

Total No. of Printed Pages : 21

(DO NOT OPEN THIS QUESTION BOOKLET BEFORE TIME OR UNTIL YOU ARE ASKED TO DO SO)

SET-Y

A

Ph.D./URS-EE-Jan-2022

SUBJECT : Physics

10005

Sr. No.

Time : 1¼ Hours

Max. Marks : 100

Total Questions : 100

Roll No. (in figures) _____ (in words) _____

Name _____ Father's Name _____

Mother's Name _____ Date of Examination _____

(Signature of the Candidate)

(Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**

2. The candidates **must return** the question booklet as well as OMR Answer-Sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.

3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.

4. Question Booklet along with answer key of all the A, B, C & D code will be got uploaded on the University website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examination in writing/through E.Mail within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.

5. The candidate **must not** do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question booklet itself. Answers **must not** be ticked in the question booklet.

6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**

7. Use only **Black or Blue Ball Point Pen** of good quality in the OMR Answer-Sheet.

8. **Before answering the questions, the candidates should ensure that they have been supplied correct and complete booklet. Complaints, if any, regarding misprinting etc. will not be entertained 30 minutes after starting of the examination.**

PHD/URS-EE-2022/(Physics)(SET-Y)/(A)

SEAL

10002

A

1. If 'm' is the mean of a Poisson distribution, then the standard deviation is given by :
- (1) \sqrt{m} (2) m^2 (3) m (4) $m/2$
2. One of the eigen values for the following 2×2 matrix, $\begin{bmatrix} 1 & 8 \\ 2 & 1 \end{bmatrix}$, is :
- (1) 4 (2) 5 (3) 6 (4) 8
3. If $f(x) = 1$, then its Laplace Transform $F(y)$ is given by :
- (1) Does not exist (2) y
(3) $1/y$ (4) 1
4. Let $u = \sin y + i \cos 2y$ and $v = \cos y - i \sin 2y$. Then for what values of y, the u and v will be conjugate of each other ?
- (1) $n\pi$ (2) $(n+1/2)\pi$
(3) 0 (4) no value of y
5. The divergence of the vector function $F = (x^3y)i + (3xy^2z)j + (3zx)k$ is :
- (1) $3x^2y + 3y^2z + 3z$
(2) $x^3 + 6xyz$
(3) $3xy^2 + 3x$
(4) $3x^2y + 6xyz + 3x$
6. The first two terms of the Taylor series about $a = 3$ for the function $f(x) = 2x + 5$ will be :
- (1) $11 - 2(x - 3)$
(2) $11 + 2(x - 3)$
(3) $11 - 7(x - 3)$
(4) $11 + 7(x - 3)$

7. When we throw a dice then what is the probability of getting the number greater than 5 ?
- (1) $1/3$ (2) $1/5$ (3) $1/6$ (4) $1/2$
8. The dimensional formula of viscosity is :
- (1) $ML^{-1}T^{-1}$ (2) MLT^{-1} (3) MLT^{-2} (4) $ML^{-1}T^{-2}$
9. A geostationary satellite is :
- (1) whose time period is same as that of Earth
(2) whose magnitude of the speed v is same as that of Earth, but have different time period
(3) whose time period and speed v both are same as that of Earth
(4) none of the above
10. The stability of a system means that :
- (1) Small changes in the system input do not result in large change in output conditions of the system
(2) Small changes in the system parameters do not result in large change in output conditions of the system
(3) Small changes in the initial conditions do not result in large change in output conditions of the system
(4) All of the above
11. In the elastic collision between two bodies :
- (1) both the total momentum and total kinetic energies of the colliding bodies are conserved
(2) only the total kinetic energy of the colliding bodies is conserved
(3) only the total momentum of the colliding bodies is conserved
(4) neither the total momentum nor the total kinetic energies of the colliding bodies are conserved.

A

12. The circular motion of an object moving with constant speed is an example of :
- (1) both periodic as well as simple harmonic motions
 - (2) periodic motion only
 - (3) simple harmonic motion only
 - (4) neither periodic nor simple harmonic motion
13. According to Einstein's Special Theory of Relativity, the laws of Physics can be formulated based on :
- (1) inertial frame of reference only
 - (2) non-inertial frame of reference only
 - (3) both the non-inertial and inertial frame of references
 - (4) quantum state only
14. When number of nucleons in a nuclei increases, then the binding energy per nucleon :
- (1) initially increases and then decreases with the mass number
 - (2) initially decreases and then increases with the mass number
 - (3) decreases continuously with the mass number
 - (4) increases continuously with mass number
15. The pseudo force concept is valid for :
- (1) the inertial frames
 - (2) the non-inertial frames
 - (3) both the inertial as well as non-inertial frames
 - (4) neither the inertial frames nor the non-inertial frames

16. The Lorentz transformation equations hold for :

- (1) non-relativistic speeds only
- (2) relativistic speeds only
- (3) all speeds : relativistic as well as non-relativistic
- (4) mass-less particles only

17. If λ is the wavelength of electrons (in \AA), which have been accelerated from rest through a potential difference of V (in Volts), then the value of product $\lambda\sqrt{V}$ is approximately equal to :

- (1) 13.60
- (2) 10.16
- (3) 12.26
- (4) None of the above

18. For a particle in a one dimensional box, the wave function is given by

$$\Psi(x) = N \sin \frac{3\pi x}{L} \quad 0 < x < L,$$

$$= 0 \quad x < 0 \text{ \& } x > L.$$

The normalization constant N is given by :

- (1) $\sqrt{\frac{1}{L}}$
- (2) $\sqrt{\frac{2}{L}}$
- (3) $\sqrt{\frac{3}{L}}$
- (4) None of the above

19. For a particle inside a box lying between $x = 0$ and $x = L$, the potential is maximum at $x =$

- (1) L
- (2) $2L$
- (3) $L/2$
- (4) $3L$

20. Energy of the 2nd excited state for a simple harmonic oscillator is equal to :

- (1) $(\hbar\omega)$
- (2) $(3\hbar\omega/2)$
- (3) $(5\hbar\omega/2)$
- (4) $(2\hbar\omega)$

A

21. The function representing matter waves :
- (1) can only be complex
 - (2) can only be a real
 - (3) can be either complex or real
 - (4) must be a Dirac-delta function
22. Which of the following transitions in a hydrogen atom emits the photon of the lowest frequency ?
- (1) $n = 2$ to $n = 1$
 - (2) $n = 3$ to $n = 1$
 - (3) $n = 4$ to $n = 2$
 - (4) $n = 4$ to $n = 3$
23. If an object, which is rotating about a fixed point P, has a kinetic energy E and angular momentum L, then :
- (1) $L \propto E^2$
 - (2) $L \propto E$
 - (3) $L \propto E^{-1}$
 - (4) $L \propto E^{1/2}$
24. Which of the following experiments first detected the spin of an electron ?
- (1) Davison and Germer experiment
 - (2) Stern and Gerlach experiment
 - (3) Zeeman Effect
 - (4) Frank and Hertz experiment
25. A charge 'q' is enclosed by a Gaussian spherical surface of radius 'R'. If the radius is increased to '3R', then the outward electric flux will :
- (1) remain unchanged
 - (2) increase by a factor of 3
 - (3) decrease by a factor of 9
 - (4) increase by a factor of 9

26. The Poisson equation for electric potential V for an isotropic and homogeneous medium having charge density ρ and dielectric constant ϵ is given by :

(1) $\nabla^2 V = -\frac{\rho}{\epsilon}$

(2) $\nabla^2 V = \frac{\rho}{\epsilon}$

(3) $\nabla \cdot V = -\frac{\rho}{\epsilon}$

(4) $\nabla \cdot V = \frac{\rho}{\epsilon}$

27. A long wire carrying a current produces a magnetic field of strength 0.8 T at a distance of 0.5 cm from it. The magnetic field at a distance of 2 cm from the wire will be :

(1) 0.40 T

(2) 0.20 T

(3) 0.16 T

(4) 0.10 T

28. What is the nature of light ?

(1) Matter

(2) Wave like

(3) Particle like

(4) Dual

29. In the Fleming's left-hand rule, the middle finger points in the direction of :

(1) Current in the wire conductor

(2) Magnetic field

(3) Force on the wire conductor

(4) Length of the wire conductor

30. If the magnetic flux linked with a coil is given to be $\phi = 5t^2 + 2t + 3$, then the magnitude of emf induced in the coil at 4 sec will be :

(1) 42 V

(2) 91 V

(3) 20.2 V

(4) None of the above

31. The magnetic susceptibility of a paramagnetic substance is :

(1) Negative and temperature-dependent

(2) Negative and temperature-independent

(3) Positive and temperature-dependent

(4) Positive and temperature-independent

A

32. An unpolarized light having intensity I_0 falls over a polaroid. The intensity of the transmitted light will be :
- (1) $I_0/2$ (2) $I_0/4$ (3) I_0 (4) Zero
33. Clausius Mossotti equation is an equation which relates :
- (1) Dielectric constant and atomic polarizability in a polar molecule
 (2) Dielectric constant and atomic polarizability in a non-polar molecule
 (3) Dielectric constant and polarization in a polar molecule
 (4) Dielectric constant and polarization in a non-polar molecule
34. The Gibb's potential is defined as :
- (1) $G = U + pV + TS$ (2) $G = U - pV + TS$
 (3) $G = U + pV - TS$ (4) $G = U - pV - TS$
35. The Helmholtz free energy is given by $F = U - TS$. Then C_V will be given by :
- (1) $C_V = T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$ (2) $C_V = T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$
 (3) $C_V = -T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$ (4) $C_V = -T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$
36. Choose the option that is the best description about the chemical potential of a thermodynamical system :
- (1) It is an extensive property only
 (2) It is an intensive property only
 (3) It is a force that drives the system to equilibrium
 (4) It is an intensive property and can be regarded as a force that drives the system to equilibrium

