an alkyne. The bromoalkane and alkyne respectively are

- A) $BrCH_2CH_2CH_2CH_2CH_3$ and $CH_3CH_2C \equiv CH$ B) $BrCH_2CH_2CH_3$ and $CH_3CH_2CH_2C \equiv CH$
C) $BrCH_2CH_2CH_2CH_2CH_3$ and $CH_3C \equiv CH$ D) $BrCH_2CH_2CH_2CH_3$ and $CH_3CH_2C \equiv CH$

SECTION – II (Total Marks:16)
(Multiple correct answer(s) type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** may be correct. Each correct answer carries **4 Marks**. There is no negative marking.

8. Which of the following acts as oxidant as well as reducing agent?

- A) H_2O_2 B) SO_2 C) O_3 D) HNO_2

9. Which of the following is more reactive than benzene towards electrophilic aromatic substitution?

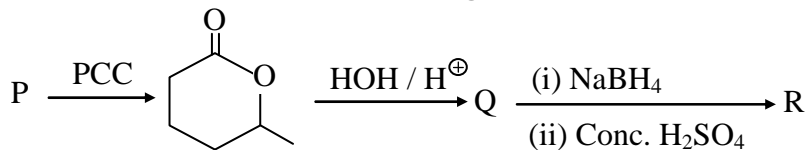
- A) pyrrole B) ferrocene C) pyridine D) nitrobenzene

10. Which of the following gives yellow precipitate with ammonium phosphomolybdate?
 A) PO_4^{3-} B) Mg^{2+} C) As^{3+} D) Ni^{2+}
11. Which of the following is paramagnetic?
 A) $\text{K}_4[\text{Fe}(\text{CN})_6]$ B) $\text{Ni}(\text{CO})_4$ C) $\text{K}_3[\text{Cr}(\text{CN})_6]$ D) $\text{K}_2[\text{Ni}(\text{Cl}_4)]$

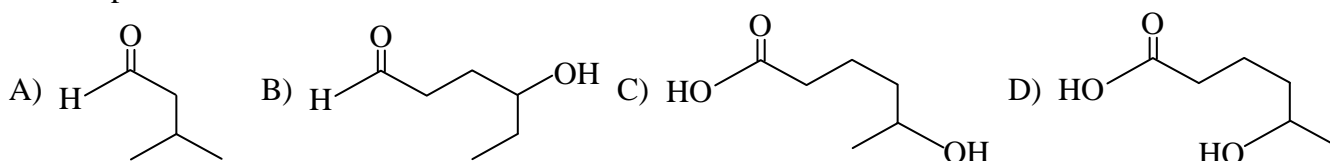
SECTION – III (Total Marks:15)
(Paragraph Type)

This section contains **2 paragraphs**. Based upon one of the paragraph **3 multiple choice questions** and based on the other paragraph **2 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

Paragraph for Question Nos. 12 to 14



12. The compound P is



13. The compound Q is

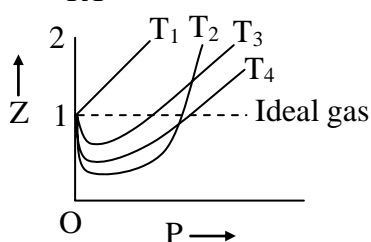


14. The compound R is



Paragraph for Question Nos. 15 to 16

$Z = \frac{PV}{RT}$; Z is called compressibility factor of gas. $Z=1$ for ideal gas.



15. The compressibility factor of the gas when molar volume of gas is very high will be
 A) 0 B) 1 C) >1 D) <1
16. Which of the following is equal to compressibility factor Z for a real gas?
 A) $\frac{V}{PV}$ B) $\frac{V}{V-b}$ C) $\frac{a}{RTV}$ D) $\frac{Pb}{RT}$

SECTION – IV (Total Marks:28)
(Integer Answer type)

This section contains **7 questions**. The answer to each of the question is a **single digit integer**, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. Each correct answer carries **4 Marks**. There is no negative marking.

