TEST SERIES GATE 2017

BOOKLET SERIES C

Paper Code: PH

Test Type: TEST SERIES

Duration: 3:00 Hours

PHYSICS

Date: 25-01-2017

Maximum Marks: 100

Read the following instructions carefully:

1. Attempt all questions.
2. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory. The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each. The subject specific GATE paper section consists of **55** questions, out of which question numbers 11 to 35 are of 1-mark each, while question numbers 36 to 65 are of 2-mark each.
3. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
4. Multiple choice type questions will have four choices against (a), (b), (c), (d), out of which only **ONE** is the correct answer.
5. For numerical answer type questions, each question will have a numerical answer and there will not be any choices.
6. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of ⅓ marks for a **1-mark** question and ⅔ marks for a **2-mark** question.
7. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.
8. Non-programmable type Calculator is allowed

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Q.1-Q. 5 carry ONE mark each.

1. How many digits are there in 3^{16} when it is expressed in the decimal form?
   (a) 3 (b) 6 (c) 7 (d) 8

2. If all horses are donkeys, some donkeys are monkeys, and some monkeys are men, then which statement must be true
   (a) All donkeys are men (b) Some horses may be men
   (c) Some horses are men (d) All horses are also monkeys

3. Find at what time between 7 and 8 O'clock will the hands of a clock be in the same straight line but not together
   (a) 5 min past 7 (b) $5\frac{2}{11}$ min past 7
   (c) $5\frac{3}{11}$ min past 7 (d) $5\frac{5}{11}$ min past 7

4. A bicycle tube has a mean circumference of 200 cm and a circular cross-section of diameter 6 cm. What is the approximate volume of water (in cc) required to completely fill the tube, assuming that it does not expand?
   (a) 600π (b) 1200π (c) 3600π (d) 1800π

5. If $|-2X + 9| = 3$ then the possible value of $|-X| - X^2$ will be
   (a) 30 (b) –30 (c) –42 (d) 42

Q.6-Q. 10 carry TWO marks each.

6. Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six-storeyed building (the ground floor is numbered 1, the floor above it 2, and so on). Anuj lives on an even-numbered floor. Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on a floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person combinations is correct?

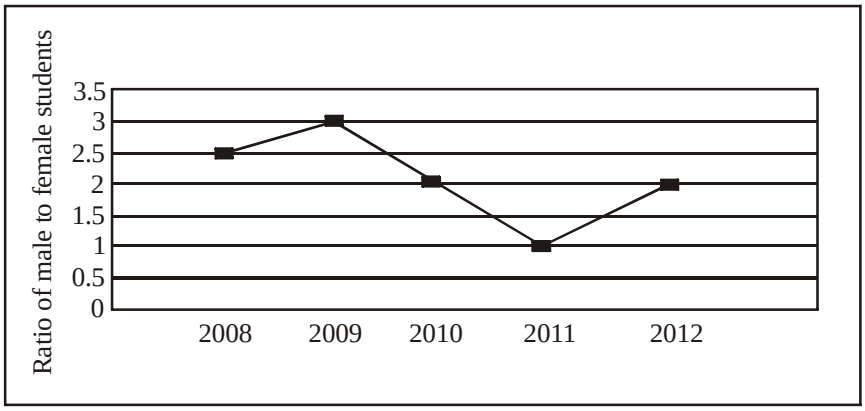
	Anuj	Bhola	Chandan	Dilip	Eswar	Faisal
(a)	6	2	5	1	3	4
(b)	2	6	5	1	3	4
(c)	4	2	6	3	1	5
(d)	2	4	6	1	3	5

7. Fresh fruit contains 68% water and dry fruit contains 20% water. How much dry fruit can be obtained from 100 kg of fresh fruits?
   (a) 32 kg (b) 40 kg (c) 52 kg (d) 80 kg

8. N is a four digit number. If the leftmost digit is removed, the resulting three digit number is $1/9^{th}$ of N. How many such N are possible?
   (a) 10 (b) 9 (c) 8 (d) 7

9. A chocolate bar having $m \times n$ unit square tiles is given. Calculate the number of cuts needed to break it completely, without stacking, into individual tiles
   (a) $(m \times n)$ (b) $(m-1)\times(n-1)$ (c) $(m \times n)-1$ (d) $(m \times n)+1$

10. The ratio of male to female students in a college for five years in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?



