Target IIT-JAM-2018

Test Series-3

Booklet Code: C

MODERN PHYSICS + ELECTRICITY & MAGNETISM

Duration: 2:30 Hours | **PHYSICS-PH** | **Date: 12-01-2018**

Maximum Marks: 100

Read the following instructions carefully:

1 Attempt all the questions.

2. **Section-A** contains **30** Multiple Choice Questions (MCQ). Each question has 4 choices (a), (b), (c) and (d), for its answer, out of which **ONLY ONE** is correct. From **Q.1 to Q.10** carries 1 Marks and **Q.11 to Q.3**0 carries 2 Marks each.

3. **Section-B** contains **10** Multiple Select Questions(MSQ). Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which **ONE or MORE than ONE** is/are correct. For each correct answer you will be awarded **2 marks.**

4. Section-**C** contains **20** Numerical Answer Type (NAT) questions. From **Q.41 to Q.50** carries **1 Mark** each and **Q.51 to Q.60** carries **2 Marks** each. For each NAT type question, the value of answer in between 0 to 9.

5. In all sections, questions not attempted will result in zero mark. In Section–A (MCQ), wrong answer will result in negative marks. For all **1 mark** questions, **1/3 marks** will be deducted for each wrong answer. For all **2 marks** questions, **2/3 marks** will be deducted for each wrong answer. In Section–B (MSQ),there is no negative and no partial marking provision. There is no negative marking in Section –C (NAT) as well.

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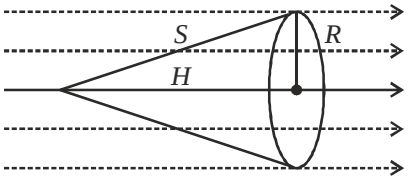
Section-A : Multiple Choice Questions (MCQ)

Q.1 to Q.10: Carry 1 Mark each.

1. A cone at radius R and height H is placed in an uniform electric field as shown in figure. The flux through the curved surface S of the cone.

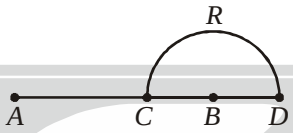


(a) $\pi R\sqrt{R^2+H^2}E$ (b) $-\pi R\sqrt{R^2+H^2}$ (c) $-\pi R^2E$ (d) zero

2. Three charges, each of value Q, are placed at the vertex of an equilateral triangle. A forth charge 'q' is placed at the centre of the triangle. If the charges remains stationary then 'q' is

(a) $Q/\sqrt{2}$ (b) $-Q/\sqrt{3}$ (c) $-Q/\sqrt{2}$ (d) $Q/\sqrt{3}$

3. Charges $+q$ and $-q$ are placed at point A and B respectively, which are a distance $2L$ apart, C is the midpoint between A and B. The workdone in moving a charge $+Q$ along the semicircle CRD, is



(a) $\dfrac{qQ}{2\pi\varepsilon_0 L}$ (b) $-\dfrac{qQ}{6\pi\varepsilon_0 L}$ (c) $\dfrac{qQ}{6\pi\varepsilon_0 L}$ (d) $\dfrac{qQ}{4\pi\varepsilon_0 L}$

4. Two spherical conductors of radii r_1 and r_2 are at potentials V_1 and V_2 respectively, then what will be the common potential when the two conductors are brought in contact

(a) $\dfrac{r_1V_1+r_2V_2}{r_1+r_2}$ (b) $\dfrac{r_1V_1+r_2V_2}{r_1-r_2}$ (c) $\dfrac{r_1V_1-r_2V_2}{r_1+r_2}$ (d) None of these

5. Two long thin wires each having charge density λ are placed along the lines $y=a$ and $y=\sqrt{3}\,x-2a$. Electric field at (0, 0, 0) is

(a) $\dfrac{\lambda}{2\pi\varepsilon_0 a}$ (b) $\dfrac{\sqrt{3}\lambda}{\pi\varepsilon_0 a}$ (c) $\dfrac{\sqrt{3}\lambda}{2\pi\varepsilon_0 a}$ (d) $\dfrac{\lambda}{4\pi\varepsilon_0 a}$

6. The work function (φ) of some metals are listed below:

Metal	*Li*	*K*	*Ag*	*Mg*
$\varphi(eV)$	2.4	2.2	4.3	3.7

When light of wavelength 300 nm is incident of the each of the metal independently, then which of the following metals will show photoelectric effect?