17. The magnetic moment of d^8 ion in square planar strong field ligands is _____

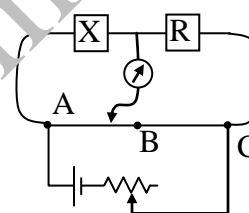
18. Electrolysis is used to determine the gold content of a sample. The sample is dissolved, and all the gold is converted to $\text{Au}^{3+}(\text{aq})$. The reduction half reaction is $\text{Au}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s})$
 What mass of gold (in grams) will be deposited at the cathode in 1.00 hour by a current of 1.50A? (At. mass of Au is 197)
19. How many hydrogen bonds are present in H_9O_4^+ ?
20. The number of π bonds present in the hydrolysis product of calcium carbide is
21. How many chiral carbon atoms are present in cyclic structure of glucose?
22. Total number of geometric isomers possible in tetrahedral complex of type M_{abcd} is _____
23. 50 ml solution of $\text{pH} = 3$ is diluted upto 500 ml. Calculate the pH of resultant solution.

PART II : PHYSICS
SECTION – I (Total Marks:21)
(Single answer type)

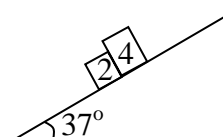
This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

24. A particle is projected obliquely at a height $h = 750\text{m}$ with a speed $v = 70\text{m/s}$. The maximum range of the projectile on reaching the ground is
 A) 500m B) 1000m C) 750m D) 1200m

25. An unknown resistance X is to be determined using resistances R_1, R_2 or R_3 of R . Their corresponding null points are A, B and C. Which of these will give most accurate reading in finding value of X ?



- A) null point –A B) null point –B C) null point –C D) All null points
26. In the figure shown, the wedge is fixed and the masses are released from rest. The coefficient of friction between 4kg and wedge is 0.8 and between 2kg and wedge is 0.6. Which of the following statement is /are correct? ($g = 10\text{m/s}^2$)

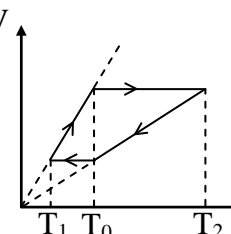


- A) \vec{a} of blocks must be same B) Friction force on 4kg is 24 N
 C) Friction force on 2kg is 12 N D) Normal reaction between block is nonzero
27. A flat, square surface with sides of length L is described by the equations $x = L, 0 \leq y \leq L, 0 \leq z \leq L$. Find the electric flux through the square due to a positive point charge q located at the origin ($x = 0, y = 0, z = 0$).
- A) $\frac{q}{4\epsilon_0}$ B) $\frac{q}{6\epsilon_0}$ C) $\frac{q}{24\epsilon_0}$ D) $\frac{q}{48\epsilon_0}$

28. A light pattern consisting of successive bright and dark bands is seen on the screen below the ripple tank (completely transparent tank). This is due to
 A) the crest of the water waves behaves as a convex lens and trough as concave lens
 B) absorption of light at select places in the water
 C) air flow near the water surface
 D) interference of waves

29. The work done by the one mole gas in the cyclic process shown in graph is W . Then

- A) $T_0 = \frac{T_1 + T_2}{2}$ B) $T_0 = \frac{W}{2R} + \frac{T_1 + T_2}{2}$
 C) $T_0 = \frac{W}{2R}$ D) $T_0 = \frac{W}{2R} + \frac{T_1 - T_2}{2}$



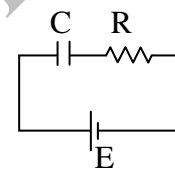
30. When an a.c. source of e.m.f $E = E_0 \sin 100t$ is connected across a circuit. It is observed that voltage leads the current by a phase angle $\frac{\pi}{4}$. If the circuit consists possibly only R-L, R-C or L-C in series the two elements could be
- A) $R = 10\Omega$, $L = 10\text{mH}$ B) $R = 10\Omega$, $C = 1000\mu\text{F}$
 C) $R = 100\Omega$, $C = 4\mu\text{F}$ D) $R = 10\Omega$, $L = 100\text{mH}$

SECTION – II (Total Marks:16)
(Multiple correct answer(s) type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** may be correct. Each correct answer carries **4 Marks**. There is no negative marking.

