JEE MAIN 2026

Sample Paper – 2

Time Allowed: 3 hours **Maximum Marks:** 300

General Instructions:

1. The test consists of total **75 questions.**

2. Each subject **(PCM)** has **25 questions.**

3. Each subject divided into two sections. **Section A** consists of 20 multiple-choice questions & **Section B** consists of 5 numerical value-type questions.

4. Marking Scheme:

- **Section A (MCQs):** +4 marks for each correct answer, –1 mark for each incorrect answer, 0 marks for unattempted.
- **Section B (Numerical):** +4 marks for each correct answer, 0 marks for incorrect or unattempted.

5. Any textual, printed, or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.

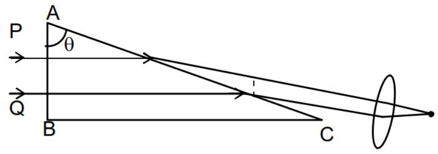
6. All calculations/written work should be done in the rough sheet is provided with the Question Paper.

Physics PART – A

SECTION – A
(One Options Correct Type)

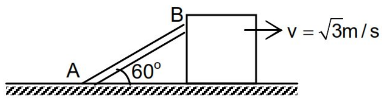
*This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.*

1. Two parallel beams of light P and Q are incident normally on a prism and the transmitted rays are brought to focus with the help of convergent lens as shown in figure. If intensities of the upper and lower beams immediately after transmission from face AC are 4I and I respectively. If resultant intensity at the focus is



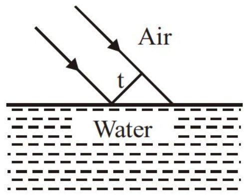
(A) I
(B) 5I
(C) 17I
(D) 9I

2. A rod AB is shown in figure. End A of the rod is fixed on the ground. Block is moving with velocity $\sqrt{3}$ m/s towards right. The speed of end B of the rod when rod makes an angle of 60° with the ground is



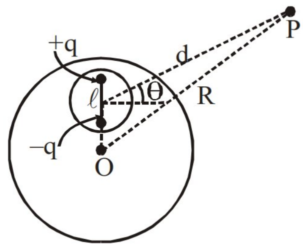
(A) 3 m/s
(B) 2 m/s
(C) 5 m/s
(D) 2.5 m/s

3. A monochromatic beam of width t is incident at 45º on an air water interface as shown in the figure. The refractive index of water is μ and that of air is 1. The width of the beam in water is,



(A) $(\mu - 1)$ T
(B) μ T
(C) $\frac{\sqrt{\mu^2 - 1}}{\mu}t$
(D) $\frac{\left(\sqrt{2\mu^2 - 1}\right)}{\mu}t$.

4. A spherical cavity is created in a neutral solid conducting sphere. Inside the cavity, a dipole is placed as shown in the figure. Electrostatic potential at point P only due to charge induced on the inner surface of the cavity is (assume that $\ell << d$)



(A) $\frac{q\ell}{4\pi\varepsilon_0}\frac{\sin\theta}{d^2}$
(B) $\frac{-q\ell\sin\theta}{4\pi\varepsilon_0 d^2}$
(C) $-\frac{q\ell}{4\pi\varepsilon_0}\frac{\sin\theta}{d}$
(D) $\frac{q\ell\sin\theta}{4\pi\varepsilon_0 d}$

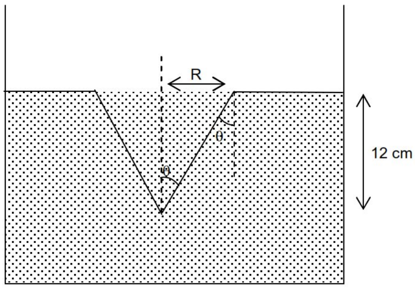
5. Hydrogen (H), deuerium (D), singly ionised helium $(He)^+$ and doubly ionised (Li^{++}) all have one electron round the nucleus. Consider n = 2 to n = 1 transition. The wavelength of emitted radiations are λ_1, λ_2, λ_3 and λ_4 respectively. Then approximately

(A) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$
(B) $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$
(C) $\lambda_1 = 2\lambda_2 = 2\sqrt{2}\lambda_3 = 3\sqrt{2}\lambda_4$
(D) $\lambda_1 = \lambda_2 = 2\lambda_3 = 3\lambda_4$

6. A tunnel is made across the earth passing through its centre. A ball is dropped from a height h in the tunnel. The motion will be periodic with time period

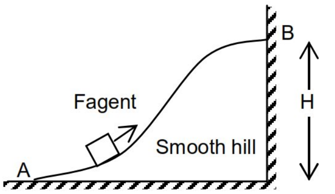
(A) $2\pi\sqrt{\frac{R}{g}}+\sqrt{\frac{2h}{g}}$
(B) $2\pi\sqrt{\frac{2R}{g}}+4\sqrt{\frac{h}{g}}$
(C) $2\pi\sqrt{\frac{R}{g}}+4\sqrt{\frac{2h}{g}}$
(D) $2\pi\sqrt{\frac{2R}{g}}+\sqrt{\frac{h}{g}}$

7. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is 4/3 and the fish is 12 cm below the surface, the radius of this circle in cm is



(A) $36\sqrt{5}$
(B) $4\sqrt{5}$
(C) $36\sqrt{7}$
(D) $36/\sqrt{7}$

8. A external agent moves the block m slowly from A to B, along a smooth hill such that every time he applies the force tangentially. Find the work done by agent in this interval.

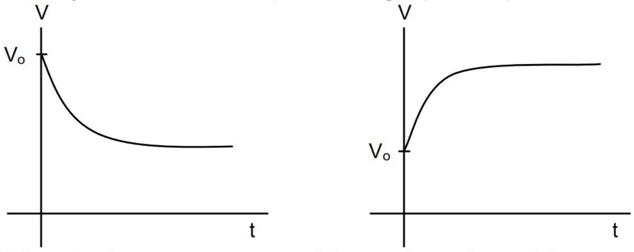


(A) $\frac{m^2g^2H^2}{L}$
(B) $\frac{mgH^2}{L}$
(C) mg(H+L)
(D) mgH

9. 1 gm of a radioactive substance takes. 50 sec to loose 0.01 gm then the half life of the sample will be

(A) $\frac{50\ln(2)}{\ln\left(\frac{100}{99}\right)}$
(B) $\frac{50\ln(2)}{\ln(100)}$
(C) $\frac{50\ln(2)}{\ln(99)}$
(D) $\frac{50\ln(2)}{\ln(0.99)}$

10. A capacitor is charged upto a potential V_o. It is then connected to a resistance R and a battery of emf E. Two possible graphs of potentials across capacitor vs time are shown.

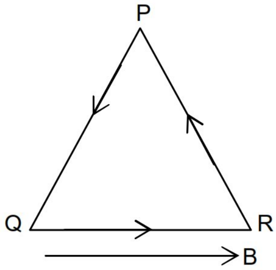


What is the most reasonable explanation of these graphs?

(A) The first graph shows what happens when the capacitor has a lesser than E potential initially and the second shows what happens when it has a greater than E potential initially.