(a) 1 : 1 (b) 2 : 1 (c) 1.5 : 1 (d) 2.5 : 1

Q.11-Q.35 carry one mark each.

11. The eigenvalues of the matrix representing the following pair of linear equations

$x + y = 0$ and $x - y = 0$

are

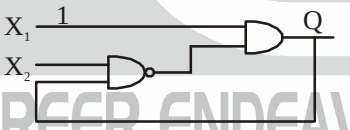
(a) 1, –1 (b) $\sqrt{2}, -\sqrt{2}$ (c) 1, 1 (d) –2, 1

12. The residue of the complex function, $f(z) = \dfrac{e^{2z}}{(z-1)^3}$ at the point z = 1, will be _____e^2.

13. Which of the following CANNOT BE the imaginary part of a complex analytic function $f(z)$?

(a) $x^2 - y^2$ (b) $x^3 - 3xy^2$ (c) $x^3 - 3xy^2 + x$ (d) $x^2 - 2y^2$

14. In the figure, as long $X_1 = 1$ and $X_2 = 1$, the output Q remains



(a) at 1 (b) at 0 (c) at its initial value (d) at unstable

15. The AND function can be realized by using only n number of NOR gates. The n equal to _____

16. N weakly coupled particles obeying Maxwell–Boltzmann statistics may each exist in one of the 3 non-degenerate energy levels of energies –E, 0 ,+E. The system is in contact with a thermal reservoir at temperature T. The value of the maximum possible entropy of the system is NKlnx, then the value of x is _____.

17. For vaporization among the following which option is correct?
(a) Entropy and specific heat at constant pressure are discontinuous at transition point.
(b) Entropy and isothermal compressibility are discontinuous at transition point.
(c) Entropy , specific heat at constant and isothermal compressibility are discontinuous at transition point.
(d) Specific heat at constant pressure , isothermal compressibility and coefficient of volume expansion at constant pressure all are infinite at transition point.

18. The specific heat at constant pressure of black body radiation inside a spherical cavity in n-dimensional space depends on the temperature as

(a) T^n (b) $T^{\left(\frac{n+3}{2}\right)}$ (c) $T^{\left(\frac{2n+3}{3}\right)}$ (d) T^{n+1}

19. Suppose a spin 1/2 particle is in the state $|\phi\rangle = \frac{1}{\sqrt{5}}\begin{bmatrix}1-i\\ \sqrt{3}\end{bmatrix}$. The expectation value of *z*-component of spin angular momentum of the particle is

(a) $\frac{\hbar}{10}$ (b) $-\frac{\hbar}{10}$ (c) $-\frac{\hbar}{5}$ (d) $\frac{\hbar}{5}$

20. Suppose the kets $|j, m_j\rangle$ are the simultaneous eigenkets of the operators J^2 and J_z with eigenvalues $j(j+1)\hbar^2$ and $m_j\hbar$ respectively. Then $|2,1\rangle$ will be eigenkets of the operator $[J_x, J_+]$ with respective eigenvalue _____ $\hbar$.

21. Which one of the following commutation relations is **NOT CORRECT**? (Symbols have usual meanings)

(a) $\left[\hat{L}^2, \hat{L}_y\right] = 0$ (b) $\left[\hat{L}_z, \hat{L}_y\right] = -i\hbar\hat{L}_x$ (c) $\left[\hat{L}_z, \hat{L}_+\right] = -\hbar\hat{L}_+$ (d) $\left[\hat{L}_z, \hat{L}_-\right] = -\hbar\hat{L}_-$

22. A planet revolves around the sun in an elliptical orbit of semi-major axis 100km. Eccentricity of the orbit is $\sqrt{3}/2$. If mass of the planet is 10^4 kg and its time period of revolution be $\pi\times10^4$ sec, then angular momentum of the planet is _____ $\times 10^{10}$ kg m^2/ sec.

