TEST SERIES FOR GATE

BOOKLET SERIES B

Paper Code: PH

Test Type: TEST SERIES

Duration: 3:00 Hours

PHYSICS

Date: 14-01-2016

Maximum Marks: 100

Read the following instructions carefully:

1. Attempt all the 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. If the sum of five consecutive integers is S, what is the largest of those integers in terms of S?

(a) $\frac{S-10}{5}$ (b) $\frac{S-10}{4}$ (c) $\frac{S+10}{5}$ (d) $\frac{S-10}{10}$

2. If the product of 4 consecutive integers is equal to one of them, what is the largest possible value of one of the integers?

(a) 0 (b) 3 (c) 4 (d) 6

3. Fill in the blank with appropriate word. He is _____ opponent, you must respect and fear him at all times.

(a) A redoubtable (b) A disingenuous
(c) C raven (d) An insignificant

4. $(0.55)^{150}$ is closest to

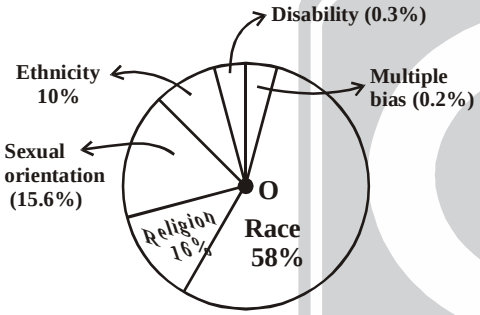
(a) 0.1 (b) 0 (c) 10 (d) 100

5. What is the Missing term in sequence ABC, A^2BC, A^2B^2C, _____, $A^3B^2C^2$.

(a) A^3B^2C (b) $A^2B^2C^2$ (c) $A^3B^3C^2$ (d) A^3BC

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

6.



Percent– distribution of Bias – Motivated offenses in 1998 in USA.
If in 1998, there were 10, 000 bias motivated offenses based on ethnicity, how many more offenses were based on religion than on sexual orientation?

(a) 4 (b) 40 (c) 400 (d) 4000

7. A person moves 8 km west, 6 km north, 3 km east, and 6 more km north. How far is this person from his starting place

(a) 13 (b) 17 (c) 19 (d) 21

8. Fill in the blank by appropriate words?
The new computer system ____ next month.

(a) Is being installed by people (b) Is be installed
(c) Is being installed (d) Is been installed

9. Fill in the blank by appropriate words it's _____ disappointing.

(a) Very much (b) Very (c) Much (d) Much very

10. If Rout is related to Defeat then which pair is correctly matched

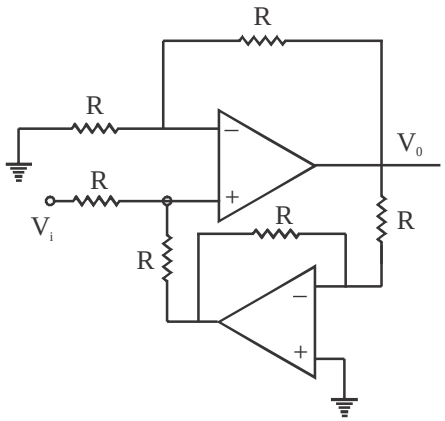
(a) Grief : Loss (b) Pathway : Ruin
(c) Memory : Oblivion (d) Ovation : Applause

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

11. For an n-p-n transistor $I_{CEO} = 410\ \mu A$, $I_{C\beta O} = 5\mu A$, the value of β is

(a) 81 (b) 91 (c) 101 (d) 111

12. Determine the voltage gain for the given circuit diagram.



(a) –10 (b) –1 (c) –0.5 (d) +0.5

13. In planetary motion if E be the energy of planet and T be its time period of revolution in elliptical orbit around the sun then:

