RPSC Assistant Professor (Physics): MCQ Book

One thousand multiple-choice questions arranged by unit, in the order of the notes. Items come from the verified question bank of the physics notes (valid source items kept, errors corrected, numerical keys recomputed). Each question has four options, one key and a short explanation. Part B and Part C difficulty is mixed within each unit.

Navigation (unit-wise)

Unit	Title	Questions
1	**Unit 1**: Mathematical Methods of Physics	Q1-Q80 (80)
2	**Unit 2**: Classical Mechanics and Relativity	Q81-Q175 (95)
3	**Unit 3**: Properties of Matter, Fluids and Elasticity	Q176-Q195 (20)
4	**Unit 4**: Oscillations, Waves and Acoustics	Q196-Q245 (50)
5	**Unit 5**: Thermodynamics and Kinetic Theory	Q246-Q320 (75)
6	**Unit 6**: Statistical Physics	Q321-Q415 (95)
7	**Unit 7**: Electrostatics and Magnetostatics	Q416-Q490 (75)
8	**Unit 8**: Electrodynamics and Electromagnetic Waves	Q491-Q585 (95)
9	**Unit 9**: Optics and Lasers	Q586-Q640 (55)
10	**Unit 10**: Quantum Mechanics	Q641-Q734 (94)
11	**Unit 11**: Atomic and Molecular Physics	Q735-Q804 (70)
12	**Unit 12**: Nuclear and Particle Physics	Q805-Q864 (60)
13	**Unit 13**: Solid State and Condensed Matter Physics	Q865-Q924 (60)
14	**Unit 14**: Electronics and Instrumentation	Q925-Q964 (40)
15	**Unit 15**: Experimental Methods, Error Analysis and Numerical Methods	Q965-Q1000 (36)

Total questions: 1000. Four options, one defensible key, explanation under each item.

Unit 1: Mathematical Methods of Physics

Vectors

Q1. If A = 2i + 3j and B = −i + 4j, then A − B equals

(A) 3i + j

(B) 3i − j

(C) i + 7j

(D) −3i − j

Answer: (B) Negate every component of B: (2+1)i + (3−4)j = 3i − j. (The source key "3i + j" was wrong.)

Q2. Two forces of 6 N and 8 N act at 60° to each other. The magnitude of the resultant is

(A) 10 N

(B) 14 N

(C) 12.17 N

(D) 7.2 N

Answer: (C) $R^2 = 36 + 64 + 2(6)(8)\cos 60° = 148$, R = 12.17 N. (10 N is the 90° result.)

Q3. Velocities 30 m/s east and 20 m/s north act simultaneously. The resultant is

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(A) 50 m/s at 37°

(B) 36.06 m/s at 33.7° north of east

(C) 40 m/s at 37° north of east

(D) 36.06 m/s at 56.3° north of east

Answer: (B) $R = \sqrt{1300} = 36.06$; $\theta = \tan^{-1}(20/30) = 33.69°$.

Q4. The quantity $\|\mathbf{A} \times \mathbf{B}\|^2$ equals

(A) $A^2B^2 + (A\cdot B)^2$

(B) $A^2B^2 - (A\cdot B)^2$

(C) $A^2 + B^2 - 2A\cdot B$

(D) $(A\cdot B)^2$

Answer: (B) $A^2B^2(1 - \cos^2\theta) = A^2B^2\sin^2\theta$.

Q5. $\mathbf{A}\cdot(\mathbf{B}\times\mathbf{C}) = 0$ for non-zero vectors means that the three vectors are

(A) mutually perpendicular

(B) parallel to each other only

(C) coplanar

(D) unit vectors

Answer: (C) The scalar triple product is the signed volume of the parallelepiped.

Q6. $\mathbf{A} \times (\mathbf{B} \times \mathbf{C})$ equals

(A) $\mathbf{B}(\mathbf{A}\cdot\mathbf{C}) - \mathbf{C}(\mathbf{A}\cdot\mathbf{B})$

(B) $\mathbf{C}(\mathbf{A}\cdot\mathbf{B}) - \mathbf{B}(\mathbf{A}\cdot\mathbf{C})$

(C) $(\mathbf{A}\times\mathbf{B})\times\mathbf{C}$

(D) $\mathbf{A}(\mathbf{B}\cdot\mathbf{C}) - \mathbf{B}(\mathbf{A}\cdot\mathbf{C})$

Answer: (A) BAC–CAB rule.

