TEST SERIES GATE 2019

BOOKLET SERIES C

FULL LENGTH TEST SERIES - 1

Paper Code: PH

Test Type: TEST SERIES

Duration: 3:00 Hours

PHYSICS-PH

Date: 19-01-2019

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. A two digit number becomes 175 % of itself when its digits are reversed. If the two digits differ by three, then the number is _____.

2. Population of a village in 2001 was 30,000. In the next year population of men increased by 15% and population of female increased by 20% and and the total population became 35, 000. What was the initial population of female of the village ?
(a) 15,000 (b) 10,000 (c) 12,000 (d) 8,000

3. In a private hostel there is food stock for 210 students. In day 1 there is one student, in day 2, there are two students, and each next day one new student continues to join the hostel, for how many days the hostel would be able to provide food for the students ?
(a) 15 (b) 12 (c) 21 (d) 20

4. _____: horse:: Board: train
(a) Stable (b) Show (c) Ride (d) Mount

5. Native: aboriginal::Naïve : _____
(a) Learned (b) Arid (c) Unsophisticated (d) Tribe

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

6. If $x+\frac{1}{x}=1$, then what is the value of $\left(x^{12}+\frac{1}{x^{12}}\right)$
(a) 0 (b) 2 (c) 1 (d) –1

7. If in a certain code
'do' is coded as '35'
'her' is coded as '50'
What will be the code for 'him' ?
(a) 62 (b) 51 (c) 45 (d) 55

8. Mahesh drives from his house in motor bike and travels 8 km towards the north, then 6 km towards east and next he decides to travel 10 km after turning to his right. Next he turns to his left and walks 4 km and after that he again takes a left turn and walks for 10 km more to complete his journey. As compared to his starting point in which direction he is standing now?
(a) North-east (b) South east (c) North (d) South-West

9. Shallot: _____:: Scallop: Mollusk
(a) Shark (b) Muscle (c) Desert (d) Onion

10. Laboratory: Germs
(a) School: Students (b) Playground: Games (c) Library: Books (d) Observatory: Planets

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

11. Lagrangian of a particle is $L=\frac{1}{2}mr^2(\dot{\theta}^2+\sin^2\theta\dot{\phi}^2)-mg\,r\cos\theta$. Which of the following statements is correct.

(a) Only energy of the particle is conserved
(b) Only angular momentum of the particle is conserved
(c) Energy and one component of angular momentum is conserved
(d) Linear momentum is conserved

12. Value of Poisson bracket $\{r^2, \vec{r}\cdot\vec{p}\}$ is

(a) $2r^2$ (b) $2r$ (c) r^2 (d) 0

13. A particle slides on smooth inclined plane. Shape of its phase space trajectory is

(a) straight line (b) circle (c) ellipse (d) parabola

14. Lagrangian of a particle is $L = a\dot{x}$ where 'a' is a constant corresponding to Hamiltonian is

(a) $\frac{p_x}{a}$ (b) ap_x (c) 0 (d) Not defined

15. A solid metallic cube of heat capacity C is at temperature 400 K. It is then thrown into the pacific ocean which is at temperatrue 300K. The change in entropy of the universe (in J/K) is

(a) 0.08C (b) 0.04C (c) 0.12C (d) 0.16C

16. Consider three-dimensional electron gas of particle density $10^{29}/m^3$ at zero kelvin. The value of Fermi energy is _____eV

[Specify your answer to one place after the decimal point]

17. The number of discontinuous quantities, out of the given quantities – ***Gibbs free energy, entropy, volume, internal energy, enthalpy*** at transition point in first order phase transition is _____.