23. A circular disc of mass *m* and radius *r* rolls down on inclined plane of inclination θ (without slipping). Torque on the disc due to friction is

(a) $mgr\sin\theta$ (b) $\frac{mgr\sin\theta}{2}$ (c) $\frac{2mgr\sin\theta}{3}$ (d) $\frac{mgr\sin\theta}{3}$

24. Poisson bracket $[L_x, yL_z]$ is equal to

(a) zL_z (b) p_zL_z (c) $zL_z - yL_y$ (d) $zL_z + yL_y$

25. Consider Maxwell's equation, $\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$. Where, $\vec{E} = -\vec{\nabla}\phi - \frac{\partial\vec{A}}{\partial t}$ and $\vec{B} = \vec{\nabla}\times\vec{A}$. When transformation $\vec{A}' = \vec{A} + \vec{\nabla}\lambda, \phi' = \phi - \alpha\frac{\partial\lambda}{\partial t}$ is done. (λ is a scalar function) $\vec{E}$ and $\vec{B}$ remain unchanged. The value of constant 'α' is

(a) 0 (b) –1 (c) 1 (d) –1/2

26. A dielectric sphere of radius *R* has polarization, $\vec{P} = kr^3\vec{r}$. The volume charge density of the bound charges inside the sphere is

(a) $-6kr^3$ (b) $-3kr^2$ (c) $-5kr^3$ (d) $-4kr^3$

27. The cube fcc (100) of a rock salt crystal lattice constant *a* is 2.814Å. If the wave length of X-rays is 0.710Å then the glancing angle corresponding to second order reflection is

(a) 10° (b) 20° (c) 14.6° (d) 7°

28. NaCl crystal has density, $\rho = 2189\ kg/m^3$ and Avogadro's number N = 6.02×10^{26} /kg mole. The volume of the unit cell is

(a) 22.18 Å^3 (b) 2.81Å^3 (c) 5.62Å^3 (d) 30Å^3

29. Which of the following field is **NOT** conservative in nature?

(a) $x\,\hat{x} + y\,\hat{y} + z\,\hat{z}$ (b) $\left(2x^3y^4 + x\right)\hat{x} + \left(2x^4y^3 + y\right)\hat{y}$

(c) $yz\,\hat{x} + xz\,\hat{y} + xy\,\hat{z}$ (d) $\left(x^2 - yx\right)\hat{x} + \left(y^2 - xy\right)\hat{y}$

30. Consider the Bohr model of the hydrogen atom. If α is the fine structure constant, then the velocity of the electron in $n = 2$ orbit is

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

31. The excited state of sodium atom $\left(^{11}\text{Na}\right)$ is a $^2P_{3/2}$ state. The difference in energy levels arising in the presence of a weak external magnetic field B, is _____ $\mu_B B$.

32. The threshold energy for the nuclear reaction, $14N\left(n,\alpha\right)^{11}B$ is _____ MeV.

33. Four particle electron, proton, He^+ and Li^+ are projected in a circular orbit of same radius perpendicular to a given magnetic field. Then the velocity will be smallest for
(a) electron (b) proton (c) Li^+ (d) He^+

34. The activity of certain radio nuclide decreases to 15% of its original value in 10 days. Its half life time is
(a) 3.65 days (b) 5.5 days (c) 2.3 days (d) 8 days

35. If the electric field making the angel with normal $\theta = 30^o$ when it is incidened from vacuum to a dielectric medium having $\varepsilon = \sqrt{3}\,\varepsilon_0$. The value of angle that electric field make in the medium with normal is _____(degree).