37. The classical partition function Z of a system tells us about :
- (1) The sum of all the states of the system
 - (2) The sum of the energy of the system
 - (3) The sum of the momentum of the system
 - (4) All of the above
38. A phase space is a :
- | | |
|-------------------------|-------------------------|
| (1) 2-Dimensional Space | (2) 3-Dimensional Space |
| (3) 4-Dimensional Space | (4) 6-Dimensional Space |
39. Mass of a gas 'A' is 9 times that of gas 'B'. The ratio of their mean velocities will be :
- | | | | |
|-----------|-----------|-----------|-----------|
| (1) 9 : 1 | (2) 1 : 9 | (3) 1 : 3 | (4) 3 : 1 |
|-----------|-----------|-----------|-----------|
40. Which of the following statistics can be used to describe the behavior of photons ?
- (1) Maxwell-Boltzmann statistics
 - (2) Fermi-Dirac statistics
 - (3) Bose-Einstein statistics
 - (4) By both Maxwell-Boltzmann statistics as well as Bose-Einstein statistics
41. Choose the *correct* option about energy distribution in the black body spectrum :
- (1) As the wavelength increases, the energy emitted also increases
 - (2) As temperature of the black body increases, the energy associated with the radiation of a specific wavelength increases
 - (3) As temperature of the black body increases, the intensity of its radiation also increases
 - (4) All of the above options are correct

A

42. If error in the measurement of radius of a spherical ball is 2%, then the error in the calculated value of the surface area of the ball will be :
(1) 2% (2) 4% (3) 6% (4) 8%
43. Five measurements are performed at different time to measure the length of a rod. The readings (in some units) are 101, 102, 98, 99 and 100. The precision of 4th measurement will be :
(1) 0.01 (2) 0.90 (3) 0.10 (4) 0.99
44. Choose the technology which was used by Intel for designing its first 8-bit microprocessor ?
(1) HMOS (2) NMOS
(3) PMOS (4) TTL
45. The Schmitt trigger circuit is a modification of one of the following multivibrators. Choose the *correct* option :
(1) Astable multivibrator (2) Bistable multivibrator
(3) Universal multivibrator (4) Monostable multivibrator
46. The electrical characteristics, which is *not* exhibited by an ideal op-amp, is :
(1) Infinite bandwidth (2) Infinite voltage gain
(3) Infinite slew rate (4) Infinite output resistance
47. How many flip-flops are required to construct an 8-bit Shift register ?
(1) 8 (2) 16 (3) 4 (4) 2
48. Which of the following diodes exhibits negative resistance in its characteristics ?
(1) Tunnel diode (2) Schottky diode
(3) Varactor diode (4) Zener diode

49. If a voltmeter is connected across the forward-biased Si-diode, it will read a voltage which would approximately be equal to :
- (1) Bias battery voltage
 - (2) Zero V
 - (3) Diode barrier potential
 - (4) 1.1 V
50. Find the value of the current limiting resistor required for connecting three LEDs (rating 3V and 3 mA) in series with a 15 volt DC source.
- (1) 1 kohm
 - (2) 2 kohm
 - (3) 3 kohm
 - (4) 5 kohm
51. The applications of Green's theorem are meant to be in :
- (1) one-dimension
 - (2) two-dimension
 - (3) three-dimension
 - (4) all of the above
52. A partial differential equation has :
- (1) only one independent variable
 - (2) two or more independent variables
 - (3) more than one dependent variables
 - (4) equal number of dependent and independent variables
53. Interpolation is a method of :
- (1) Interrelating
 - (2) Estimating
 - (3) Integrating
 - (4) Combining

A

54. Which one of the following quantities is *not* a second order tensor ?

- (1) Stress (2) Strain
(3) Pressure (4) Moment of Inertia

55. Which of the following is a Laplace equation ?

- (1) $\nabla V = 0$ (2) $\nabla^2 V = -\rho/\epsilon_0$
(3) $\nabla \cdot J = - (dp/dt)$ (4) $\nabla^2 V = 0$

56. The Runge-Kutta method is used to solve :

- (1) Ordinary differential equations of n^{th} order
(2) Linear differential equations
(3) Simultaneous non-linear equations
(4) None of these

57. Which of the following is *true* about trapezoidal rule ?

- (1) It is exact for polynomials of degree ≤ 1
(2) It is exact for polynomials of order 2 only
(3) It is exact for polynomials of degree ≥ 1
(4) It is exact for polynomials of degree 2 only

58. A group $(M, *)$ is said to be an abelian if :

- (1) $(x + y) = (y + x)$
(2) $(x + y) = -(y + x)$
(3) $(x * y) = (y * x)$
(4) $(x * y) = -(y * x)$

59. Which of the following systems is said to be a dynamical system ?
- (1) $y(n) = 6x(n) + 7$
 - (2) $y(n) = 2x(n) + 3x(n-1) + 5$
 - (3) $y(n) = 4x(n) + 3x^2(n) + 3$
 - (4) $y(n) = 5x(n) + 6x^2(n) + 6x^3(n) + 8$
60. The asymptotic stability is associated with a system which is :
- (1) under the influence of input
 - (2) not under the influence of input
 - (3) under influence of output
 - (4) not under the influence of output
61. The Poisson bracket $\{x, xp_x - yp_y + ax^2 + by^2\}$, where a and b are constants, is equal to :
- | | |
|-----------|-----------|
| (1) x | (2) y |
| (3) p_x | (4) p_y |
62. The Jacobi's method is also known as :
- (1) Displacement method
 - (2) Simultaneous displacement method
 - (3) Simultaneous method
 - (4) Diagonal method
63. Suppose P , Q and R be functions of phase space variables (coordinates and momenta of a mechanical system). If $\{ , \}$ represents the Poisson bracket, then the value of $\{P, \{Q, R\}\} - \{\{P, Q\}, R\}$ will be :
- | | |
|-----------------------|-----------------------|
| (1) 0 | (2) $\{Q, \{R, P\}\}$ |
| (3) $\{P, \{R, Q\}\}$ | (4) $\{\{R, P\}, Q\}$ |

A

64. Choose the **correct** statement about group velocity in a dispersive medium :
- (1) Group velocity is less than the phase velocity only
 - (2) Group velocity is more than the phase velocity
 - (3) Group velocity is equal to the phase velocity only
 - (4) Group velocity can be both more than or less than the phase velocity depending upon the nature of dispersive medium
65. Wave guide can be regarded as :
- (1) Low-pass filter
 - (2) High-pass filter
 - (3) Band-pass filter
 - (4) Both low pass as well as high-pass filter
66. If for a transmission line, $\frac{L}{C} = \frac{R}{G}$, then which one of the following would be **correct** ?
- (1) The transmission line will be loss-less
 - (2) The transmission is called as distortion-less
 - (3) $Z_0^2 = \frac{R}{G}$
 - (4) The attenuation constant will be imaginary
67. The reason why Northern Lights only occur in the North and Southern Lights occur in South is :
- (1) Charged particles from the Sun follow the axis of rotation of the Earth
 - (2) Charged particles from the Sun deviate from the electric field lines near the poles
 - (3) Charged particles from the Sun penetrate the Earth's magnetic field near the poles
 - (4) Charged particles from the Sun are trapped in the Earth's magnetic field near the poles

68. Which auxiliary function is useful in solving the radiation problem involving evaluation of the E & H fields from the sources J & M ?

- (1) Scalar potentials
- (2) Vector potentials
- (3) Divergence potentials
- (4) Gradient potentials

69. To properly account for the fine structure of the spectrum of hydrogen atom one must consider :

- (1) Spin angular momentum
- (2) Orbital angular momentum
- (3) Principal quantum number n
- (4) Coulomb potential of the hydrogen-nuclei

70. Consider a particle of mass m is scattered by a potential $V(r) = g\delta^3(r)$. The differential cross-section as per Born Approximation will be :

- | | |
|---------------------------------------|---------------------------------------|
| (1) $\frac{m^2 g^2}{4\pi^2 \hbar^2}$ | (2) $\frac{3m^2 g^2}{4\pi^2 \hbar^2}$ |
| (3) $\frac{3m^2 g^2}{2\pi^2 \hbar^2}$ | (4) $\frac{m^2 g^2}{2\pi^2 \hbar^2}$ |

71. The WKB approximation is valid :

- (1) For systems having large mass
- (2) For systems having high energy
- (3) For systems with slowly varying potential
- (4) For systems having large mass, high energy and slowly varying potential

A

72. Which of the following are also called continuous phase transitions ?
- (1) Zeroth-order phase transitions
 - (2) First-order phase transitions
 - (3) Second-order phase transitions
 - (4) Higher than 2nd order phase transitions
73. Choose the *correct* statement about the diamagnetic susceptibility :
- (1) It increases with temperature
 - (2) It decreases with temperature
 - (3) It does not vary with change in temperature
 - (4) It first increases then becomes temperature independent
74. Which among the following is a diamagnetic substance ?
- (1) Copper (2) Iron (3) Gadolinium (4) Palladium
75. What is the value of 1 Bohr magneton ?
- (1) $9.27 \times 10^{-21} \text{ A m}^2$
 - (2) $9.27 \times 10^{-24} \text{ A m}^2$
 - (3) $9.27 \times 10^{-25} \text{ A m}^2$
 - (4) $2.27 \times 10^{-27} \text{ A m}^2$
76. A diamagnetic solid having a relative magnetic permeability of 0.9995 is placed in a magnetic field of strength 10000 A/m. The magnetization so produced in the solid is :
- (1) -5 A/m
 - (2) -10005 A/m
 - (3) -9995 A/m
 - (4) None of the above

77. Which of the following equation represent the diffusion equation in one dimension
(c = concentration, D_x = diffusion coefficient along x) ?