(B) The first graph shows what happens when the capacitor has a greater than E potential initially and the second shows what happens when it has a lesser than E potential initially.
(C) The first graph is the correct qualitative shape for any initial potential, but the second is not possible.
(D) The second graph is the correct qualitative shape for any initial potential, but the first is not possible.

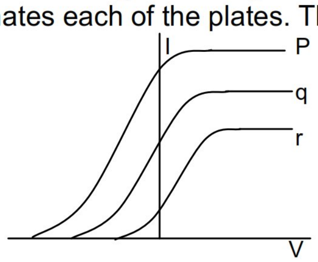
11. An equilateral triangular loop PQR of side l carries a currents I in the direction shown. The loop is kept in uniform magnetic field B, directed parallel to the base of triangle QR as shown. Net torque τ acting on loop is

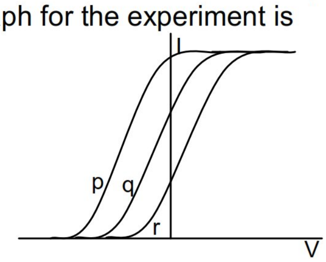


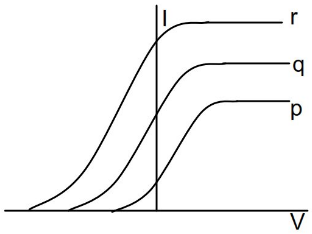
(A) F = $\frac{\sqrt{3}}{2}\mu^2 B$
(B) F = $\sqrt{3}$ ilB
(C) $\tau = 0$
(D) $\tau = \frac{\sqrt{3}\,l^2 iB}{4}$

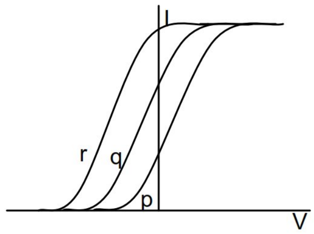
12. A particle moves in x-y plane such that its position vector varies with time as $\vec{r} = (2\sin 3t)\hat{i} + 2(1-\cos 3t)\hat{j}$. The equation of trajectory of the particle will be
(A) $x^2 + y^2 = 1$
(B) $x^2 + (2-y)^2 = 4$
(C) $(2-x)^2 + y^2 = 4$
(D) $(1-x)^2 + (1-y)^2 = 4$

13. Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions ϕ_p = 2.0 eV, ϕ_q = 2.5 eV and ϕ_r = 3.0 eV, respectively. A light beam containing wavelengths of 550 nm, 450 nm and 350 nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is

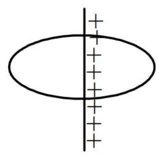
(A)


(B)


(C)


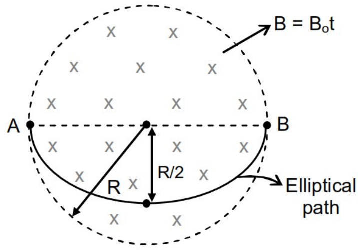
(D)


14. A very long uniformly charged rod falls with a constant velocity *V* through the center of a circular loop. Then the magnitude of induced emf in loop is (charge per unit length of rod = λ)



(A) $\frac{\mu_0}{2\pi}\lambda V^2$
(B) $\frac{\mu_0}{2}\lambda V^2$
(C) $\frac{\mu_0}{2\lambda}V$
(D) zero

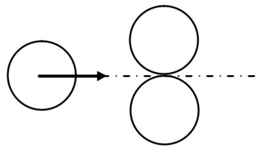
15. There is a uniform time varying magnetic field in a circular region as shown in the figure. Find out the potential difference across 2 point along an elliptical path as shown in figure.



(A) $\frac{\pi R^2}{2} B_o$ (B) $\frac{\pi R^2}{2} B_o$

(C) $\frac{\pi R^2}{4} B_o$ (D) $\frac{\pi R^2}{5} B_o$

16. Two smooth identical stationary spheres are kept touching each other on a smooth horizontal floor as shown. A third identical sphere moving horizontally with a constant speed hits both stationary spheres symmetrically. If after collision the third sphere moves in same direction with one fourth of its initial speed , the coefficient of restitution will be



(A) 2/3 (B) 1/3

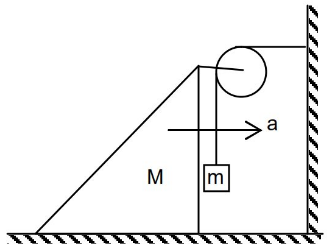
(C) 1/4 (D) 1/6

17. A siren placed at a railway platform is emitting sound of frequency 5 kHz. A passenger is sitting in a moving train. A records a frequency of 5.5 kHz when the train approaches the siren. During his return journey in a different train B he records the frequency of 6 kHz while approaching the same siren. The ratio of velocity of train B to train A is

(A) $\frac{242}{252}$ (B) $\frac{5}{6}$

(C) 2 (D) $\frac{11}{6}$

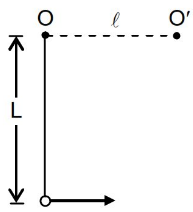
18. If wedge is moving with acceleration a as shown in the figure then value of net force on m is



(A) ma (B) $\sqrt{2}$ ma

(C) mg (D) zero

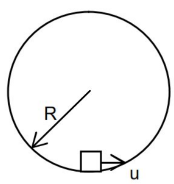
19. A particle is hanging from a fixed pint 0 by means of a string of length L. There is a small nail O′ in the same horizontal line with O at a distance $\ell(<L)$ from O. The minimum velocity with which particle should be projected from its lowest position in order that it may make a complete revolution round the nail.



(A) $\sqrt{3gL}$ (B) $\sqrt{5gL}$

(C) $\sqrt{g(5L-3\ell)}$ (D) $\sqrt{g(5\ell-3L)}$

20. A particle is given an initial speed 'u' inside a smooth fixed spherical shell of radius R = 1 m such that it is just able to complete the circle. Acceleration of the particle when its velocity is vertical, is



(A) $g\sqrt{10}$ (B) g

(C) $g\sqrt{2}$ (D) 3 g

SECTION – B

(Numerical Answer Type)

*This section contains **05** Numerical based questions. The answer to each question is rounded off to the nearest integer value.*

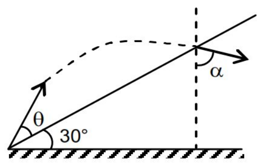
21. A boat which has a speed of 6 km/h in still water crosses a river of width 1 km along the shortest possible path in 20 min. The velocity of the river water in km/h is $3\sqrt{N}$. Find the value of N.

22. If 10% of the current passes through a moving coil galvanometer of resistance 99 ohm, then the shunt resistance will be:

23. A hollow sphere and a solid sphere have equal mass and equal moment of inertia about the respective diameter. If the ratio of their square of radii is given by 3/N. Find the value of N.

24. A steel wire of cross-sectional area $2mm^2$ and Young's modulus $2\times10^{11} N/m^2$ is stretched longitudinally by a force of 200 N. The elastic potential energy stored per unit volume in the string is $\frac{N}{2}\times 10^4$. Find the value of 'N'.

25. A particle is projected at an angle $\theta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ with the inclined plane of angle 30° with horizontal. If α is the angle that its velocity vector makes with vertical at the point of collision (with the inclined plane) if $\alpha = 5K°$. Find the value of 'K'.