(a) $T^2 \propto \frac{1}{|E|}$ (b) $T^2 \propto \frac{1}{|E|^3}$ (c) $T^2 \propto \frac{1}{\sqrt{|E|}}$ (d) $T^2 \propto \frac{1}{\sqrt{|E|^3}}$

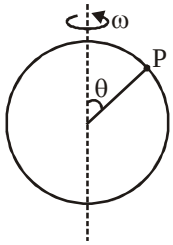
14. Consider current I flowing from $-\infty$ to $+\infty$ in wires laid along x-axis and y-axis. Magnetic field at (0, 0, d) is

(a) $\frac{\mu_0 I}{2\pi d}$ (b) $\frac{\mu_0 I}{\sqrt{2}\pi d}$ (c) $\frac{\mu_0 I}{\pi d}$ (d) 0

15. An electric field $\vec{E} = 2x^2\hat{x} + 3y^2\hat{y}$ exists in space. Let $A(1, 1, 0)$ and $B(0, 1, 1)$ be two points in the space. Potential difference between these two points is

(a) $\frac{4}{3}$ (b) $\frac{2}{3}$ (c) $-\frac{1}{3}$ (d) $-\frac{2}{3}$

16. A non-conducting sphere of radius R and having uniform surface charge density σ is rotated with uniform angular speed ω, surface current density at point P shown in the figure is



(a) $\sigma R\omega \sin\theta$ (b) $\sigma R\omega \cos\theta$

(c) $\sigma R\omega$ (d) $\sigma R\omega \cos^2\theta$

17. Lagrangian of a system is $L = \frac{1}{2}m(\dot{q} - q)^2 - V(q)$ hamiltonian of system is

(a) $H = \frac{p^2}{2m} + \frac{1}{2}q^2 + V(q)$ (b) $H = \frac{p^2}{2m} - \frac{1}{2}q^2 + V(q)$

(c) $H = \frac{p^2}{2m} + pq + V(q)$ (d) $H = \frac{p^2}{2m} - pq + V(q)$

18. A circular ring of mass M has inner and outer radii R and 2R respectively. Moment inertia of ring about an axis through centre which is perpendicular to its plane is

(a) $3MR^2$ (b) $\frac{5MR^2}{2}$ (c) $\frac{3MR^2}{2}$ (d) $\frac{7MR^2}{2}$

19. Type of electromagnetic radiation emitted in transition $\frac{3}{2}^{+} \longrightarrow \frac{1}{2}^{-}$ is

(a) E_1, M_2 (b) M_1, E_2 (c) E_2, M_3 (d) M_2, E_3

20. Consider the following α – decay , $^{235}_{92}U \longrightarrow {}^{231}_{90}Th + {}^{4}_{2}He$

The kinetic energy of α – particle is T_α . The Q-value of the reaction is _____ T_α . (Upto two decimal places).

21. Consider the following process involving elementary particles.

(i) $n + p \longrightarrow \Sigma^0 + p$ (ii) $p + \bar{p} \longrightarrow \Omega^- + \Omega^+$

The correct statement is
(a) both (i) and (ii) are allowed
(b) (ii) is not allowed because it violates energy conservation principle.
(c) (i) is not allowed because it violates energy conservation principle
(d) (i) is not allowed while (ii) is allowed.

22. Given the matrix $A = \begin{bmatrix} 1 & \beta \\ \alpha & \alpha \end{bmatrix}\begin{bmatrix} \alpha & \beta \\ 1 & \beta \end{bmatrix}$, where α and β are the roots of the equation $x^2 + x + 1 = 0$, then matrix A will be

(a) $\begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix}$ (b) $\begin{bmatrix} -1 & 1 \\ 1 & 2 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & -1 \\ -1 & -2 \end{bmatrix}$ (d) $\begin{bmatrix} -1 & -1 \\ -1 & -2 \end{bmatrix}$

23. If $f(x) = [x]$ represents the greatest integer function, then the derivative of $f(x)$ at $x = -1$ will be

(a) 0 (b) $\delta(x+1)$ (c) $-\delta(x+1)$ (d) 1

24. A beam of electrons and another beam of protons (each particle has an energy of 6.5 eV), are incident separately on two identical barriers respectively each of 10.2 eV high and 10 A^0 wide. Which of the following is a **CORRECT** statement?
(a) The electron will have greater transmission compared to proton.
(b) The proton will have greater transmission compared to electron.
(c) Both electron and proton will have equal tranmission probabilities.
(d) Neither electron nor protons can cross the barrier.