[specify your answer in integer]

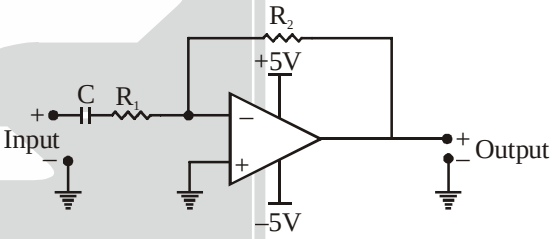
18. The circuit shown is a

(a) Low pass filter with $f_{3dB} = \frac{1}{(R_1+R_2)C} rad/s$

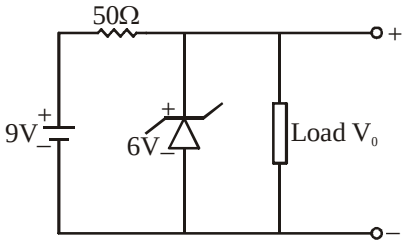
(b) High pass filter with $f_{3dB} = \frac{1}{R_1C} rad/s$

(c) Low pass filter with $f_{3dB} = \frac{1}{R_1C} rad/s$

(d) High pass filter with $f_{3dB} = \frac{1}{(R_1+R_2)C} rad/s$



19. A zener diode in the circuit shown in figure has a knee current of 5 mA, and a maximum allowed power dissipation of 300 mW. What are the minimum and maximum load currents that can be drawn safely from the circuit, keeping the output voltage V_0 constant at 6V?



(a) 0 mA, 180 mA (b) 5 mA, 110 mA

(c) 10 mA, 55 mA (d) 60 mA, 180 mA

20. 12 MHz clock frequency is applied to a cascaded counter of modulus-3 counter, modulus-4 counter and modulus-5 counter. What are the lowest output frequency and the overall modulus, respectively?

(a) 200 kHz, 60 (b) 1 MHz, 60 (c) 3 MHz, 12 (d) 4 MHz, 12

21. $\psi_{n,\ell,m}(\vec{r})$ are the hydrogen atom stationary state. The state of an electron in a hydrogen atom is

$$\phi(\vec{r}) = \psi_{3,2,1}(\vec{r}) + \psi_{2,1,1}(\vec{r}) + 3\psi_{3,1,-1}(\vec{r})$$

If the z-component of angular momentum is measured, the probability of finding $\hbar$ is _____(Upto two decimal places).

22. $\langle r^2 \rangle$ in the 2s state of hydrogen atom is $42a_0^2$. The value of $\langle x^2 + y^2 \rangle$ for the state is

(a) $14a_0^2$ (b) $28a_0^2$ (c) $42a_0^2$ (d) None of these

23. A relativistic particle of momentum 3 GeV/c has an energy of 5 GeV. Its compton wave length is _____fm. [Upto two decimal places].

24. The wavefunction of a free particle is,

$$\psi(x) = 2\,e^{ikx} + 3\,e^{2ikx}$$

Its average energy is,

(a) $\frac{20\,\hbar^2k^2}{m}$ (b) $\frac{\hbar^2k^2}{20m}$ (c) $\frac{20}{13}\frac{\hbar^2k^2}{m}$ (d) $\frac{13}{20}\frac{\hbar^2k^2}{m}$

25. Consider the following reactions through strong interactions

I $\pi^+ + n \longrightarrow \Lambda^0 + K^+$

II $\mathrm{P} + n \longrightarrow \Lambda^0 + \Sigma^+$

then

(a) Reactions- I is allowed only (b) Reactions-II is allowed only
(c) Reaction-I and -II are allowed (d) Both the reactions I & II are forbidden

26. In a cyclotron, magnetic field applied is 2π tesla, If Deuteron is to be accelerated, then the frequency of the oscillating potential applied across the does is

(a) 4.79×10^7 Hz (b) 5.25×10^7 Hz (c) 2.79×10^7 Hz (d) 8.89×10^7 Hz

[mass of ${}^2_1H = 3.344 \times 10^{-27}$ kg]

27. Assume the energy of two particles in the field of each other is given by the following function,

$U(r) = -\frac{a}{r} + \frac{b}{r^9}$, where r_0 is minimum separation between two particles

then the potential energy at the stable equilibrium is

(a) $-\frac{a}{r_0}\left(\frac{8}{9}\right)$ (b) $-\frac{a}{8}\frac{9}{r_0}$ (c) $\frac{a}{8}\frac{r_0}{9}$ (d) $-\frac{a}{8}\frac{9}{r_0}$