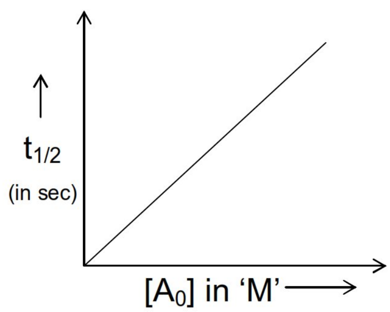
Chemistry PART – B

SECTION – A
(One Options Correct Type)

*This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.*

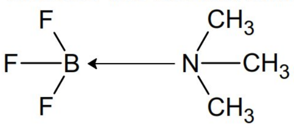
26. The correct statement regarding the third orbit of hydrogen atom is
(A) it can accommodate a maximum of nine electrons
(B) it contains nine degenerate atomic orbitals
(C) it contains nine atomic orbitals having three sets of degeneracy
(D) it contains nine sub-shells

27.



What is the unit of rate constant of the reaction, for which the above graph is given?
(A) s^{-1} (B) mol $L^{-1}s^{-1}$
(C) mol L^{-1}s (D) mol^{-1} L^2s^{-1}

28. Choose the correct statement regarding the following molecule

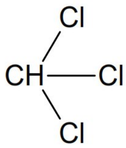


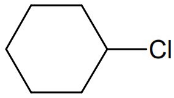
(A) $\angle$FBF bond angle is 120°
(B) Nitrogen undergoes sp^2 hybridization
(C) $p\pi$ - $p\pi$ back bond between B & F in the molecule is more dominant than that in isolated BF_3 molecule
(D) All central atoms have the same type of hybridization

29. 200 mL of 0.4 M solution of CH_3COONa is mixed with 400 mL of 0.2 M solution of CH_3COOH. After complete mixing, 400 mL of 0.1 M NaCl is added to it. What is the pH of the resulting solution? [K_a of $CH_3COOH = 10^{-5}$]
(A) 5.4 (B) 6
(C) 5 (D) 6.2

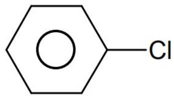
30. Which of the following bond angle is not observed in PCl_5 molecule in gaseous state?
(A) 120° (B) 180°
(C) 90° (D) 60°

31. In which of the following compound, chlorine exerts the maximum number of electronic effects?

(A) 

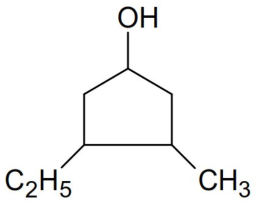
(B) 

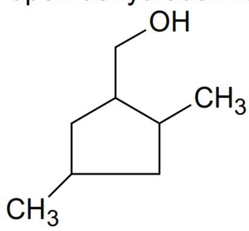
(C) $CH_2 = CH - CH_2Cl$

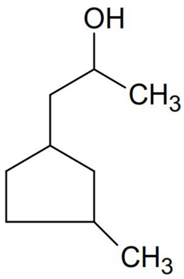
(D) 

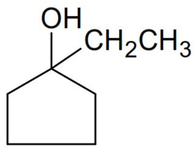
32. Which of the following reaction does not produce H_3PO_4?
(A) Reaction between P_4O_{10} and H_2O
(B) Heating of H_3PO_3
(C) Heating of H_3PO_2
(D) Reaction between Ca_3P_2 and H_2O

33. Which alcohol forms a derivative of cyclohexene upon dehydration reaction?

(A) 

(B) 

(C) 

(D) 

34. Which of the following is a colourless complex ion?
(A) $[Cu(NH_3)_4]^{2+}$
(B) $[Cr(H_2O)_6]^{3+}$
(C) $[FeF_6]^{3-}$
(D) $[Mn(H_2O)_6]^{3+}$

35. Which of the following salt can increase the boiling point of water by maximum extent?
(Assume equimolar quantities are added)
(Assume complete dissociation of the salts)
(A) NaCl
(B) $CaCl_2$
(C) $AlCl_3$
(D) KCl

36. A hydrogen electrode is prepared by using a sample of HCl solution with pH = 4 and H_2 gas at 1 atm pressure. What is the electrode potential of the electrode?
(A) 0.814 V
(B) -0.236 V
(C) -0.06 V
(D) -0.618 V

37. $P(g) + 2Q(g) \longrightarrow PQ_2(g);\ \Delta H = 18\,\text{kJ mol}^{-1}$

The entropy change of the above reaction(ΔS_{system}) is 60 $JK^{-1}mol^{-1}$. At what temperature, the reaction becomes spontaneous?

(A) Below 200 K
(B) Above 300 K
(C) Below 300 K
(D) Above 200 K and below 300 K

38. The incorrect statement regarding glycine is

(A) it is the simplest α-amino acid
(B) it contains two functional groups
(C) it contains a chiral carbon atom
(D) it can exist as zwitter ion

39. 1.2 L of 0.4 M HCl solution can be completely neutralized by

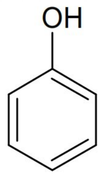
(A) 600 mL of 1.2 M NaOH solution
(B) 800 mL of 0.2 M NaOH solution
(C) 19.2 g of solid NaOH
(D) 4.8 mole of NaOH

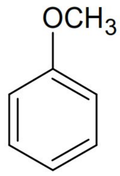
40. $(X) \xrightarrow{Ba^{2+}} \underset{\text{White ppt}}{Y\downarrow} \xrightarrow{Cl_2/H_2O} \underset{\text{White ppt}}{Z\downarrow}$

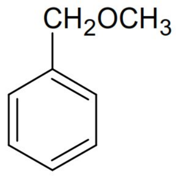
If the precipitate (Z↓) is $BaSO_4$, which of the following can be (X)?

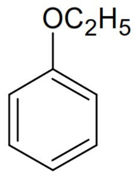
(A) Na_2SO_4
(B) Na_2SO_3
(C) $NaHSO_4$
(D) Na_2CO_3

41. The structure of anisole is

(A) 

(B) 

(C) 

(D) 

42.

$$CH_3CH_2\underset{\underset{CH_3}{|}}{C} = CHCH_3 \xrightarrow{\text{Reagent}} CH_3CH_2\underset{\underset{CH_3}{|}}{C}H\overset{\overset{OH}{|}}{C}HCH_3$$

Which reagent forms the above organic product as the single product in the above reaction?

