PhysicsByAaryan

TIFR Physics 2018

Complete TIFR GS Physics Paper · 2018 · 40 questions

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Classical Mechanics

Q1. [TIFR_2018_A_Q12]

Year 2018 · Classical Mechanics · Basic Mechanics · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A heavy steel ball is struck by a small steel pellet moving horizontally with velocity $20\,\mathrm{m}\,s^{-1}$. If the pellet bounces off the steel ball with no slippage, and then rises vertically to a height 10 m above the point of contact, then what is 100 times the elastic coefficient of restitution (e) i.e. $100e$?

Q2. [TIFR_2018_A_Q3]

Year 2018 · Classical Mechanics · Pseudo Forces · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

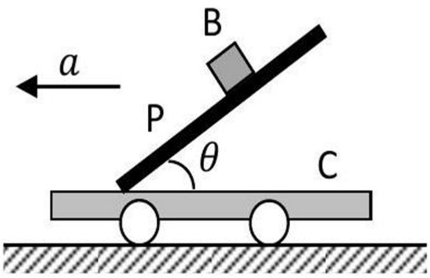
A small block B of mass m is placed on an inclined plane P , which makes an angle θ with a horizontal cart C , on which P is rigidly fixed (see figure). The coefficient of friction between the block B and the plane C is μ. When the cart stays stationary the block slides down. If the cart C is moving in the horizontal direction with acceleration a, the minimum value of a for which the block remains static on the plane is

(a) $g\frac{\tan\theta-\mu}{\mu\tan\theta+1}$

(b) $g(\mu-\sin\theta\cos\theta)$

(c) $g\frac{1-\mu\tan\theta}{\mu+\tan\theta}$

(d) $g(\cos\theta-\mu\sin\theta)$



Q3. [TIFR_2018_A_Q4]

Year 2018 · Classical Mechanics · Lagrangian and Hamiltonian · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A particle of mass m moving in one-dimension x is subjected to the Lagrangian

$$L=\frac{1}{2}m(\dot{x}-\lambda x)^2$$

where λ is a real constant. If it starts at the origin at $t=0$, its motion corresponds to the equation (a is a constant)

(a) $x=a\exp\lambda t$

(b) $x=a\sin\lambda t$

(c) $x=a\{1-\exp(-\lambda t)\}$

(d) $x=a\sinh\lambda t$

Q4. [TIFR_2018_B_Q23]

Year 2018 · Classical Mechanics · Lagrangian and Hamiltonian · Only int. Phd · 5 marks

TIFR GS	2018	Section B

The Hamiltonian of a dynamical system is equal to its total energy, provided that its Lagrangian

(a) does not contain velocity-dependent terms.

(b) has no explicit time dependence.

(c) is separable in generalized coordinates and velocities.

(d) does not have terms which explicitly depend on the coordinates.

Q5. [TIFR_2018_C_Q33]

Year 2018 · Classical Mechanics · Canonical Transformation and poison bracket · Only PhD · 5 marks

TIFR GS	2018	Section C

A dynamical system with one degree of freedom is described by canonical coordinates (p, q). The generator F of the canonical transformation $(p, q) \rightarrow (-q, p)$ is

(a) $F = -p\dot{q}$

(b) $F = pq$

(c) $F = p\dot{q}$

(d) $F = -\dot{p}q$

Electromagnetism

Q6. **[TIFR_2018_A_Q15]**
Year 2018 · Electromagnetism · Radiations · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

Consider a dipole antenna with length ℓ, charge q and frequency ω. The power emitted by the antenna at a large distance r is P. Now suppose the length ℓ is increased to $\sqrt{2}\ell$, the charge is increased to $\sqrt{3}q$ and the frequency is increased to $\sqrt{5}\omega$. By what factor is the radiated power increased?

Q7. **[TIFR_2018_A_Q16]**
Year 2018 · Electromagnetism · Electrostatics · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

Calculate the self-energy, in Joules, of a spherical conductor of radius 8.5 cm , which carries a charge $100\mu\text{C}$.

