

JEE MAIN Sample Paper 04

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: Physics

Section A: Multiple Choice Questions (20 Questions)

1. A physical quantity P is given by $P = \frac{a^{1/2}b^2}{c^3d}$. If relative errors in a , b , c , d are 2%, 1%, 3%, 5% respectively, find max % error in P .

- A. 11%
- B. 17%
- C. 8%
- D. 14%

2. A projectile is fired at angle θ . The radius of curvature of its trajectory at the point where its velocity makes $\theta/2$ with horizontal is:

- A. $\frac{u^2 \cos^2 \theta}{g \cos^3(\theta/2)}$
 - B. $\frac{u^2 \cos^2 \theta}{g}$
 - C. $\frac{u^2 \sin^2 \theta}{g \cos^3(\theta/2)}$
 - D. $\frac{u^2 \cos^2(\theta/2)}{g \cos^3 \theta}$
-

3. Minimum force to move block up an incline is F_1 , and to prevent it from sliding down is F_2 . If $F_1 = 3F_2$, find μ_s :

- A. $1/3 \tan \theta$
 - B. $1/2 \tan \theta$
 - C. $2 \tan \theta$
 - D. $3 \tan \theta$
-

4. Particle mass m moves in circle R . If $a_c = k^2 R t^2$, power delivered to the particle by forces is:

- A. $mk^2 R^2 t$
 - B. $mk^2 R^2 t^2$
 - C. $mk R^2 t$
 - D. Zero
-

5. Minimum velocity v for a cylinder (M, R) rolling without slipping to mount a step of height $h = R/4$:

- A. $\sqrt{5gR/6}$
- B. $\sqrt{11gR/6}$
- C. $\sqrt{7gR/4}$

D. $\sqrt{5gR/7}$

6. Escape velocity from a planet with double the mass and double the radius of Earth is:

- A. v_e
 - B. $\sqrt{2}v_e$
 - C. $2v_e$
 - D. $v_e/\sqrt{2}$
-

7. Elongation of wire (L, r) is l for weight W. For another wire (2L, 2r) of same material with 2W weight, elongation is:

- A. l
 - B. $2l$
 - C. $l/2$
 - D. $4l$
-

8. In cycle $1 \rightarrow 2 \rightarrow 3 \rightarrow 1$ (isochoric, adiabatic, isobaric), find efficiency:

- A. $1 - \frac{\gamma(T_3 - T_1)}{T_2 - T_1}$
 - B. $1 - \frac{T_3 - T_1}{\gamma(T_2 - T_1)}$
 - C. $1 - \frac{\gamma(T_2 - T_1)}{T_3 - T_1}$
 - D. $1 - \frac{T_2 - T_1}{\gamma(T_3 - T_1)}$
-

9. RMS speed of O_2 at T is v . If $T \rightarrow 2T$ and it dissociates into atoms, new RMS speed:

- A. v
- B. $2v$
- C. $\sqrt{2}v$

D. $4v$

10. Fundamental frequency of an open organ pipe is f_0 . If one end is closed, the new frequency will be:

A. f_0

B. $f_0/2$

C. $2f_0$

D. $3f_0/2$

11. Work bringing three identical $+q$ from equilateral side a to side $a/2$ is:

A. $\frac{3q^2}{4\pi\epsilon_0 a}$

B. $\frac{3q^2}{2\pi\epsilon_0 a}$

C. $\frac{q^2}{4\pi\epsilon_0 a}$

D. Zero

12. Potential across capacitor C is V . Battery removed, plate distance doubles. Work done is:

A. $1/2 CV^2$

B. CV^2

C. $-1/2 CV^2$

D. Zero

13. Resistor X in meter bridge balances at 40cm. Adding 10Ω in series shifts it 10cm right. X is:

A. 10Ω

B. 20Ω

C. 30Ω

D. 40Ω

14. Particle (m, q) in B field enters at 30° to boundary. Time spent in field:

- A. $\pi m/3qB$
 - B. $5\pi m/3qB$
 - C. $2\pi m/qB$
 - D. $\pi m/6qB$
-

15. Induced EMF of rod length L rotating at ω in perpendicular field B:

- A. $B\omega L^2$
 - B. $1/2B\omega L^2$
 - C. $2B\omega L^2$
 - D. Zero
-

16. Power factor of LCR circuit where $V_R = 10V$, $V_C = 20V$, $V_L = 20V$:

- A. 0.5
 - B. 1.0
 - C. 0.707
 - D. 0.8
-

17. For EM wave along $+z$, $\vec{E} = E_0 \sin(kz - \omega t)\hat{i}$. The $\vec{B}$ field is:

- A. $\frac{E_0}{c} \sin(kz - \omega t)\hat{j}$
- B. $-\frac{E_0}{c} \sin(kz - \omega t)\hat{j}$
- C. $E_0 c \sin(kz - \omega t)\hat{j}$

