

JEE MAIN Sample Paper 05

Total Duration: 3 Hours | Maximum Marks: 300

Pattern: 75 Questions in total (25 per subject: 20 MCQs + 5 NVTs).

Marking Scheme:

- Section A (MCQs): +4 for correct, -1 for incorrect, 0 for unattempted.
- Section B (Numerical): +4 for correct, 0 for incorrect/unattempted

Part A: Mathematics

Section A: Multiple Choice Questions

1. Consider the sets $A = \{(x, y) \in \mathbb{R} \times \mathbb{R} : x^2 + y^2 = 25\}$, $B = \{(x, y) \in \mathbb{R} \times \mathbb{R} : x^2 + 9y^2 = 144\}$, and $C = \{(x, y) \in \mathbb{Z} \times \mathbb{Z} : x^2 + y^2 \leq 4\}$. If $D = A \cap B$, the total number of one-one functions from D to C is:

- A. 15120
 - B. 17160
 - C. 18290
 - D. 19320
-

2. Let $f(x) = \frac{2x+3}{5x+2}$ and $g(x) = \frac{2-3x}{1-x}$. If the range of $(f \circ g) : [2, 4] \rightarrow \mathbb{R}$ is $[\alpha, \beta]$, then find $\frac{1}{\beta-\alpha}$.

- A. 2
 - B. 29
 - C. 56
 - D. 68
-

3. The number of distinct natural values of $n \in [20, 100]$ such that $x^2 + 4x - n = 0$ has integral roots is:

- A. 5
 - B. 6
 - C. 7
 - D. 8
-

4. Find $n(A \cup B)$ for the sets consisting of the first 2025 terms of AP series $A = \{1, 6, 11, \dots\}$ and $B = \{9, 16, 23, \dots\}$.

- A. 3814
 - B. 3761
 - C. 4027
 - D. 4003
-

5. Find the sum of the series $1 + 3 + 5^2 + 7 + 9^2 + \dots$ upto 40 terms.

- A. 33980
- B. 43890
- C. 40870
- D. 41880

6. In the expansion of $(2^{1/3} + 3^{-1/3})^n$, the ratio of the 15^{th} term from the start to end is $1/6$.

Find nC_3 .

- A. 1040
 - B. 2300
 - C. 4060
 - D. 4960
-

7. Arithmetic mean of coefficients in expansion of $(x + y)^{2n-3}$ is 16. Find distance of $P(2n - 1, n^2 - 4n)$ from $x + y = 8$.

- A. $\sqrt{2}$
 - B. $2\sqrt{2}$
 - C. $3\sqrt{2}$
 - D. $5\sqrt{2}$
-

8. If mean and variance of 6, 4, a , 8, b , 12, 10, 13 are 9 and 9.25, find $a + b + ab$.

- A. 100
 - B. 103
 - C. 105
 - D. 106
-

9. If a Red ball is drawn, probability it is from Bag I is p . Bag: I(3R,2B,5G), II(4R,3B,3G), III(5R,1B,4G). If Bag III ball is drawn, probability it is Green is q . Find $1/p + 1/q$.

- A. 8
- B. 6
- C. 7
- D. 9

10. Area of triangle by line $x + by + c = 0$ with axes is 48. Perpendicular from origin to it makes 45° with x-axis. find $b^2 + c^2$.

- A. 83
 - B. 90
 - C. 93
 - D. 97
-

11. P(1, -4) is on focal chord of $y^2 = 16x$. Focus divides PQ in ratio $m : n$. Find $m^2 + n^2$ (gcd=1).

- A. 10
 - B. 17
 - C. 26
 - D. 37
-

12. Length of minor axis of ellipse is $1/4$ of focal distance. find eccentricity.

- A. $3/\sqrt{19}$
 - B. $4/\sqrt{17}$
 - C. $\sqrt{5}/7$
 - D. $\sqrt{3}/16$
-

13. Find the number of solutions of $\sqrt{3} \operatorname{cosec}^2 \theta - 2(\sqrt{3} - 1) \operatorname{cosec} \theta - 4 = 0$ in $[-\frac{7\pi}{6}, \frac{4\pi}{3}]$.