Q8. [TIFR_2018_B_Q26]

Year 2018 · Electromagnetism · Electric Field in matter · Only int. Phd · 5 marks

TIFR GS	2018	Section B

An atom of atomic number Z can be modelled as a point positive charge surrounded by a rigid uniformly negatively charged solid sphere of radius R. The electric polarisability α of this system is defined as

$$\alpha = \frac{p_E}{E}$$

where p_E is the dipole moment induced on application of electric field E which is small compared to the binding electric field inside the atom. It follows that $\alpha =$

(a) $\frac{4\pi\epsilon_0}{R^3}$
(b) $\frac{8\pi\epsilon_0}{R^3}$
(c) $4\pi\epsilon_0 R^3$
(d) $8\pi\epsilon_0 R^3$

Q9. [TIFR_2018_C_Q34]

Year 2018 · Electromagnetism · Electrostatics · Only PhD · 5 marks

TIFR GS	2018	Section C

The electrostatic charge density $\rho(r)$ corresponding to the potential

$$\varphi(r) = \frac{q}{4\pi\epsilon_0}\frac{1}{r}\left(1 + \frac{\alpha r}{2}\right)\exp(-\alpha r)$$

is $\rho =$

(a) $q\delta(r) - 2q\alpha^3\exp(-\alpha r)$
(b) $q\delta(r) - q\frac{\alpha^3}{4}\exp(-\alpha r)$
(c) $-q\delta(r) - 2q\alpha^3 ex\,p(-\alpha r)$
(d) $q\delta(r) - q\frac{\alpha^3}{2}\exp(-\alpha r)$

Q10. [TIFR_2018_C_Q35]

Year 2018 · Electromagnetism · Potential Formulation · Only PhD · 5 marks

TIFR GS	2018	Section C

The Hamiltonian of a particle of charge q and mass m in an electromagnetic field is given by

$$H = \frac{1}{2m}|\vec{p} - q\vec{A}(\vec{x},t)|^2 + q\varphi(\vec{x},t)$$

where $(\varphi, \vec{A})$ are the electromagnetic potentials. Clearly this Hamiltonian changes under a gauge transformation

$$\varphi \to \varphi - \frac{\partial \chi}{\partial t}\ \vec{A} \to \vec{A} + \vec{\nabla}\chi$$

where $\chi(\vec{x},t)$ is a gauge function. Nevertheless the motion of the particle is not affected because

(a) the action of the particle changes only by surface terms which do not vary.

(b) the Lorentz force is modified to balance the effect of the gauge transformation.

(c) the Lagrangian does not change under the gauge transformation.

(d) the motion of the particle is correctly described only in the Lorenz gauge.

Electronics

Q11. [TIFR_2018_A_Q10]

Year 2018 · Electronics · Logic Gates · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

In Boolean terms, $(A + B)(A + C)$ is equal to

(a) ABC

(b) $A + BC$

(c) $\mathrm{A(B + C)}$

(d) $\mathrm{(A + B + C)(A + B)}$

Q12. [TIFR_2018_A_Q9]

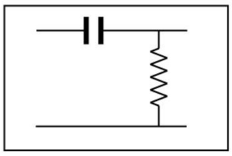
Year 2018 · Electronics · Filters · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

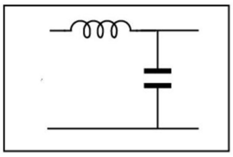
The figure below shows an unknown circuit, with an input and output voltage signal.