28. If number density of a free electrons gas changes from 10^{28} to 10^{26} electrons/n^3, the value of plasma frequency (in Hz) changes from 5.7×10^{15} to

(a) 5.7×10^{13} (b) 5.7×10^{14} (c) 5.7×10^{16} (d) 5.7×10^{17}

29. A system of non-interacting fermi particles with fermi energy E_F, has density of states proportional to $\sqrt{E}$, where E is the energy of a particle. The average energy per particle at temperature $T = 0$ is

(a) $\frac{1}{6}E_F$ (b) $\frac{1}{5}E_F$ (c) $\frac{2}{5}E_F$ (d) $\frac{3}{5}E_F$

30. In a resonant cavity, an electromagnetic oscillation of frequency ω_0 dies out as

$$A(t) = \begin{cases} A_0\, e^{-\omega_0 t/2Q}\, e^{-i\omega_0 t} & ; \quad t > 0 \\ 0 & ; \quad t < 0 \end{cases}$$

where Q is a constant.

The frequency distribution of the oscillation $a^*(\omega)\alpha(\omega)$, where $a(\omega)$ is the Fouier transform of $A(t)$ is

(a) $\frac{A_0^2}{2\pi}\frac{1}{(\omega-\omega_0)^2-(\omega_0/2Q)^2}$ (b) $\frac{A_0^2}{2\pi}\frac{1}{(\omega+\omega_0)^2-(\omega_0/2Q)^2}$

(c) $\frac{A_0^2}{2\pi}\frac{1}{(\omega+\omega_0)^2+(\omega_0/2Q)^2}$ (d) $\frac{A_0^2}{2\pi}\frac{1}{(\omega-\omega_0)^2+(\omega_0/2Q)^2}$

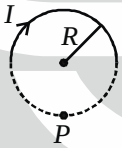
31. The inverse laplace transform of $f(s) = \frac{s^2}{(s^2+a^2)(s^2+b^2)}$ is

(a) $\frac{1}{(a^2-b^2)}\left[\frac{\sin at}{a} - \frac{\sin bt}{b}\right]$ (b) $\frac{1}{(a^2-b^2)}\left[\frac{\cos at}{a} - \frac{\cos bt}{b}\right]$

(c) $\frac{1}{(a^2-b^2)}\left[a\sin at - b\sin bt\right]$ (d) $\frac{1}{(a^2-b^2)}\left[a\cos at - b\cos bt\right]$

32. In a rigid rotator, if the energy of the second excited state is 3meV, then the energy of the fourth excited state (in meV) is _____(Answer is in integer)

33. A wire is bent into a semicircle of radius R carrying current I. P is a point on the middle of the periphery of the circle as shown in figure. The magnitude of the magnetic field at P will _____ $\mu_0 I/4\pi R$.



34. A point charge Q is at origin of a spherical coordinate system. The electric flux crosses through the portion of a spherical shell described by $r \le R$, $0 \le \phi \le 2\pi$, $0 \le \theta \le \frac{\pi}{2}$ is

(a) $\frac{Q}{4}$ (b) $\frac{Q}{2}$ (c) $\frac{Q}{8}$ (d) $\frac{Q}{6}$

35. Given the electric field $\vec{E} = -5e^{-r/a}\,\hat{r}$ in cylindrical coordinates, the energy stored in the volume described by $r \le 2a$, $0 \le \phi \le 2\pi$ and $0 \le z \le 5a$ is _____ $a \times 10^{-10}$. [Answer upto two decimal places]

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

36. A solid sphere is given a translational velocity on a rough horizontal surface. Fractional loss in its kinetic energy till the time it begins to roll is

(a) $\frac{2}{7}$ (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) $\frac{5}{7}$