Q.36-Q.65 carry TWO marks each.

36. If the surface $5x^2 - 2pyz = 9x$ be orthogonal to the surface $4x^2y + z^3 = 4$ at point A(1, 1, –2), then p is equal to _____

37. Given that $\sum_{n=1}^{\infty}\frac{1}{n^2} = \frac{\pi^2}{6}$ and $\sum_{n=1}^{\infty}(-1)^{n+1}\frac{1}{n^2} = \frac{\pi^2}{12}$. Then value of $\sum_{n=1}^{\infty}\frac{1}{(2n-1)^2}$ will be

(a) $\frac{\pi^2}{8}$ (b) $\frac{\pi^2}{4}$ (c) $\frac{\pi^2}{16}$ (d) $\frac{\pi^2}{32}$

38. The value of the contour integral,

$$\oint_C \frac{1+\cos(z)}{(z-\pi)^2}dz$$

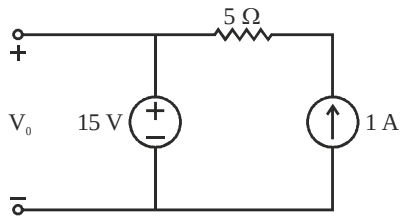
(Where C is defined by equation $\left|z - i\frac{3\pi}{2}\right| = 3$), will be _____

39. A combinational circuit has input A, B and C and its Karnaugh Map is as shown. The output of the circuit is given by

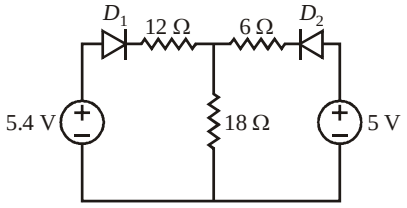
C \ AB	00	01	11	10
0		1		1
1	1		1	

(a) $\left(\bar{A}B + A\,\bar{B}\right)C$ (b) $\left(\bar{A}B + A\,\bar{B}\right)\bar{C}$ (c) $\bar{A}\bar{B}\bar{C}$ (d) $A \oplus B \oplus C$

40. In the circuit of figure the value of voltage v_o is _____V.



41. In the circuit shown below diodes has cutin voltage of 0.6 V. The diode in ON state are



(a) only D_1 (b) only D_2 (c) both D_1 and D_2 (d) None of these

42. A particle is confined to a one-dimensional potential box with the following potential:

$$V(x)=\begin{cases}0 & \text{for } 0<x<L\\ \infty & \text{otherwise}\end{cases}$$

If the particle is subjected to the perturbation of the form $V_p(x)=\omega_0 L\,\delta\left(x-\frac{L}{2}\right)$, where ω_0 is small constant. The first order correction to the ground state energy of the particle will be

(a) 0 (b) ω_0 (c) $2\omega_0$ (d) $4\omega_0$

43. Consider a particle of mass *m* moving in 1-D potential $V(x)=V_0+\beta x^2$, then the minimum energy of the particle will be

(a) $V_0+\sqrt{\frac{\beta\hbar^2}{2m}}$ (b) $V_0+\sqrt{\frac{2\beta\hbar^2}{m}}$ (c) $V_0+\sqrt{\frac{\beta\hbar^2}{4m}}$ (d) $V_0+\sqrt{\frac{3\beta\hbar^2}{4m}}$

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

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

The state of the particle with energy $5\hbar\omega$ is *g*-fold degenerate. The value of *g* is _____

45. A system comprises of three electrons. There are three single particle energy levels accessible to each of these electrons. The number of possible configurtions for this system is

(a) 1 (b) 3 (c) 6 (d) 7

46. The entropy of a gas containing *N* particles enclosed in a volume *V* is given by $S=Nk_B\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)$, where *E* is the total energy, *a* is constant and k_B is Boltzmann constant. The chemical potential μ of the system at a temperature *T* is