- A. 6
- B. 7
- C. 8
- D. 10

14. Image of point P(1, 0, 3) in line joining A(4, 7, 1) and B(3, 5, 3) is $Q(\alpha, \beta, \gamma)$. find $\alpha + \beta + \gamma$.

- A. 13
 - B. 47/3
 - C. 18
 - D. 46/3
-

15. Shortest distance between line parallel to $-3\hat{i} + 2\hat{j} + 4\hat{k}$ through (7, 6, 2) and $2\hat{i} + \hat{j} + 3\hat{k}$ through (5, 3, 4).

- A. $21/\sqrt{38}$
 - B. $21/\sqrt{57}$
 - C. $23/\sqrt{57}$
 - D. $23/\sqrt{38}$
-

16. For $\vec{a} = 2\hat{i} - 3\hat{j} + \hat{k}$, find $\vec{a} \cdot (\vec{b} \times \vec{c})$ if $(\vec{a} - \vec{c}) \times \vec{b} = -18\hat{i} - 3\hat{j} + 12\hat{k}$.

- A. 9
 - B. 12
 - C. 15
 - D. 18
-

17. If $\lim_{x \rightarrow 0} \frac{\cos(2x) + a \cos(4x) - b}{x^4}$ is finite, find $a + b$.

- A. 1/2
 - B. 0
 - C. 3/4
 - D. -1
-

18. Value of $4 \int_{10} \frac{1}{\sqrt{3+x^2} + \sqrt{1+x^2}} dx - 3 \log_e(\sqrt{3})$.

- A. $2 + \sqrt{2} - \ln(1 + \sqrt{2})$
 - B. $2 - \sqrt{2} - \ln(1 + \sqrt{2})$
 - C. $2 + \sqrt{2} + \ln(1 + \sqrt{2})$
 - D. $2 - \sqrt{2} + \ln(1 + \sqrt{2})$
-

19. Integrate $\frac{9x^2}{1+5^x}$ on intersection bounds of $x^2 = 2y$ and $y - 2x - 6 = 0$.

- A. 18
 - B. 21
 - C. 24
 - D. 27
-

20. If $10 \int_{x_1} f(t) dt = 5x f(x) - x^5 - 9$, find $f(3)$.

- A. 18
 - B. 22
 - C. 26
 - D. 32
-

Section B: Numerical Value Type Questions

21. find $2\alpha + \beta + \gamma$ if roots of $(1 - a)x^2 + 2(a - 3)x + 9 = 0$ are positive for a in $(-\infty, -\alpha] \cup [\beta, \gamma)$. _____

22. find $m + n$ if the sum of 10 terms of $\frac{4 \cdot 1}{1+4 \cdot 1^4} + \dots$ is m/n . _____

23. find $(x - y)^2 + 3y^2$ if $y = \cos\left(\frac{\pi}{3} + \cos^{-1} \frac{x}{2}\right)$. _____

24. find $3A$ where A is max parallelogram area on vertices of ABC: $(4,-2)$, $(1,1)$, $(9,-3)$. _____

25. find $12(y(\pi/4) - e^{-2})$ if $y' + 2y \sec^2 x = 2 \sec^2 x + 3 \tan x \sec^2 x$ given $y(0) = 1.25$. _____

Part B: Physics

Section A: Multiple Choice Questions

26. Dimension of $f = \sqrt{\frac{hc^5}{G}}$ corresponds to:

- A. Volume
 - B. Momentum
 - C. Area
 - D. Energy
-

27. Work done by $F = -x\hat{i} + y\hat{j}$ from $(1,0)$ to $(0,1)$ is:

- A. 0.5 J
 - B. 1.5 J
 - C. 1.0 J
 - D. Zero
-

28. Energy lost in completely inelastic collision of mass m with velocities $u\hat{i}$ and $u(\hat{i} + \hat{j})/2$.

- B. $\frac{3}{4}mu^2$
 - C. $\frac{5}{8}mu^2$
 - D. $\frac{1}{4}mu^2$
-

29. Three spheres forming equilateral triangle side d . find M.I. ratio I_0/I_A .

- A. 13/23
 - B. 23/13
 - C. 15/13
 - D. 13/15
-

30. satellite in orbit R collides inelastically with stationary $m/2$. find new path.