(1) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial^2 c}{\partial x^2}$

(2) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial c}{\partial x}$

(3) $\frac{\partial c}{\partial t} = D_x \frac{\partial^2 c}{\partial x^2}$

(4) $\frac{\partial c}{\partial x} = D_x \frac{\partial^2 c}{\partial t^2}$

78. In the random walk, after N steps, the particle will be roughly :

(1) $\sqrt{N(N-1)}$ steps away from where it started

(2) \sqrt{N} steps away from where it started

(3) $\sqrt{N(2N-1)}$ steps away from where it started

(4) $\sqrt{2N}$ steps away from where it started

79. Which of the following characteristics are *not* desirable for an ideal transducer ?

(1) A high dynamic range

(2) A low linearity

(3) High repeatability

(4) Low noise

80. In the inverting circuit, the op-amp is in :

(1) Saturation region

(2) Linear region

(3) Cut-off region

(4) Non-linear region

A

81. Choose the active filter out of the following :

- (1) Band pass filter
- (2) RC filter
- (3) Butterworth filter
- (4) Notch filter

82. The input impedance of a quarter wave transformer required for matching a load impedance of 100 Ohm to a transmission line having characteristic impedance of 50 Ohm will be :

- (1) 2 Ohm
- (2) 0.5 Ohm
- (3) 200 Ohm
- (4) 25 Ohm

83. Out of the following, choose the 'guarding arm(s)' :

- (1) a parallel RC combination
- (2) a series RC combination
- (3) a parallel LC combination
- (4) all of the above

84. What will be the Fourier Transform of $e^{-\frac{x^2}{2}}$?

- (1) $\frac{1}{2}e^{-\frac{\omega^2}{2}}$
- (2) $\frac{\pi}{2}$
- (3) $\sqrt{\pi}$
- (4) $e^{-\frac{\omega^2}{2}}$

85. At high magnetic field, the splitting of the spectral lines in a spectrum of an atom gets disturbed. This is the case of :

- (1) Anomalous Zeeman effect
- (2) Paschen-back effect
- (3) Inverse Zeeman effect
- (4) Stark effect

86. The electromagnetic spectrum in which nuclear magnetic resonance occurs is :
- (1) Microwave region
 - (2) Radio frequency region
 - (3) Infrared region
 - (4) Ultraviolet region
87. Which of the following is determined using the IR spectroscopy ?
- (1) Molecular formula of a compound
 - (2) Types of bonds in a compound
 - (3) Molecular weight of a compound
 - (4) The number of atoms in a unit-cell of a compound
88. The Raman effect is related to scattering of :
- (1) Atoms (2) Electrons (3) Protons (4) Photons
89. The absorbance corresponding to $\%T = 80$ is :
- (1) 0.087 (2) 0.091 (3) 0.094 (4) 0.097
90. The Q value due to the dielectric loss in a rectangular waveguide having a loss tangent of 0.0004 will be :
- (1) 1250 (2) 2500 (3) 5000 (4) 4000
91. Choose the *correct* option about the experimentally observed Hall voltage of an intrinsic Silicon specimen. :
- (1) Hall voltage will be negative
 - (2) Hall voltage will be positive
 - (3) Hall voltage will be zero
 - (4) Sign of Hall voltage would depend upon the magnitude of the measuring current

A

92. The number of atoms per unit cell in the Diamond crystal structure is :
- (1) 2 (2) 4
(3) 6 (4) 8
93. Which of the following is structure sensitive property of a type-II superconductor ?
- (1) Critical Transition temperature
(2) Upper Critical field
(3) Lower Critical field
(4) Critical Current density
94. The heat capacity C_V of a solid at very low temperature takes the form, given by :
- (1) $C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{T}{\theta}\right)^3$
(2) $C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{T}{\theta}\right)^3$
(3) $C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{\theta}{T}\right)^3$
(4) $C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{\theta}{T}\right)^3$
95. Which one of the following is a Frankel defect ?
- (1) One *Mg* vacancy and one *Mg* Interstitial in *MgO*
(2) One *Zn* vacancy and one oxygen vacancy in *ZnO*
(3) *Na* at potassium site in *KCl*
(4) None of the above

96. In the radioactive transformation, ${}_{15}\text{P}^{30} \rightarrow {}_{14}\text{Si}^{30} + \text{X}$, the emitted particle X is a/an :
- (1) Positron (2) Proton
(3) Electron (4) Neutron
97. The Neutrinos are the particles having following properties :
- (1) Uncharged and Spin-less
(2) Uncharged and have Spin
(3) Charged and Spin-less
(4) Charged and have Spin
98. The Nuclear-fission process is best explained by :
- (1) Liquid-Drop model
(2) Proton-proton model
(3) Quark model
(4) Independent particle model of the nucleus
99. Choose the particle that is *not* made by quarks :
- (1) Positron (2) Proton
(3) Neutron (4) Electron
100. The Nuclear forces are :
- (1) Spin independent
(2) Both charge and spin independent
(3) Spin dependent but charge independent
(4) Charge dependent

Total No. of Printed Pages : 21

(DO NOT OPEN THIS QUESTION BOOKLET BEFORE TIME OR UNTIL YOU ARE ASKED TO DO SO)

B

Ph.D./URS-EE-Jan-2022

SET-Y

SUBJECT : Physics

10002

Sr. No.

Time : 1¼ Hours

Max. Marks : 100

Total Questions : 100

Roll No. (in figures) _____ (in words) _____

Name _____ Father's Name _____

Mother's Name _____ Date of Examination _____

(Signature of the Candidate)

(Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**
2. The candidates **must return** the question booklet as well as OMR Answer-Sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
4. Question Booklet along with answer key of all the A, B, C & D code will be got uploaded on the University website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examination in writing/through E-Mail within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
5. The candidate **must not** do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question booklet itself. Answers **must not** be ticked in the question booklet.
6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
7. Use only **Black** or **Blue Ball Point Pen** of good quality in the OMR Answer-Sheet.
8. **Before answering the questions, the candidates should ensure that they have been supplied correct and complete booklet. Complaints, if any, regarding misprinting etc. will not be entertained 30 minutes after starting of the examination.**

PHD/URS-EE-2022/(Physics)(SET-Y)/(B)

SEAL

1. In the elastic collision between two bodies :
 - (1) both the total momentum and total kinetic energies of the colliding bodies are conserved
 - (2) only the total kinetic energy of the colliding bodies is conserved
 - (3) only the total momentum of the colliding bodies is conserved
 - (4) neither the total momentum nor the total kinetic energies of the colliding bodies are conserved.

2. The circular motion of an object moving with constant speed is an example of :
 - (1) both periodic as well as simple harmonic motions
 - (2) periodic motion only
 - (3) simple harmonic motion only
 - (4) neither periodic nor simple harmonic motion

3. According to Einstein's Special Theory of Relativity, the laws of Physics can be formulated based on :
 - (1) inertial frame of reference only
 - (2) non-inertial frame of reference only
 - (3) both the non-inertial and inertial frame of references
 - (4) quantum state only

4. When number of nucleons in a nuclei increases, then the binding energy per nucleon :
 - (1) initially increases and then decreases with the mass number
 - (2) initially decreases and then increases with the mass number
 - (3) decreases continuously with the mass number
 - (4) increases continuously with mass number

5. The pseudo force concept is valid for :
- (1) the inertial frames
 - (2) the non-inertial frames
 - (3) both the inertial as well as non-inertial frames
 - (4) neither the inertial frames nor the non-inertial frames
6. The Lorentz transformation equations hold for :
- (1) non-relativistic speeds only
 - (2) relativistic speeds only
 - (3) all speeds : relativistic as well as non-relativistic
 - (4) mass-less particles only
7. If λ is the wavelength of electrons (in Å), which have been accelerated from rest through a potential difference of V (in Volts), then the value of product $\lambda\sqrt{V}$ is approximately equal to :
- (1) 13.60
 - (2) 10.16
 - (3) 12.26
 - (4) None of the above
8. For a particle in a one dimensional box, the wave function is given by

$$\Psi(x) = N \sin \frac{3\pi x}{L} \quad 0 < x < L,$$

$$= 0 \quad x < 0 \text{ \& } x > L.$$

The normalization constant N is given by :

- (1) $\sqrt{\frac{1}{L}}$
- (2) $\sqrt{\frac{2}{L}}$
- (3) $\sqrt{\frac{3}{L}}$
- (4) None of the above

B

3

9. For a particle inside a box lying between $x = 0$ and $x = L$, the potential is maximum at $x =$
- (1) L (2) $2L$
(3) $L/2$ (4) $3L$
10. Energy of the 2nd excited state for a simple harmonic oscillator is equal to :
- (1) $(\hbar\omega)$ (2) $(3\hbar\omega/2)$
(3) $(5\hbar\omega/2)$ (4) $(2\hbar\omega)$
11. Choose the *correct* option about the experimentally observed Hall voltage of an intrinsic Silicon specimen. :
- (1) Hall voltage will be negative
(2) Hall voltage will be positive
(3) Hall voltage will be zero
(4) Sign of Hall voltage would depend upon the magnitude of the measuring current
12. The number of atoms per unit cell in the Diamond crystal structure is :
- (1) 2 (2) 4
(3) 6 (4) 8
13. Which of the following is structure sensitive property of a type-II superconductor ?
- (1) Critical Transition temperature
(2) Upper Critical field
(3) Lower Critical field
(4) Critical Current density

14. The heat capacity C_V of a solid at very low temperature takes the form, given by :

$$(1) C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{T}{\theta}\right)^3$$

$$(2) C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{T}{\theta}\right)^3$$

$$(3) C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{\theta}{T}\right)^3$$

$$(4) C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{\theta}{T}\right)^3$$

15. Which one of the following is a Frankel defect ?

(1) One *Mg* vacancy and one *Mg* Interstitial in *MgO*

(2) One *Zn* vacancy and one oxygen vacancy in *ZnO*

(3) *Na* at potassium site in *KCl*

(4) None of the above

16. In the radioactive transformation, ${}_{15}\text{P}^{30} \rightarrow {}_{14}\text{Si}^{30} + \text{X}$, the emitted particle X is a/an :

(1) Positron

(2) Proton

(3) Electron

(4) Neutron

17. The Neutrinos are the particles having following properties :

(1) Uncharged and Spin-less

(2) Uncharged and have Spin

(3) Charged and Spin-less

(4) Charged and have Spin

18. The Nuclear-fission process is best explained by :
- (1) Liquid-Drop model
 - (2) Proton-proton model
 - (3) Quark model
 - (4) Independent particle model of the nucleus
19. Choose the particle that is *not* made by quarks :
- | | |
|--------------|--------------|
| (1) Positron | (2) Proton |
| (3) Neutron | (4) Electron |
20. The Nuclear forces are :
- (1) Spin independent
 - (2) Both charge and spin independent
 - (3) Spin dependent but charge independent
 - (4) Charge dependent
21. The WKB approximation is valid :
- (1) For systems having large mass
 - (2) For systems having high energy
 - (3) For systems with slowly varying potential
 - (4) For systems having large mass, high energy and slowly varying potential
22. Which of the following are also called continuous phase transitions ?
- (1) Zeroth-order phase transitions
 - (2) First-order phase transitions
 - (3) Second-order phase transitions
 - (4) Higher than 2nd order phase transitions