D. $\frac{E_0}{c} \cos(kz - \omega t) \hat{j}$

18. Slab μ, t in YDSE shifts central fringe by n . Then t is:

- A. $\frac{n\lambda}{\mu-1}$
B. $\frac{n\lambda}{\mu}$
C. $\frac{(n-1)\lambda}{\mu}$
D. $\frac{\mu\lambda}{n-1}$
-

19. Ratio of max to min wavelength of Lyman series:

- A. 4/3
B. 3/2
C. 9/5
D. 5/3
-

20. Voltage in Zener diode breakdown region beyond knee point is:

- A. Increasing
B. Decreasing
C. Almost constant
D. Zero
-

Section B: Numerical Value Questions (5 Questions)

21. Block 2kg drops 40cm onto spring ($k=1960$). Find max compression $x \times 10^{-2}$ m. find x:

22. Lens ($f=20$) and Mirror ($R=20$) 15cm apart. Object at 40cm. find final image dist from mirror:

23. Electron 100eV projected at plate ($\sigma = -2 \times 10^{-6}$). Find distance to fail strike ($\times 10^{-4}$ m):

24. Activity drop 80% to 10% for radioactive substance with 20 min half-life takes: _____ min.

25. SHM ($A=10$ cm), distance where $KE = 3PE$: _____

Part B: Chemistry

Section A: Multiple Choice Questions (20 Questions)

26. Number of radial nodes for a $4d$ orbital is:

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

27. Correct order of first ionization enthalpies (IE1) for N, O, F, Ne:

- A. $N < O < F < Ne$
- B. $O < N < F < Ne$
- C. $O < F < N < Ne$
- D. $N < F < O < Ne$

28. Species with highest bond order among oxygen species:

- A. O₂
 - B. O₂⁺
 - C. O₂⁻
 - D. O₂²⁻
-

29. Internal energy change (kJ/mol) for water at 100°C (Vap Enthalpy=40.66):

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

30. Dissociation α relates to pressure P for PCl₅ as:

- A. $\alpha \propto P$
 - B. $\alpha \propto 1/\sqrt{P}$
 - C. $\alpha \propto 1/P$
 - D. $\alpha \propto P^2$
-

31. Weak acid (0.01M) conductivity 10, limiting 400. Find K_a :

- A. 6.25×10^{-6}
 - B. 2.5×10^{-4}
 - C. 1.25×10^{-5}
 - D. 5.0×10^{-5}
-

32. Time for 87.5% completion if half-life is 30 mins:

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

33. Boiling point is highest for 0.1M:

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

34. CFSE and moment for $[\text{CoF}_6]^{3-}$:

- 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
-

35. Lanthanoid contraction is caused by shielding of:

- A. 4f electrons
 - B. 5d electrons
 - C. 6s electrons
 - D. s electrons
-

36. phosphorus acid with P-P bond:

- A. Hypophosphorous
- B. Orthophosphoric

- C. Pyrophosphoric
 - D. Hypophosphoric
-

37. Most stable carbocation among these:

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

38. Ozonolysis of 2-methylbut-2-ene results in:

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

39. Product of 2-bromobutane with alcoholic KOH:

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

40. Reimer-Tiemann reaction on phenol gives:

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

D. Chlorobenzene

41. Lacks alpha-H and won't undergo Aldol:

- A. Acetaldehyde
 - B. Propanal
 - C. Benzaldehyde
 - D. Acetone
-

42. Order of acidic strength (Acetic to Trichloroacetic acids):

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

43. Primary amine product with Hinsberg reagent is:

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

44. Which is non-reducing?

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

45. Prussian blue formula in nitrogen test:

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

Section B: Numerical Value Questions (5 Questions)

46. Max water mass (g) from 12g mixture (2:1 molar). _____

47. E_a (kJ/mol) for rate quadrupling 293 to 313. _____

48. FP drop ($\times 10^{-2}$) for ionized 0.2m acid. _____

49. Count diamagnetic species in N_2 , O_2 , B_2 , C_2 , He_2^+ , NO^+ , CN^- . _____

50. Sum of S oxidation states in Caro's and Marshall's acids. _____

Part C: Mathematics

Section A: Multiple Choice Questions (20 Questions)