(A) H_2O/H^+
(B) $\dfrac{Hg(OCOCH_3)_2, H_2O}{NaBH_4}$
(C) $\dfrac{B_2H_6, THF}{NaOH, H_2O_2}$
(D) $KMnO_4/OH^-/Cold$

43. The most acidic oxide of chlorine is

(A) Cl_2O
(B) ClO_2
(C) Cl_2O_3
(D) Cl_2O_7

44. What is the hybridization of xenon in XeO_4?
(A) sp^3
(B) sp^3d
(C) sp^3d^2
(D) sp^3d^3

45. Which of the following compound forms two stereoisomers when treated with NH_2OH in weakly acidic medium?
(A) CH_3COCH_3
(B) HCHO
(C) $CH_3COC_2H_5$
(D) $C_2H_5COCH_2CH_3$

SECTION – B

(Numerical Answer Type)

*This section contains **05** Numerical based questions. The answer to each question is rounded off to the nearest integer value.*

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46. In the following reaction:
$$P_4 + xNaOH + yH_2O \longrightarrow PH_3 + 3NaH_2PO_2$$
Sum of x + y is

47. Compound X dissociates according to the reaction $2X(g) \rightleftharpoons 2Y(g) + Z(g)$, with degree of dissociation which is small compared to unity, if the expression for α in terms of equilibrium constant K_P and total pressure P is given as $\alpha = \left(\frac{2K_P}{P}\right)^{1/n}$. The value of n is

48. If ΔG^o for the half cell MnO_4^- / MnO_2 in an acid solution is -x F, then find the value of x
Given $\left(\text{Given}: E^o_{MnO_4^-/Mn^{2+}} = 1.5\,V; E^o_{MnO_2/Mn^{2+}} = 1.25\,V\right)$

49. Sample of 28 mL of $H_2O_2(aq)$ solution required 10 mL of 0.1 M $KMnO_4(aq)$ solution for complete reaction in acidic medium. What is volume strength of H_2O_2?

50. For a reaction $A \rightarrow B$, ΔH = +ve, graph between log K_{eq} and $\frac{1}{T}$ is a straight line of slope $= -\frac{1}{4.606}$. Find ΔH in calories.

Mathematics

PART – C

SECTION – A
(One Options Correct Type)

*This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.*

51. The 7^{th} term in $\left(\frac{1}{y}+y^2\right)^{10}$, when expanded in descending power of y, is

(A) $\frac{210}{y^2}$ (B) $\frac{y^2}{210}$

(C) $210y^2$ (D) none of these

52. If $(1-y)\left(1+2x+4x^2+8x^3+16x^4+32x^5\right)=1-y^6,(y\neq 1)$, then a value of $\frac{y}{x}$ is

(A) $\frac{1}{2}$ (B) 2

(C) $\frac{1}{4}$ (D) 4

53. If $0<a<b<c$, and the roots α, β of the equation $ax^2+bx+c=0$ are imaginary, then the incorrect option is

(A) $|\alpha|=|\beta|$ (B) $|\alpha|>1$

(C) $|\beta|<1$ (D) $\alpha=\bar{\beta}$

54. $\sqrt{-1-\sqrt{-1-\sqrt{-1-......to\infty}}}=$

(A) 1 (B) –1

(C) ω (D) 2

55. The largest value of the positive integer k for which n^k+1 divides $1+n+n^2+.......+n^{127}$ is divisible by

(A) 8 (B) 16

(C) 32 (D) 64

56. If $f(z)=\frac{7-z}{1-z^2}$, where $z=1+2i$, then $|f(z)|$ is equal to

(A) $\frac{|z|}{2}$ (B) $|z|$

(C) $2|z|$ (D) None of these

57. The chords of contact of the pair of tangents to the circle $x^2+y^2=1$ drawn from any point on the line $2x+y=4$ pass through the point

(A) $\left(\frac{1}{2},\frac{1}{4}\right)$ (B) $\left(\frac{1}{4},\frac{1}{2}\right)$

(C) $\left(1,\frac{1}{2}\right)$ (D) $\left(\frac{1}{2},1\right)$

58. A lamp post standing at a point A on a circular path of radius 'r' subtends an angle α at some point B on the path and AB subtends an angle of 45° at any other point on the path, the height of the lamp post is

(A) $\frac{r}{\sqrt{2}}\tan\alpha$ (B) $\sqrt{2}r\tan\alpha$

(C) $\sqrt{2}r\cot\alpha$ (D) $\frac{r}{\sqrt{2}}\cot\alpha$

59. The total number of dissimilar terms in the expansion of $(x_1+x_2+......+x_n)^3$ is

(A) n^3 (B) $\frac{n^3+3n^2}{4}$

(C) $\frac{n(n+1)(n+2)}{6}$ (D) $\frac{n^2(n+1)^2}{4}$

60. The number of values of x in $[0,2\pi]$ satisfying the inequation $|\cos x-\sin x|\geq\sqrt{2}$ is

(A) 0 (B) 1

(C) 2 (D) none of these

61. Consider the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, having it's eccentricity equal to e. P is any variable point on it and P_1,P_2 are the foot of perpendiculars drawn from P to the x and y–axis respectively. The line P_1P_2 will always be a normal to an ellipse whose eccentricity is equal to:

(A) e^2 (B) $\sqrt{e}$

(C) $\sqrt{\frac{2e}{1+e}}$ (D) e

62. Let A be the centre of the circle $x^2+y^2-2x-4y-20=0$, and B(1,7) and D(4,–2) are points on the circle then, if tangents be drawn at B and D, which meet at C, a then area of quadrilateral ABCD is -

(A) 150 (B) 75

(C) 75/2 (D) 300

63. If four whole numbers taken at random are multiplied together then the probability that the last digit in the product is 1, 3, 7 or 9 is

(A) $\frac{16}{6^{25}}$ (B) $\frac{15}{6^{25}}$

(C) $\frac{14}{6^{25}}$ (D) $\frac{11}{6^{25}}$

64. The equation of the line touching both the parabola $y^2 = 4x$ and $x^2 = -32y$ is

(A) $x + 2y + 4 = 0$ (B) $2x + y - 4 = 0$

(C) $x - 2y - 4 = 0$ (D) $x - 2y + 4 = 0$

65. If α, β be the roots of $x^2 - x - 1 = 0$ and $A_n = \alpha^n + \beta^n$, then AM of A_{n-1} and A_n is

(A) $2A_{n+1}$ (B) $(1/2)A_{n+1}$

(C) $2A_{n-2}$ (D) none of these

66. The equation of the image of the circle $x^2 + y^2 + 16x - 24y + 183 = 0$ by the line mirror $4x + 7y + 13 = 0$ is

(A) $x^2 + y^2 + 32x - 4y + 235 = 0$ (B) $x^2 + y^2 + 32x + 4y - 235 = 0$

(C) $x^2 + y^2 + 32x - 4y - 235 = 0$ (D) $x^2 + y^2 + 32x + 4y + 235 = 0$

67. The centre of square ABCD is at $z = 0$. A is z_1. Then the centroid of triangle ABC is

(A) $z_1(\cos\pi \pm i\sin\pi)z$ (B) $\frac{z_1}{3}(\cos\pi \pm i\sin\pi)$

(C) $z_1(\cos\pi/2 \pm i\sin\pi/2)$ (D) $\frac{z_1}{3}(\cos\pi/2 \pm i\sin\pi/2)$

68. The sum of all the numbers which can be formed by using the digits 1, 3, 5, 7 all at a time and which have no digit repeated, is

(A) $16 \times 4!$ (B) $1111 \times 3!$

(C) $16 \times 1111 \times 3!$ (D) $16 \times 1111 \times 4!$

69. If $\sqrt{\log_2 x} - 0.5 = \log_2 \sqrt{x}$, then x equals

(A) odd integer (B) prime number

(C) composite number (D) irrational

70. If foci of hyperbola lie on $y = x$ and one of the asymptote is $y = 2x$, then equation of the hyperbola, given that it passes through (3, 4), is