23. Choose the *correct* statement about the diamagnetic susceptibility :
- (1) It increases with temperature
 - (2) It decreases with temperature
 - (3) It does not vary with change in temperature
 - (4) It first increases then becomes temperature independent
24. Which among the following is a diamagnetic substance ?
- (1) Copper (2) Iron (3) Gadolinium (4) Palladium
25. What is the value of 1 Bohr magneton ?
- (1) $9.27 \times 10^{-21} \text{ A m}^2$ (2) $9.27 \times 10^{-24} \text{ A m}^2$
(3) $9.27 \times 10^{-25} \text{ A m}^2$ (4) $2.27 \times 10^{-27} \text{ A m}^2$
26. A diamagnetic solid having a relative magnetic permeability of 0.9995 is placed in a magnetic field of strength 10000 A/m. The magnetization so produced in the solid is :
- (1) -5 A/m (2) -10005 A/m
(3) -9995 A/m (4) None of the above
27. Which of the following equation represent the diffusion equation in one dimension ($c = \text{concentration}$, $D_x = \text{diffusion coefficient along } x$) ?
- (1) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial^2 c}{\partial x^2}$
(2) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial c}{\partial x}$
(3) $\frac{\partial c}{\partial t} = D_x \frac{\partial^2 c}{\partial x^2}$
(4) $\frac{\partial c}{\partial x} = D_x \frac{\partial^2 c}{\partial t^2}$

28. In the random walk, after N steps, the particle will be roughly :
- (1) $\sqrt{N(N-1)}$ steps away from where it started
 - (2) \sqrt{N} steps away from where it started
 - (3) $\sqrt{N(2N-1)}$ steps away from where it started
 - (4) $\sqrt{2N}$ steps away from where it started
29. Which of the following characteristics are **not** desirable for an ideal transducer ?
- (1) A high dynamic range
 - (2) A low linearity
 - (3) High repeatability
 - (4) Low noise
30. In the inverting circuit, the op-amp is in :
- (1) Saturation region
 - (2) Linear region
 - (3) Cut-off region
 - (4) Non-linear region
31. The applications of Green's theorem are meant to be in :
- | | |
|---------------------|----------------------|
| (1) one-dimension | (2) two-dimension |
| (3) three-dimension | (4) all of the above |
32. A partial differential equation has :
- (1) only one independent variable
 - (2) two or more independent variables
 - (3) more than one dependent variables
 - (4) equal number of dependent and independent variables

33. Interpolation is a method of :
- (1) Interrelating
(2) Estimating
(3) Integrating
(4) Combining
34. Which one of the following quantities is *not* a second order tensor ?
- (1) Stress
(2) Strain
(3) Pressure
(4) Moment of Inertia
35. Which of the following is a Laplace equation ?
- (1) $\nabla V = 0$
(2) $\nabla^2 V = -\rho/\epsilon_0$
(3) $\nabla \cdot J = - (d\rho/dt)$
(4) $\nabla^2 V = 0$
36. The Runge-Kutta method is used to solve :
- (1) Ordinary differential equations of n^{th} order
(2) Linear differential equations
(3) Simultaneous non-linear equations
(4) None of these
37. Which of the following is *true* about trapezoidal rule ?
- (1) It is exact for polynomials of degree ≤ 1
(2) It is exact for polynomials of order 2 only
(3) It is exact for polynomials of degree ≥ 1
(4) It is exact for polynomials of degree 2 only
38. A group $(M, *)$ is said to be an abelian if :
- (1) $(x + y) = (y + x)$
(2) $(x + y) = -(y + x)$
(3) $(x * y) = (y * x)$
(4) $(x * y) = -(y * x)$

B

39. Which of the following systems is said to be a dynamical system ?
- (1) $y(n) = 6x(n) + 7$
 - (2) $y(n) = 2x(n) + 3x(n - 1) + 5$
 - (3) $y(n) = 4x(n) + 3x^2(n) + 3$
 - (4) $y(n) = 5x(n) + 6x^2(n) + 6x^3(n) + 8$
40. The asymptotic stability is associated with a system which is :
- (1) under the influence of input
 - (2) not under the influence of input
 - (3) under influence of output
 - (4) not under the influence of output
41. The magnetic susceptibility of a paramagnetic substance is :
- (1) Negative and temperature-dependent
 - (2) Negative and temperature-independent
 - (3) Positive and temperature-dependent
 - (4) Positive and temperature-independent
42. An unpolarized light having intensity I_0 falls over a polaroid. The intensity of the transmitted light will be :
- (1) $I_0/2$
 - (2) $I_0/4$
 - (3) I_0
 - (4) Zero
43. Clausius Mossotti equation is an equation which relates :
- (1) Dielectric constant and atomic polarizability in a polar molecule
 - (2) Dielectric constant and atomic polarizability in a non-polar molecule
 - (3) Dielectric constant and polarization in a polar molecule
 - (4) Dielectric constant and polarization in a non-polar molecule

44. The Gibb's potential is defined as :

(1) $G = U + pV + TS$

(3) $G = U + pV - TS$

(2) $G = U - pV + TS$

(4) $G = U - pV - TS$

45. The Helmholtz free energy is given by $F = U - TS$. Then C_V will be given by :

(1) $C_V = T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$

(3) $C_V = -T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$

(2) $C_V = T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$

(4) $C_V = -T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$

46. Choose the option that is the best description about the chemical potential of a thermodynamical system :

(1) It is an extensive property only

(2) It is an intensive property only

(3) It is a force that drives the system to equilibrium

(4) It is an intensive property and can be regarded as a force that drives the system to equilibrium

47. The classical partition function Z of a system tells us about :

(1) The sum of all the states of the system

(2) The sum of the energy of the system

(3) The sum of the momentum of the system

(4) All of the above

48. A phase space is a :

(1) 2-Dimensional Space

(3) 4-Dimensional Space

(2) 3-Dimensional Space

(4) 6-Dimensional Space

49. Mass of a gas 'A' is 9 times that of gas 'B'. The ratio of their mean velocities will be :
- (1) 9 : 1
(2) 1 : 9
(3) 1 : 3
(4) 3 : 1
50. Which of the following statistics can be used to describe the behavior of photons ?
- (1) Maxwell-Boltzmann statistics
(2) Fermi-Dirac statistics
(3) Bose-Einstein statistics
(4) By both Maxwell-Boltzmann statistics as well as Bose-Einstein statistics
51. The function representing matter waves :
- (1) can only be complex
(2) can only be a real
(3) can be either complex or real
(4) must be a Dirac-delta function
52. Which of the following transitions in a hydrogen atom emits the photon of the lowest frequency ?
- (1) $n = 2$ to $n = 1$
(2) $n = 3$ to $n = 1$
(3) $n = 4$ to $n = 2$
(4) $n = 4$ to $n = 3$
53. If an object, which is rotating about a fixed point P, has a kinetic energy E and angular momentum L, then :
- (1) $L \propto E^2$
(2) $L \propto E$
(3) $L \propto E^{-1}$
(4) $L \propto E^{1/2}$

54. Which of the following experiments first detected the spin of an electron ?

- (1) Davison and Germer experiment
- (2) Stern and Gerlach experiment
- (3) Zeeman Effect
- (4) Frank and Hertz experiment

55. A charge 'q' is enclosed by a Gaussian spherical surface of radius 'R'. If the radius is increased to '3R', then the outward electric flux will :

- (1) remain unchanged
- (2) increase by a factor of 3
- (3) decrease by a factor of 9
- (4) increase by a factor of 9

56. The Poisson equation for electric potential V for an isotropic and homogeneous medium having charge density ρ and dielectric constant ϵ is given by :

- (1) $\nabla^2 V = -\frac{\rho}{\epsilon}$
- (2) $\nabla^2 V = \frac{\rho}{\epsilon}$
- (3) $\nabla \cdot V = -\frac{\rho}{\epsilon}$
- (4) $\nabla \cdot V = \frac{\rho}{\epsilon}$

57. A long wire carrying a current produces a magnetic field of strength 0.8 T at a distance of 0.5 cm from it. The magnetic field at a distance of 2 cm from the wire will be :

- (1) 0.40 T
- (2) 0.20 T
- (3) 0.16 T
- (4) 0.10 T

58. What is the nature of light ?

- (1) Matter
- (2) Wave like
- (3) Particle like
- (4) Dual

59. In the Fleming's left-hand rule, the middle finger points in the direction of :

- (1) Current in the wire conductor
- (2) Magnetic field
- (3) Force on the wire conductor
- (4) Length of the wire conductor

60. If the magnetic flux linked with a coil is given to be $\phi = 5t^2 + 2t + 3$, then the magnitude of emf induced in the coil at 4 sec will be :
- (1) 42 V (2) 91 V
(3) 20.2 V (4) None of the above
61. Choose the **correct** option about energy distribution in the black body spectrum :
- (1) As the wavelength increases, the energy emitted also increases
(2) As temperature of the black body increases, the energy associated with the radiation of a specific wavelength increases
(3) As temperature of the black body increases, the intensity of its radiation also increases
(4) All of the above options are correct
62. If error in the measurement of radius of a spherical ball is 2%, then the error in the calculated value of the surface area of the ball will be :
- (1) 2% (2) 4% (3) 6% (4) 8%
63. Five measurements are performed at different time to measure the length of a rod. The readings (in some units) are 101, 102, 98, 99 and 100. The precision of 4th measurement will be :
- (1) 0.01 (2) 0.90 (3) 0.10 (4) 0.99
64. Choose the technology which was used by Intel for designing its first 8-bit microprocessor ?
- (1) HMOS (2) NMOS (3) PMOS (4) TTL
65. The Schmitt trigger circuit is a modification of one of the following multivibrators. Choose the **correct** option :
- (1) Astable multivibrator (2) Bistable multivibrator
(3) Universal multivibrator (4) Monostable multivibrator

66. The electrical characteristics, which is *not* exhibited by an ideal op-amp, is :
- (1) Infinite bandwidth
(2) Infinite voltage gain
(3) Infinite slew rate
(4) Infinite output resistance
67. How many flip-flops are required to construct an 8-bit Shift register ?
- (1) 8
(2) 16
(3) 4
(4) 2
68. Which of the following diodes exhibits negative resistance in its characteristics ?
- (1) Tunnel diode
(2) Schottky diode
(3) Varactor diode
(4) Zener diode
69. If a voltmeter is connected across the forward-biased Si-diode, it will read a voltage which would approximately be equal to :
- (1) Bias battery voltage
(2) Zero V
(3) Diode barrier potential
(4) 1.1 V
70. Find the value of the current limiting resistor required for connecting three LEDs (rating 3V and 3 mA) in series with a 15 volt DC source.
- (1) 1 kohm
(2) 2 kohm
(3) 3 kohm
(4) 5 kohm
71. The Poisson bracket $\{x, xp_x - yp_y + ax^2 + by^2\}$, where a and b are constants, is equal to :
- (1) x
(2) y
(3) p_x
(4) p_y