25. The difference of energy between $n = 2$ and $n = 1$ level of a particle in a one dimensional infinite potential well is 6 units of energy. In the same units of energy, the difference of energy between $n = 3$ and $n = 2$ level, is

..... (Your answer should be **an integer**)

26. 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 energy eigenvalues of the particle will be ($n = 0, 1, 2, 3$.....)

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

27. In which of the following systems will the velocity of electron in the first Bohr orbit be maximum?

(a) Hydrogen atom (b) Deuterium atom

(c) Singly ionized helium (d) Doubly ionized lithium

28. The population inversion in a two level laser material CANNOT be achieved by optical pumping because

(a) The rate of upward transitions is equal to the rate of downward transitions.
(b) The upward transitions are forbidden but downward transitions are allowed.
(c) The upward transitions are allowed but downward transitions are forbidden.
(d) The spontaneous decay rate of the higher level is very low.

29. The ground state term symbol of oxygen atom will be

(a) $^3P_0$ (b) $^3P_2$ (c) $^4D_2$ (d) $^4D_0$

30. 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 **NOT** 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) $a\psi_{322} + b\psi_{320} + c\psi_{310}$

31. A monoatomic crystalline solid comprises of N atoms, out of which n-atoms are in interstitial positions. If the available interstitial sites is N, then number of possible microstates is

(a) $\frac{N!}{n!(N-n)!}\frac{N!}{n!(N-n)!}$ (b) $\frac{N!}{n!(N-n)!}\frac{N!}{n!(N+n)!}$

(c) $\frac{N!}{n!(N-n)!}$ (d) $\frac{N!}{n!(N+n)!}$

32. 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 equation of the state is

(a) $PV = \frac{2}{3}E$ (b) $PV = 3E$ (c) $PV = 2E$ (d) $PV = \frac{3}{2}E$

33. The relation between the collision probability 'P_c' and the molecular mean free path λ is

(a) $P_c = \lambda^2$ (b) $P_c = \lambda$ (c) $P_c = \lambda^{-1}$ (d) $P_c = \lambda^3$

34. The low temperature heat capacity in Graphite can be expressed as

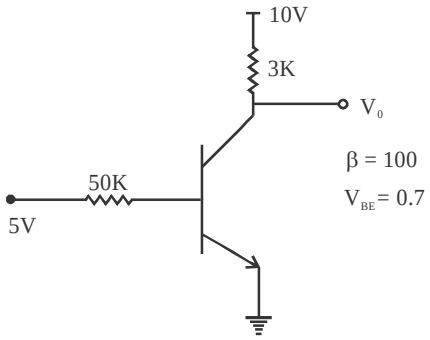
(a) $AT + BT^3$ (b) $AT + BT^2$ (c) $(A + B)T^2$ (d) $A + BT^3$

35. The total energy of an ionic solid is given by $U = -\frac{\alpha e^2}{4\pi \in_0 r} + \frac{B}{r^9}$. Where α is Medulung constant and 'r' is distance between the nearest neighbours withing the crystal. If r_0 is the equilibrium separation, then the constant B is given by

(a) $\frac{\alpha\, e^2 r_0^{\,8}}{36\pi \in_0}$ (b) $\frac{2\alpha\, e^2 r_0^{\,8}}{9\pi \in_0}$ (c) $\frac{\alpha\, e^2 r_0^{\,10}}{36\pi \in_0}$ (d) $-\frac{\alpha\, e^2 r_0^{\,10}}{36\pi \in_0}$

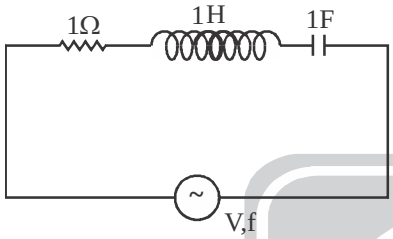
Q.36-Q.65 carry TWO marks each.