(A) $x^2 - y^2 - \frac{5}{2}xy + 5 = 0$ (B) $2x^2 - 2y^2 + 5xy + 5 = 0$

(C) $2x^2 + 2y^2 - 5xy + 10 = 0$ (D) none of these

SECTION – B

(Numerical Answer Type)

*This section contains **05** Numerical based questions. The answer to each question is rounded off to the nearest integer value.*

71. The number of real solutions of the equation $\frac{x^2}{1-|x-5|}=1$ is

72. The value of $\lim_{x\to 0}\left\{\frac{\log_e(1+x)}{x^2}+\frac{x-1}{x}\right\}$ is λ, then the value of 8λ will be

73. A line makes angles $\alpha, \beta, \gamma, \delta$ with the four diagonals of a cube then $\cos^2\alpha + \cos^2\beta + \cos^2\gamma + \cos^2\delta =$

74. If in a triangle ABC, b + c = 4a. Then $\cot\frac{B}{2}\cot\frac{C}{2}$ is equal to

75. Let $S_n=\cot^{-1}\left(3x+\frac{2}{x}\right)+\cot^{-1}\left(6x+\frac{2}{x}\right)+\cot^{-1}\left(10x+\frac{2}{x}\right)+.....+n$ terms, where $x>0$. If $\lim_{n\to\infty}S_n=1$, then $\cot^{-1}x$ equals

SOLUTIONS

Physics

PART – A

SECTION – A

1. D

Sol. At focus path diff. = 0

$\Rightarrow \; I = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = 9I.$

2. B

Sol. Let the length of rod is ℓ and co-ordinate of B is (x, y)

$\vec{v}_B = v_x\hat{i} + v_y\hat{j} = \sqrt{3}\hat{i} + v_y\hat{j}$

$x^2 + y^2 = \ell^2 \;\Rightarrow\; 2xv_x + 2yv_y = 0 \Rightarrow \sqrt{3} + \frac{y}{x}v_y = 0$

$\Rightarrow \sqrt{3} + \tan 60^\circ v_y = 0 \;\; v_y = -1$ m/s

$\vec{v}_B = \sqrt{3}\hat{i} - 1\hat{j}$

$|\vec{v}_B| = \sqrt{3+1} = 2 m/s$

3. D

Sol. Apply Snell's law and use geometry.

4. B

Sol. If there is any charge inside the cavity of the conductor, the charge induced on the inner surface of the cavity is such that it will produce same amount of electric field but in opposite direction at each and every point outside the cavity as produced by the charge in the cavity.

5. A

Sol. $\frac{hc}{\lambda} = RhCZ^2\left(1 - \frac{1}{4}\right)$

$\Rightarrow \frac{1}{\lambda_1} : \frac{1}{\lambda_2} : \frac{1}{\lambda_3} : \frac{1}{\lambda_4} = 1 : 1 : 4 : 9$

$\Rightarrow \lambda_1 : \lambda_2 : \lambda_3 : \lambda_4 = 1 : 1 : \frac{1}{4} : \frac{1}{9}$

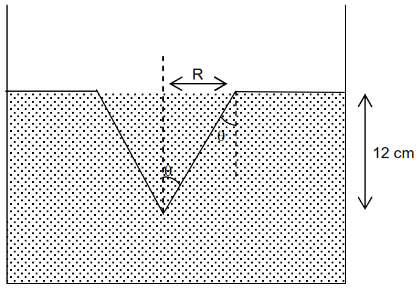
6. C

Sol. $T = T_{shm} + 4\sqrt{\frac{2h}{g}}$

7. D

Sol. $\theta = \theta_C$ (critical angle)

$\frac{R}{12} = \tan\theta_C$



8. D

Sol. $W_{agent} - mgH = 0$

$W_{agent} = mgH$

9. A

Sol. $N = N_o e^{-\lambda t}$

$0.99 = 1\ e^{-\lambda t} \Rightarrow \lambda t = \ln\left(\frac{100}{99}\right)$

$50 \text{ sec} = t = \frac{\ln\left(\frac{100}{99}\right)}{\lambda}$

$\Rightarrow \quad t_{1/2} = \frac{50\ln(2)}{\ln(100/99)}$

10. B

Sol. If the capacitor has greater than E potential initially its potential will decrease and graph is first one. When capacitor has less than E potential initially it will follow the second graph.

11. D

Sol. $\vec{\tau} = \vec{\mu} \times \vec{B}$

$= (i\vec{A}) \times \vec{B}$

12. B

Sol. $x = 2\sin 3t$

$y = 2 - 2\cos 3t$

$\sin^2 3t + \cos^2 3t = 1$

13. A

Sol. As λ increases saturation current also increases.

14. D

Sol. $\phi_B = 0$

$\because \ \vec{B} \perp \vec{S}$

$\therefore \ \dfrac{d\phi_B}{dt} = 0$

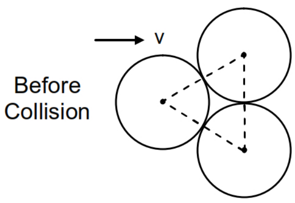
15. C

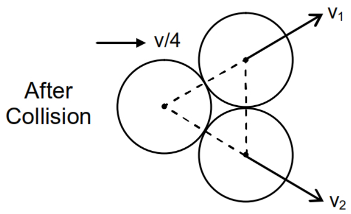
Sol. $\Delta V = \left|\dfrac{d\phi}{dt}\right| = (\text{Area}) \times \dfrac{dB}{dt} = \dfrac{\pi R}{2}\left(\dfrac{R}{2}\right)(B_o)$

$\Delta V_{AB} = \dfrac{\pi R^2}{4} B_o$

16. C

Sol.





$2mv_1\cos 30° + m\dfrac{v}{4} = mv$ ...(i)

$e = \dfrac{v_1 - \dfrac{v}{4}\cos 30°}{v\cos 30°}$ ...(ii)

17. C

Sol. Using doppler's effect to calculate apparent frequency.

18. B

Sol. Net force $F = m\,a_{net} = m\sqrt{a^2 + a^2} = ma\sqrt{2}$.

19. C

Sol. From conservation of mechanical energy.

$\dfrac{1}{2}mv^2 = mg\,L + \dfrac{1}{2}m3(L - \ell)g$

$\therefore \quad v = \sqrt{g(5L - 3\ell)}$

20. A

Sol. $a = \sqrt{a_t^2 + a_c^2}$

SECTION – B

21. 3

Sol. t = 20 min = $\frac{1}{3}$hr

1 km = $\sqrt{(6)^2 - V^2} \times \left(\frac{1}{3}\text{hr}\right)$

V = $3\sqrt{3}$ km/hr

22. 11

Sol. $I_1 = \left(\frac{s}{s+99}\right) \times I$

$\frac{I_1}{I} = \frac{s}{99+s} = 0.1$

$s = 11\Omega$

23. 5

Sol. $\frac{2}{3}MR_1^2 = \frac{2}{5}MR_2^2$

24. 5

Sol. EPE per unit volume = $\frac{1}{2} \times \text{stress} \times \text{strain}$

25. 6

Sol. Time of height, T = $\frac{4V}{g\sqrt{7}}$, V = speed of projection

$V_H = \frac{V\sqrt{3}}{2\sqrt{7}}$

$V_\perp = \frac{3V}{2\sqrt{7}}$, when projectile with incline.