(a) *K* only (b) *K* and *Li* only (c) *K*, *Li* and *Mg* only (d) All metals

7. Let φ_1 and φ_2 denote, the normalized eigenstates of a aprticle with energy eigenvalues E_1 and E_2 respectively. At time t = 0, the particle is prepared in a state

$$\psi(x,t=0)=\frac{1}{\sqrt{2}}\varphi_1(x)+\frac{1}{\sqrt{2}}\varphi_2(x)$$

It is observed that both $\psi(x,t=T_1)$ and are $\psi(x,t=T_2)$ orthogonal to $\psi(x,t=0)$. The minimum non-zero value of T_2-T_1, is

(a) $\frac{\pi\hbar}{|E_1 - E_2|}$ (b) $\frac{2\pi\hbar}{|E_1 - E_2|}$ (c) $\frac{\pi\hbar}{2|E_1 - E_2|}$ (d) $\frac{4\pi\hbar}{|E_1 - E_2|}$

8. A particle is moving in a two-dimensional potential well described as following:

$$V(x, y) = 0 \quad \text{for } 0 < x < L, -L < y < L$$
$$= \infty \quad \text{otherwise}$$

The ground state eigenfunction for the system, is

(a) $\frac{\sqrt{2}}{L}\sin\frac{\pi x}{L}\sin\frac{\pi y}{2L}$ (b) $\frac{\sqrt{2}}{L}\cos\frac{\pi x}{L}\sin\frac{\pi y}{2L}$ (c) $\frac{\sqrt{2}}{L}\sin\frac{\pi x}{L}\cos\frac{\pi y}{2L}$ (d) $\frac{\sqrt{2}}{L}\cos\frac{\pi x}{L}\cos\frac{\pi y}{2L}$

9. Let $\hat{x}$ and $\hat{p}_x$ denote the position and momentum operator of a particle. The commutator bracket

$\left[\frac{\hat{p}_x^2}{2m} + \alpha x^2, \frac{\hat{p}_x^2}{m} + \beta x^2\right]$ will be zero, if

(a) $\alpha = \beta$ (b) $\alpha = 2\beta$ (c) $\alpha = \frac{\beta}{2}$ (d) $\alpha = \frac{\beta}{4}$

10. For a particle of energy E in one-dimensional square well of depth $-V_0$, centered at the origin and width a, the bound state wave function for large negative x is of the form

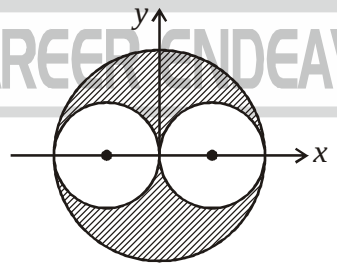
(a) $\exp\left(\frac{1}{\hbar}\sqrt{2mE}\,x\right)$ (b) $\exp\left(\frac{1}{\hbar}\sqrt{-2mE}\,x\right)$ (c) $\sin\left(\frac{1}{\hbar}\sqrt{-2mE}\,x\right)$ (d) $\cos\left(\frac{1}{\hbar}\sqrt{2mE}\,x\right)$

Q.11 to Q.30: Carry 2 Marks each.

11. An infinitely long wire is placed at distance d from a large grounded conducting sheet. The wire carries uniform linear charge density λ. Workdone per unit length in moving the wire to separation $2d$ keeping its orientation parallel to the sheet, is

(a) $\frac{\lambda^2}{4\pi\varepsilon_0 d}$ (b) $\frac{\lambda^2}{4\pi\varepsilon_0}\ln 2$ (c) $\frac{\lambda^2}{2\pi\varepsilon_0}\ln 2$ (d) $\frac{\lambda^2}{2\pi\varepsilon_0}$

12. From a uniformly charged sphere of radius R and volume charge density ρ, two spherical portions of radii $R/2$ are removed as shown in the figure.