(a) $\mu=-k_BT\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)\right]$ (b) $\mu=-k_BT\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)-\frac{5}{2}\right]$

(c) $\mu = k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)+\frac{5}{2}\right]$ (d) $\mu = k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)\right]$

47. In the scattering experiment, the potential is spherically symmetric and the particle are scattered such energy that only *s*-waves and *p*-waves are needed to be considered. Suppose the differential cross section can be written as

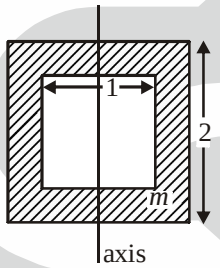
$$\frac{d\sigma(\theta)}{d\Omega} = A + B\cos\theta + C\cos^2\theta$$

The value of the total cross section can be expressed as

(a) $4\pi\left(A+\frac{C}{3}\right)$ (b) $4\pi\left(A-\frac{C}{3}\right)$ (c) $4\pi\left(A-\frac{C}{2}\right)$ (d) $4\pi\left(A+\frac{C}{2}\right)$

48. The total energy, E of an ideal non-relativistic fermi gas in three dimensional is given by $E \propto \frac{N^{5/9}}{V^{2/3}}$, where N is the number of particle and V is the volume of the gas. The value of $\frac{PV}{E}$ is _____

49. A square plate of mass 12 kg has a square cut as shown in the figure. Moment of inertia of the plate about the axis shown is _____ kg m^2 (sides are given in meter)



50. Hamiltonian of a system is $H = \frac{p_\theta^2}{2m\ell^2} + mg\ell(1-\cos\theta)$.

If the quantity $\frac{p_\theta^2}{2m\ell^2} - mg\ell(1-\cos\theta) + \int_0^t \frac{\alpha g p_\theta \sin\theta}{\ell} dt$ is a constant of motion then value of α is

(a) 2 (b) –2 (c) 1 (d) –1

51. A particle is moving in a circle of radius r_0 with constant speed v_0. Suddenly radial force acting on the particle becomes zero. Radial speed of the particle as a function of radial distance (r) varies as

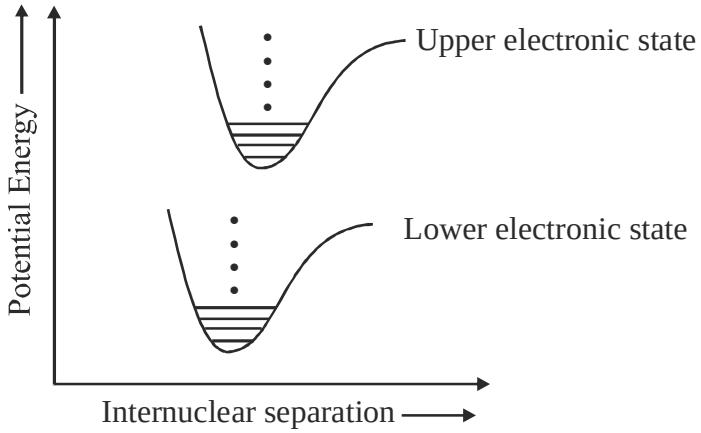
(a) $\frac{v_0 r}{r_0}$ (b) $\frac{v_0 r_0}{r}$ (c) $v_0\sqrt{1-\frac{r_0^2}{r^2}}$ (d) $v_0\sqrt{1-\frac{r^2}{r_0^2}}$

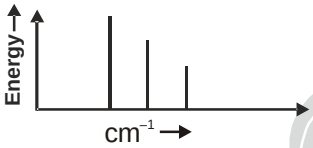
52. If the doublet splitting of the first excited state $2^2D_{5/2} - 2^2D_{3/2}$ of H atom is 0.23 cm^{-1}, then the corresponding separation of He^+ is _____ cm^{-1}.