72. The Jacobi's method is also known as :

- (1) Displacement method
- (2) Simultaneous displacement method
- (3) Simultaneous method
- (4) Diagonal method

73. Suppose P, Q and R be functions of phase space variables (coordinates and momenta of a mechanical system). If $\{ , \}$ represents the Poisson bracket, then the value of $\{P, \{Q, R\}\} - \{\{P, Q\}, R\}$ will be :

- | | |
|-----------------------|-----------------------|
| (1) 0 | (2) $\{Q, \{R, P\}\}$ |
| (3) $\{P, \{R, Q\}\}$ | (4) $\{\{R, P\}, Q\}$ |

74. Choose the *correct* statement about group velocity in a dispersive medium :

- (1) Group velocity is less than the phase velocity only
- (2) Group velocity is more than the phase velocity
- (3) Group velocity is equal to the phase velocity only
- (4) Group velocity can be both more than or less than the phase velocity depending upon the nature of dispersive medium

75. Wave guide can be regarded as :

- (1) Low-pass filter
- (2) High-pass filter
- (3) Band-pass filter
- (4) Both low pass as well as high-pass filter

76. If for a transmission line, $\frac{L}{C} = \frac{R}{G}$, then which one of the following would be correct ?
- (1) The transmission line will be loss-less
 - (2) The transmission is called as distortion-less
 - (3) $Z_0^2 = \frac{R}{G}$
 - (4) The attenuation constant will be imaginary
77. The reason why Northern Lights only occur in the North and Southern Lights occur in South is :
- (1) Charged particles from the Sun follow the axis of rotation of the Earth
 - (2) Charged particles from the Sun deviate from the electric field lines near the poles
 - (3) Charged particles from the Sun penetrate the Earth's magnetic field near the poles
 - (4) Charged particles from the Sun are trapped in the Earth's magnetic field near the poles
78. Which auxiliary function is useful in solving the radiation problem involving evaluation of the E & H fields from the sources J & M ?
- (1) Scalar potentials
 - (2) Vector potentials
 - (3) Divergence potentials
 - (4) Gradient potentials
79. To properly account for the fine structure of the spectrum of hydrogen atom one must consider :
- (1) Spin angular momentum
 - (2) Orbital angular momentum
 - (3) Principal quantum number n
 - (4) Coulomb potential of the hydrogen-nuclei

80. Consider a particle of mass m is scattered by a potential $V(r) = g\delta^3(r)$. The differential cross-section as per Born Approximation will be :

- (1) $\frac{m^2 g^2}{4\pi^2 \hbar^2}$ (2) $\frac{3m^2 g^2}{4\pi^2 \hbar^2}$
 (3) $\frac{3m^2 g^2}{2\pi^2 \hbar^2}$ (4) $\frac{m^2 g^2}{2\pi^2 \hbar^2}$

81. If 'm' is the mean of a Poisson distribution, then the standard deviation is given by :

- (1) \sqrt{m} (2) m^2 (3) m (4) $m/2$

82. One of the eigen values for the following 2×2 matrix, $\begin{bmatrix} 1 & 8 \\ 2 & 1 \end{bmatrix}$, is :

- (1) 4 (2) 5 (3) 6 (4) 8

83. If $f(x) = 1$, then its Laplace Transform $F(y)$ is given by :

- (1) Does not exist (2) y
 (3) $1/y$ (4) 1

84. Let $u = \sin y + i \cos 2y$ and $v = \cos y - i \sin 2y$. Then for what values of y , the u and v will be conjugate of each other ?

- (1) $n\pi$ (2) $(n+1/2)\pi$
 (3) 0 (4) no value of y

85. The divergence of the vector function $F = (x^3y)i + (3xy^2z)j + (3zx)k$ is :

- (1) $3x^2y + 3y^2z + 3z$
 (2) $x^3 + 6xyz$
 (3) $3xy^2 + 3x$
 (4) $3x^2y + 6xyz + 3x$

P. T. O.

86. The first two terms of the Taylor series about $a = 3$ for the function $f(x) = 2x + 5$ will be :
- (1) $11 - 2(x - 3)$
 - (2) $11 + 2(x - 3)$
 - (3) $11 - 7(x - 3)$
 - (4) $11 + 7(x - 3)$
87. When we throw a dice then what is the probability of getting the number greater than 5 ?
- (1) $1/3$
 - (2) $1/5$
 - (3) $1/6$
 - (4) $1/2$
88. The dimensional formula of viscosity is :
- (1) $ML^{-1}T^{-1}$
 - (2) MLT^{-1}
 - (3) MLT^{-2}
 - (4) $ML^{-1}T^{-2}$
89. A geostationary satellite is :
- (1) whose time period is same as that of Earth
 - (2) whose magnitude of the speed v is same as that of Earth, but have different time period
 - (3) whose time period and speed v both are same as that of Earth
 - (4) none of the above
90. The stability of a system means that :
- (1) Small changes in the system input do not result in large change in output conditions of the system
 - (2) Small changes in the system parameters do not result in large change in output conditions of the system
 - (3) Small changes in the initial conditions do not result in large change in output conditions of the system
 - (4) All of the above

91. Choose the active filter out of the following :

- (1) Band pass filter
- (2) RC filter
- (3) Butterworth filter
- (4) Notch filter

92. The input impedance of a quarter wave transformer required for matching a load impedance of 100 Ohm to a transmission line having characteristic impedance of 50 Ohm will be :

- | | |
|-------------|-------------|
| (1) 2 Ohm | (2) 0.5 Ohm |
| (3) 200 Ohm | (4) 25 Ohm |

93. Out of the following, choose the 'guarding arm(s)' :

- (1) a parallel RC combination
- (2) a series RC combination
- (3) a parallel LC combination
- (4) all of the above

94. What will be the Fourier Transform of $e^{-\frac{x^2}{2}}$?

- | | |
|---|-------------------------------|
| (1) $\frac{1}{2} e^{-\frac{\omega^2}{2}}$ | (2) $\frac{\pi}{2}$ |
| (3) $\sqrt{\pi}$ | (4) $e^{-\frac{\omega^2}{2}}$ |

95. At high magnetic field, the splitting of the spectral lines in a spectrum of an atom gets disturbed. This is the case of :

- (1) Anomalous Zeeman effect
- (2) Paschen-back effect
- (3) Inverse Zeeman effect
- (4) Stark effect

96. The electromagnetic spectrum in which nuclear magnetic resonance occurs is :
- (1) Microwave region
 - (2) Radio frequency region
 - (3) Infrared region
 - (4) Ultraviolet region
97. Which of the following is determined using the IR spectroscopy ?
- (1) Molecular formula of a compound
 - (2) Types of bonds in a compound
 - (3) Molecular weight of a compound
 - (4) The number of atoms in a unit-cell of a compound
98. The Raman effect is related to scattering of :
- (1) Atoms
 - (2) Electrons
 - (3) Protons
 - (4) Photons
99. The absorbance corresponding to $\%T = 80$ is :
- (1) 0.087
 - (2) 0.091
 - (3) 0.094
 - (4) 0.097
100. The Q value due to the dielectric loss in a rectangular waveguide having a loss tangent of 0.0004 will be :
- (1) 1250
 - (2) 2500
 - (3) 5000
 - (4) 4000

Total No. of Printed Pages : 21

(DO NOT OPEN THIS QUESTION BOOKLET BEFORE TIME OR UNTIL YOU ARE ASKED TO DO SO)

C

Ph.D./URS-EE-Jan-2022

SET-Y

SUBJECT : Physics

10007

Sr. No.

Time : 1¼ Hours

Max. Marks : 100

Total Questions : 100

Roll No. (in figures) _____ (in words) _____

Name _____ Father's Name _____

Mother's Name _____ Date of Examination _____

(Signature of the Candidate)

(Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**
2. The candidates **must return** the question booklet as well as OMR Answer-Sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
4. Question Booklet along with answer key of all the A, B, C & D code will be got uploaded on the University website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examination in writing/through E.Mail within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
5. The candidate **must not** do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question booklet itself. Answers **must not** be ticked in the question booklet.
6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
7. Use only **Black or Blue Ball Point Pen** of good quality in the OMR Answer-Sheet.
8. *Before answering the questions, the candidates should ensure that they have been supplied correct and complete booklet. Complaints, if any, regarding misprinting etc. will not be entertained 30 minutes after starting of the examination.*

PHD/URS-EE-2022/(Physics)(SET-Y)/(C)

SEAL

1. Choose the *correct* option about energy distribution in the black body spectrum :
 - (1) As the wavelength increases, the energy emitted also increases
 - (2) As temperature of the black body increases, the energy associated with the radiation of a specific wavelength increases
 - (3) As temperature of the black body increases, the intensity of its radiation also increases
 - (4) All of the above options are correct

2. If error in the measurement of radius of a spherical ball is 2%, then the error in the calculated value of the surface area of the ball will be :
 - (1) 2%
 - (2) 4%
 - (3) 6%
 - (4) 8%

3. Five measurements are performed at different time to measure the length of a rod. The readings (in some units) are 101, 102, 98, 99 and 100. The precision of 4th measurement will be :
 - (1) 0.01
 - (2) 0.90
 - (3) 0.10
 - (4) 0.99

4. Choose the technology which was used by Intel for designing its first 8-bit microprocessor ?
 - (1) HMOS
 - (2) NMOS
 - (3) PMOS
 - (4) TTL

5. The Schmitt trigger circuit is a modification of one of the following multivibrators. Choose the *correct* option :
 - (1) Astable multivibrator
 - (2) Bistable multivibrator
 - (3) Universal multivibrator
 - (4) Monostable multivibrator

6. The electrical characteristics, which is *not* exhibited by an ideal op-amp, is :
 - (1) Infinite bandwidth
 - (2) Infinite voltage gain
 - (3) Infinite slew rate
 - (4) Infinite output resistance