51. Range of $f(x) = \frac{x^2-4}{x^2+4}$ is:

- A. $[-1, 1)$
- B. $(-1, 1]$

C. $[-1, 1]$

D. $(-1, 1)$

52. Maximum value of $|z|$ if $|z - 3i| = 1$:

A. 2

B. 3

C. 4

D. 5

53. Ratio $(2s - q) : q$ for roots in GP:

A. $(r^2 - p^2) : p^2$

B. $p^2 : r^2$

C. $(r^2 + p^2) : (r^2 - p^2)$

D. $r^2 : p^2$

54. Range of determinant of $\begin{pmatrix} 1 & \sin \theta \\ -\sin \theta & 1 \end{pmatrix}$:

A. 0

B. $[1, 2]$

C. $(0, 1)$

D. $[2, 4]$

55. Number of ways to put 5 balls in 3 boxes (none empty):

A. 6

B. 10

C. 21

D. 15

56. Coeff x^7 in expansion 1 equals coeff x^{-7} in exp 2. find ab :

- A. 1
 - B. -1
 - C. 2
 - D. 1/2
-

57. infinite GP first term and ratio if sum=15, sum of sq=45.

- A. 5, 2/3
 - B. 10, 1/3
 - C. 3, 4/5
 - D. 15, 1/2
-

58. $\lim_{x \rightarrow 0} \frac{\int \dots}{x \sin x}$ is:

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

59. $f(x) = 2x^3 - 3x^2 - 12x + 5$. find $b - a$ (from max/min):

- A. 3
- B. -3
- C. 1

D. 2

60. Value of integral $\int \frac{dx}{x^2(x^4+1)^{3/4}}$:

A. $-(x^4 + 1)^{1/4}/x + C$

B. $-(1 + 1/x^4)^{1/4} + C$

C. $(x^4 + 1)^{1/4}/x + C$

D. $(1 + 1/x^4)^{1/4} + C$

61. Value of odd function integral over symmetric interval:

A. 0

B. π

C. 2π

D. $\pi/2$

62. Differential equation solution for $xy' + 2y = x^2$:

A. $y = x^2/4 + 3/4x^2$

B. $y = x^2/3 + 2/3x^2$

C. $y = x^2/2 + 1/2x^2$

D. $y = x^2 + 1$

63. Midpoint locus for intercepted line segment:

A. $x^2 + y^2 = 4p^2$

B. $1/x^2 + 1/y^2 = 4/p^2$

C. $1/x^2 - 1/y^2 = 4/p^2$

D. $x^2 - y^2 = 4p^2$

64. Common chord length of circles:

A. $\sqrt{2}$

B. $2/\sqrt{5}$

C. $\sqrt{5}$

D. $4\sqrt{5}$

65. Ellipse equation with focus (2,0), directrix $x=8$, $e=1/2$:

A. $x^2/16 + y^2/12 = 1$

B. $x^2/12 + y^2/16 = 1$

C. $(x-2)^2/16 + y^2/12 = 1$

D. $x^2/16 + (y-2)^2/12 = 1$

66. Vector angle based on triple cross product result:

A. 30°

B. 45°

C. 60°

D. 90°

67. parallel measured distance of point from plane:

A. 7

B. 1

C. $1/7$

D. 2

68. Possible values of x for given variance set:

- A. 6, $14/3$
 - B. 8, $16/3$
 - C. 4, $8/3$
 - D. 10, $14/3$
-

69. Prob exactly one of A or B:

- A. 0.2
 - B. 0.4
 - C. 0.6
 - D. 0.8
-

70. evaluate $\cos^{-1}(\cos(7\pi/6))$:

- A. $7\pi/6$
 - B. $5\pi/6$
 - C. $\pi/6$
 - D. $-\pi/6$
-

Section B: Numerical Value Type Questions (5 Questions)

71. Min elements in symmetric closure of relation $2x=3y$ on $\{1..100\}$: _____

72. Prob second ball red in draw. find $p + q$. _____

73. Constant term in expansion of power 10: _____

74. local minimum points of integral function: _____

75. Sum of solutions $k\pi$. find k: _____

Answer Key & Detailed Explanation

Part A: Physics

1. (B) Sum of weighted errors: $1/2(2) + 2(1) + 3(3) + 5 = 1 + 2 + 9 + 5 = 17\%$.

2. (A) Radius $R = v^2/g \cos \phi$. Substituting velocity and component at $\theta/2$ yields option A.

3. (B) From $F_1 = mg(\sin + \mu \cos)$ and $F_2 = mg(\sin - \mu \cos)$, solving $F_1 = 3F_2$ gives $\mu = 1/2 \tan \theta$.

4. (A) $a_c = v^2/R$. Work power $P = F_t v$. result is $mk^2 R^2 t$.

5. (A) Conserving angular momentum about the step corner leads to velocity $\sqrt{5gR/6}$.

6. (A) $v_e = \sqrt{2GM/R}$. If mass and radius double, ratio is 1, so velocity is same.

7. (A) Elongation $\Delta L = FL/AY$. Ratio analysis shows elongation remains l .

8. (A) Standard efficiency derivation for isochoric rejection cycle.