From the form of the input and output signals, one can infer that the circuit is likely to be

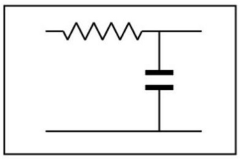
(a)



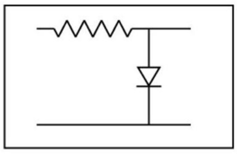
(b)



(c)



(d)

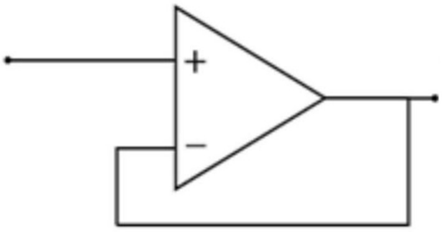


Q13. [TIFR_2018_B_Q28]

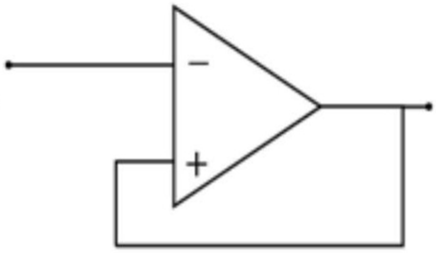
Year 2018 · Electronics · OPAMP · Only int. Phd · 5 marks

TIFR GS	2018	Section B

Consider the following circuits $\mathrm{C}-1$ and $\mathrm{C}-2$.



$\mathbf{C-1}$



$\mathbf{C-2.}$

You can apply the golden rules of an ideal op-amp to

(a) both C -1 and C -2

(b) neither C -1 nor C-2

(c) only C-1

(d) only C-2

Q14. [TIFR_2018_B_Q29]

Year 2018 · Electronics · AC and DC Circuits · Only int. Phd · 5 marks

TIFR GS	2018	Section B

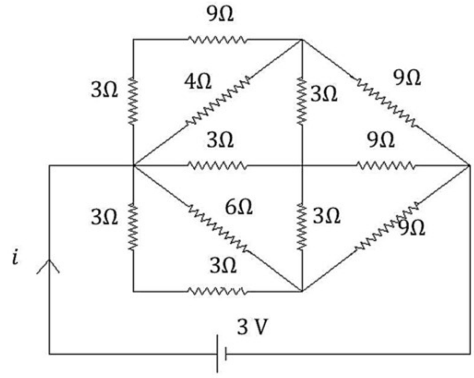
The current i flowing through the following circuit is

(a) 1.0 A

(b) 0.75 A

(c) 0.6 A

(d) 0.5 A

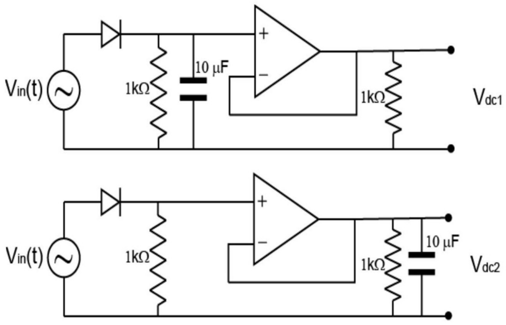


Q15. [TIFR_2018_C_Q38]

Year 2018 · Electronics · Mixed · Only PhD · 5 marks

TIFR GS	2018	Section C

A signal $V_{in}(t) = 5\sin(100\pi t)$ is sent to both the circuits sketched below.



If the DC output voltage of the top circuit has a value V_{dc1} and the bottom circuit has a value V_{dc2}, then which of the following statements about the relative value of V_{dc1} and V_{dc2} is correct?

(a) It will depend on the slew rate of the op-amp.

(b) $V_{dc1} = V_{dc2}$

(c) $V_{dc1} < V_{dc2}$

(d) $V_{dc1} > V_{dc2}$

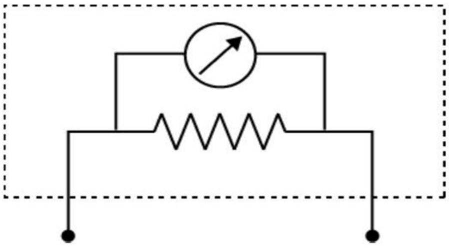
Experimental Physics

Q16. [TIFR_2018_A_Q19]

Year 2018 · Experimental Physics · Instruments · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A realistic voltmeter can be modelled as an ideal voltmeter with an input resistor in parallel as shown below:



Such a realistic voltmeter, with input resistance $1\text{k}\Omega$, gives a reading of 100 mV when connected to a voltage source with source resistance 50Ω. What will a similar voltmeter, with input resistance $1\text{M}\Omega$, read in mV , when connected to the same voltage source?