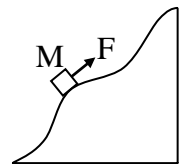
31. A ring, Disc, Solid sphere and hollow sphere each of mass m and different radius start together from rest at top of inclined plane and roll down without slipping.
- A) All will reach the bottom of incline together
 B) Body with maximum radii will reach bottom first
 C) They will reach in order solid sphere, disc, hollow sphere and ring.
 D) All of them will have same kinetic energy at the bottom of incline.
32. Standing waves can be produced
- A) When two identical waves with a phase difference of π are moving in the opposite direction in a long wire.
 B) On a string clamped at both the ends.
 C) On a string clamped at one end free at the other.
 D) When incident wave gets reflected from a wall

33. In the circuit shown, in steady state, the capacitance C decreases by x factor instantly (say $t = 0$)



- A) The charge deposited in the capacitor finally ($t \rightarrow \infty$) will be cq/x
 B) The voltage across the capacitor increases by x at $t = 0$
 C) Battery supplies energy to the capacitor for $t > 0$
 D) Energy is stored in the battery for $t > 0$

34. A body of mass M was slowly hauled up the rough hill by a force F which at each point was directed along a tangent to the hill. Work done by the force



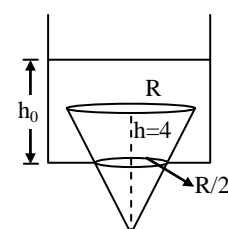
- A) is independent of shape of trajectory
 B) depends upon the vertical component of displacement but is independent of horizontal component
 C) depends upon both the component
 D) does not depend upon coefficient of friction.

SECTION – III (Total Marks:15)
(Paragraph Type)

This section contains **2 paragraphs**. Based upon one of the paragraph **3 multiple choice questions** and based on the other paragraph **2 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

Paragraph for Question Nos. 35 to 37

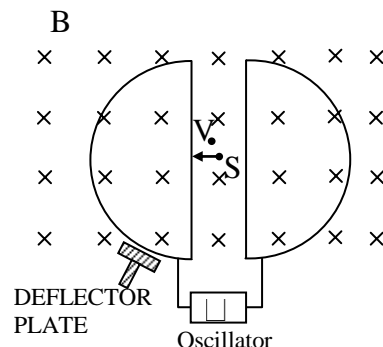
A circular hole of radius $r = \frac{R}{2}$ at the bottom of an initially full water container is sealed by a solid cone of density $\rho \left(= \frac{\rho_w}{2} \right)$, base radius R and height $h = 4R$. Initially $h_0 = 4R$.



35. The ratio of force exerted by water to weight of the cone is
- A) 1/4 B) 1/2 C) 1/8 D) 1/6
36. The depth of the water is now slowly reduced. At certain depth, the cone rises out of the hole. The value of H is
- A) R B) $2R$ C) $3R$ D) $5R/2$

Paragraph for Question Nos. 38 to 39

To study structure of matter on smallest scale, we need protons, deuterons etc., of high energy about 10 MeV to slam into a solid target. A device used to accelerate charged particles is shown in figure. Two hollow D-shaped objects (open on their straight edges) are made of copper. These dees, as they are called, are part of an electric oscillator that alternates the electric potential differences across the gap between the dees. The electrical signs of the dees are alternated so that the electric field in the gap alternates in direction, first toward one dee and then the other dee, back and forth. This whole set-up is subjected to inward magnetic field(B) as shown.



Suppose that a proton, injected by a source S at centre at time $t = 0$. Let us assume that at the instant the proton emerges into the centre gap from the first dee, the potential difference between dees is reversed. Thus the proton again faces a negatively charged dee and is again accelerated. This process continues, the circulating proton always being in step with the oscillations of the dee potential, until the proton has spiraled out to the edge of the dee system.

37. Choose the correct statement.
- A) Inside dees, electric field alternates
 - B) Inside dees, proton gains speed
 - C) Inside dees, proton does not accelerate
 - D) The time it takes to come out of "any dee" remains constant.
38. For a proton, the device is operated at frequency f_0 for a given map field B. If proton is replaced by α - particle ($m_\alpha = 4m_p, q_\alpha = 2e$), then the device has to be operated at
- A) same frequency, f_0
 - B) $2f_0$
 - C) $f_0 / 2$
 - D) $f_0 / 4$

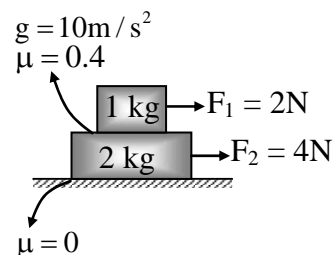
39. Speed Vs time graph for proton is best represented by