Magnitude of electric field at the centre of one of the cavities is

(a) 0 (b) $\frac{\rho R}{3\varepsilon_0}$ (c) $\frac{\rho R}{6\varepsilon_0}$ (d) $\frac{\rho R}{8\varepsilon_0}$

13. An electric dipole of dipole moment $p\hat{i}$ is placed at (0, 0, 0). If $\vec{E}$ be the field of dipole then value of line integral $\int_C \vec{E}\cdot\vec{dl}$ along semicircle $C: x^2 + y^2 = R^2$ from $(R, 0)$ to $(-R, 0)$ in anticlockwise sense is

(a) $-\frac{p}{4\pi\varepsilon_0 R^2}$ (b) $-\frac{p}{2\pi\varepsilon_0 R^2}$ (c) $\frac{p}{2\pi\varepsilon_0 R^2}$ (d) $\frac{p}{4\pi\varepsilon_0 R^2}$

14. A sphere has uniform polarization $P_0\hat{z}$. Potential difference between centre of sphere and the point $(0, 0, 2R)$ is (where R is radius of the sphere).

(a) $-P_0R/3\varepsilon_0$ (b) $-P_0R/6\varepsilon_0$ (c) $-P_0R/8\varepsilon_0$ (d) $-P_0R/12\varepsilon_0$

15. A long wire carrying current I is placed along z-axis with current flowing in +z-direction. If $\vec{B}$ be the magnetic field of the wire, then value of line integral $\int_P^Q \vec{B}\cdot\vec{dl}$ along the curve $C: x = a$ from P to Q is [where P and Q have co-ordinates $(a, -a, 0)$ and $(a, a, 0)$ respectively].

(a) $\mu_0 I$ (b) $\mu_0 I/2$ (c) $\mu_0 I/3$ (d) $\mu_0 I/4$

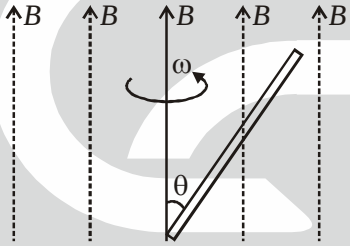
16. When a non relativistic charge particle of mass 'm', charge q and speed 'v' is thrown into a uniform perpendicular magnetic field from outside, it comes out of the field in time T_1. When direction of initial velocity is changed by angle θ it comes out in time T_2. $|T_1 - T_2|$ is equal to

(a) $\theta m/qB$ (b) m/qB (c) $2\theta m/qB$ (d) $2m/qB$

17. A charge Q is uniformly distributed on annular ring of inner and outer radii R_1 and R_2. If the ring is uniformly rotated about its axis with angular velocity ω, what will be magnetic field at its centre.

(a) $\dfrac{\mu_0 Q\omega}{\pi(b+a)}$ (b) $\dfrac{\mu_0 Q\omega}{2\pi(b+a)}$ (c) $\dfrac{\mu_0 Q\omega}{(b+a)}$ (d) $\dfrac{\mu_0 Q\omega}{2(b+a)}$

18. A thin conducting rod of length 'l' is rotated with uniform angular velocity ω as shown in the figure in presence of a uniform magnetic field. Motional e.m.f. between centre and free end of the rod is



(a) $\frac{1}{8}B\omega l^2\sin\theta$ (b) $\frac{3}{8}B\omega l^2\sin^2\theta$ (c) $\frac{3}{8}B\omega l^2\sin\theta$ (d) $\frac{1}{8}B\omega l^2\sin^2\theta$

19. A square loop of side 'a' and resistance R is placed in uniform magnetic field perpendicular to its plane. If the loop is rotated with uniform angular velocity ω about its one side, heat generated during one complete rotation will be