Q17. [TIFR_2018_B_Q22]

Year 2018 · Experimental Physics · Data Anaysis · Only int. Phd · 5 marks

TIFR GS	2018	Section B

Given the following xy data

x	1.0	2.0	3.0	4.0	5.0
y	0.002	0.601	0.948	1.21	1.42

which of the following would be the best curve, with constant positive parameters a and b, to fit this data?

(a) $y = ax - b$

(b) $y = a - \exp(-bx)$

(c) $y = a\log_{10} bx$

(d) $y = a + \exp bx$

Q18. **[TIFR_2018_B_Q30]**

Year 2018 · Experimental Physics · Error Analysis · Only int. Phd · 5 marks

TIFR GS	2018	Section B

Two students A and B try to measure the time period T of a pendulum using the same stopwatch, but following two different methods. Student A measures the time taken for one oscillation, repeats this process $N(\gg 1)$ times and computes the average. On the other hand, Student B just once measures the time taken for N oscillations and divides that number by N. The error in the measurement of the stopwatch is much smaller than the time period.

Assuming that the accuracy of the stopwatch is sufficiently high which of the following statements is true about the errors in T as measured by A and by B ?

(a) A and B will measure the time period with the same accuracy.

(b) It is not possible to determine if the measurement made by A or B has the larger error.

(c) The measurement made by A has a smaller error than that made by B.

(d) The measurement made by A has a larger error than that made by B.

Q19. **[TIFR_2018_C_Q39]**

Year 2018 · Experimental Physics · Instruments · Only PhD · 5 marks

TIFR GS	2018	Section C

Consider the circuit shown on the right, which involves an op-amp and two resistors, with an input voltage marked INPUT.

Which of the following circuit components, when connected across the input terminals, is most likely to create a problem in the normal operation of the circuit?

(a) A voltage source with very high Thevenin resistance.

(b) A voltage source with a very low Thevenin resistance.

(c) A current source with a very high Norton resistance.

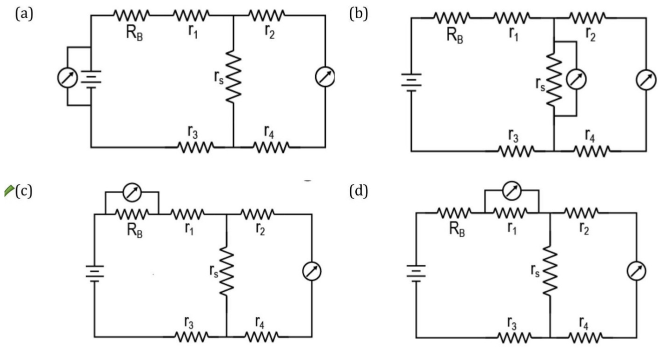
(d) 1A current source with a very low Norton resistance.

Q20. [TIFR_2018_C_Q40]

Year 2018 · Experimental Physics · Instruments · Only PhD · 5 marks

TIFR GS	2018	Section C

Which one of the following circuits, constructed only with resistors and voltmeters, will allow you to obtain the correct value of resistance r_s using the voltmeter readings? Note that the value of R_B is known while r_1, r_2, r_3, r_4 and r_s are all unknown. [Assume that the voltmeters and resistors are ideal.]

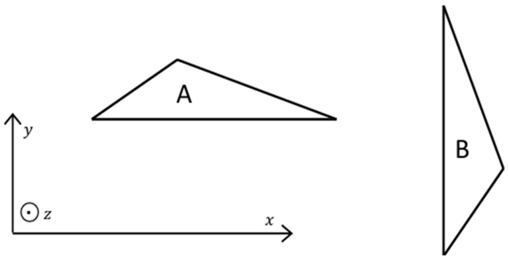


Geometry

Q21. [TIFR_2018_A_Q1]

Year 2018 · Geometry · Geometry · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A



Refer to the figure above. If the z-axis points out of the plane of the paper towards you, the triangle marked ' A ' can be transformed (and suitably re-positioned) to the triangle marked 'B' by