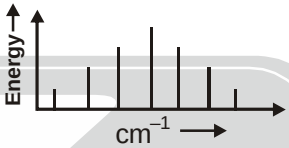
53. Given that the rotational constant and centrifugal distortion constant of IR active molecule are $10.593\,cm^{-1}$ and $5.3\times10^{-4}cm^{-1}$. The vibrational frequency of the IR active molecule will be

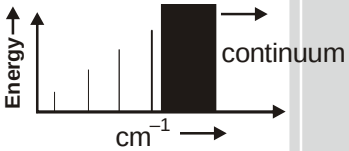
(a) $9\times10^{11}Hz$ (b) $9\times10^{12}Hz$ (c) $9\times10^{13}Hz$ (d) $9\times10^{14}Hz$

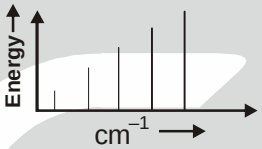
54. In a diatomic molecule, the internuclear separation of the ground and first excited electronic state are the same as shown in the figure. If the molecule is initially in the lowest vibrational state of the ground state, then the absorption spectrum will appear as



(a) 

(b) 

(c) 

(d) 

55. Consider the four processes

(I) $\pi^+ + n \to \Lambda^0 + k^+$ (II) $\pi^+ + n \to \pi^- + p$

(III) $\pi^- + p \to \pi^0 + \Lambda^0$ (IV) $\pi^- + p \to \Lambda^0 + k^0$

Which of the above is/are allowed under the conservation of strangeness, conservation of baryon number and conservation of charge

(a) I and II (b) I and IV (c) III and IV (d) II and IV

56. A current distribution give rises to the magnetic vector potential $\bar{A}(r,\theta,z) = kr^{-r}\sin\theta\hat{z}$, where k is a constant. Corresponding magnetic field at any point (r,θ,z) will be

(a) $\vec{B}(r,\theta,z) = \hat{r}\frac{k}{r}e^{-r}\cos\theta + \hat{\theta}ke^{-r}\cos\theta$ (b) $\vec{B}(r,\theta,z) = \hat{r}\frac{k}{r}e^{-r}\cos\theta + \hat{\theta}ke^{-r}\sin\theta$

(c) $\vec{B}(r,\theta,z) = \hat{r}\frac{k}{r}e^{-r} + \hat{\theta}ke^{-r}\sin\theta$ (d) $\vec{B}(r,\theta,z) = \hat{r}\frac{k}{r}\sin\theta e^{-r} + \hat{\theta}ke^{-r}\sin\theta$

57. A uniformly charged sphere of radius 'a' and total charge Q is centered at the origin and spinning at a constant angular velocity ω about z-axis. The current density at point (r,θ,ϕ) inside the sphere will be

(a) $\sigma\omega r\hat{\phi}$ (b) $\frac{3Q}{4\pi a^3}\omega r\cos\theta\hat{\phi}$ (c) $\frac{3Q}{4\pi a^3}\omega r\sin\theta\,\hat{\phi}$ (d) $\frac{3Q}{4\pi a^3}\omega r^2\sin\theta\,\hat{\phi}$

58. The excitations of a three –dimensional solid are bosonic in nature with their frequency ω and wave-number k are related by $\omega \propto k$. If the chemical potential is zero, the behaviour of the specific heat of the solid at low temperature is proportional to

(a) $T^{1/2}$ (b) $T^{3/2}$ (c) T^3 (d) T

59. A point source emitting alpha particles is placed at a distance 1*m* from a counter which records any alpha particle falling on its 1cm^2 window. If the source contains 6×10^{16} active nuclei and the counter records a rate of 50000 counts/second. Assume that the source emits alpha particles uniformly in all directions and the alpha particles fall nearly normally on the window. The Decay constant of the radioactive process is _____$\times10^{-7}\,s^{-1}$.