(a) $\dfrac{a^4B^2\omega^2}{R}$ (b) $\dfrac{a^4B^2\omega^2}{2R}$ (c) $\dfrac{a^4B^2\omega^2}{4R}$ (d) $\dfrac{2a^4B^2\omega^2}{R}$

20. For a certain medium, the relation between the refractive index n and angular frequenecy ω is given as

$$n = \sqrt{1 - \frac{B}{\omega^2 - \omega_0^2}}\ ;\ B > 0$$

The ratio of $\dfrac{c}{v_g}$ in the given medium, will be

(a) $n + \dfrac{B\omega^2}{n\left(\omega^2 - \omega_0^2\right)^2}$ (b) $n - \dfrac{B\omega^2}{n\left(\omega^2 - \omega_0^2\right)^2}$ (c) $n + \dfrac{B\omega^2}{n\left(\omega^2 + \omega_0^2\right)^2}$ (d) $n - \dfrac{B\omega^2}{n\left(\omega^2 - \omega_0^2\right)^2}$

21. Which of the following statements is not true about binding energy per nucleon ?
(a) It is maximum for iron
(b) Its average value is about 5 MeV
(c) It is almost constant for most of the nuclei
(d) It increases for low mass nuclei and then becomes almost constant

22. The ground state energy of a particle of mass *m* in a two dimensional isotropic harmonic oscillator potential, is not zero. This is because
(a) The ground state does not have any nodes.
(b) This is the most convenient choice of the zero level of potential energy.
(c) The potential is symmetric about the origin.
(d) Position and momentum of the particle cannot be measured simultaneously accurately.

23. The wavefunction of a particle moving in free space is given by,

$$\psi(x) = \exp(ikx) + 2\exp(-ikx)$$

The probability current density corresponding to the wave function, is

(a) $5\frac{\hbar k}{m}\hat{i}$ (b) $-5\frac{\hbar k}{m}\hat{i}$ (c) $3\frac{\hbar k}{m}\hat{i}$ (d) $-3\frac{\hbar k}{m}\hat{i}$

24. Particles of energy *E* are incident on a rectangular potential barrier of height $V_0 (< E)$ and width *L*. The minimum value of the width *L*, for which there will be maximum reflection from the barrier is

(a) $\frac{\pi\hbar}{2\sqrt{2m(E-V_0)}}$ (b) $\frac{\pi\hbar}{\sqrt{2m(E-V_0)}}$ (c) $\frac{3\pi\hbar}{2\sqrt{2m(E-V_0)}}$ (d) 0

25. If N_0 is the original mass of the substance of half-life period $t_{½} = 5$ years, then the amount of substance left after 15 years
(a) $N_0/8$ (b) $N_0/16$ (c) $N_0/2$ (d) $N_0/4$

26. An atom of mass *M* can be excited to a state of mass $M + \Delta$ by photon capture. The fre quency of the photon which can cause this transition is

(a) $\frac{\Delta c^2}{h}$ (b) $\frac{\Delta^2 c^2}{2Mh}$ (c) $\frac{\Delta c^2(2M+\Delta)}{2Mh}$ (d) $\frac{\Delta c^2(2M+\Delta)}{h}$

27. A rod of length *l* carries a total charge *q* distributed uniformly. If this is observed in a frame moving with a speed *v* along the rod, the charge per unit length measured by the moving observer will be

(a) $\frac{q}{l}\left(1-\frac{v^2}{c^2}\right)$ (b) $\frac{q}{l}\sqrt{1-\frac{v^2}{c^2}}$ (c) $\frac{q}{l\sqrt{1-\frac{v^2}{c^2}}}$ (d) $\frac{q}{l\left(1-\frac{v^2}{c^2}\right)}$

28. Electric field in a region is $\vec{E} = 3\left(z\hat{i} + x\hat{k}\right)$. The flux through a semicircular region $x^2 + y^2 = 1\ (x \geq 0)$ is
(a) 3 (b) 4 (c) 2 (d) 5