(a) rotation about z-direction by $\pi/2$, then reflection in the yz-plane

(b) reflection in the xz-plane, then rotation by $-\pi/2$ about z-direction

(c) reflection in the yz-plane, then rotation by $\pi/2$ about z-direction

(d) rotation about x-direction by $\pi/2$, then rotation by $-\pi/2$ in the yz-plane

Mathematical Physics

Q22. **[TIFR_2018_A_Q11]**

Year 2018 · Mathematical Physics · Differential Equations · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

Consider the two equations

$$\frac{x^2}{3} + \frac{y^2}{2} = 1$$
$$x^3 - y = 1$$

How many simultaneous real solutions does this pair of equations have?

Q23. **[TIFR_2018_A_Q2]**

Year 2018 · Mathematical Physics · Matrices · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

If a 2×2 matrix $\mathbb{M}$ is given by

$$\mathbb{M} = \begin{pmatrix} 1 & (1-i)/\sqrt{2} \\ (1+i)/\sqrt{2} & 0 \end{pmatrix}$$

then $\det\exp \mathbb{M} =$

(a) e^2

(b) e

(c) $2i\sin\sqrt{2}$

(d) $\exp(-2\sqrt{2})$

Q24. [TIFR_2018_B_Q21]

Year 2018 · Mathematical Physics · Differential Equations · Only int. Phd · 5 marks

TIFR GS	2018	Section B

If $y(x)$ satisfies the differential equation

$$y'' - 4y' + 4y = 0$$

with boundary conditions $y(0) = 1$ and $y'(0) = 0$,

then $y\left(-\frac{1}{2}\right) =$

(a) $-\frac{e}{2}$

(b) $\frac{1}{2}\left(e + \frac{1}{e}\right)$

(c) $\frac{1}{e}$

(d) $\frac{2}{e}$

Q25. [TIFR_2018_C_Q31]

Year 2018 · Mathematical Physics · Fourier and Laplace Analysis · Only PhD · 5 marks

TIFR GS	2018	Section C

The Fourier series which reproduces, in the interval $0 \leq x < 1$, the function

$$f(x) = \sum_{n=-\infty}^{+\infty} \delta(x - n)$$

where n is an integer, is

(a) $1 + 2\cos 2\pi x + 2\cos 4\pi x + 2\cos 6\pi x + \cdots +$ (to ∞)

(b) $1 + \cos \pi x + \cos 2\pi x + \cos 3\pi x + \cdots$ (to ∞)

(c) $\cos \pi x + \cos 2\pi x + \cos 3\pi x + \cdots$ (to ∞)

(d) $(\cos \pi x + \sin \pi x) + \frac{1}{2}(\cos 2\pi x + \sin 2\pi x) + \frac{1}{3}(\cos 3\pi x + \sin 3\pi x) + \cdots$ (to ∞)

Q26. [TIFR_2018_C_Q32]

Year 2018 · Mathematical Physics · Complex Analysis · Only PhD · 5 marks

TIFR GS	2018	Section C

The value of the integral

$$\frac{1}{\pi}\int_{-\infty}^{\infty}\frac{\cos x}{x^2+a^2}$$

is

(a) $1/2a$

(b) $1/2\pi a$

(c) $\exp(-a)/a$

(d) $\pi a \exp(-a)$

Nuclear and Particle Physics

Q27. [TIFR_2018_A_Q20]

Year 2018 · Nuclear and Particle Physics · Accelerator and Detectors · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

An electron enters a linear accelerator with a speed $v = 10\ \mathrm{m-s^{-1}}$. A vertical section of the accelerator tube is shown in the figure, where the lengths of the successive sections are designed such that the electron takes the same time $\tau = 20\ \mathrm{ms}$ to traverse each section.

If the momentum of the electron increases by 2% every time it crosses the narrow gap between two sections, what is the length (in km) of the collider which will be required to accelerate it to $100\ \mathrm{km\ -s^{-1}}$?