Q7. For $\mathbf{A} = (1,2,3)$, $\mathbf{B} = (2,-1,1)$, $\mathbf{A} \times \mathbf{B}$ is

(A) $(5, 5, -5)$

(B) $(-5, -5, 5)$

(C) $(5, -5, 5)$

(D) $(1, 2, 3)$

Answer: (A) $(2\cdot1 - 3\cdot(-1),\ 3\cdot2 - 1\cdot1,\ 1\cdot(-1) - 2\cdot2) = (5, 5, -5)$.

Q8. $\varepsilon_{ijk}\,\varepsilon_{ijk}$ (summed over all indices) equals

(A) 3

(B) 6

(C) 9

(D) 27

Answer: (B) $\varepsilon_{ijk}\,\varepsilon_{ijm} = 2\delta_{km}$, so the full contraction is $2\cdot3 = 6$.

Q9. The volume element in spherical coordinates is

(A) $r\,dr\,d\theta\,d\varphi$

(B) $r^2\,dr\,d\theta\,d\varphi$

(C) $r^2\sin\theta\,dr\,d\theta\,d\varphi$

(D) $r\sin\theta\,dr\,d\theta\,d\varphi$

Answer: (C) Scale factors $1, r, r\sin\theta$.

Q10. In plane polar coordinates the tangential acceleration is

(A) $r\ddot{\theta}$

(B) $r\ddot{\theta} + 2\dot{r}\dot{\theta}$

(C) $\ddot{r} - r\dot{\theta}^2$

(D) $2\dot{r}\dot{\theta}$

Answer: (B) $a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$ (the second term is the Coriolis term).

Q11. The Coriolis force on a particle moving with velocity $\mathbf{v}$ in a frame rotating at $\boldsymbol{\Omega}$ is

(A) $-2m\,\boldsymbol{\Omega}\times\mathbf{v}$

(B) $+2m\,\boldsymbol{\Omega}\times\mathbf{v}$

(C) $-m\,\boldsymbol{\Omega}\times(\boldsymbol{\Omega}\times\mathbf{r})$

(D) $m\,\Omega^2\,r$

Answer: (A) It is perpendicular to $\mathbf{v}$ and does no work.

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Calculus

Q12. lim x→0 (1 − cos x)/x² equals

(A) 0

(B) 1/2

(C) 1

(D) ∞

Answer: (B) cos x ≈ 1 − x²/2.

Q13. lim x→0 (tan x − x)/x³ equals

(A) 0

(B) 1/3

(C) 1/6

(D) 1

Answer: (B) tan x = x + x³/3 + …

Q14. The Maclaurin series of ln(1 + x) converges for

(A) −1 < x < 1 only

(B) −1 < x ≤ 1

(C) −1 ≤ x < 1

(D) all x

Answer: (B) It converges at x = 1 (alternating harmonic) and diverges at x = −1.

Q15. The cyclic relation (∂x/∂y)_z (∂y/∂z)_x (∂z/∂x)_y equals

(A) +1

(B) −1

(C) 0

(D) xyz

Answer: (B) Standard result for F(x,y,z) = 0.

Q16. Γ(5/2) equals

(A) (3/4)√π

(B) (3/2)√π

(C) √π

(D) (15/8)√π

Answer: (A) (3/2)(1/2)Γ(1/2) = (3/4)√π = 1.329.

Q17. ∫₀^∞ x² e^(−x²) dx equals

(A) √π/4

(B) √π/2

(C) √π

(D) 1/2

Answer: (A) (1/2)Γ(3/2) = √π/4.

Q18. The Jacobian for the transformation from Cartesian to plane polar coordinates is

(A) 1

(B) r

(C) r²

(D) 1/r

Answer: (B) dx dy = r dr dθ.

Q19. The maximum of f = xy on x² + y² = 1 is

(A) 1

(B) 1/2

(C) √2/2

(D) 2

Answer: (B) At x = y = 1/√2, f = 1/2.

Q20. For several simultaneous constraints g_k = 0, the Lagrange condition is

(A) ∇f = λ ∇g_k for one λ

(B) ∇f = Σ λ_k ∇g_k

(C) ∇f = 0

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(D) $\nabla f \cdot \nabla g_k = 0$

Answer: (B) One multiplier per independent constraint.

Q21. B(m, n) equals

(A) $\Gamma(m)\Gamma(n)/\Gamma(m+n)$

(B) $\Gamma(m+n)/(\Gamma(m)\Gamma(n))$

(C) $\Gamma(m)+\Gamma(n)$

(D) $(m-1)!(n-1)!$

Answer: (A) Beta–Gamma relation.

Q22. $\int_0^{\infty} x^3 e^{(-2x)} dx$ equals

(A) 3/8

(B) 3/4

(C) 6

(D) 1/8

Answer: (A) $3!/2^4 = 6/16 = 3/8$.