Tan $\alpha = \frac{1}{\sqrt{3}}$, $\alpha = 30°$.

PART – B

SECTION – A

26. B

Sol. In H-atom, the orbitals(five 3d, three 3p and one 3s) have same energy. So, they are called degenerate orbitals.

27. B

Sol. It is a zero order reaction.

28. D

Sol. Hybridization of boron changes to sp^3.

29. C

Sol. $pH = p_{Ka} + \log\frac{[CH_3COONa]}{[CH_3COOH]} = 5 + \log\frac{200 \times 0.4}{400 \times 0.2} = 5$

30. D

Sol. The observed bond angles are 120°, 180° and 90°.

31. D

Sol. In chlorobenzene, Cl exerts –I and +R effect. In other compounds, it only exerts –I effect.

32. D

Sol. $Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3$

33. B

Sol. Expansion of ring takes place in (B). In(C) the initially formed carbocation does not undergo rearrangement to initiate ring expansion.

34. C

Sol. Due to stable $t_{2g}^3 e_g^2$ configuration of Fe^{3+} ion.

35. C

Sol. It produces maximum number of ions as compared to other salts.

36. B

Sol. $E = E^\circ - \frac{0.0591}{n}\log\frac{1}{[H^+]} = 0 - \frac{0.0591}{n}\log\frac{1}{10^{-4}} = -0.236\,V$

37. B

Sol. For spontaneous process, $\Delta G < 0$.

$\therefore \Delta H - T\Delta S < 0$, $\Delta H < T\Delta S$

$\therefore T > \frac{\Delta H}{\Delta S} = \frac{18000}{60} = 300K$

38. C

Sol. It contains no chiral atom, $H_2N - CH_2 - COOH$.

39. C

Sol. Moles of HCl = $\frac{1200 \times 0.4}{1000} = 0.48$

Moles of NaOH = $\frac{19.2}{40} = 0.48$

40. B

Sol. $X = Na_2SO_3$
$Y = BaSO_3$
$Z = BaSO_4$

41. B

Sol. Anisole is the simplest aromatic ether.

42. C

Sol. Anti Markownikoff reaction takes place in this case.

43. D

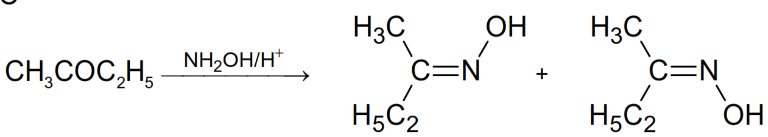
Sol. In Cl_2O_7, the oxidation number of Cl is maximum.

44. A

Sol. Oxygen forms both sigma and pi bonds with xenon.

45. C

Sol.



SECTION – B

46. 6

Sol. $P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_2$

x + y = 6

47. 3

Sol. $2X(g) \rightleftharpoons 2Y(g) + Z(g)$

$1 - \alpha \qquad \alpha \qquad \frac{\alpha}{2}$ Total moles = $1 + \frac{\alpha}{2} = \frac{2+\alpha}{2}$

$$K_P = \frac{(P_Y)^2 (P_Z)}{(P_X)^2}$$

$$= \frac{\left(\frac{2\alpha}{(2+\alpha)}\right)^2 P^2 . \left(\frac{\alpha}{2+\alpha}\right) P}{\left(\frac{2(1-\alpha)}{(2+\alpha)}\right)^2 P^2}$$ neglecting α compared to 1 and solving

$$\alpha = \left(\frac{2K_P}{P}\right)^{1/3} \Rightarrow n = 3$$

48. 5

Sol. $4H^+ + MnO_4^- \rightleftharpoons MnO_2 + 2H_2O$

$$\Delta G^\circ = -3F\left(\frac{1.5\times5 - 2\times1.25}{3}\right) = -5F$$

x = 5

49. 1

Sol. $KMnO_4$ H_2O_2

$N_1V_1 = N_2V_2$

$5 \times 0.1 \times 10 = 28 \times N_2$

$$N_2 = \frac{5}{28}$$

$V = 5.6 \times N$

$$= 5.6 \times \frac{5}{28} = 1$$

50. 1

Sol. $\text{Slope} = \frac{-\Delta H}{2.303R}$

$$\text{so, } \frac{-\Delta H}{2.303R} = \frac{-1}{4.606}$$

$\Delta H = 1$ cal

Mathematics PART – C

SECTION – A

51. C

Sol. When $\left(\frac{1}{y}+y^2\right)^{10}$ is expanded, the powers of y go on increasing as the terms proceed.

Hence it is expanded in ascending powers of y. So $\left(y^2+\frac{1}{y}\right)^{10}$, when expanded, will be in descending powers of y.

Hence, $t_7 = {}^{10}C_6\left(y^2\right)^4\left(\frac{1}{y}\right)^6 = \frac{10\times9\times8\times7}{4\times3\times2\times1}y^2$

$=210y^2$

52. B

Sol. We can rewrite the given expression as $(1-y)\frac{\left[1-(2x)^6\right]}{1-2x}=1-y^6$, one of the possible values of y is clearly 2x. Therefore, one of the possible values of $\frac{y}{x}$ is 2.

53. C

Sol. Since roots are imaginary, therefore $b^2-4ac<0$ and the roots α and β are given by

$\alpha=\frac{-b+i\sqrt{4ac-b^2}}{2a}$ and $\beta=\frac{-b-i\sqrt{4ac-b^2}}{2a}$

Clearly, $\alpha=\overline{\beta}$. Therefore, $|\alpha|=|\beta|$.

Further more,

$|\alpha|=\sqrt{\frac{b^2}{4a^2}+\frac{4ac-b^2}{4a^2}}=\sqrt{\frac{c}{a}}$

$\Rightarrow|\alpha|>1 \qquad [\because c>a]$.

54. C

Sol. Let $x=\sqrt{-1-\sqrt{-1-\sqrt{-1-....\text{to}\,\infty}}}$

Then $x=\sqrt{-1-x}$ or $x^2=-1-x$

or $x^2+x+1=0$

$\therefore\ x=\frac{-1\pm\sqrt{1-4.1.1}}{2.1}=\frac{-1\pm\sqrt{-3}}{2}$

$=\frac{-1\pm\sqrt{3}i}{2}=\omega$ or ω^2.

55. D

Sol. $1+n+n^2+......+n^{127}=\frac{n^{128}-1}{n-1}$

$=\frac{\left(n^{64}-1\right)\left(n^{64}+1\right)}{n-1}$

$=\left(1+n+n^2+......+n^{63}\right)\left(n^{64}+1\right)$

$\therefore k=64$ which is divisible by 8, 16, 32 and 64.