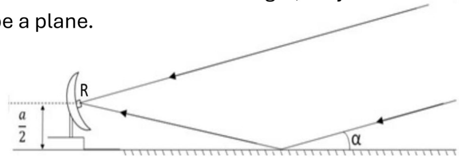
Optics

Q28. **[TIFR_2018_A_Q5]**

Year 2018 · Optics · Interference · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

The sketch below shows a radio antenna located at the edge of a calm lake, which has a receiver R at the centre of the dish at a height $a/2$ above the ground. This is picking up a signal from a distant radio-emitting star which is just rising above the horizon. However, the receiver also picks up a reflected signal from the surface of the lake, which, at the relevant radio-wavelength, may be taken to be a plane.



If the instantaneous angle of the star above the horizon is denoted α, the receiver R will detect the first interference maximum when $\alpha =$

(a) $\arcsin\left(\frac{\lambda}{2a}\right)^{1/3}$

(b) $\arcsin\left(\frac{\lambda}{a}\right)^{1/3}$

(c) $\arcsin\frac{\lambda}{2a}$

(d) $\arcsin\frac{\lambda}{a}$

Q29. **[TIFR_2018_A_Q8]**

Year 2018 · Optics · Ray Optics · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

The characteristic impedance of a co-axial cable is independent of the

(a) dielectric medium between the core and the outer mesh

(b) length of the cable

(c) outer diameter

(d) core diameter

Quantum Mechanics

Q30. [TIFR_2018_A_Q13]

Year 2018 · Quantum Mechanics · Basic Quantum Mechanics · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A particle is in the ground state of a cubical box of side ℓ. Suddenly one side of the box changes from ℓ to 4ℓ. If p is the probability of finding the particle in the ground state of the new box, what is $1000p$?

Q31. [TIFR_2018_A_Q14]

Year 2018 · Quantum Mechanics · Basic Quantum Mechanics · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

The wave-function Ψ of a particle in a one-dimensional harmonic oscillator potential is given by

$$\Psi = \left(\frac{1}{\pi\ell^2}\right)^{1/4}\left(1+\frac{\sqrt{2}x}{\ell}\right)\exp\left(-\frac{x^2}{2\ell^2}\right)$$

where $\ell = 100\mu\,\mathrm{m}$. Find the expectation value of the position x of this particle, in $\mu\mathrm{m}$.

Q32. **[TIFR_2018_A_Q6]**
Year 2018 · Quantum Mechanics · Potential Well · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A particle is confined inside a one-dimensional box of length ℓ and left undisturbed for a long time. In the most general case, its wave-function MUST be

(a) the ground state of energy.

(b) periodic, where ℓ equals an integer number of periods.

(c) any one of the energy eigenfunctions.

(d) a linear superposition of the energy eigenfunctions.

Q33. **[TIFR_2018_B_Q24]**
Year 2018 · Quantum Mechanics · Basic Quantum Mechanics · Only int. Phd · 5 marks

TIFR GS	2018	Section B

A particle in a one-dimensional harmonic oscillator potential is described by a wave-function $\psi(x,t)$. If the wavefunction changes to $\psi(\lambda x,t)$ then the expectation value of kinetic energy T and the potential energy V will change, respectively, to

(a) $\lambda^2 T$ and $\lambda^2 V$

(b) T/λ^2 and $\lambda^2 V$

(c) T/λ^2 and V/λ^2

(d) $\lambda^2 T$ and V/λ^2

Q34. **[TIFR_2018_B_Q25]**

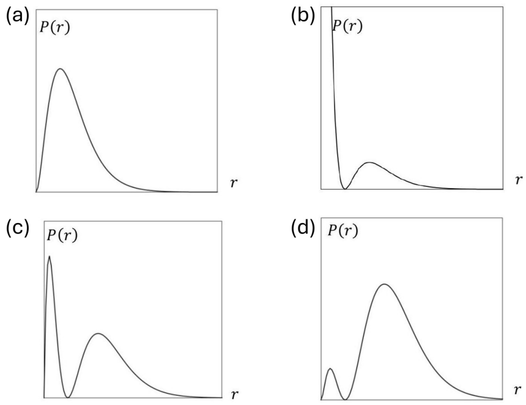
Year 2018 · Quantum Mechanics · Angular Momentum and Hydrogen atom · Only int. Phd · 5 marks