29. The binding energy of a light nucleus (*Z*, *A*) in MeV is given by the approximate formula:

$$B(Z,A) \approx 16A - 20A^{2/3} - \frac{3}{4}z^2A^{-1/3} - 30\frac{(N-Z)^2}{A}$$

where $N = A - Z$ is the neutron number.The value of *Z* of the most stable isobar for a given *A* is

(a) $\frac{A}{2}\left(1+\frac{A^{2/3}}{80}\right)^{-1}$ (b) $\frac{A}{2}\left(1-\frac{A^{2/3}}{120}\right)^{-1}$ (c) $\frac{A}{2}\left(1+\frac{A^{4/3}}{120}\right)^{-1}$ (d) $\frac{A}{2}\left(1-\frac{A^{4/3}}{160}\right)^{-1}$

30. A π^+ meson at rest decays into a μ^+ meson and a neutrino in 2.5×10^{-8}s. Assuming that the π^+ meson has kinetic energy equal to its rest energy. What distance would the meson travel before decaying as seen by an observer at rest

(a) 13 m (b) 6.5 m (c) 10 m (d) 5 m

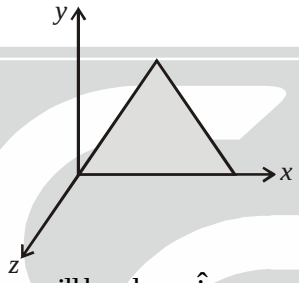
Section-B : Multiple Select Questions (MSQ)

Q.31 to Q.40: Carry 2 Marks each.

31. Electric potential inside a solid sphere of radius *R* at distance '*r*' from the centre is $\phi(r) = (ar^3 + b)$, then the correct statement(s) is/are :

(a) Electric field at $r = 2R$ depends on only a
(b) Electric field at $r = 2R$ depends on only b
(c) Electric field at $r = 2R$ depends on both a and b
(d) Electric field at $r = 2R$ does not depend a and b

32. A plane electromagnetic wave $\vec{E} = \hat{j}\,E_0 \cos(\omega t - kx)$ propagating in space. It $E_0 = 5\times10^{-4}\ \frac{\text{V}}{\text{m}}$ and $\omega = 10\pi\times10^6\ \frac{\text{rad}}{\text{sec}}$. The correct statement(s) is/are :

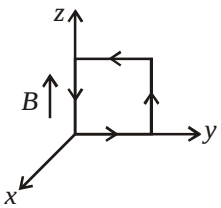


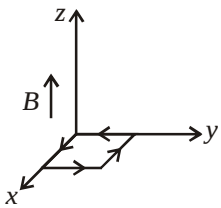
(a) The direction of the pyonting vector will be along $\hat{i}$.
(b) The magnetic field corresponding to electromagnetic wave is given by $\vec{B} = 1.67\times10^{-12}\cos(\omega t - kx)\,\hat{k}$.
(c) The amplitude of e.m.f. induced in the equilateral triangular loop of sides $a = 50$ cm and the resistance of the each side is $100\ \Omega$ as shown in figure is 5.65 μ volt.
(d) The amplitude of induce above current in the above loop will be 18.8 nA.

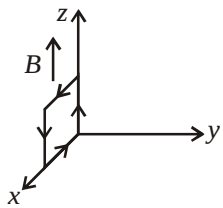
33. A sphere of radius *R* has uniform volume charge density (ρ). Choose the INCORRECT statement(s) :

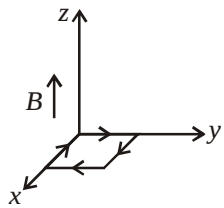
(a) The ratio of potential at the centre and electric field at the surface of sphere is depends on only radius of the sphere *R*.
(b) The ratio of potential at the centre and electric field at the surface of sphere is depends on only the charge density of the sphere (ρ).
(c) The ratio of potential at the centre and electric field at the surface of sphere is depends on both radius *R* and charge density (ρ) of the sphere.
(d) The ratio of potential at the centre and electric field at the surface of sphere is independent of both radius *R* and charge density (ρ) of the sphere.