56. A

Sol. Let $z=1+2i$

$\Rightarrow |z|=\sqrt{1+4}=\sqrt{5}$

Now, $f(z)=\frac{7-z}{1-z^2}=\frac{7-(1+2i)}{1-(1+2i)^2}$

$=\frac{6-2i}{1-1-4i^2-4i}=\frac{6-2i}{4-4i}$

$=\frac{(3-i)(2+2i)}{(2-2i)(2+2i)}$

$=\frac{6-2i+6i-2i^2}{4-4i^2}=\frac{6+4i+2}{4+4}$

$=\frac{8+4i}{8}=1+\frac{1}{2}i$

$f(z)=1+\frac{1}{2}i$

$\therefore |f(z)|=\sqrt{1+\frac{1}{4}}=\sqrt{\frac{4+1}{4}}=\frac{\sqrt{5}}{2}=\frac{|z|}{2}$

57. A

Sol. Let P (t, 4 – 2t) be any point on the line $2x+y=4$. The equation of the chord of contact of tangents drawn from P to the circle $x^2+y^2=1$ is

$tx+(4-2t)y=1\Rightarrow(4y-1)+t(x-2y)=0$

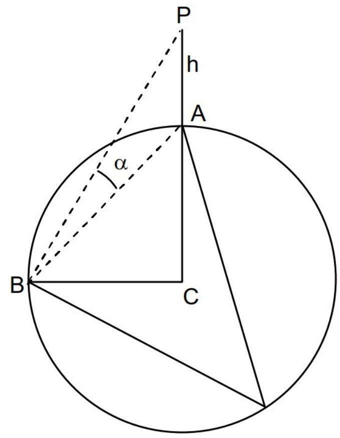
Clearly, it passes through the point of intersection of the lines $4y-1=0$ and $x-2y=0$ i.e. $\left(\frac{1}{2},\frac{1}{4}\right)$.

58. B

Sol. Let AP be the lamp post of height h at a point A on a circular path of radius r and centre C.

Let B be the point on this path such that $\underline{|PBA} = \alpha \Rightarrow AB = h\cot\alpha$

Since AB subtends an angle 45° at another point of the path it subtends an angle of 90° at the centre C so that $\underline{|BCA} = 90^\circ$



Also $CA = CB = r$

$\Rightarrow AB = \sqrt{2}r$

Also $h\cot\alpha = \sqrt{2}r$

$\Rightarrow h = \sqrt{2}\,r\tan\alpha$

59. C

Sol. We know that the total number of terms in $\left(x_1 + x_2 + ... + x_r\right)^n$ is ${}^{n+r-1}C_{r-1}$

So, the total number of terms in $\left(x_1 + x_2 + ... + x_n\right)^3$ is

$${}^{3+n-1}C_{n-1} = {}^{n+2}C_{n-1} = {}^{n+2}C_3 = \frac{(n+2)(n+1)n}{6}$$

60. C

Sol. We know that

$|\cos x - \sin x| \le \sqrt{2}$

$\therefore |\cos x - \sin x| \ge \sqrt{2}$

$\Rightarrow |\cos x - \sin x| = \sqrt{2}$

$\Rightarrow \cos x - \sin x = \sqrt{2}, -\sqrt{2}$

$\Rightarrow \cos\left(x + \frac{\pi}{4}\right) = 1, -1$

$\Rightarrow x + \frac{\pi}{4} = 0, \pi, 2\pi$

$\Rightarrow x = \frac{3\pi}{4}, \frac{7\pi}{4}$ $\qquad \left[\because x \in [0, 2\pi]\right]$

Hence, there are two values of x.

61. D

Sol. Let $P = (a\cos\theta, b\sin\theta)$

$\Rightarrow P_1 = (a\cos\theta, 0), P_2 = (0, b\sin\theta)$

Thus, equation of line P_1P_2 is $\frac{x}{a\cos\theta} + \frac{y}{b\sin\theta} = 1$

$$\Rightarrow \quad \frac{x/a}{\cos(-\theta)} - \frac{y/b}{\sin(-\theta)} = 1$$

which is clearly a normal to the ellipse of the form $\frac{x^2}{A^2}+\frac{y^2}{B^2}=1$

where $\frac{A}{A^2-B^2}=\frac{\lambda}{a}$, and $\frac{B}{A^2-B^2}=\frac{\lambda}{b}$

If $a>b$, then $B>A$.

Let the eccentricity of the second ellipse be e_1

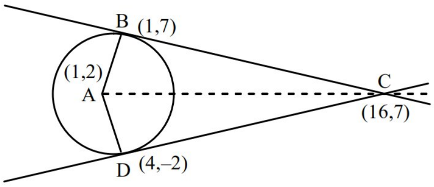
$\Rightarrow \quad 1-e_1^2=\frac{A^2}{B^2}=\frac{b^2}{a^2}=1-e^2$

$\Rightarrow \quad e_1=e$

Hence (D) is the correct answer.

62. B

Sol. Here centre A (1,2), and Tangent at (1,7) is



x.1 + y.7 – 1 (x+1) – 2 (y+7) – 20 = 0

or y = 7 ...(1)

Tangent at D (4,–2) is

3x – 4y – 20 = 0 ...(2)

Solving (1) and (2), C is (16, 7)

Area ABCD = AB x BC

$= 5 \times \sqrt{256+49-32-28-20} \quad = 5 \times 15 = 75$ units

Hence (B) is the correct answer.

63. A

Sol. Random experiment here is that selecting a digit at units place in each of the four numbers.

The digit at units place in each of the numbers can be any one of the ten digits 0, 1, 2, …, 9.

$\therefore$ The total number of ways in which the digit at units place in four numbers can be, is $n(S) = 10 \times 10 \times 10 \times 10 = 10^4$.

Let E be the event that the digit in the units place of product of the four numbers is 1, 3, 7 or 9.

Since, in order to have 1, 3, 7 or 9 in units place in the product each and every number should be ended with 1, 3, 7 or 9.

$\therefore n(E) = 4 \times 4 \times 4 \times 4 = 4^4$

$P(E) = \frac{n(E)}{n(S)}=\frac{4^4}{10^4}=\frac{16}{6^{25}}$

Hence (A) is the correct answer.

64. D

Sol. Equation of tangent in terms of slope of parabola $y^2=4x$ is $y=mx+\frac{1}{m}$ ....(i)

$\because$ Eq. (i) is also tangent of $x^2=-32y$

then $\quad x^2=-32\left(mx+\frac{1}{m}\right)$

$\Rightarrow \quad x^2+32mx+\frac{32}{m}=0$

$\therefore \quad B^2 = 4AC$ (Condition of tangency)

$\Rightarrow (32m)^2 = 4.1.\frac{32}{m}$

$\Rightarrow \quad m^3 = \frac{1}{8}$ or $m = \frac{1}{2}$

From Eq. (i), $y = \frac{x}{2} + 2$

$\Rightarrow x - 2y + 4 = 0$

Hence (D) is the correct answer.

65. B

Sol. $\alpha + \beta = 1$ and $\alpha\beta = -1$

AM of A_{n-1} and $A_n = \frac{A_{n-1} + A_n}{2}$

$= \frac{\alpha^{n-1} + \beta^{n-1} + \alpha^n + \beta^n}{2}$

$= \frac{\alpha^{n-1}(1+\alpha) + \beta^{n-1}(1+\beta)}{2}$

$= \frac{\alpha^{n-1}(\alpha^2) + \beta^{n-1}(\beta^2)}{2} \quad (\because \alpha^2 = \alpha + 1 \text{ and } \beta^2 = \beta + 1)$

$= \frac{1}{2}(\alpha^{n+1} + \beta^{n+1})$

$= \frac{1}{2}A_{n+1}$

Hence (B) is the correct answer.