VectorCalc

Q23. $\nabla \times (\nabla f)$ equals

(A) $\nabla^2 f$

(B) 0

(C) ∇f

(D) f

Answer: (B) The curl of a gradient vanishes.

Q24. $\nabla \cdot r$ (r = position vector) equals

(A) 1

(B) 3

(C) 0

(D) r

Answer: (B) $\partial x/\partial x + \partial y/\partial y + \partial z/\partial z = 3$.

Q25. $\nabla^2 (1/r)$ is

(A) 0 everywhere

(B) $-4\pi\,\delta^3(r)$

(C) $4\pi\,\delta^3(r)$

(D) $1/r^3$

Answer: (B) Zero for $r \neq 0$ but $-4\pi\delta^3$ at the origin.

Q26. For F = (yz, xz, xy) the curl is

(A) (x, y, z)

(B) 0

(C) (1,1,1)

(D) $(-x,-y,-z)$

Answer: (B) $F = \nabla(xyz)$.

Q27. The flux of F = r out of a sphere of radius R is

(A) $(4/3)\pi R^3$

(B) $4\pi R^3$

(C) $4\pi R^2$

(D) 3R

Answer: (B) $F \cdot n = R$ over area $4\pi R^2$; also $\int 3\, dV = 4\pi R^3$.

Q28. $\oint$ F·dl for F = (−y, x, 0) on the unit circle (counter-clockwise) is

(A) 0

(B) π

(C) 2π

(D) 4π

Answer: (C) Curl = $2\,\hat{z}$, area π.

Q29. Stokes' theorem relates

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(A) volume integral of div to surface flux
(B) flux of curl to circulation on the boundary
(C) line integral of gradient to end points
(D) surface integral to area

Answer: (B) $\iint (\nabla \times F)\cdot dS = \oint F \cdot dl$.

Q30. The radial part of the spherical Laplacian is

(A) $\partial^2/\partial r^2$
(B) $r^{-2}\,\partial/\partial r\,(r^2\,\partial/\partial r)$
(C) $r^{-1}\,\partial/\partial r\,(r\,\partial/\partial r)$
(D) $r\,\partial^2/\partial r^2$

Answer: (B) Standard form.

Q31. $\nabla^2(r^2)$ in three dimensions equals

(A) 2
(B) 3
(C) 6
(D) 12

Answer: (C) $n(n+1)$ with $n = 2$ gives 6.

Q32. The Laplacian of $\ln \rho$ in two dimensions ($\rho \neq 0$) is

(A) $1/\rho^2$
(B) 0
(C) $2/\rho$
(D) $-1/\rho$

Answer: (B) It is the potential of an infinite line charge.

Matrices

Q33. For an n×n matrix, the sum of eigenvalues equals

(A) determinant
(B) trace
(C) rank
(D) n

Answer: (B) $\mathrm{Tr}\,A = \Sigma\,\lambda$.

Q34. Eigenvalues of [[1,2],[2,1]] are

(A) 1, 2
(B) 3, −1
(C) 3, 1
(D) 0, 2

Answer: (B) 1 ± 2.

Q35. Eigenvalues of the 3×3 matrix with every entry 1 are

(A) 3, 0, 0
(B) 1, 1, 1
(C) 3, 3, 0
(D) 3, 1, 0

Answer: (A) Rank 1, trace 3.

Q36. Eigenvalues of a Hermitian matrix are

(A) always real
(B) always imaginary
(C) of unit modulus
(D) complex in general

Answer: (A) Proved from $v\dagger Av$.

Q37. The eigenvalues of a unitary matrix

(A) are real
(B) have unit modulus
(C) are zero or one
(D) are positive

Answer: (B) $\|Uv\| = \|v\|$.

Q38. The matrix with $A^2 - 7A + 10I = 0$ has inverse

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(A) (7I − A)/10

(B) (A − 7I)/10

(C) (7I + A)/10

(D) (10I − A)/7

Answer: (A) Cayley–Hamilton.

Q39. [σ_x, σ_y] equals

(A) 0

(B) 2iσ_z

(C) iσ_z

(D) −2iσ_z

Answer: (B) σ_iσ_j = δ_ij + iε_ijk σ_k.

Q40. e^(iπ σ_x) equals

(A) I

(B) −I

(C) σ_x

(D) iσ_x

Answer: (B) cosπ + iσ_x sinπ.