34. A rectangular loop of sides 10 cm and 5 cm carrying a current 12 A is placed in the different orientations as shown in the figures below :

(A) 

(B) 

(C) 

(D) 

It there is a uniform magnetic field 0.3 T in the positive *z*-direction. The CORRECT statement(s) is/are :

(a) Orientations the loop (A) would be stable and (C) will be unstable.
(b) Orientations the loop (B) would be stable and (D) will be unstable.
(c) Orientations the loop (B) would be stable and (C) will be unstable.
(d) Orientations the loop (D) would be stable and (C) will be unstable.

35. Suppose ψ_{nlm} be the eigenfunction of the Hamiltonian operator of the hydrogen atom where n, l, m are principal, orbital and magnetic quantum number respectively. Which of the following wavefunctions is/are an eigenfunction of above mentioned Hamiltonian operator? (a,b,c are constants)

(a) $a\psi_{320} + b\psi_{321} + c\psi_{32-2}$ (b) $a\psi_{421} + b\psi_{420} + c\psi_{410}$

(c) $a\psi_{211} + b\psi_{311} + c\psi_{410}$ (d) $a\psi_{322} + b\psi_{320} + c\psi_{310}$

36. Consider a particle of mass *m* is moving under the following 2-D potential:

$$V(x, y) = \frac{1}{2} m\omega^2 \left(x^2 + 9y^2\right)$$

Which of the following statements is/are **CORRECT**?

(a) The energy eigenvalues of the particle is given by $(n+2)\hbar\omega$.

(b) The degeneracy of the third excited state is 2.

(c) The energy of the fourth excited state is $6\hbar\omega$.

(d) The wave function of the third excited state will be $y \exp\left[-\frac{m\omega}{2\hbar}\left(x^2 + 3y^2\right)\right]$

37. A current flows through along cable such that current density is uniform at every point on its cross section. Which of the following statements is/are correct?
(a) Magnetic field inside is proportional to distance from axis
(b) Magnetic field outside is inversely proportional to distance from axis
(c) Poynting vector is radially inward at every point inside the cable.
(d) Curl of magnetic field is non-zero inside the cable and zero outside the cable.

38. The filament of a light bulb is cylindrical with length 20 mm and radius 0.05 mm. The filament is maintained at a temperature 5000 K by an electric current. Assume that the filament behaves approximately as a black body, emitting radiation isotropically. At night, you observe the light bulb from a distance 10 km with the pupil of your eye fully dilated to a radius 3 mm. Which of the following statements is/are CORRECT? (Given: Stefan-Boltzman constant = $5.6\times10^{-8}\ W.m^{-2}.K^{-4}$, Wien's Law constant = $2.9\times10^{-3}\ m.K$)

(a) Total power radiated by the filament, is 220 *W*.

(b) The amount of radiation power that enters your eye, is $4.95\times10^{-12} W$.

(c) The wavelength at which the filament radiate the most power, is 580 *nm*.

(d) The number of radiated photons enter your eye per second, is 1.5×10^{7}.

39. Dimension of acitivity of a sample is

(a) $\frac{1}{\text{Time}}$ (b) $\frac{\text{energy}}{\text{planck constant}}$ (c) $\frac{\text{Force}}{\text{mass}}$ (d) work done

40. Two particles are moving with relativistic velocity in directions at right angles, they have moments P_1 and P_2 and total energies E_1 and E_2. If they are the sole products of disintegration of a heavier object, then which of the following statements about heavier object is true

(a) Rest mass is $\frac{1}{c^2}\left[\left(E_1 + E_2\right)^2 - \left(P_1^2 + P_2^2\right)c^2\right]^{1/2}$ (b) Velocity is $\left[c^2\left(P_1^2 + P_2^2\right)^{1/2} / \left(E_1 + E_2\right)\right]$

(c) Rest mass is $\frac{1}{c^2}\left[\left(E_1+E_2\right)^2+\left(P_1^2+P_2^2\right)c^2\right]^{1/2}$ (d) Velocity $\left[c^2\left(P_1^2-P_2^2\right)^{1/2}/\left(E_1-E_2\right)\right]$

Section-C : Numerical Answer Type (NAT)

Q.41 to Q.50: Carry 1 Mark each.