TIFR GS	2018	Section B

An electron is in the $2s$ level of the hydrogen atom, with the radial wave-function

$$\psi(r) = \frac{1}{2\sqrt{2}a_0^{3/2}}\left(2 - \frac{r}{a_0}\right)\exp\left(-\frac{r}{2a_0}\right)$$

The probability $P(r)$ of finding this electron between distances r to $r + dr$ from the centre is best represented by the sketch



Q35. **[TIFR_2018_C_Q36]**

Year 2018 · Quantum Mechanics · Angular Momentum and Hydrogen atom · Only PhD · 5 marks

TIFR GS	2018	Section C

The electron of a free hydrogen atom is initially in a state with quantum numbers $n = 3$ and $\ell = 2$. It then makes an electric dipole transition to a lower energy state. Which one of the given states could it be in after the transition?

(a) $n = 3, \ell = 0$

(b) $n = 2, \ell = 1$

(c) $n = 3, \ell = 1$

(d) $n = 2, \ell = 2$

Solid State Physics

Q36. [TIFR_2018_C_Q37]

Year 2018 · Solid State Physics · Lattice Vibrations and Thermal Properties · Only PhD · 5 marks

TIFR GS	2018	Section C

Consider a monoatomic solid lattice at a low temperature $T \ll T_D$, where T_D is the characteristic Debye temperature of the solid $T_D = \hbar\omega_m/k_B$ where ω_m is the maximum possible frequency of the lattice vibrations). The heat capacity of the solid is proportional to

(a) T/T_D

(b) T_D/T

(c) $(T/T_D)^3$

(d) $(T_D/T)^2$

Statistical Mechanics

Q37. [TIFR_2018_A_Q18]

Year 2018 · Statistical Mechanics · Canonical Ensemble · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

N particles are distributed among three energy levels having energies: $0, k_BT$ and $2k_BT$ respectively. If the total equilibrium energy of the system is approximately $42.5k_BT$ then find the value of N (to the closest integer).

Thermodynamics

Q38. [TIFR_2018_A_Q17]

Year 2018 · Thermodynamics · Carnot Cycle · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A heat engine is operated between two bodies that are kept at constant pressure. The constant pressure heat capacity C_p of the reservoirs is independent of temperature. Initially the reservoirs are at temperatures 300 K and 402 K . If, after some time, they come to a common final temperature T_f, the process remaining adiabatic, what is the value of T_f (in Kelvin)?

Q39. [TIFR_2018_A_Q7]

Year 2018 · Thermodynamics · Kinetic Theory of Gases · Both int. phd and phd · 3 marks

TIFR GS	2018	Section A

A classical ideal gas of atoms with masses m is confined in a three-dimensional potential

$$V(x,y,z) = \frac{\lambda}{2}(x^2 + y^2 + z^2)$$

at a temperature T. If k_B is the Boltzmann constant, the root mean square (r.m.s.) distance of the atoms from the origin is

(a) $\left(\frac{3k_BT}{\lambda}\right)^{1/2}$

(b) $\left(\frac{2k_BT}{3\lambda}\right)^{1/2}$

(c) $\left(\frac{3k_BT}{2\lambda}\right)^{1/2}$

(d) $\left(\frac{k_BT}{\lambda}\right)^{1/2}$

Q40. [TIFR_2018_B_Q27]

Year 2018 · Thermodynamics · Phase transition · Only int. Phd · 5 marks

TIFR GS	2018	Section B

A many-body system undergoes a phase transition between two phases A and B at a temperature T_c. The temperature-dependent specific heat at constant volume C_V of the two phases are given by $C_V^{(A)} = aT^3 + bT$ and $C_V^{(B)} = cT^3$. Assuming negligible volume change of the system, and no latent heat generated in the phase transition, T_c is