7. How many flip-flops are required to construct an 8-bit Shift register ?
(1) 8 (2) 16 (3) 4 (4) 2
8. Which of the following diodes exhibits negative resistance in its characteristics ?
(1) Tunnel diode (2) Schottky diode
(3) Varactor diode (4) Zener diode
9. If a voltmeter is connected across the forward-biased Si-diode, it will read a voltage which would approximately be equal to :
(1) Bias battery voltage
(2) Zero V
(3) Diode barrier potential
(4) 1.1 V
10. Find the value of the current limiting resistor required for connecting three LEDs (rating 3V and 3 mA) in series with a 15 volt DC source.
(1) 1 kohm (2) 2 kohm (3) 3 kohm (4) 5 kohm
11. The function representing matter waves :
(1) can only be complex
(2) can only be a real
(3) can be either complex or real
(4) must be a Dirac-delta function
12. Which of the following transitions in a hydrogen atom emits the photon of the lowest frequency ?
(1) $n = 2$ to $n = 1$ (2) $n = 3$ to $n = 1$
(3) $n = 4$ to $n = 2$ (4) $n = 4$ to $n = 3$

13. If an object, which is rotating about a fixed point P, has a kinetic energy E and angular momentum L, then :
- (1) $L \propto E^2$ (2) $L \propto E$
(3) $L \propto E^{-1}$ (4) $L \propto E^{1/2}$
14. Which of the following experiments first detected the spin of an electron ?
- (1) Davison and Germer experiment
(2) Stern and Gerlach experiment
(3) Zeeman Effect
(4) Frank and Hertz experiment
15. A charge 'q' is enclosed by a Gaussian spherical surface of radius 'R'. If the radius is increased to '3R', then the outward electric flux will :
- (1) remain unchanged
(2) increase by a factor of 3
(3) decrease by a factor of 9
(4) increase by a factor of 9
16. The Poisson equation for electric potential V for an isotropic and homogeneous medium having charge density ρ and dielectric constant ϵ is given by :
- (1) $\nabla^2 V = -\frac{\rho}{\epsilon}$ (2) $\nabla^2 V = \frac{\rho}{\epsilon}$
(3) $\nabla \cdot V = -\frac{\rho}{\epsilon}$ (4) $\nabla \cdot V = \frac{\rho}{\epsilon}$
17. A long wire carrying a current produces a magnetic field of strength 0.8 T at a distance of 0.5 cm from it. The magnetic field at a distance of 2 cm from the wire will be :
- (1) 0.40 T (2) 0.20 T (3) 0.16 T (4) 0.10 T

18. What is the nature of light ?
(1) Matter (2) Wave like (3) Particle like (4) Dual
19. In the Fleming's left-hand rule, the middle finger points in the direction of :
(1) Current in the wire conductor
(2) Magnetic field
(3) Force on the wire conductor
(4) Length of the wire conductor
20. If the magnetic flux linked with a coil is given to be $\phi = 5t^2 + 2t + 3$, then the magnitude of emf induced in the coil at 4 sec will be :
(1) 42 V (2) 91 V
(3) 20.2 V (4) None of the above
21. If 'm' is the mean of a Poisson distribution, then the standard deviation is given by :
(1) \sqrt{m} (2) m^2 (3) m (4) $m/2$
22. One of the eigen values for the following 2×2 matrix, $\begin{bmatrix} 1 & 8 \\ 2 & 1 \end{bmatrix}$, is :
(1) 4 (2) 5 (3) 6 (4) 8
23. If $f(x) = 1$, then its Laplace Transform $F(y)$ is given by :
(1) Does not exist (2) y
(3) $1/y$ (4) 1
24. Let $u = \sin y + i \cos 2y$ and $v = \cos y - i \sin 2y$. Then for what values of y, the u and v will be conjugate of each other ?
(1) $n\pi$ (2) $(n+1/2)\pi$ (3) 0 (4) no value of y

25. The divergence of the vector function $F = (x^3y)i + (3xy^2z)j + (3zx)k$ is :
- (1) $3x^2y + 3y^2z + 3z$
(2) $x^3 + 6xyz$
(3) $3xy^2 + 3x$
(4) $3x^2y + 6xyz + 3x$
26. The first two terms of the Taylor series about $a = 3$ for the function $f(x) = 2x + 5$ will be :
- (1) $11 - 2(x - 3)$
(2) $11 + 2(x - 3)$
(3) $11 - 7(x - 3)$
(4) $11 + 7(x - 3)$
27. When we throw a dice then what is the probability of getting the number greater than 5 ?
- (1) $1/3$ (2) $1/5$ (3) $1/6$ (4) $1/2$
28. The dimensional formula of viscosity is :
- (1) $ML^{-1}T^{-1}$ (2) MLT^{-1} (3) MLT^{-2} (4) $ML^{-1}T^{-2}$
29. A geostationary satellite is :
- (1) whose time period is same as that of Earth
(2) whose magnitude of the speed v is same as that of Earth, but have different time period
(3) whose time period and speed v both are same as that of Earth
(4) none of the above

30. The stability of a system means that :
- (1) Small changes in the system input do not result in large change in output conditions of the system
 - (2) Small changes in the system parameters do not result in large change in output conditions of the system
 - (3) Small changes in the initial conditions do not result in large change in output conditions of the system
 - (4) All of the above
31. Choose the *correct* option about the experimentally observed Hall voltage of an intrinsic Silicon specimen. :
- (1) Hall voltage will be negative
 - (2) Hall voltage will be positive
 - (3) Hall voltage will be zero
 - (4) Sign of Hall voltage would depend upon the magnitude of the measuring current
32. The number of atoms per unit cell in the Diamond crystal structure is :
- | | |
|-------|-------|
| (1) 2 | (2) 4 |
| (3) 6 | (4) 8 |
33. Which of the following is structure sensitive property of a type-II superconductor ?
- (1) Critical Transition temperature
 - (2) Upper Critical field
 - (3) Lower Critical field
 - (4) Critical Current density

34. The heat capacity C_V of a solid at very low temperature takes the form, given by :

$$(1) C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{T}{\theta}\right)^3$$

$$(2) C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{T}{\theta}\right)^3$$

$$(3) C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{\theta}{T}\right)^3$$

$$(4) C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{\theta}{T}\right)^3$$

35. Which one of the following is a Frankel defect ?

- (1) One *Mg* vacancy and one *Mg* Interstitial in *MgO*
- (2) One *Zn* vacancy and one oxygen vacancy in *ZnO*
- (3) *Na* at potassium site in *KCl*
- (4) None of the above

36. In the radioactive transformation, ${}_{15}\text{P}^{30} \rightarrow {}_{14}\text{Si}^{30} + \text{X}$, the emitted particle X is a/an :

- | | |
|--------------|-------------|
| (1) Positron | (2) Proton |
| (3) Electron | (4) Neutron |

37. The Neutrinos are the particles having following properties :

- (1) Uncharged and Spin-less
- (2) Uncharged and have Spin
- (3) Charged and Spin-less
- (4) Charged and have Spin

38. The Nuclear-fission process is best explained by :
- (1) Liquid-Drop model
 - (2) Proton-proton model
 - (3) Quark model
 - (4) Independent particle model of the nucleus
39. Choose the particle that is *not* made by quarks :
- (1) Positron (2) Proton (3) Neutron (4) Electron
40. The Nuclear forces are :
- (1) Spin independent
 - (2) Both charge and spin independent
 - (3) Spin dependent but charge independent
 - (4) Charge dependent
41. The Poisson bracket $\{x, xp_x - yp_y + ax^2 + by^2\}$, where a and b are constants, is equal to :
- (1) x (2) y (3) p_x (4) p_y
42. The Jacobi's method is also known as :
- (1) Displacement method
 - (2) Simultaneous displacement method
 - (3) Simultaneous method
 - (4) Diagonal method
43. Suppose P, Q and R be functions of phase space variables (coordinates and momenta of a mechanical system). If $\{ , \}$ represents the Poisson bracket, then the value of $\{P, \{Q, R\}\} - \{\{P, Q\}, R\}$ will be :
- (1) 0 (2) $\{Q, \{R, P\}\}$ (3) $\{P, \{R, Q\}\}$ (4) $\{\{R, P\}, Q\}$

C

44. Choose the *correct* statement about group velocity in a dispersive medium :
- (1) Group velocity is less than the phase velocity only
 - (2) Group velocity is more than the phase velocity
 - (3) Group velocity is equal to the phase velocity only
 - (4) Group velocity can be both more than or less than the phase velocity depending upon the nature of dispersive medium
45. Wave guide can be regarded as :
- (1) Low-pass filter
 - (2) High-pass filter
 - (3) Band-pass filter
 - (4) Both low pass as well as high-pass filter
46. If for a transmission line, $\frac{L}{C} = \frac{R}{G}$, then which one of the following would be *correct* ?
- (1) The transmission line will be loss-less
 - (2) The transmission is called as distortion-less
 - (3) $Z_0^2 = \frac{R}{G}$
 - (4) The attenuation constant will be imaginary
47. The reason why Northern Lights only occur in the North and Southern Lights occur in South is :
- (1) Charged particles from the Sun follow the axis of rotation of the Earth
 - (2) Charged particles from the Sun deviate from the electric field lines near the poles
 - (3) Charged particles from the Sun penetrate the Earth's magnetic field near the poles
 - (4) Charged particles from the Sun are trapped in the Earth's magnetic field near the poles

48. Which auxiliary function is useful in solving the radiation problem involving evaluation of the E & H fields from the sources J & M ?
- (1) Scalar potentials
 - (2) Vector potentials
 - (3) Divergence potentials
 - (4) Gradient potentials
49. To properly account for the fine structure of the spectrum of hydrogen atom one must consider :
- (1) Spin angular momentum
 - (2) Orbital angular momentum
 - (3) Principal quantum number n
 - (4) Coulomb potential of the hydrogen-nuclei
50. Consider a particle of mass m is scattered by a potential $V(r) = g\delta^3(r)$. The differential cross-section as per Born Approximation will be :
- | | |
|---------------------------------------|---------------------------------------|
| (1) $\frac{m^2 g^2}{4\pi^2 \hbar^2}$ | (2) $\frac{3m^2 g^2}{4\pi^2 \hbar^2}$ |
| (3) $\frac{3m^2 g^2}{2\pi^2 \hbar^2}$ | (4) $\frac{m^2 g^2}{2\pi^2 \hbar^2}$ |
51. The magnetic susceptibility of a paramagnetic substance is :
- (1) Negative and temperature-dependent
 - (2) Negative and temperature-independent
 - (3) Positive and temperature-dependent
 - (4) Positive and temperature-independent