41. X-rays with an energy of 300 keV undergo Compton scattering with a target. If the scattered X-rays are detected at 30^0 relative to the incident X-rays, then energy of the scattered X-ray will be _____ *KeV*.
(Your answer should be an **INTEGER**).

42. To observe small objects, one measures the diffraction of particles whose de Broglie wavelength is approximately equal to the object's size. The kinetic energy required for electrons to resolve a large a nucleus of size 10 *fm*, will be _____*MeV*. (Your answer should be an **INTEGER**).

43. A quantum system with three orthonormal states $|1\rangle$, $|2\rangle$ and $|3\rangle$ is described by following hamiltonian :

$$\hat{H}=|1\rangle\langle 1|-i|1\rangle\langle 2|+2|2\rangle\langle 1|-2|2\rangle\langle 2|+2i|1\rangle\langle 3|+\sqrt{3}|3\rangle\langle 1|+|3\rangle\langle 3|$$

The sum of energy eigenvalues of the system, is _____ units. (Your answer should be an **INTEGER**)

44. A particle of mass *m* is moving under the following 3-D potential:

$$V(x,y,z)=\begin{cases}0 & \text{for } 0<x<a, 0<y<a, 0<z<a\\ \infty & \text{elsewhere}\end{cases}$$

If the particle is found to be in an eigenstate of energy $\frac{27\pi^2\hbar^2}{2ma^2}$, then degeneracy of the eigenstate is _____

(Your answer should be an **INTEGER**)

45. An electron is bound in an infinite square-well potential on the *x*- axis. The width of the well is *L* and the well extends from *x* = 0 nm to *x* = 4.5 nm. In a given state, the normalized wave function of the electron is given by:

$$\psi(x)=\sqrt{\frac{2}{L}}\sin\left(\frac{10\pi x}{L}\right)$$

The probability of finding the electron at *x = 2.25 nm*, is closest to _____(Your Answer should be upto **ONE Decimal Places**)

46. The masses of ^{11}C and ^{11}B are respectively 11.0114u and 11.0093u. The maximum energy of a positron can have in the β^+ decay of ^{11}C to ^{11}B is _____KeV.

47. A circular loop of radius 'a' and carrying a current 'I' is symmetrically kept inside the hollow cube of side '4a' such that centre of loop coincides with the centre of the cube. Total magnetic flux through the cube is _____

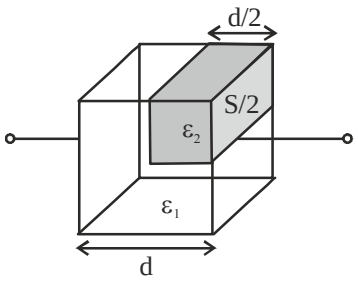
48. Two semi-infinite grounded conducting planes meet at an angle 30º the number of image charges formed _____

49. the value of magnetic field required to maintain non-relativistic proton of energy 1 MeV in a circular orbit of radius 100 mm is (Given : $m_p=1.67\times10^{-27}kg, e=1.6\times10^{-19}C$) _____Tesla.

50. If $\vec{D}=\left(2y^2+z\right)\hat{i}+4xy\hat{j}+x\hat{k}Cm^{-2}$, the total charge enclosed by the cube $0\le x<1, 0\le y<1, 0\le z<1$ is _____*C*.

Q.51 to Q.60: Carry 2 Marks each.

51. A parallel plate capacitor having plates of area *S* and plate separation *d*, has capacitance c_1 in air. When two dielectrics of different relative permitivities ($\varepsilon_1 = 2$ and $\varepsilon_3 = 4$) are introduced between the two plates as shown in the figure, the capacitance becomes c_2, the ratio c_2/c_1 is _____.



(Upto 2nd decimal place).

52. Two equal charges $+Q$ are separated by a distance '2*d*'. A grounded conducting sphere is placed midway between them. The two charges experience zero force for the radius of the sphere $R = (d/\beta)$, then the value of β is _____.