37. A particle moves under a force $\vec{F} = -K\vec{r}$. Which of the following path is not possible for the particle.

(a) straight line (b) circle (c) ellipse (d) parabola

38. If transformation $(q, p) \to (Q, P)$ where

$Q = \alpha q \cos\theta + p \sin\theta$

$P = -q \sin\theta + p \cos\theta$ is canonical, then value of 'α' is _____

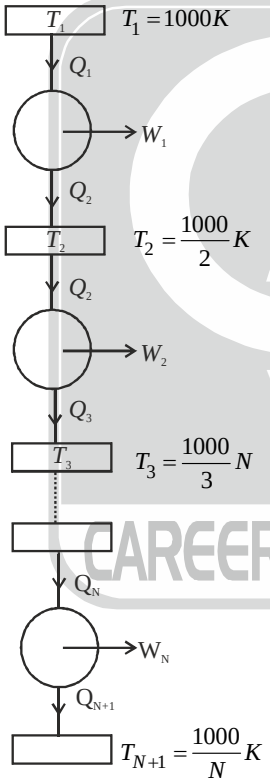
39. A particle of mass *m* initially at rest is acted upon by constant force *F*. As it moves, a drag force *–Kv*, where *v* is instantaneous velocity also acts on it. Net force acting on the particle at time *t* is

(a) $F(1-e^{-Kt/m})$ (b) $F(1+e^{-Kt/m})$ (c) $Fe^{-Kt/m}$ (d) $F/2(1+e^{-Kt/m})$

40. Consider a small system for which the energies, of the states, measured relative to the ground state are $\varepsilon_n = n(0.02eV), n = 0,1,2,.....$. The temperature of the system is 273 K. If the probability of finding the system in the energy ε_n is given by $P_n = Ce^{-\varepsilon_n/k_BT}$, the value of C is _____
[Specify your answer to two places after the decimal point]

41. The fraction of particles in the ground state in Bose-Einstein condensation is 0.6 at temperature 4.25K. The Bose temperature is _____ K. [Specify your answer one place after the decimal point]

42. *N* number of Carnot engines are connected in such a way that all the waste heat of first engine goes as an input heat of the second engine and so an. It is also shown in the following figure.

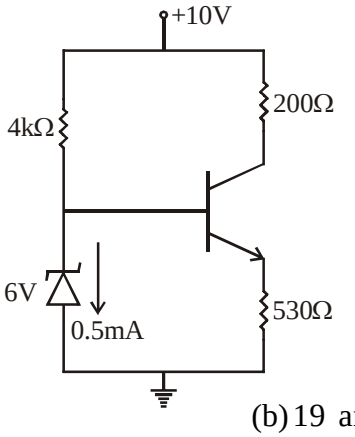


If the temperature of the source and sink engine vary as shown in the above figure, the efficiency of the whole system is _____when N = 10.
[Specify your answer to one place after the decimal point]

43. The angular frequency (ω) of boson gas vary with wave number (k) as $\omega \propto k^3$. If the chemical potential of the bosons is zero, the specific heat of the gas varies with temperature as T^n. The value of *n* _____is.

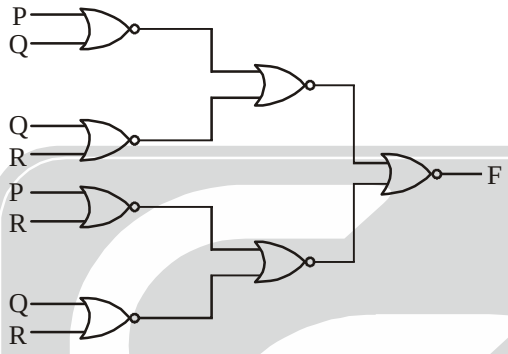
[Specific your answer in integers]