36. For the given transistor circuit shown below. The power dissipation at emitter junction is



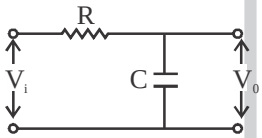
(a) 6.1 mW (b) 7.1 mW (c) 7.5 mW (d) 10 mW

37. For the given circuit diagram shown



The quality factor is _____

38. For the given circuit diagram shown below



gain at cut-off frequency is _____

39. Two particles of masses m and $2m$ are moving with velocities $\vec{v}_1$ and $\vec{v}_2$ respectively. Ratio of speed of first to the second in centre of mass frame is _____

40. The acceleration of a car starting from rest decreases by an amount proportional increase in its speed, from 1.5 m/s^2 at the starting to 0.5 m/s^2 when speed is 5 m/s. Speed of the car after long time will be _____ m/s.

41. Two electron of rest mass m_0 are moving with speed $\frac{3c}{5}$ at right angle with respect to lab frame. Energy of one electron in the rest frame of another is

(a) $\frac{5m_0c^2}{4}$ (b) $\frac{5m_0c^2}{3}$ (c) $\frac{25m_0c^2}{16}$ (d) $\frac{4m_0c^2}{5}$

42. Lagrangian of a system is $L = \frac{1}{2}m\left(\dot{s}^2 + s^2\dot{\phi}^2 + \dot{z}^2\right) - mgz$ in cyclindrical coordinate. Which of the following is consserved.

(a) L_z, p_z and energy only (b) L_z only

(c) L_z, p_x, p_y only (d) L_z, p_x, p_y and energy

43. A thin a charged circular ring is placed coaxially with a long solenoide. The ring is outside the solenoide. Charge on the ring is 1μC and radius of the solenoid is 10 cm. When current in the solenoide is dropped from 2A to 0 the ring begins to rotate with angular momentum $2\pi \times 10^{-8}\ kgm^2s^{-1}$. Number of turns per unit length in the solenoid is

(a) $5\times10^{2}\ cm^{-1}$ (b) $5\times10^{4}\ cm^{-1}$ (c) $5\times10^{5}\ cm^{-1}$ (d) $5\times10^{6}\ cm^{-1}$

44. A charge Q is uniformly distributed in the volume of a solid sphere of radius R. If potential at the surface is taken to be zero, potential at its centre will be

(a) zero (b) $\frac{Q}{4\pi \in_0 R}$ (c) $\frac{3Q}{8\pi \in_0 R}$ (d) $\frac{Q}{8\pi \in_0 R}$

45. At $t = 0$ a particle begins to move with under a force $F = 3\text{-}4v$, where v is instantaneous speed of particle, its speed at $t = \infty$ will be _____

46. A point particle of mass 'm' and charge 'q' is thrown into a uniform magnetic field B with initial speed u. If pitch and radius of its helical path are equal then change in velocity of the particle in time $\frac{\pi m}{qB}$ is

(a) 0 (b) $2u$ (c) $\frac{4\pi u}{\sqrt{1+4\pi^2}}$ (d) $\frac{2\pi u}{\sqrt{1+4\pi^2}}$

47. A car is moving with speed $4c/5$ with respect to ground. A light beam is emitted at 90° to the direction of velocity of car as seen from the car. The angle of light beam velocity of car as seen from round is

(a) $\cos^{-1}\frac{4}{5}$ (b) $\cos^{-1}\frac{3}{4}$ (c) $\cos^{-1}\frac{3}{5}$ (d) $\cos^{-1}\frac{3}{10}$