53. The normalized wavefunction of a particle in three dimensions is given by

$$\psi(r,\theta,\varphi) = \frac{1}{\sqrt{\pi a^3}} \exp\left(-\frac{r}{a}\right) [a > 0]$$

The ratio of the most probable distance from the origin to the mean distance from the origin, is _____ (Your answer should be upto **TWO decimal places**).

54. A quantum mechanical system consists of one-dimensional infinite box of Length *L*. Five identical non-interacting spin 3/2 particles, are first placed in the box and the ground state energy of the system is found to be 32 eV. If eleven such identical particles are placed inside the box, then the ground state energy of the system will be _____*eV*. (Your answer should be an **INTEGER**)

55. Electrons of energy 9 *eV* are sent from the negative *x* side towards *x* = 0, where the potential suddenly jumps from *V* = 0 to *V* = 5 *eV*. Let λ_1 be the periodicity of the wavefunction of the electron in the region where the potential is zero and λ_2 be the periodicity of the wave function of the electron in the region where the potential is 5 *eV*. The ratio λ_1 / λ_2 will be _____ (Your Answer should be upto **TWO Decimal Places**)

56. Hydrogen atom in states of high quantum number have been created in the laboratory and oberved in space. If the radius of the atom is 0.0100 mm, then the energy of the atom is _____$\times 10^{-5}$ eV. (upto second decimal place) (Given Bohr's radius $a_0 = 5.292 \times 10^{-11}$ m)

57. The energy of the He^+ in its first excited state is _____eV.

58. An electromagnetic wave

$$\vec{E} = -20\, e^{i\left(4x+3y-5\times10^8 t\right)}\, \hat{k} \quad V/m$$

is travelling in isotropic linear non-magnetic dielectric medium. The dielectric constant (ε_r) of the dielectric medium is _____

59. A light beam emitted by a 5-watt laser has a uniform cross-section of 0.5 mm^2. The amplitude of electric field associated with the beam (in V/m) is _____$\times 10^4$

60. If a particle has kinetic energy equal to its rest mass energy then the velocity of the particle is _____*c*.

***** END OF QUESTION PAPER *****

Space for Rough Work

IIT-JAM PHYSICA-PH

TEST SERIES - 3

(Modern Physics + Electricity & Magnetism)

Date : 12-01-2018

Booklet: B

ANSWER KEY

Section-A : Multiple Choice Questions (MCQ)

1. (c)	**2.** (b)	**3.** (b)	**4.** (a)	**5.** (a)
6. (c)	**7.** (b)	**8.** (c)	**9.** (c)	**10.** (b)
11. (b)	**12.** (d)	**13.** (c)	**14.** (d)	**15.** (d)
16. (c)	**17.** (b)	**18.** (c)	**19.** (b)	**20.** (a)
21. (b)	**22.** (d)	**23.** (d)	**24.** (a)	**25.** (a)
26. (c)	**27.** (c)	**28.** (c)	**29.** (a)	**30.** (a)

Section-B : Multiple Select Questions (MSQ)

31. (a)	**32.** (a),(b),(c),(d)	**33.** (b),(c),(d)	**34.** (b)
35. (a),(b),(d)	**36.** (a),(b),(c),(d)	**37.** (a),(b),(c),(d)	**38.** (a),(b),(c),(d)
39. (a),(b)	**40.** (a),(b)		

Section-C : Numerical Answer Type (NAT)

41. (277 to 279)	**42.** (121 to 125)	**43.** (0)	**44.** (4)
45. (0)	**46.** (934 to 936)	**47.** (0)	**48.** (11)
49. (1.44)	**50.** (2)	**51.** (2.33)	**52.** (8)
53. (0.65 to 0.69)	**54.** (187 to 189)	**55.** (0.65 to 0.69)	**56.** (–7.21 to –7.25)
57. (–13.6)	**58.** (9)	**59.** (8.5 to 8.9)	60. (0.84 to 0.88)