(a) $\sqrt{\frac{4b}{c-a}}$

(b) $\sqrt{\frac{3b}{c-a}}$

(c) $\sqrt{\frac{2b}{c}}$

(d) $\sqrt{\frac{b}{c-a}}$

Answer Key & Index

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1	TIFR_2018_A_Q12	Classical Mechanics	Basic Mechanics	49	3
2	TIFR_2018_A_Q3	Classical Mechanics	Pseudo Forces	a	3
3	TIFR_2018_A_Q4	Classical Mechanics	Lagrangian and Hamiltonian	d	3
4	TIFR_2018_B_Q23	Classical Mechanics	Lagrangian and Hamiltonian	b	5
5	TIFR_2018_C_Q33	Classical Mechanics	Canonical Transformation and p	b	5
6	TIFR_2018_A_Q15	Electromagnetism	Radiations	150	3
7	TIFR_2018_A_Q16	Electromagnetism	Electrostatics	529	3
8	TIFR_2018_B_Q26	Electromagnetism	Electric Field in matter	c	5
9	TIFR_2018_C_Q34	Electromagnetism	Electrostatics	d	5
10	TIFR_2018_C_Q35	Electromagnetism	Potential Formulation	a	5
11	TIFR_2018_A_Q10	Electronics	Logic Gates	b	3
12	TIFR_2018_A_Q9	Electronics	Filters	a	3
13	TIFR_2018_B_Q28	Electronics	OPAMP	c	5
14	TIFR_2018_B_Q29	Electronics	AC and DC Circuits	b	5
15	TIFR_2018_C_Q38	Electronics	Mixed	d	5
16	TIFR_2018_A_Q19	Experimental Physics	Instruments	105	3
17	TIFR_2018_B_Q22	Experimental Physics	Data Anaysis	c	5
18	TIFR_2018_B_Q30	Experimental Physics	Error Analysis	d	5
19	TIFR_2018_C_Q39	Experimental Physics	Instruments	b	5
20	TIFR_2018_C_Q40	Experimental Physics	Instruments	c	5
21	TIFR_2018_A_Q1	Geometry	Geometry	a	3
22	TIFR_2018_A_Q11	Mathematical Physics	Differential Equations	2	3
23	TIFR_2018_A_Q2	Mathematical Physics	Matrices	b	3
24	TIFR_2018_B_Q21	Mathematical Physics	Differential Equations	d	5
25	TIFR_2018_C_Q31	Mathematical Physics	Fourier and Laplace Analysis	a	5
26	TIFR_2018_C_Q32	Mathematical Physics	Complex Analysis	c	5
27	TIFR_2018_A_Q20	Nuclear and Particle Physics	Accelerator and Detectors	102	3
28	TIFR_2018_A_Q5	Optics	Interference	b	3
29	TIFR_2018_A_Q8	Optics	Ray Optics	b	3
30	TIFR_2018_A_Q13	Quantum Mechanics	Basic Quantum Mechanics	58	3
31	TIFR_2018_A_Q14	Quantum Mechanics	Basic Quantum Mechanics	71	3
32	TIFR_2018_A_Q6	Quantum Mechanics	Potential Well	d	3
33	TIFR_2018_B_Q24	Quantum Mechanics	Basic Quantum Mechanics	d	5
34	TIFR_2018_B_Q25	Quantum Mechanics	Angular Momentum and Hydrogen	d	5
35	TIFR_2018_C_Q36	Quantum Mechanics	Angular Momentum and Hydrogen	b	5
36	TIFR_2018_C_Q37	Solid State Physics	Lattice Vibrations and Thermal	c	5

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37	TIFR_2018_A_Q18	Statistical Mechanics	Canonical Ensemble	100	3
38	TIFR_2018_A_Q17	Thermodynamics	Carnot Cycle	347	3
39	TIFR_2018_A_Q7	Thermodynamics	Kinetic Theory of Gases	a	3
40	TIFR_2018_B_Q27	Thermodynamics	Phase transition	b	5