44. In the circuit below, $V_{BE} = 0.7V$. The β and V_{CE} are



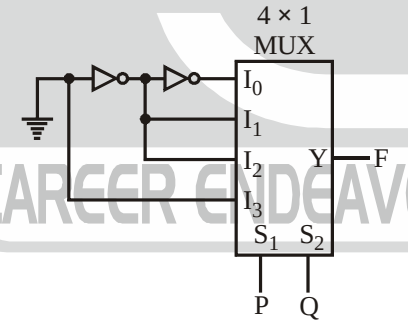
(a) 19 and 2.8 V (b) 19 and 4.7 V
(c) 38 and 2.8 V (d) 38 and 4.7 V

45. What is the boolean expression for the output F of the combinational logic circuit of NOR gates given below?



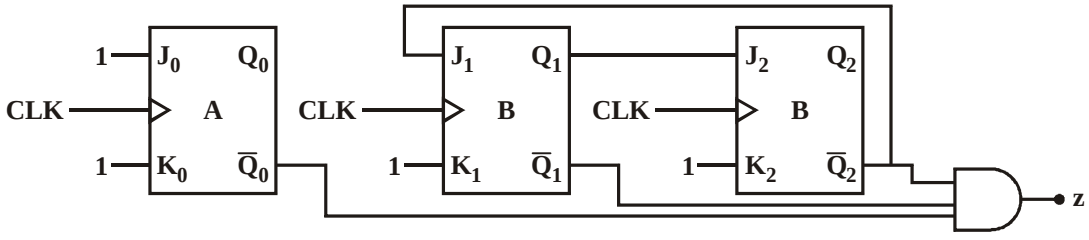
(a) $\overline{Q+R}$ (b) $\overline{P+Q}$ (c) $\overline{P+R}$ (d) $\overline{P+Q+R}$

46. The logic function implemented by the circuit below is (gound implies logic 0)



(a) F = AND (P, Q) (b) F = OR (P, Q) (c) F = XNOR (P, Q) (d) F = XOR (P, Q)

47. Consider a sequential circuit using three J-K flip-flops and one AND gate shown in figure. Output of the circuit becomes '1' after every N-clock cycles. The value of N is



(a) 4 (b) 7 (c) 8 (d) 6

48. Consider the spin-state of a particle to be $|\chi\rangle = \frac{1}{2}\left[|\uparrow\rangle + i\sqrt{3}|\downarrow\rangle\right]$. The value of $\left\langle\left\{\sigma_x\ \sigma_y, i\,e^{\sigma_z}\right\}\right\rangle$ for the given state is equal to

(a) $\frac{3-e}{2e}+e$ (b) $\frac{3+e}{2e}-e$ (c) $\frac{3-e^2}{2e}$ (d) $\frac{3+e^2}{2e}$

49. A 1-D harmonic oscillator of frequency ω is perturbed by a hamiltonian of the form $H_P = \lambda x$. The total correction to the ground state energy for a particle of mass *m* will be

(a) $+\frac{\lambda^2}{2m\omega^2}$ (b) zero (c) $-\frac{\lambda^2}{2m\omega^2}$ (d) $-\frac{2\lambda^2}{m\omega^2}$

50. 8 non-interacting protons, when placed in a 1-D infinite potential well of width *a* have ground state energy E_A. When they are placed in a 2-D isotropic Harmonic oscillator of frequency $\omega = \frac{\hbar}{ma^2}$, the ground state energy becomes E_B. $\frac{E_A}{E_B}$ is equal to _____(Upto two decimal places).

51. In an elastic scattering process only *s* waves need to be considered. For two incident particles of equal mass and energies E_A and E_B, $\delta_0^A = 90^o$ and $\delta_0^B = 60^o$. If the ratio of scattering cross-section of *A* to that of *B* is ½, $\frac{E_A}{E_B}$ is equal to _____[Upto two decimal places].