48. The quark structure of ψ meson is

(a) $\frac{u\bar{u}+d\bar{d}}{\sqrt{2}}$ (b) $c\bar{c}$ (c) $b\bar{b}$ (d) $\bar{b}c$

49. Proton and antiproton collide head on to give rise the following reaction :

$$p + \bar{p} \longrightarrow \Delta^{++} + \overline{\Delta^{++}}$$

The rest masses of p and Δ^{++} are 938 MeV/c² and 1232 MeV/c² respectively. In the centre of mass frame, minimum kinetic energy of proton is _____ MeV.

50. The electric field associated with a monochromatic beam of light becomes zero 1.4×10^{15} times per second. If this light falls on a metal surface having work function 2.2 eV, the maximum kinetic energy of the emitted photoelectrons will be (in the units of **eV**) ..... (Your answer should be upto **two decimal** places)

51. A simple harmonic oscillator of mass m_0 and angular frequency ω is perturbed by an additional potential that is proportional to x^3. The second order correction to the ground state energy of the oscillator will be of the form

(a) $-\frac{9\hbar^2}{8m_0^3\omega^4}$ (b) $-\frac{2\hbar^2}{8m_0^3\omega^4}$ (c) $-\frac{11\hbar^2}{8m_0^3\omega^4}$ (d) $-\frac{7\hbar^2}{8m_0^3\omega^4}$

52. Two spin-1/2 particles, each of mass '*m*' are placed in a 1-D box of length '*L*'. The system is in spin '0' state and its energy is $3.125\frac{h^2}{mL^2}$. The space part of the wavefunction will be of form

(a) $\frac{\sqrt{2}}{L}\left[\sin\frac{3\pi x_1}{L}\sin\frac{4\pi x_2}{L}-\sin\frac{4\pi x_1}{L}\sin\frac{3\pi x_2}{L}\right]$

(b) $\frac{\sqrt{2}}{L}\left[\sin\frac{2\pi x_1}{L}\sin\frac{3\pi x_2}{L}-\sin\frac{3\pi x_1}{L}\sin\frac{2\pi x_2}{L}\right]$

(c) $\frac{\sqrt{2}}{L}\left[\sin\frac{2\pi x_1}{L}\sin\frac{3\pi x_2}{L}+\sin\frac{3\pi x_1}{L}\sin\frac{2\pi x_2}{L}\right]$

(d) $\frac{\sqrt{2}}{L}\left[\sin\frac{3\pi x_1}{L}\sin\frac{4\pi x_2}{L}+\sin\frac{4\pi x_1}{L}\sin\frac{3\pi x_2}{L}\right]$

53. 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) $4\pi\left(A+\frac{C}{2}\right)$

54. The spin-orbit interaction in an sodium atom is given by $H=2\vec{L}.\vec{S}$, where $\vec{L}$ and $\vec{S}$ denote the orbital and spin angular momenta respectively, of the electron. The splitting between the levels $^2P_{3/2}$ and $^2P_{1/2}$ (due to spin-orbit interaction) is (Take $\hbar^2=1$)

..... units (Your answer should be **an integer**)

55. At a given temparature, for a rigid rotator, the probability that the system is in the rotational state $J=0$ is 0.4, in state $J=1$ is 0.35 and in state $J=2$ is 0.25. The average enegy of the rotator at the given tempararture will be (Given: Rotational constant of the rotator is *B*)

(a) 4.5 *B* (b) 1.2 *B* (c) 2.2 *B* (d) 4.8 *B*

56. The moment of inertia of the IR active molecule in the $v=0$ and $v=1$ levels is $15.2\times10^{-47}\,kg-m^2$. The wave number difference between the *R*(1) and *P*(1) lines of the fundamemtal band for that IR active molecule is