52. An unpolarized light having intensity I_0 falls over a polaroid. The intensity of the transmitted light will be :
- (1) $I_0/2$ (2) $I_0/4$ (3) I_0 (4) Zero
53. Clausius Mossotti equation is an equation which relates :
- (1) Dielectric constant and atomic polarizability in a polar molecule
(2) Dielectric constant and atomic polarizability in a non-polar molecule
(3) Dielectric constant and polarization in a polar molecule
(4) Dielectric constant and polarization in a non-polar molecule
54. The Gibb's potential is defined as :
- (1) $G = U + pV + TS$ (2) $G = U - pV + TS$
(3) $G = U + pV - TS$ (4) $G = U - pV - TS$
55. The Helmholtz free energy is given by $F = U - TS$. Then C_V will be given by :
- (1) $C_V = T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$ (2) $C_V = T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$
(3) $C_V = -T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$ (4) $C_V = -T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$
56. Choose the option that is the best description about the chemical potential of a thermodynamical system :
- (1) It is an extensive property only
(2) It is an intensive property only
(3) It is a force that drives the system to equilibrium
(4) It is an intensive property and can be regarded as a force that drives the system to equilibrium

57. The classical partition function Z of a system tells us about :
- (1) The sum of all the states of the system
 - (2) The sum of the energy of the system
 - (3) The sum of the momentum of the system
 - (4) All of the above
58. A phase space is a :
- | | |
|-------------------------|-------------------------|
| (1) 2-Dimensional Space | (2) 3-Dimensional Space |
| (3) 4-Dimensional Space | (4) 6-Dimensional Space |
59. Mass of a gas 'A' is 9 times that of gas 'B'. The ratio of their mean velocities will be :
- | | | | |
|-----------|-----------|-----------|-----------|
| (1) 9 : 1 | (2) 1 : 9 | (3) 1 : 3 | (4) 3 : 1 |
|-----------|-----------|-----------|-----------|
60. Which of the following statistics can be used to describe the behavior of photons ?
- (1) Maxwell-Boltzmann statistics
 - (2) Fermi-Dirac statistics
 - (3) Bose-Einstein statistics
 - (4) By both Maxwell-Boltzmann statistics as well as Bose-Einstein statistics
61. The WKB approximation is valid :
- (1) For systems having large mass
 - (2) For systems having high energy
 - (3) For systems with slowly varying potential
 - (4) For systems having large mass, high energy and slowly varying potential

62. Which of the following are also called continuous phase transitions ?
- (1) Zeroth-order phase transitions
 - (2) First-order phase transitions
 - (3) Second-order phase transitions
 - (4) Higher than 2nd order phase transitions
63. Choose the *correct* statement about the diamagnetic susceptibility :
- (1) It increases with temperature
 - (2) It decreases with temperature
 - (3) It does not vary with change in temperature
 - (4) It first increases then becomes temperature independent
64. Which among the following is a diamagnetic substance ?
- (1) Copper (2) Iron (3) Gadolinium (4) Palladium
65. What is the value of 1 Bohr magneton ?
- (1) $9.27 \times 10^{-21} \text{ A m}^2$
 - (2) $9.27 \times 10^{-24} \text{ A m}^2$
 - (3) $9.27 \times 10^{-25} \text{ A m}^2$
 - (4) $2.27 \times 10^{-27} \text{ A m}^2$
66. A diamagnetic solid having a relative magnetic permeability of 0.9995 is placed in a magnetic field of strength 10000 A/m. The magnetization so produced in the solid is :
- (1) -5 A/m
 - (2) -10005 A/m
 - (3) -9995 A/m
 - (4) None of the above

67. Which of the following equation represent the diffusion equation in one dimension (c = concentration, D_x = diffusion coefficient along x) ?

(1) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial^2 c}{\partial x^2}$

(2) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial c}{\partial x}$

(3) $\frac{\partial c}{\partial t} = D_x \frac{\partial^2 c}{\partial x^2}$

(4) $\frac{\partial c}{\partial x} = D_x \frac{\partial^2 c}{\partial t^2}$

68. In the random walk, after N steps, the particle will be roughly :

(1) $\sqrt{N(N-1)}$ steps away from where it started

(2) \sqrt{N} steps away from where it started

(3) $\sqrt{N(2N-1)}$ steps away from where it started

(4) $\sqrt{2N}$ steps away from where it started

69. Which of the following characteristics are *not* desirable for an ideal transducer ?

(1) A high dynamic range

(2) A low linearity

(3) High repeatability

(4) Low noise

70. In the inverting circuit, the op-amp is in :

(1) Saturation region

(2) Linear region

(3) Cut-off region

(4) Non-linear region

71. Choose the active filter out of the following :
- (1) Band pass filter
 - (2) RC filter
 - (3) Butterworth filter
 - (4) Notch filter
72. The input impedance of a quarter wave transformer required for matching a load impedance of 100 Ohm to a transmission line having characteristic impedance of 50 Ohm will be :
- (1) 2 Ohm
 - (2) 0.5 Ohm
 - (3) 200 Ohm
 - (4) 25 Ohm
73. Out of the following, choose the 'guarding arm(s)' :
- (1) a parallel RC combination
 - (2) a series RC combination
 - (3) a parallel LC combination
 - (4) all of the above
74. What will be the Fourier Transform of $e^{-\frac{x^2}{2}}$?
- (1) $\frac{1}{2}e^{-\frac{\omega^2}{2}}$
 - (2) $\frac{\pi}{2}$
 - (3) $\sqrt{\pi}$
 - (4) $e^{-\frac{\omega^2}{2}}$
75. At high magnetic field, the splitting of the spectral lines in a spectrum of an atom gets disturbed. This is the case of :
- (1) Anomalous Zeeman effect
 - (2) Paschen-back effect
 - (3) Inverse Zeeman effect
 - (4) Stark effect

76. The electromagnetic spectrum in which nuclear magnetic resonance occurs is :
- (1) Microwave region
 - (2) Radio frequency region
 - (3) Infrared region
 - (4) Ultraviolet region
77. Which of the following is determined using the IR spectroscopy ?
- (1) Molecular formula of a compound
 - (2) Types of bonds in a compound
 - (3) Molecular weight of a compound
 - (4) The number of atoms in a unit-cell of a compound
78. The Raman effect is related to scattering of :
- (1) Atoms
 - (2) Electrons
 - (3) Protons
 - (4) Photons
79. The absorbance corresponding to $\%T = 80$ is :
- (1) 0.087
 - (2) 0.091
 - (3) 0.094
 - (4) 0.097
80. The Q value due to the dielectric loss in a rectangular waveguide having a loss tangent of 0.0004 will be :
- (1) 1250
 - (2) 2500
 - (3) 5000
 - (4) 4000
81. In the elastic collision between two bodies :
- (1) both the total momentum and total kinetic energies of the colliding bodies are conserved
 - (2) only the total kinetic energy of the colliding bodies is conserved
 - (3) only the total momentum of the colliding bodies is conserved
 - (4) neither the total momentum nor the total kinetic energies of the colliding bodies are conserved.

82. The circular motion of an object moving with constant speed is an example of :
- (1) both periodic as well as simple harmonic motions
 - (2) periodic motion only
 - (3) simple harmonic motion only
 - (4) neither periodic nor simple harmonic motion
83. According to Einstein's Special Theory of Relativity, the laws of Physics can be formulated based on :
- (1) inertial frame of reference only
 - (2) non-inertial frame of reference only
 - (3) both the non-inertial and inertial frame of references
 - (4) quantum state only
84. When number of nucleons in a nuclei increases, then the binding energy per nucleon :
- (1) initially increases and then decreases with the mass number
 - (2) initially decreases and then increases with the mass number
 - (3) decreases continuously with the mass number
 - (4) increases continuously with mass number
85. The pseudo force concept is valid for :
- (1) the inertial frames
 - (2) the non-inertial frames
 - (3) both the inertial as well as non-inertial frames
 - (4) neither the inertial frames nor the non-inertial frames

86. The Lorentz transformation equations hold for :

- (1) non-relativistic speeds only
- (2) relativistic speeds only
- (3) all speeds : relativistic as well as non-relativistic
- (4) mass-less particles only

87. If λ is the wavelength of electrons (in \AA), which have been accelerated from rest through a potential difference of V (in Volts), then the value of product $\lambda\sqrt{V}$ is approximately equal to :

- (1) 13.60
- (2) 10.16
- (3) 12.26
- (4) None of the above

88. For a particle in a one dimensional box, the wave function is given by

$$\Psi(x) = N \sin \frac{3\pi x}{L} \quad 0 < x < L,$$

$$= 0 \quad x < 0 \text{ \& } x > L.$$

The normalization constant N is given by :

- (1) $\sqrt{\frac{1}{L}}$
- (2) $\sqrt{\frac{2}{L}}$
- (3) $\sqrt{\frac{3}{L}}$
- (4) None of the above

89. For a particle inside a box lying between $x = 0$ and $x = L$, the potential is maximum at $x =$

- (1) L
- (2) $2L$
- (3) $L/2$
- (4) $3L$

90. Energy of the 2nd excited state for a simple harmonic oscillator is equal to :

- (1) $(\hbar\omega)$
- (2) $(3\hbar\omega/2)$
- (3) $(5\hbar\omega/2)$
- (4) $(2\hbar\omega)$

91. The applications of Green's theorem are meant to be in :
- (1) one-dimension (2) two-dimension
(3) three-dimension (4) all of the above
92. A partial differential equation has :
- (1) only one independent variable
(2) two or more independent variables
(3) more than one dependent variables
(4) equal number of dependent and independent variables
93. Interpolation is a method of :
- (1) Interrelating (2) Estimating (3) Integrating (4) Combining
94. Which one of the following quantities is *not* a second order tensor ?
- (1) Stress (2) Strain
(3) Pressure (4) Moment of Inertia
95. Which of the following is a Laplace equation ?
- (1) $\nabla V = 0$ (2) $\nabla^2 V = -\rho/\epsilon_0$
(3) $\nabla \cdot J = - (dp/dt)$ (4) $\nabla^2 V = 0$
96. The Runge-Kutta method is used to solve :
- (1) Ordinary differential equations of n^{th} order
(2) Linear differential equations
(3) Simultaneous non-linear equations
(4) None of these

97. Which of the following is *true* about trapezoidal rule ?
- (1) It is exact for polynomials of degree ≤ 1
 - (2) It is exact for polynomials of order 2 only
 - (3) It is exact for polynomials of degree ≥ 1
 - (4) It is exact for polynomials of degree 2 only
98. A group $(M, *)$ is said to be an abelian if :
- (1) $(x + y) = (y + x)$
 - (2) $(x + y) = -(y + x)$
 - (3) $(x * y) = (y * x)$
 - (4) $(x * y) = -(y * x)$
99. Which of the following systems is said to be a dynamical system ?
- (1) $y(n) = 6x(n) + 7$
 - (2) $y(n) = 2x(n) + 3x(n - 1) + 5$
 - (3) $y(n) = 4x(n) + 3x^2(n) + 3$
 - (4) $y(n) = 5x(n) + 6x^2(n) + 6x^3(n) + 8$
100. The asymptotic stability is associated with a system which is :
- (1) under the influence of input
 - (2) not under the influence of input
 - (3) under influence of output
 - (4) not under the influence of output

(DO NOT OPEN THIS QUESTION BOOKLET BEFORE TIME OR UNTIL YOU ARE ASKED TO DO SO)

D

SET-Y

Ph.D./URS-EE-Jan-2022

SUBJECT : Physics

10028

Sr. No.