52. Consider the semi-empirical mass formula

$$B = a_v A - a_s A^{2/3} - a_c z(z-1)A^{-1/3} - a_{sym}\frac{(A-2z)^2}{A} + \delta$$

the most stable nuclei for given A is

(a) $Z_{\min} = \frac{A}{2}\left(\frac{1}{1+\frac{1}{4}A^{2/3}a_c/a_{sys}}\right)$ (b) $Z_{\min} = \frac{1}{1+\frac{1}{4}A^{2/3}a_c/a_{sys}}$

(c) $Z_{\min} = \frac{4A}{a_c/a_{sys}}$ (d) $Z_{\min} = \frac{2}{3}A$

53. Meson is assumed as the exchange particle between the nucleon causing the nuclear force. If the range of the nuclear force between the necleon is 1.5 fm, the mass of the exchange particle must be
(a) 50.5 MeV/c^2 (b) 100 MeV/c^2
(c) 125.44 MeV/c^2 (d) 133.33 MeV/c^2

54. The tight binding energy dispersion (*E-K*) relation for electrons in one-dimensional array of atom having lattice constant *a* and total length *L* is

$E = -2\gamma\cos(ka)$, where γ = constant and k = wave vector

The density of states of electrons (including spin degeneracy) in the band is given by

(a) $\frac{L}{\pi\gamma a\sin(ka)}$ (b) $\frac{L}{2\pi\gamma a\sin(ka)}$ (c) $\frac{L}{2\pi\gamma a\cos(ka)}$ (d) $\frac{L}{\pi\gamma a\cos(ka)}$

55. A function $f(x)$ is expanded in a legendre series $f(x)=\sum_{n=0}^{\infty} a_n P_n(x)$. If $f(x)=e^x, |x|$, then $\sum_{n=0}^{\infty}\frac{2a_n^2}{2n+1}$ is equal to _____. $\left(\int_{-1}^{+1}[P_n(x)]^2\,dx=\frac{2}{2n+1}\right)$

56. If $\hat{A}=\begin{pmatrix}-1 & 0\\ 0 & 1\end{pmatrix}$ and $\hat{B}=\begin{pmatrix}2 & 0\\ 0 & -2\end{pmatrix}$. Then $\det\left[e^{\hat{B}}\,\hat{A}e^{-\hat{B}}\right]$ is equal to _____.
[Answer should be an integer]

57. Consider the integral $-\int_0^1 x^k \ln x\,dx,\ k>-1$. The value of this integral is _____.

(a) $\frac{\Gamma(1)}{(k+1)^2}$ (b) $\frac{\Gamma(2)}{(k+1)^2}$ (c) $\frac{\Gamma(1)}{(k+1)}$ (d) $\frac{\Gamma(2)}{(k+1)}$

[where $\Gamma(x)$ is the Gamma function]

58. Consider the differential equation : $(s^2+1)\,f'(s)+sf(s)=0,\ f(0)=1$. Then $f(z)$ is equal to _____.
[Answer upto two decimal places]

59. The term symbols for the electronic ground state of calcium (Z = 20) and Flurorine (Z = 9) respectively are

(a) $^1S_0$ and $^2P_{1/2}$ (b) $^2S_{1/2}$ and $^2P_{3/2}$ (c) $^2S_{1/2}$ and $^2P_{1/2}$ (d) $^1S_0$ and $^2P_{3/2}$

60. An atom in its single state is subjected to a magnetic field. The Zeeman splitting of its 4500 Å spectral lines is 14 m^{-1}. The magnitude of the magnetic field is _____ Tesla.
$\left[e=1.6\times10^{-19}c,\ m_e=9.11\times10^{-31}\text{ kg},\ c=3\times10^8\text{ m/s}\right]$ (Upto two decimal places)

61. The fundamental b and for Co molecule is centered at X m^{-1} 4 the first overtone at Y m^{-1}. the bibrational frequency of CO molecule in terms of velocity of light C is (in S^{-1})

(a) (Y– X)C (b) (3X – Y)C (c) (X – 3Y)C (d) $(2X-Y)\frac{C}{2}$

62. Consider the function $f(z)=\frac{\sqrt{z(z-1)}}{z^{3/2}}$. Which of the following statement is correct ?

(a) $z=0,1$ are branch points of $f(z)$.