(a) 734 m^{-1} (b) 1101 m^{-1} (c) 1520 m^{-1} (d) 2049 m^{-1}

57. The lattice constant 'a' of a fcc solid is 2 Å. The number of atoms per cm^2 on (111) plane are

(a) 5.8×10^{15} (b) 2.9×10^{15} (c) 2.5×10^{15} (d) 2.5×10^{16}

58. The dispersion relation for electron in 3-dimensional lattice in tight binding approximation is given by

$$E(k)=E_0-A\left[\cos(k_xa)+\cos k_ya+\cos k_za\right]$$

where 'a' is a lattice constant and the value of *A* is 1 eV. The band width of the band along [111] direction is

(a) 1 eV (b) 3 eV (c) 6 eV (d) 8 eV

59. The series

$$\frac{1-(\pi/6)^2/2!+(\pi/6)^4/4!-...}{(\pi/6)-(\pi/6)^3/3!+(\pi/6)^5/5!-...}$$

sums to

(a) $1/\sqrt{3}$ (b) $1/2$ (c) 1 (d) $\sqrt{3}$

60. 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) $\mu = -k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)\right]$ (b) $\mu = -k_B T\left[\ln\left(\frac{aVE^{3/2}}{N^{5/2}}\right)-\frac{5}{2}\right]$

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

61. A thin polarised is interposed between a pair of two crossed polaroids and made to rotate at a rate 45 degree/sec about their common axis. If an unpolarised light of intensity 1 watt/cm^2 falls on the first polaroid, then the intensity of transmitted light at time t = 0.5 sec will be

(a) $\frac{1}{16} watt/cm^2$ (b) $\frac{1}{8} watt/cm^2$ (c) $\frac{1}{4} watt/cm^2$ (d) $\frac{1}{10} watt/cm^2$

62. A laser beam has a power of 100 mW and an aperture of 4×10^{-3}m. It emits light of wavelength 6000Å. The beam is focussed with a lens of focal length 0.1m. The intensity of the image is _____$\times10^8$ W/m^2.

63. The band gap (E_g) in a BCS superconductor is measured to be 3 meV at 0 K. The critical temperatuer (T_C) of the superconductor is:

(a) 5 K (b) 10 K (c) 2 K (d) 15 K

64. Consider a 20 μm diameter p-n junction fabricated in silicon. The donor density is 10^{16} per cm^3. The charge developed on the n-side is $1.6\times10^{-13}C$. Then the width (in μm) of the depletion region on the n-side of the p-n junction is _____

65. For parallel beam of electrons incident into two slits and we get a interference pattern. Now, if we increase the velocity of electron beam two times of its initial velocity. Then choose the correct statements.

(a) angular width of principle maxima will decrease

(b) angular width of principle maxima will increase

(c) intensity will be two times of its initial intesity.

(d) intesity will be half of its initial intensity.

Space for rough work

PHYSICS-PH

Date: 14-01-2016

GATE TEST SERIES-II

ANSWER SHEET

1. (d)	2. (b)	3. (a)	4. (c)	5. (a)	6. (c)	7. (a)
8. (c)	9. (a)	10. (a)				
11. (a)	12. (d)	13. (b)	14. (b)	15. (d)	16. (a)	17. (c)
18. (b)	19. (a)	20. (1.01 to 1.02)		21. (c)	22. (d)	23. (b)
24. (a)	25. (10)	26. (d)	27. (d)	28. (a)	29. (b)	30. (c)
31. (a)	32. (a)	33. (c)	34. (b)	35. (a)	36. (a)	37. (1)
38. (0.5)	39. (2)	40. (7.5)	41. (c)	42. (d)	43. (b)	44. (d)
45. (0.75)	46. (c)	47. (a)	48. (b)	49. (294)	50. (0.68 to 0.70)	
51. (c)	52. (d)	53. (a)	54. (3)	55. (c)	56. (b)	57. (a)
58. (c)	59. (a)	60. (b)	61. (a)	62. (4.4 to 4.5)		
63. (b)	64. (0.3 to 0.33)		65. (a)			