Q41. Two equal masses, wall springs k and a coupling spring κ: the normal-mode frequencies are

(A) √(k/m) and √((k+κ)/m)

(B) √(k/m) and √((k+2κ)/m)

(C) √(2k/m) and √(κ/m)

(D) both √(k/m)

Answer: (B) In-phase mode does not stretch κ; out-of-phase mode feels k+2κ.

Complex

Q42. ∮ dz/z over the unit circle counter-clockwise equals

(A) 0

(B) 2πi

(C) πi

(D) 1

Answer: (B) Basic residue.

Q43. ∫ dx/(1 + x²) over the real line equals

(A) π

(B) 2π

(C) π/2

(D) 0

Answer: (A) 2πi · 1/(2i).

Q44. The residue of e^z / z³ at z = 0 is

(A) 1

(B) 1/2

(C) 1/6

(D) 0

Answer: (B) Coefficient of 1/z in the Laurent series.

Q45. The singularity of sin z / z at z = 0 is

(A) a simple pole

(B) a double pole

(C) removable

(D) essential

Answer: (C) The limit is 1.

Q46. ∮ over the circle of radius 2 of dz/(z² + 1) equals

(A) 2πi

(B) πi

(C) 0

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(D) π

Answer: (C) Residues ±1/(2i) cancel.

Q47. The Cauchy–Riemann equations are

(A) u_x = v_y, u_y = v_x

(B) u_x = v_y, u_y = −v_x

(C) u_x = −v_y, u_y = v_x

(D) u_x = u_y

Answer: (B) Direction-independent derivative.

ODE

Q48. The solution of $y'' + 2y' + 5y = 0$ is

(A) e^(−x)(A cos2x + B sin2x)

(B) e^(x)(A cos2x + B sin2x)

(C) Ae^(−x) + Be^(−5x)

(D) (A + Bx)e^(−x)

Answer: (A) Roots $-1 \pm 2i$.

Q49. A damped oscillator ($\ddot{x} + 2\gamma\dot{x} + \omega_0^2 x = 0$) is critically damped when

(A) $\gamma = \omega_0$

(B) $\gamma = \omega_0/2$

(C) $\gamma = 2\omega_0$

(D) $\gamma = 0$

Answer: (A) Repeated root.

Q50. The amplitude-resonance frequency of a driven damped oscillator is

(A) ω_0

(B) $\sqrt{(\omega_0^2 - \gamma^2)}$

(C) $\sqrt{(\omega_0^2 - 2\gamma^2)}$

(D) $\sqrt{(\omega_0^2 + 2\gamma^2)}$

Answer: (C) Maximum of $A(\omega)$.

Q51. After one time constant, a charging RC capacitor reaches what fraction of its final voltage?

(A) 50%

(B) 63.2%

(C) 36.8%

(D) 86.5%

Answer: (B) $1 - e^{-1}$.

Q52. After one time constant, a discharging RC capacitor falls to

(A) 63.2%

(B) 36.8%

(C) 50%

(D) 13.5%

Answer: (B) $e^{-1}\, V_0$.

Special

Q53. $\int_{-1}^{1} P_2(x)^2\, dx$ equals

(A) 2/5

(B) 2/3

(C) 1

(D) 2

Answer: (A) 2/(2n+1).

Q54. The weight function for Hermite polynomials is

(A) 1

(B) e^(−x²)

(C) e^(−x)

(D) x

Answer: (B) Orthogonality on $(-\infty, \infty)$.

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Q55. The first zero of $J_0(x)$ is at

(A) 1.000

(B) 2.405

(C) 3.832

(D) 3.142

Answer: (B) $\alpha_{01} = 2.405$.

Transforms

Q56. At a jump discontinuity a Fourier series converges to

(A) the left limit

(B) the right limit

(C) the mean of the two

(D) zero always

Answer: (C) Dirichlet.

Q57. The Gibbs overshoot near a jump is approximately

(A) 1%

(B) 9% of the jump

(C) 50% of the jump

(D) 0 as $N \to \infty$

Answer: (B) About 8.95%, independent of N.

Q58. $L\{f'(t)\}$ equals

(A) $sF(s)$

(B) $sF(s) - f(0)$

(C) $F(s)/s$

(D) $F(s) - f(0)$

Answer: (B) Integration by parts.

Q59. $\int (x+3)\,\delta(x^2 - 4)\,dx$ equals

(A) 1/2

(B) 3/2

(C) 5/4

(D) 3

Answer: (B) Roots ± 2 with modulus of g-prime equal to 4: 5/4 + 1/4.

PDE

Q60. The equation $u_{xx} + 2u_{xy} + u_{yy} = 0$ is

(A) elliptic

(B) hyperbolic

(C) parabolic

(D) none of these

Answer: (C) $B^2 - AC = 0$.