60. The spin-parity of grounded state of $^{47}_{22}Ti$ nucleus is

(a) $\left(\frac{7}{2}\right)^-$ (b) $\left(\frac{7}{2}\right)^+$ (c) $\left(\frac{5}{2}\right)^-$ (d) $\left(\frac{5}{2}\right)^+$

61. In a certain region of space through which an EM wave is propagating the poynting's vector is given by $\vec{s} = \hat{z}\,0.16\cos^2\left(kz-\omega t\right)W/m^2$. The total time average power carried by the wave through 100 cm^2 of area on the plane $y+2z=5$ will be _____mW.

62. An electric field is represented by $\vec{E} = \hat{i}y + \hat{j}x$. The corresponding potential function ϕ will be (assume $\phi = 0$ at the point (0, 0)

(a) xy (b) $-xy$ (c) $\frac{x^2+y^2}{2}$ (d) $\frac{x^2-y^2}{2}$

63. The potential on the surface of a hollow sphere of radius 'a' is given by $\phi_0(\theta) = A\sin^2\theta/2$, where θ is the polar angle. The potential at any inside point can be written as

(a) $\frac{A}{2}\left(1-\frac{r}{a}\cos\theta\right)$ (b) $\frac{A}{2}\left(1+\frac{r}{a}\cos\theta\right)$ (c) $A\left(1+\frac{r}{a}\cos\theta\right)$ (d) $A\left(1-\frac{r}{a}\cos\theta\right)$

64. An electron beam accelerated through a potential of 300 volt. The radius of Ewald sphere in reciprocal space is (in Å^{-1})

(a) $2\sqrt{2}\,\pi$ (b) $\frac{\pi}{\sqrt{2}}$ (c) 2π (d) π

65. In the Bethe-Weizsäcker semi-empirical mass formula the coulomb repulsion term is

(a) $-\frac{3}{5}\left(\frac{e^2}{4\pi\varepsilon_0}\right)\frac{z^2}{A^{1/3}}$ (b) $-\frac{3}{5}\left(\frac{e^2}{4\pi\varepsilon_0}\right)\frac{z(z-1)}{A^{1/3}}$

(c) $\left(\frac{e^2}{8\pi\varepsilon_0}\,\frac{z^2}{A^{1/3}}\right)\times10^{15}$ (d) $\left(\frac{e^2}{8\pi\varepsilon_0}\,\frac{z(z-1)}{A^{1/3}}\right)\times10^{15}$

Space for rough work

PHYSICS-PH

Date: 25-01-2017

GATE TEST SERIES-C

ANSWER KEY

1. (d)	**2.** (b)	**3.** (d)	**4.** (d)	**5.** (b)
6. (b)	**7.** (b)	**8.** (d)	**9.** (c)	**10.** (c)
11. (b)	**12.** (2)	**13.** (d)	**14.** (d)	**15.** (3)
16. (3)	**17.** (d)	**18.** (a)	**19.** (b)	**20.** (–1)
21. (c)	**22.** (1)	**23.** (d)	**24.** (c)	**25.** (c)
26. (a)	**27.** (c)	**28.** (a)	**29.** (d)	**30.** (a)
31. (**1.32 to 1.34**)	**32.** (**0.14 to 0.16**)	**33.** (d)	**34.** (**3.60 to 3.70**)	**35.**(45)
36. (1)	**37.** (a)	**38.** (0)	**39.** (d)	**40.** (15)
41. (c)	**42.** (c)	**43.** (a)	**44.** (2)	**45.** (d)
46. (b)	**47.** (a)	**48.** (0.66 to 0.70)	**49.** (5)	**50.** (b)
51. (c)	**52.** (**3.65 to 3.70**)	**53.** (c)	**54.** (b)	**55.** (b)
56. (b)	**57.** (c)	**58.** (c)	**59.** (**1.04 to 1.06**)	**60.**(c)
61. (**0.71 to 0.73**)	**62.** (b)	**63.** (a)	**64.** (a)	**65.** (d)