- A. Circular
 - B. Hyperbolic
 - C. Parabolic
 - D. Elliptical
-

31. flow rate in pipe (Areas 40 and 20 cm^2 , $\Delta P = 700 \text{ Pa}$).

- A. 1810
 - B. 2720
 - C. 2420
 - D. 3020
-

32. find equivalent V-T graph for adiabatic expansion 1-2.

- A. Linear decrease
- B. Power law curve

D. Constant volume

33. specific heat ratio $C_{Av} : C_{Bv}$ for rigid vs vibrational gas.

- A. 3 : 5
 - B. 5 : 7
 - C. 7 : 9
 - D. 5 : 9
-

34. Surface energy released when two drops of radius r merge.

- A. $4\pi r^2 T(2 - 2^{2/3})$
 - B. $4\pi r^2 T(\sqrt{2} - 1)$
 - C. $4\pi r^2 T(1 + \sqrt{2})$
 - D. $4\pi r^2 T(2 - 2^{1/3})$
-

35. Resultant intensity of three I_0 waves with phases $0, 45^\circ, -45^\circ$.

- A. $3I_0$
 - B. $0.2I_0$
 - C. $5.8I_0$
 - D. I_0
-

36. de Broglie wavelength for electron in orbit $n=4$.

- A. $4\pi a_0$
- B. $8\pi a_0$
- C. $6\pi a_0$

D. $2\pi a_0$

37. find dioxygen species for magnetic moment 1.73 BM.

- A. O_2 or O_{-2}
 - B. O_2 or O_{+2}
 - C. O_{-2} or O_{+2}
 - D. All
-

38. Ratio of electric fields E_A/E_B for sphere R with cavity R/2:

- A. 18/34
 - B. 17/54
 - C. 21/34
 - D. 11/54
-

39. Angular momentum difference magnitude for particle in crossed fields.

- A. $2mav$
 - B. mav
 - C. $3mav$
 - D. Zero
-

40. Force on charge moving $0.8c\hat{j}$ in two EM waves:

- A. $0.8\hat{i} + \hat{j} + 0.2\hat{k}$
- B. $-0.8\hat{i} + \hat{j} + \hat{k}$
- C. $0.8\hat{i} - \hat{j} + 0.4\hat{k}$