9. (B) $v \propto \sqrt{T/M}$. Temperature doubles, mass halves (dissociation), factor is $\sqrt{2 \times 2} = 2$.

10. (B) Open fundamental $v/2L$, closed fundamental $v/4L$.

11. (A) $W = U_f - U_i$. Ratio of separation halves, potential doubles.

12. (A) Energy $Q^2/2C$. Distance doubles, C halves, energy doubles. Work = $\Delta U = 1/2 CV^2$.

13. (B) Ratio $X/Y = 40/60$. New ratio $(X + 10)/Y = 50/50$. Solving gives $X = 20\Omega$.

14. (A) Angle subtended at center is $2\theta = 60^\circ$. Time is $T/6$.

15. (B) Standard formula for rotating rod in magnetic field.

16. (B) Since $V_L = V_C$, circuit is in resonance, power factor is 1.

17. (A) Direction of propagation is $\vec{E} \times \vec{B}$. $\hat{i} \times \hat{j} = \hat{k}$.

18. (A) Path difference shift $(\mu - 1)t = n\lambda$.

19. (A) $\lambda \propto 1/(1 - 1/n^2)$. Max ($n = 2$) vs Min ($n = \infty$) gives 4/3.

20. (C) Definition of Zener voltage stabilization.

21. 10 Conservation $mg(h + x) = 1/2kx^2$.

22. (16.67) Using mirror and lens equations in series.

23. (8.85) Energy balance against electrostatic field work.

24. (60) 80% to 10% is 3 half-lives.

25. 5 Energy relation $A^2 - x^2 = 3x^2$.

Part B: Chemistry

26. (B) nodes = $n - l - 1 = 4 - 2 - 1 = 1$.

27. (B) Half-filled stable Nitrogen is higher than Oxygen. Neon is maximum.

28. (B) Bond order: O_2 is 2.0, O_2^+ is 2.5 (max).

29. (A) $\Delta U = \Delta H - RT \approx 37.5$.

30. (B) From $K_p \approx \alpha^2 P$, so $\alpha \propto 1/\sqrt{P}$.

31. (A) $\alpha = 10/400$. $K_a = C\alpha^2 = 6.25 \times 10^{-6}$.

32. (B) 87.5% completion is exactly 3 half-lives.

33. (D) van't Hoff factor is 4 for potassium ferricyanide (max particles).

34. (A) High spin complex calculations for d_6 configuration.

35. (A) Poor shielding of nucleus by 4f shell.

36. (D) Hypophosphoric acid is $H_4P_2O_6$.

37. (C) Tertiary butyl carbocation is most stable.

38. (A) Double bond breaks into ketone and aldehyde groups.

39. (B) trans-but-2-ene is the Saytzeff major product.

40. (A) Ortho-hydroxybenzaldehyde is the product.

41. (C) Benzaldehyde lacks acidic hydrogens.

42. (D) Acid strength increases with electron withdrawing chlorines.

43. (B) Sulfonamide of primary amine has acidic H, dissolves in base.

44. (C) Sucrose glycosidic bond involves both reducing carbons.

45. (A) Correct IUPAC ferric-ferrocyanide formula.

46. (12) Stoichiometric calculation for water formation.

47. (53) $\log(4) = (E_a/2.303R) (20 / T_1 \cdot T_2)$.

48. (45) $i = 1.2$, depression = $i \cdot K_f \cdot m$.

49. (4) N_2 , C_2 , NO^+ , CN^- .

50. (12) S is +6 in both.

Part C: Mathematics

51. (A) $y = 1 - 8/(x^2+4)$. Range follows from denominator values.

52. (C) Max dist = center dist (3) + radius (1) = 4.

53. (A) sum/product relations in GP leads to p^2/r^2 ratio.

54. (B) $\det = 1 + \sin^2$. ranges from 1 to 2.

55. (A) $C(4, 2)$ calculation for distinct boxes.

56. (A) Coefficient balance results in product 1.

57. (A) Solving infinite GP equations for a and r.

58. (B) L'Hopital result at $x=0$.

59. (A) Critical points at -1 and 2. Difference is 3.

60. (B) Substitution transforms denominator.

61. (A) Integral of odd function over symmetric interval is zero.

62. (A) Solving LDE with IF = x^2 .

63. (B) Locus calculation for line segment midpoint.

64. (A) Intersection of circle equations.

65. (A) Verify distance of center from lines.

66. (B) Scalar comparison in triple product.

67. (B) Formula for parallel distance calculation.

68. (A) variance shift properties.

69. (C) $P(\text{only A}) + P(\text{only B})$ calculation.

70. (B) principal range check for 210 degrees.

71. (66) ordered pairs x2.

72. (11) Probability sum.

73. (180) term $r=2$.

74. (1) sign change check.

75. (5) total sum of pi fractions.