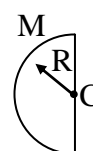
SECTION – IV (Total Marks:28)
(Integer Answer type)

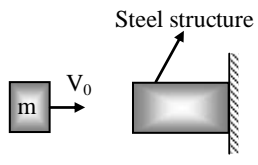
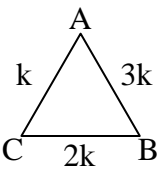
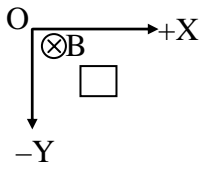
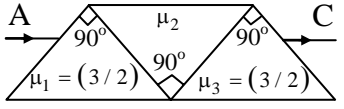
This section contains **7 questions**. The answer to each of the question is a **single digit integer**, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. Each correct answer carries **4 Marks**. There is no negative marking.

40. The two forces (F_1, F_2) start acting on the resting blocks simultaneously. The force of friction between the blocks is _____



41. Figure shows a hemispherical solid body of M and radius R.
- Case(i): A particle of m is taken from C to infinity.
 - Case(ii): Same particle is taken from surface. The ratio of work done in case(i) to that in case(ii) is $\frac{X}{2}$. Find the value of X.



42. A block of $m = 1000\text{kg}$ strikes a cuboid structure of volume $V = 4\text{m}^3$. structure made of steel ($Y = 2 \times 10^{11}\text{N/m}^2$) such that the structure experiences a maximum stress $S = 2 \times 10^8\text{N/m}^2$. The initial speed V_0 is found to be $\boxed{n}0\text{ m/s}$. Find the missing number n .
- 
43. Three rods of identical cross-sectional area and length with conductivities as shown are joined to form an equilateral triangle. The points A and C are maintained at T and $7T$ respectively. Assuming that only heat conduction takes place then the ratio of heat flow Q_1 (from C to A) to heat flow Q_2 (from C to B) is found to be $\frac{X}{6}$. Find the value of X.
- 
44. In the figure shown, a square loop of side $a = 1\text{m}$, mass $m = 100\text{g}$ and resistance $R = 8\Omega$ starts falling due to gravity. The magnetic field, $\vec{B} = \left(\frac{B_0}{a}\right)y(-\hat{k})$ is present in space. After the loop attains terminal velocity, find the rate at which G.P.E. is lost (in Watt).
- 
45. Three right angled prisms of refractive indices $\mu_1 = \mu_3 = \frac{3}{2}$ and μ_2 are joined together so that a ray incident at A emerges un-deviated at C. The value of μ_2 is found to be $\sqrt{\frac{x}{2}}$. Find the value of x .
- 
46. The work done in increasing the potential of a capacitor from V volt to $2V$ volt is W . Then, the work done in increasing the potential of the same capacitor from $2V$ volt to $4V$ volt will be (in watt)

PART III : MATHEMATICS
SECTION – I (Total Marks:21)
(Single answer type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **3 marks**. Each wrong answer carries **-1 mark**.

47. If $\arg(z) < 0$, then $\arg\left(\frac{z - \bar{z}}{2}\right)$ is equal to
 A) 0 B) $\frac{\pi}{2}$ C) $-\frac{\pi}{2}$ D) π
48. If $a_1, a_2, a_3, \dots, a_{4001}$ are terms of an A.P. such that $\frac{1}{a_1 a_2} + \frac{1}{a_2 a_3} + \dots + \frac{1}{a_{4000} a_{4001}} = 10$ and $a_2 + a_{4000} = 50$ then $|a_1 - a_{4001}|$ is equal to
 A) 20 B) 30 C) 40 D) none of these
49. For $0 < \theta < 2\pi$, $\sin^{-1}(\sin \theta) > \cos^{-1}(\sin \theta)$ is true when
 A) $\left[\frac{\pi}{4}, \pi\right]$ B) $\left[\pi, \frac{3\pi}{2}\right]$ C) $\left[\frac{\pi}{4}, \frac{3\pi}{4}\right]$ D) $\left[\frac{3\pi}{4}, 2\pi\right]$
50. Let $F(x) = c \sin x \int_0^x \cos t dt + 2 \int_0^x t dt + c \cos^2 x - x^2$. If $x^2 - 2x + 3 \geq F(x) \forall x \in R$ then the greatest area bounded by $x F(x), y = 0$ and $x = 5$ is
 A) 16 B) 25 C) 8 D) $\frac{35}{2}$
51. If the curves $x^2 - y^2 = 4$ and $xy = \sqrt{5}$ intersect at points A and B, then the possible number of point(s) C on the curve $x^2 - y^2 = 4$ such that the triangle ABC is equilateral is
 A) 0 B) 1 C) 2 D) 4
52. If A and B are two events such that $P(A \cap B) = 0.3$ and $P(A' \cap B') = 0.6$, then the value of $P(A \cap B' \text{ or } A' \cap B)$ is equal to
 A) 0.9 B) 0.7 C) 0.3 D) 0.1
53. The number of values of k for which the equation $x^2 - 3x + k = 0$ has two distinct roots lying in the interval $(0, 1)$ are
 A) three B) two C) infinitely many D) no value of k satisfies the requirement