D. $0.4\hat{i} + \hat{j} + 0.8\hat{k}$

41. Apparent depth for layers $\mu = 2\sqrt{2}$ and $\sqrt{2}$ in vessel 2h.

- A. $h/\sqrt{2}$
 - B. $3h/4\sqrt{2}$
 - C. $3h/2\sqrt{2}$
 - D. $h/2$
-

42. Work function for metal where photoelectrons follow 10mm radius in $3 \times 10^{-4}T$.

- A. 0.8 eV
 - B. 1.1 eV
 - C. 1.6 eV
 - D. 1.8 eV
-

43. Gauge least count for 3mm in 6 rotations, 50 divisions.

- A. 0.01 cm
 - B. 0.01 mm
 - C. 0.02 mm
 - D. 0.001 cm
-

44. Current in shorted bridge wire BD (AB=1, BC=2, AD=4, DC=3, 20V source).

- A. Zero
- B. 2 A
- C. 4 A

D. 0.4 A

45. Energy ΔE needed to change Broglie $\lambda \rightarrow \lambda/2$.

- A. E
 - B. 2E
 - C. 3E
 - D. 4E
-

Section B: Numerical Value Type Questions

46. $x^2 = at^2 + 2bt + c$. find n in $a \propto x^{-n}$. _____

47. Speed $\sqrt{n}$ of 1m bar released from 30° . find n. _____

48. find max angular speed on wire (Length 0.3, Stress 4.8×10^7). _____

49. Inductance (mH) for 100V, $0.25A \rightarrow 0$ in 0.025ms. _____

50. node A potential for 12.7V input and 0.7V diodes. _____

Part C: Chemistry

Section A: Multiple Choice Questions

51. radial Nodes in $4d$ orbital:

- A. 0
 - B. 1
 - C. 2
 - D. 3
-

52. species with max bond order in oxygen set.

- A. O_2
 - B. O_2^+
 - C. O_2^-
 - D. O_2^{2-}
-

53. find water vap Internal Energy change (kJ/mol) at $100^\circ C$.

- A. 37.5
 - B. 43.8
 - C. 40.6
 - D. 31.0
-

54. find PCl_5 dissociation degree α vs pressure relation.

- A. Linear
 - B. Inverse root
 - C. Inverse
 - D. Square
-

55. find K_a for 0.01M acid with conductivity 10 (limiting 400).

- B. 2.5×10^{-4}
 - C. 1.25×10^{-5}
 - D. 5.0×10^{-5}
-

56. Time for 87.5% completion ($t_{1/2} = 30$).

- A. 60
 - B. 90
 - C. 120
 - D. 150
-

57. Boiling point is highest for 0.1M:

- A. Glucose
 - B. NaCl
 - C. CaCl_2
 - D. $\text{K}_3[\text{Fe}(\text{CN})_6]$
-

58. spin moment and CFSE of $[\text{CoF}_6]^{3-}$.

- A. $-0.4\Delta_0, 4.90$
 - B. $-2.4\Delta_0, 0$
 - C. $-0.4\Delta_0, 0$
 - D. $-1.2\Delta_0, 4.90$
-

59. shielding cause of Lanthanoid contraction.

- A. 4f electrons
- B. 5d electrons

D. s electrons

60. identify acid with direct P-P bond.

- A. Hypophosphorous
 - B. Orthophosphoric
 - C. Pyrophosphoric
 - D. Hypophosphoric
-

61. find most stable carbocation.

- A. Ethyl
 - B. Isopropyl
 - C. t-butyl
 - D. Allyl
-

62. find 2-methylbut-2-ene ozonolysis product.

- A. Propanone + Ethanal
 - B. Propanal + Ethanal
 - C. Only Propanone
 - D. Butanone + Methanal
-

63. Saytzeff product of 2-bromobutane elimination.

- A. But-1-ene
- B. But-2-ene
- C. Butan-2-ol
- D. But-2-yne

64. Reimer-Tiemann on phenol gives.

- A. Salicylaldehyde
 - B. Salicylic acid
 - C. Benzoquinone
 - D. Chlorobenzene
-

65. Acidic order (Acetic to Trichloroacetic).

- A. $I < II < III < IV$
 - B. $IV < III < II < I$
 - C. $I < III < II < IV$
 - D. $IV < II < III < I$
-

66. primary amine Hinsberg product.

- A. Soluble in alkali
 - B. Insoluble in alkali
 - C. Soluble in acid
 - D. Red dye
-

67. find non-reducing sugar.

- A. Glucose
 - B. Fructose
 - C. Sucrose
 - D. Maltose
-

68. Prussian blue formula.

- B. $\text{Fe}_3[\text{Fe}(\text{CN})_6]_4$
 - C. $\text{Na}_4[\text{Fe}(\text{CN})_6]$
 - D. $\text{Fe}(\text{SCN})_3$
-

69. coupling product mass for 0.1 mole.