Numerical

Q61. Newton–Raphson for $x^2 - 2 = 0$ from $x_0 = 2$ gives $x_2 =$

(A) 1.4167

(B) 1.5

(C) 1.4142

(D) 1.25

Answer: (A) $x_1 = 1.5$, $x_2 = 1.416667$.

Q62. The global error of Euler's method is

(A) $O(h)$

(B) $O(h^2)$

(C) $O(h^3)$

(D) $O(h^4)$

Answer: (A) Local $O(h^2)$, global $O(h)$.

Q63. For $y' = 2y$, $y(0) = 1$, Euler with $h = 0.2$ gives $y(0.4) =$

(A) 1.96

(B) 2.2255

(C) 1.44

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(D) 2.0736

Answer: (A) 1.4 then 1.96.

Q64. Simpson's 1/3 rule requires

(A) an odd number of intervals

(B) an even number of intervals

(C) any number of intervals

(D) equal weights

Answer: (B) Parabolic arcs over interval pairs.

Probability

Q65. For a Poisson distribution with mean λ the variance is

(A) λ^2

(B) $\sqrt{\lambda}$

(C) λ

(D) 2λ

Answer: (C) Mean = variance.

Groups

Q66. The number of generators of SU(3) is

(A) 3

(B) 6

(C) 8

(D) 9

Answer: (C) $N^2 - 1$.

Items carried from the source notes (verified or corrected)

Q67. A scalar quantity has

(A) only magnitude

(B) magnitude and direction

(C) direction only

(D) neither magnitude nor direction

Answer: (A) Carried from the source set; key verified.

Q68. The geometric law of vector addition is the

(A) parallelogram (triangle) law

(B) dot-product law

(C) cross-product law

(D) scalar multiplication law

Answer: (A) Carried from source; the key was verified.

Q69. The magnitude of A × B equals

(A) AB $\sin\theta$

(B) AB $\cos\theta$

(C) A + B

(D) A/B

Answer: (A) Carried from source (option text repaired).

Q70. The dot product is most directly used to compute

(A) work, W = F·d

(B) torque

(C) magnetic force

(D) angular momentum

Answer: (A) Carried from source.

Q71. The direction of A × B is

(A) perpendicular to both A and B

(B) along A

(C) along B

(D) a scalar, no direction

Answer: (A) Carried from source.

Q72. d/dx (e^x) equals

(A) e^x

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(B) $x\,e^{x-1}$

(C) e^{-x}

(D) 1

Answer: (A) Carried from source.

Q73. d/dx of the integral of f(t) from a to x equals f(x). This is

(A) the fundamental theorem of calculus

(B) Rolle's theorem

(C) the mean value theorem

(D) Green's theorem

Answer: (A) Carried from source.

Q74. The general solution of $y'' + 4y = 0$ is

(A) A cos2x + B sin2x

(B) A e^(2x) + B e^(−2x)

(C) (A + Bx)e^(2x)

(D) A e^(4x)

Answer: (A) Carried from source.

Q75. Exponential decay is described by

(A) $dN/dt = -\lambda N$

(B) $dN/dt = +\lambda N$

(C) $d^2x/dt^2 = -\omega^2 x$

(D) $\nabla^2\varphi = 0$

Answer: (A) Carried from source.

Q76. For $f = x^2 + y^2$, $\partial f/\partial x$ equals

(A) 2x

(B) 2y

(C) x^2

(D) 2x + 2y

Answer: (A) Carried from source.

Q77. The gradient of f = sin x cos y is

(A) (cos x cos y, −sin x sin y)

(B) (cos x, sin x)

(C) (cos x sin y, sin x cos y)

(D) (−cos x cos y, sin x sin y)

Answer: (A) Corrected: the source key "(cos x, sin x)" was wrong.

Q78. $\int e^x\,dx$ equals

(A) $e^x + C$

(B) $e^x/x + C$

(C) $x\,e^x + C$

(D) $\ln x + C$

Answer: (A) Carried from source.

Q79. Integration by parts states

(A) $\int u\,dv = uv - \int v\,du$

(B) $\int u\,dv = uv + \int v\,du$

(C) $\int u\,dv = u\,dv - v\,du$

(D) $\int u\,dv = u\,v'$

Answer: (A) Carried from source.

Q80. The derivative of x^2 is

(A) 2x

(B) x^2

(C) 1/x

(D) ln x

Answer: (A) Carried from source (trivial item retained).

Unit 2: Classical Mechanics and Relativity

Items carried from the source notes (verified or corrected)

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