SECTION – II (Total Marks:16)
(Multiple correct answer(s) type)

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** may be correct. Each correct answer carries **4 Marks**. There is no negative marking.

54. Let P be any point on the curve $S = 0$ such that tangents from P to $x^2 + y^2 - 2x - 4y - 4 = 0$ makes 60° with each other and from point Q perpendicular tangents are drawn to S, then
 A) locus of P is a circle of radius 5
 B) locus of P is a circle of radius 6
 C) locus of Q is a circle of radius $5\sqrt{2}$
 D) locus of Q is a circle of radius $6\sqrt{2}$
55. A function $f : R \rightarrow R^+$ satisfies $f(x+y) = f(x) \cdot f(y), \forall x, y \in R, f(0) = 1, f'(0) = 2$, then
 A) $\int_0^{\ln 3} [f(x)e^{-x}] dx = \ln 4.5$ (where [.] denotes greatest integer function)
 B) $\lim_{x \rightarrow 0} [f(x)]$ does not exist (where [.] denotes greatest integer function)
 C) $f^{-1}(x) = \ln \sqrt{x}, \forall x > 0$
 D) $f(x) < e^{x^2-4x}$ has infinite solution in (0, 6)
56. Let z_1 and z_2 be two complex numbers such that $z_1^2 - 4z_2 = 16 + 20i$. If α and β are roots of $x^2 + z_1x + z_2 + M = 0$ (where M is complex number) and $|(\alpha - \beta)^2| = 28$, then
 A) maximum value of $|M|$ is $7 + \sqrt{41}$
 B) maximum value of $|M|$ is $5 + \sqrt{41}$
 C) minimum value of $|M|$ is $7 - \sqrt{41}$
 D) minimum value of $|M|$ is $5 - \sqrt{41}$
57. The system of equations $ax + by + cz = q - r, bx + cy + az = r - p$ and $cx + ay + bz = p - q$ is
 A) consistent if $p = q = r$
 B) inconsistent if $a = b = c$, and p, q, r are distinct
 C) consistent if a, b, c are distinct and $a + b + c \neq 0$
 D) all of above

SECTION – III (Total Marks:15)
(Paragraph Type)

This section contains **2 paragraphs**. Based upon one of the paragraph **3 multiple choice questions** and based on the other paragraph **2 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. Each correct answer carries **3 Marks**. Each wrong answer carries **-1 mark**.

Paragraph for Question Nos. 58 to 59

Let $g(x) = \int_0^x (t^2 + t + 1) dt$, and $f(x)$ be a decreasing function $\forall x \geq 0$ such that

$\vec{A} = f(x)\hat{i} + g(x)\hat{j}, \vec{B} = g(x)\hat{i} + f(x)\hat{j}$ make an obtuse angle with each other $\forall x \geq 0$ then

58. Which of the following is true (for $x > 0$)?
 A) $f(x) < 0, g(x) > 0$
 B) $f(x) > 0, g(x) > 0$
 C) $f(x) < 0, g(x) < 0$
 D) none of these
59. $\lim_{x \rightarrow \infty} f(x)g(x)$ is
 A) $+\infty$
 B) $-\infty$
 C) 0
 D) none of these

Paragraph for Question Nos. 60 to 61

A curve $x = f(y)$ passing through origin is such that slope of tangent at any point is reciprocal of sum of co-ordinates of the point of tangency.