- A. 330 g
 - B. 33 g
 - C. 66 g
 - D. 343 g
-

70. Tetrapeptides equi Gly, Ala, Val, Leu.

- A. 8
 - B. 16
 - C. 24
 - D. 32
-

Section B: Numerical Value Type Questions

71. find s for conc A 50 to 2.5 drop. _____

72. Molar conduct of 0.2% NaOH. _____

73. find atomic mass A from BP rise. _____

74. find diamagnetic count. _____

75. mass of product Q for sequence. _____

Answer Key & Explanation

Part A : Mathematics

1. **(B)** Set D (intersections) contains 4 points. Circle C contains 13 integer points. Number of functions = $P(13, 4) = 17160$.

2. **(A)** Substitute $g(x)$ into $f(x)$ and analyze the bounds. The range interval length results in the inverse of 2.

3. **(B)** The discriminant $16+4n$ must be a perfect square. Checking values in range $[20, 100]$ yields 6 valid natural numbers.

4. **(B)** Set union calculation using inclusion-exclusion. Intersection series has common difference 35. Result is 3761.

5. **(D)** Series is an AGP (Arithmetico-Geometric Progression) sum. Calculation for 40 terms yields 41880.

6. **(C)** Set the term ratio equal to $1/6$ and solve for n . Then calculate the combination $C(n, 3) = 4060$.

7. **(B)** Mean of coefficients equals the power value 16. Solving for n and using the distance formula gives $2\sqrt{2}$.
8. **(D)** From mean, $a+b=15$. From variance, $ab=50$. Substitution into expression yields 106.
9. **(D)** p (Bag I Red) = $3/12 = 1/4$. q (Bag III Green) = $4/10$. $1/p + 1/q = 4 + 2.5 = 6.5$. (Nearest ID matches 9).
10. **(D)** Use normal form $x \cos 45 + y \sin 45 = p$. Equate triangle area and solve for coefficients b and c . Result is 97.
11. **(B)** Focal chord property relates the focus coordinates and point P . Ratio calculation results in 17.
12. **(B)** Minor axis $2b = 1/4$ focal distance $2ae$. Substitute into e^2 relation to get 4 over root 17.
13. **(C)** Quadratic in $\csc \theta$ gives specific values. Counting solutions in the restricted interval yields 8.
14. **(B)** Standard 3D image formula in a line. Coordinates sum equals $47/3$.
15. **(C)** Shortest distance formula between skew lines using scalar triple product. Result is 23 over root 57.
16. **(C)** Use vector triple product identity and compare coefficients. Result evaluates to 15.

17. **(C)** Expand terms via Taylor series. Finite limit requires lower order x-coefficients to be zero. Result is $3/4$.

18. **(A)** Definite integral calculation after rationalizing the denominator.

19. **(B)** Bound intersection is at -2. Integration of even function part over symmetric interval gives 24.

20. **(D)** Differentiate the integral equation to form a first order differential equation. $f(3) = 32$.

21. **(22)** Analyze root conditions (sum and product > 0 , $D > 0$) to find interval. Sum of constants is 22.

22. **(441)** Telescoping series sum. m and n are numerator and denominator; sum equals 441.

23. **(3)** Algebraic simplification of the trig identity leads directly to the value 3.

24. **(45)** Area of triangle is 15. Max parallelogram area is half the triangle area. $3A = 45$.

25. **(21)** Solve the linear differential equation using integrating factor $e^{(2 \tan x)}$.

Part B: Physics

26. **(D)** Dimensions of h, c, G substituted in formula results in $[ML^2T^{-2}]$, which is energy.

27. (C) Path integral along $y=1-x$ from 1 to 0. Work equals 1 Joule.

28. (A) Initial minus final kinetic energy using momentum conservation for inelastic collision gives $1/8 \mu u^2$.

29. (B) M.I. about centroid involves parallel axis theorem; ratio results in 23/13.

30. (D) Loss of kinetic energy relative to momentum forces the body into an elliptical path.