(b) $z=0,1$ are simple poles of $f(z)$.

(c) $z=0$ is a simple pole and $z=1$ is a branch point of $f(z)$.

(d) $z=0$ is a removable singularity and $z=1$ is a branch point of $f(z)$.

63. A long solenoid of radius *a* has self inductance *L*, resistance *R* and *n* number of tern per unit length and *a* circular conducting ring of radius *a* is placed inside the solenoid in such a way that the axis of both ring and solenoid parallel to each other now if we connect solenoid with a voltage source *V*, then

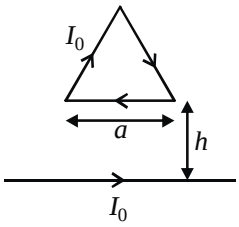
(a) induced emf on the ring is $\frac{\pi b^2\mu_0 Vn}{L}e^{-Rt/L}$ (b) induced emf on the ring is $\frac{\pi a^2\mu_0 Vn}{L}e^{-\frac{L}{R}t}$

(c) the maximum rdial force on the ring is $\frac{\mu_0^2V^2n^2\pi b^2}{L}$.

(d) the maximum radial force on the ring is $\frac{\mu_0^2V^2n^2\pi a^2}{L}$

64. The value of the integral $\int_{-\infty}^{+\infty} \frac{x^2}{x^4+1} dx$ is _____ $\times \sqrt{2}\pi$. [Answer upto two decimal places]

65. An equilateral triangle of side *a* carrying current I_0 is placed near a long straight wire as shown in figure. The force on the triangle is given by



(a) $\frac{\mu_0 I_0^2}{2\pi}\left(\frac{a}{h} - 2\ln\left(1+\frac{\sqrt{3}a}{2h}\right)\right)$

(b) $\frac{\mu_0 I_0^2}{2\pi}\left(\frac{a}{h} + 2\ln\left(1+\frac{\sqrt{3}a}{2h}\right)\right)$

(c) $\frac{\mu_0 I_0^2}{2\pi}\left(\frac{a}{h} + 2\ln\left(1-\frac{\sqrt{3}a}{2h}\right)\right)$

(d) $\frac{\mu_0 I_0^2}{2\pi}\left(\frac{a}{h} - 2\ln\left(1-\frac{\sqrt{3}a}{2h}\right)\right)$

****

Space for rough work

PHYSICS-PH

GATE TEST SERIES-C

Date: 19-01-2019

FULL LENGTH TEST SERIES-1

ANSWER KEY

1. (36)	**2.** (b)	**3.** (d)	**4.** (d)	**5.** (c)
6. (b)	**7.** (b)	**8.** (a)	**9.** (d)	**10.** (d)
11. (c)	**12.** (a)	**13.** (d)	**14.** (d)	
15.(b)	**16.** (7.7 to 7.9)	**17.** (4)	**18.** (b)	
19. (c)	**20.** (a)	**21.** (0.16 to 0.20)	**22.** (b)	
23. (0.29 to 0.33)	**24.** (c)	**25.** (a)	**26.** (a)	
27. (a)	**28.** (b)	**29.** (d)	**30.** (d)	
31. (c)	**32.** (10)	**33.** (0.438 to 0.445)	**34.** (b)	
35. (7.88 to 7.90)	**36.** (a)	**37.** (d)	**38.** (1)	
39. (c)	**40.** (0.32 to 0.42)	**41.** (7.7 to 7.9)	**42.** (0.9)	
43. (1)	**44.** (a)	**45.** (b)	**46.** (d)	
47. (d)	**48.** (c)	**49.** (c)	**50.** (18.49 to 18.53)	
51. (2.65 to 2.69)	**52.** (a)	**53.** (d)	**54.** (a)	
55.(3.60 to 3.64)	**56.** (-1)	**57.** (b)	**58.** (0.44 to 0.48)	
59. (d)	**60.** (0.29 to 0.33)	**61.** (b)	**62.** (c)	
63. (b)	**64.** (0.50)	**65.** (a)		