60. Slope of tangent to curve at the point where ordinate is $\log_e 3$ is
 A) 1
 B) $\frac{1}{3}$
 C) $\frac{1}{2}$
 D) -2
61. $\int_0^1 x dy$ is equal to
 A) $e - \frac{1}{2}$
 B) $e - \frac{3}{2}$
 C) $e - \frac{5}{2}$
 D) $e + 1$
62. $\int_{\frac{1}{e}}^e x e^{-y} d(e^y)$ is equal to
 A) $e - e^{-1} - \frac{1}{3}$
 B) $e - e^{-1} - 2$
 C) $e - \frac{1}{e}$
 D) $e + e^{-1} + \frac{1}{3}$

SECTION – IV (Total Marks:28)
(Integer Answer type)

This section contains **7 questions**. The answer to each of the question is a **single digit integer**, ranging from 0 to 9. The bubble corresponding to the correct answer is to be darkened in the ORS. Each correct answer carries **4 Marks**. There is no negative marking.

63. If a, b, c are in H.P. and $\left(\frac{a+b}{2a-b}\right) + \left(\frac{c+b}{2c-b}\right) \leq \sqrt{\lambda\sqrt{\lambda\sqrt{\lambda\sqrt{\lambda\sqrt{\lambda\dots\infty}}}}}$, then find the least value of λ .
(Where a, b, c are positive).

64. A staircase has 10 steps. A person can go up the steps one at a time, two at a time, or any combination of 1's and 2's. If the number of ways in which the person can go up the stairs is p , then find $\frac{p}{89}$.

65. If the normals to curve $y = x^2$ at the points P, Q & R pass through the point $\left(0, \frac{3}{2}\right)$, find the radius of the circle circumscribing ΔPQR .

66. Let a & b be two positive real numbers. Evaluate $\int_a^b \frac{e^{x/a} - e^{b/x}}{x} dx$

67. Let 'f' be a function such that $f(xy) = f(x) \cdot f(y) \forall x, y \in R^+$ and $f(1+x) = 1 + x(1+g(x))$, where $\lim_{x \rightarrow 0} g(x) = 0$. The value of $\int_1^2 \frac{f(x)}{f'(x)} \cdot \frac{1}{1+x^2} dx$ is $\frac{1}{2} \log_e \left(\frac{a}{b}\right)$ where a & b are co-prime. Find $a+b$.

68. If $\vec{A}, \vec{B}, \vec{C}$ are vectors such that $|\vec{B}| = |\vec{C}|$, then find $((\vec{A} + \vec{B}) \times (\vec{A} + \vec{C})) \cdot (\vec{B} \times \vec{C}) \cdot (\vec{B} + \vec{C})$

69. If $\int_0^x f(x) \sin t dt = \text{constant}$, $0 < x < 2\pi$ and $f(\pi) = 2$ then find the value of $f(\pi/2)$.

KEY

CHEMISTRY

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|-------|---------|-------|--------|-------|-------|
| 1. C | 2. B | 3. C | 4. D | 5. C | 6. C |
| 7. D | 8. ABCD | 9. AB | 10. AC | 11. C | 12. C |
| 13. B | 14. C | 15. B | 16. B | 17. 0 | 18. 4 |
| 19. 4 | 20. 2 | 21. 5 | 22. 0 | 23. 4 | |

PHYSICS

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|-------|--------|----------|---------|--------|-------|
| 24. B | 25. B | 26. B | 27. C | 28. A | 29. B |
| 30. D | 31. CD | 32. ABCD | 33. ABD | 34. AC | 35. A |
| 36. B | 37. D | 38. C | 39. A | 40. 0 | 41. 3 |
| 42. 4 | 43. 5 | 44. 2 | 45. 7 | 46. 4 | |

MATHEMATICS

- | | | | | | |
|-------|--------|---------|--------|-------|-------|
| 47. C | 48. B | 49. C | 50. B | 51. A | 52. D |
| 53. D | 54. BD | 55. ABC | 56. AC | 57. D | 58. A |
| 59. B | 60. C | 61. C | 62. B | 63. 4 | 64. 1 |
| 65. 1 | 66. 0 | 67. 7 | 68. 0 | 69. 4 | |