66. D

Sol. Image of the centre = (–16, –2)

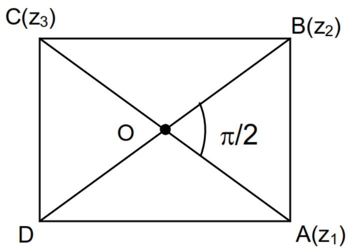
So equation of required circle is

$(x + 16)^2 + (y + 2)^2 = 5^2$

Hence (D) is the correct answer.

67. D

Sol. $\because$ OA = OB = OC = OD



Let $B(z_2)$ and $C(z_3)$

$\therefore \frac{z_2 - 0}{z_1 - 0} = \frac{OB}{OA} e^{i\pi/2} \Rightarrow z_2 = iz_1$

and $z_3 = -z_1$

($\because$ O is the mid point of A and C)

$\therefore$ Centoid $= \frac{z_1 + iz_1 - z_1}{3}$

$= \frac{iz_1}{3} = \frac{z_1}{3}\left(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}\right) \quad$ ....(i)

If B at D, then $z_2 = -iz_1$

$\therefore$ Centroid $= \dfrac{z_1 - iz_1 - z_1}{3}$

$= -\dfrac{iz_1}{3} = \dfrac{z_1}{3}\left(\cos\dfrac{\pi}{2} - i\sin\dfrac{\pi}{2}\right)$ ....(ii)

Combining Eqs. (i) and (ii), we get

Centroid of Δ ABC $= \dfrac{z_1}{3}\left(\cos\dfrac{\pi}{2} \pm i\sin\dfrac{\pi}{2}\right)$

Hence (D) is the correct answer.

68. C

Sol. $3!(1+3+5+7)+(10)\times 3!(1+3+5+7)$
$+10^2 \times 3!(1+3+5+7)+10^3 \times 3!(1+3+5+7)$

Hence (C) is the correct answer.

69. B

Sol. $\sqrt{\log_2 x} - 0.5 = \log_2 \sqrt{x}$

$\Rightarrow \sqrt{\log_2 x} = 0.5 = 0.5 \log_2 x \Rightarrow y - 0.5 = 0.5y^2$

$\Rightarrow y^2 - 2y + 1 = 0 \Rightarrow y = 1 \Rightarrow \log_2 x = 1 \Rightarrow x = 2$

Hence (B) is the correct answer.

70. C

Sol. Major axis of hyperbola bisects the asymptote
$\Rightarrow$ equation of other asymptote x = 2y
equation of hyperbola (y – 2x)(x – 2y) + k = 0 it passes through (3, 4)
$\Rightarrow$ required equation $2x^2 + 2y^2 - 5xy + 10 = 0$.

SECTION – B

71. 0

Sol. We have,

$$\frac{x^2}{1-|x-5|} = 1$$

$\Rightarrow x^2 = 1-|x-5|$

$\Rightarrow x^2 - 1 = -|x-5|$

The total number of real solutions of this equation is equal to the number of points of intersection of the curves $y = x^2 - 1$ and $y = -|x-5|$. Clearly, these two curves do not intersect. Hence, the given equation has no solution.

72. 4

Sol. Required limit $= \dfrac{\log_e(1+x) + x^2 - x}{x^2}$

$$= \lim_{x\to 0} \frac{\left(x - \frac{x^2}{2} + \frac{x^3}{3} - \ldots\ldots\right) + x^2 - x}{x^2}$$

$$= \lim_{x\to 0} \frac{\frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \ldots\ldots}{x^2}$$

$$= \lim_{x\to 0} \frac{x^2\left(\frac{1}{2} + \frac{x}{3} - \ldots\ldots\right)}{x^2} = \frac{1}{2}$$

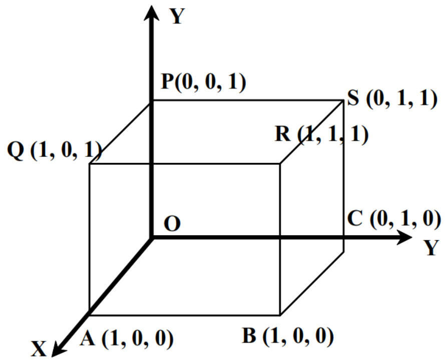
Hence 8λ will be equal to 4.

73. 1

Sol. The direction ratios of the diagonal $\overrightarrow{OR}$ is (1, 1, 1)

Direction cosine are

$$\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$$



Similarly direction cosine of $\overrightarrow{AS}$ are

$$\left(\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}\right)$$

$\overrightarrow{BP}$ are $\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}\right)$

$\overrightarrow{CQ}$ are $\left(\frac{1}{\sqrt{3}}, \ -\frac{1}{\sqrt{3}}, \ \frac{1}{\sqrt{3}}\right)$

Let l, m, n be direction cosines of the line

$\cos\alpha = \frac{l+m+n}{\sqrt{3}}$, $\cos\beta = \frac{l-m-n}{\sqrt{3}}$, $\cos\gamma = \frac{l+m-n}{\sqrt{3}}$, $\cos\delta = \frac{l-m+n}{\sqrt{3}}$

$\cos^2\alpha + \cos^2\beta + \cos^2\gamma + \cos^2\delta = \frac{4\left(l^2+m^2+n^2\right)}{3} = \frac{4}{3}$ (since $l^2 + m^2 + n^2 = 1$)

Hence answer is 00001.33.

74. 2

Sol. $b + c = 4a$

$\sin B + \sin C = 4\sin A$

$$\cos\frac{B-C}{2} = 4\cos\frac{B+C}{2}$$

$$\cos\frac{B}{2}\cos\frac{C}{2} + \sin\frac{B}{2}\sin\frac{C}{2} = 4\left[\cos\frac{B}{2}\cos\frac{C}{2} - \sin\frac{B}{2}\sin\frac{C}{2}\right]$$

$$3\cos\frac{B}{2}\cos\frac{C}{2} = 5\sin\frac{B}{2}\sin\frac{C}{2}$$

$$\cot\frac{B}{2}\cot\frac{C}{2} = \frac{5}{3}.$$

75. 1

Sol. As, $T_n = \cot^{-1}\left[\frac{(n+1)(n+2)}{2}x + \frac{2}{x}\right]$

$\Rightarrow T_n = \tan^{-1}\left(\frac{2x}{(n+2)(n+1)x^2+4}\right)$

$\therefore T_n = \tan^{-1}\left(\left(\frac{n+2}{2}\right)x\right) - \tan^{-1}\left(\left(\frac{n+1}{2}\right)x\right)$

So, $S_n = \tan^{-1}\left(\left(\frac{n+2}{2}\right)x\right) - \tan^{-1}x$

$\Rightarrow \lim_{n\to\infty} S_n = \frac{\pi}{2} - \tan^{-1}x$

$= \cot^{-1}x = 1$ (given)

$\Rightarrow \quad x = \cot 1$