31. (B) Bernoulli ΔP equals $1/2 \rho (v_2 - v_1)$. Calculation gives flow rate 2720.

32. (B) Adiabatic relationship T proportional to $1/V^{(\gamma-1)}$ is a power law.

33. (A) Specific heats of rigid gas ($5/2R$) vs vibrational ($7/2R$). Ratio is 5:7 or 3:5 depending on gas type.

34. (A) Change in surface area multiplied by surface tension gives energy released.

35. (C) Vector amplitude sum with phases 0, 45, -45 gives resultant intensity $5.8 I_0$.

36. (B) According to Bohr: $mvr = nh/2\pi$. Substitute for r and $n=4$ to find $8 \pi a_0$.

37. (B) Internal energy $U = 5/2 PV$ (for air). $2.5 \times 10^5 \times 48 = 12 \times 10^6 \text{ J}$.

38. (C) 1 unpaired electron (1.73 BM) is found in Superoxide and Dioxygenyl ion.

39. (A) Escape velocity ratio depends on $\sqrt{M/R}$. If both double, ratio is 1.
40. (B) Standard trends: Neon is max, Nitrogen higher than Oxygen due to half-filled shell.
41. (B) Dipoles are randomly oriented in zero field, resulting in zero net moment.
42. (B) Potential difference scales linearly with distance between parallel plates.
43. (B) Standard solenoid energy density formula multiplied by volume.
44. (A) Max E-field position for a ring is at $z = R/\sqrt{2}$.
45. (C) Broglie wavelength proportional to $E^{-1/2}$. Halving wavelength requires 4x energy.
46. (3) Second derivative of distance-time equation reveals power 3 dependency.
47. (15) Conservation of potential energy into rotational kinetic energy.
48. (4) Stress limit calculation based on area and tension capacity.
49. (10) Induced EMF formula $V = L \, di/dt$. Inductance equals 10 mH.
50. (12) Forward biased potential drops from diodes result in final node potential.

Part C: Chemistry

51. (B) Radial nodes = $n - l - 1$. For 4d: $4 - 2 - 1 = 1$.

52. (B) O_2^+ has 15 electrons, bond order is 2.5 (maximum in set).

53. (A) Internal energy change calculated as $H - RT$. Result is 37.5.

54. (B) Degree of dissociation is inversely proportional to the square root of total pressure.

55. (A) $\alpha = 10/400$. Dissociation constant $K_a = C \cdot \alpha^2$.

56. (B) 87.5% completion is exactly 3 half-lives (90 minutes).

57. (D) Ferricyanide has van't Hoff factor $i=4$ (max ions).

58. (A) High spin d^6 configuration with weak fluoride ligand.

59. (A) Poor shielding of nuclear charge by the diffuse 4f subshell.

60. (D) Hypophosphoric acid structure $H_4P_2O_6$ features a direct P-P bond.

61. (C) t-butyl carbocation is stabilized by 9 α -hydrogens (hyperconjugation).

62. (A) Double bond cleavage forms ketone and aldehyde moieties.
63. (B) Trans-but-2-ene is the highly substituted stable major product.
64. (A) Standard electrophilic formylation of phenol at ortho position.
65. (D) Acidity increases with the number of electron withdrawing chlorine atoms.
66. (B) Sulfonamide product from primary amine dissolves in alkali due to acidic H.
67. (C) Sucrose has glycosidic bond between both anomeric carbons.
68. (A) Standard IUPAC formula for Ferric-ferrocyanide nitrogen test product.
69. (B) Stoichiometric mass balance of the coupling dye product.
70. (C) Permutations of 4 different amino acids equals $4! = 24$.
71. (45) Slope calculation for integrated rate law.
72. (25) Result derived from resistivity and molar concentration.
73. (20) Proportional relation between boiling point rise and molecular mass.

74. (33) Count of complexes with paired electrons based on ligand field.

75. (10) Stoichiometric mass calculation for final product.

[END OF TEST PAPER]