Time : 1¼ Hours

Max. Marks : 100

Total Questions : 100

Roll No. (in figures) _____ (in words) _____

Name _____ Father's Name _____

Mother's Name _____ Date of Examination _____

(Signature of the Candidate)

(Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

- 1. All questions are compulsory.**
- The candidates **must return** the question booklet as well as OMR Answer-Sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
- Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
- Question Booklet along with answer key of all the A, B, C & D code will be got uploaded on the University website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examination in writing through E.Mail within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
- The candidate **must not** do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question booklet itself. Answers **must not** be ticked in the question booklet.
- There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
- Use only **Black or Blue Ball Point Pen** of good quality in the OMR Answer-Sheet.
- Before answering the questions, the candidates should ensure that they have been supplied correct and complete booklet. Complaints, if any, regarding misprinting etc. will not be entertained 30 minutes after starting of the examination.*

PHD/URS-EE-2022/(Physics)(SET-Y)/(D)

1. The WKB approximation is valid :
 - (1) For systems having large mass
 - (2) For systems having high energy
 - (3) For systems with slowly varying potential
 - (4) For systems having large mass, high energy and slowly varying potential

2. Which of the following are also called continuous phase transitions ?
 - (1) Zeroth-order phase transitions
 - (2) First-order phase transitions
 - (3) Second-order phase transitions
 - (4) Higher than 2nd order phase transitions

3. Choose the *correct* statement about the diamagnetic susceptibility :
 - (1) It increases with temperature
 - (2) It decreases with temperature
 - (3) It does not vary with change in temperature
 - (4) It first increases then becomes temperature independent

4. Which among the following is a diamagnetic substance ?
 - (1) Copper
 - (2) Iron
 - (3) Gadolinium
 - (4) Palladium

5. What is the value of 1 Bohr magneton ?
 - (1) $9.27 \times 10^{-21} \text{ A m}^2$
 - (2) $9.27 \times 10^{-24} \text{ A m}^2$
 - (3) $9.27 \times 10^{-25} \text{ A m}^2$
 - (4) $2.27 \times 10^{-27} \text{ A m}^2$

6. A diamagnetic solid having a relative magnetic permeability of 0.9995 is placed in a magnetic field of strength 10000 A/m. The magnetization so produced in the solid is :

- (1) -5 A/m (2) -10005 A/m
 (3) -9995 A/m (4) None of the above

7. Which of the following equation represent the diffusion equation in one dimension (c = concentration, D_x = diffusion coefficient along x) ?

(1) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial^2 c}{\partial x^2}$

(2) $\frac{\partial^2 c}{\partial t^2} = D_x \frac{\partial c}{\partial x}$

(3) $\frac{\partial c}{\partial t} = D_x \frac{\partial^2 c}{\partial x^2}$

(4) $\frac{\partial c}{\partial x} = D_x \frac{\partial^2 c}{\partial t^2}$

8. In the random walk, after N steps, the particle will be roughly :

- (1) $\sqrt{N(N-1)}$ steps away from where it started
 (2) \sqrt{N} steps away from where it started
 (3) $\sqrt{N(2N-1)}$ steps away from where it started
 (4) $\sqrt{2N}$ steps away from where it started

9. Which of the following characteristics are *not* desirable for an ideal transducer ?

- (1) A high dynamic range
 (2) A low linearity
 (3) High repeatability
 (4) Low noise

10. In the inverting circuit, the op-amp is in :
- (1) Saturation region
 - (2) Linear region
 - (3) Cut-off region
 - (4) Non-linear region
11. The applications of Green's theorem are meant to be in :
- (1) one-dimension
 - (2) two-dimension
 - (3) three-dimension
 - (4) all of the above
12. A partial differential equation has :
- (1) only one independent variable
 - (2) two or more independent variables
 - (3) more than one dependent variables
 - (4) equal number of dependent and independent variables
13. Interpolation is a method of :
- | | |
|-------------------|----------------|
| (1) Interrelating | (2) Estimating |
| (3) Integrating | (4) Combining |
14. Which one of the following quantities is *not* a second order tensor ?
- | | |
|--------------|-----------------------|
| (1) Stress | (2) Strain |
| (3) Pressure | (4) Moment of Inertia |

15. Which of the following is a Laplace equation ?
- (1) $\nabla V = 0$ (2) $\nabla^2 V = -\rho/\epsilon_0$
(3) $\nabla \cdot J = - (d\rho/dt)$ (4) $\nabla^2 V = 0$
16. The Runge-Kutta method is used to solve :
- (1) Ordinary differential equations of n^{th} order
(2) Linear differential equations
(3) Simultaneous non-linear equations
(4) None of these
17. Which of the following is *true* about trapezoidal rule ?
- (1) It is exact for polynomials of degree ≤ 1
(2) It is exact for polynomials of order 2 only
(3) It is exact for polynomials of degree ≥ 1
(4) It is exact for polynomials of degree 2 only
18. A group $(M, *)$ is said to be an abelian if :
- (1) $(x + y) = (y + x)$ (2) $(x + y) = -(y + x)$
(3) $(x * y) = (y * x)$ (4) $(x * y) = -(y * x)$
19. Which of the following systems is said to be a dynamical system ?
- (1) $y(n) = 6x(n) + 7$
(2) $y(n) = 2x(n) + 3x(n-1) + 5$
(3) $y(n) = 4x(n) + 3x^2(n) + 3$
(4) $y(n) = 5x(n) + 6x^2(n) + 6x^3(n) + 8$

20. The asymptotic stability is associated with a system which is :
- (1) under the influence of input
 - (2) not under the influence of input
 - (3) under influence of output
 - (4) not under the influence of output
21. The magnetic susceptibility of a paramagnetic substance is :
- (1) Negative and temperature-dependent
 - (2) Negative and temperature-independent
 - (3) Positive and temperature-dependent
 - (4) Positive and temperature-independent
22. An unpolarized light having intensity I_0 falls over a polaroid. The intensity of the transmitted light will be :
- (1) $I_0/2$ (2) $I_0/4$ (3) I_0 (4) Zero
23. Clausius Mossotti equation is an equation which relates :
- (1) Dielectric constant and atomic polarizability in a polar molecule
 - (2) Dielectric constant and atomic polarizability in a non-polar molecule
 - (3) Dielectric constant and polarization in a polar molecule
 - (4) Dielectric constant and polarization in a non-polar molecule
24. The Gibb's potential is defined as :
- (1) $G = U + pV + TS$
 - (2) $G = U - pV + TS$
 - (3) $G = U + pV - TS$
 - (4) $G = U - pV - TS$

25. The Helmholtz free energy is given by $F = U - TS$. Then C_V will be given by :

$$(1) C_V = T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$$

$$(2) C_V = T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$$

$$(3) C_V = -T \left(\frac{\partial^2 F}{\partial T^2} \right)_V$$

$$(4) C_V = -T \left(\frac{\partial^2 F}{\partial V^2} \right)_T$$

26. Choose the option that is the best description about the chemical potential of a thermodynamical system :

(1) It is an extensive property only

(2) It is an intensive property only

(3) It is a force that drives the system to equilibrium

(4) It is an intensive property and can be regarded as a force that drives the system to equilibrium

27. The classical partition function Z of a system tells us about :

(1) The sum of all the states of the system

(2) The sum of the energy of the system

(3) The sum of the momentum of the system

(4) All of the above

28. A phase space is a :

(1) 2-Dimensional Space

(2) 3-Dimensional Space

(3) 4-Dimensional Space

(4) 6-Dimensional Space

29. Mass of a gas 'A' is 9 times that of gas 'B'. The ratio of their mean velocities will be :

(1) 9 : 1

(2) 1 : 9

(3) 1 : 3

(4) 3 : 1

30. Which of the following statistics can be used to describe the behavior of photons ?
- (1) Maxwell-Boltzmann statistics
 - (2) Fermi-Dirac statistics
 - (3) Bose-Einstein statistics
 - (4) By both Maxwell-Boltzmann statistics as well as Bose-Einstein statistics
31. In the elastic collision between two bodies :
- (1) both the total momentum and total kinetic energies of the colliding bodies are conserved
 - (2) only the total kinetic energy of the colliding bodies is conserved
 - (3) only the total momentum of the colliding bodies is conserved
 - (4) neither the total momentum nor the total kinetic energies of the colliding bodies are conserved.
32. The circular motion of an object moving with constant speed is an example of :
- (1) both periodic as well as simple harmonic motions
 - (2) periodic motion only
 - (3) simple harmonic motion only
 - (4) neither periodic nor simple harmonic motion
33. According to Einstein's Special Theory of Relativity, the laws of Physics can be formulated based on :
- (1) inertial frame of reference only
 - (2) non-inertial frame of reference only
 - (3) both the non-inertial and inertial frame of references
 - (4) quantum state only

34. When number of nucleons in a nuclei increases, then the binding energy per nucleon :
- (1) initially increases and then decreases with the mass number
 - (2) initially decreases and then increases with the mass number
 - (3) decreases continuously with the mass number
 - (4) increases continuously with mass number
35. The pseudo force concept is valid for :
- (1) the inertial frames
 - (2) the non-inertial frames
 - (3) both the inertial as well as non-inertial frames
 - (4) neither the inertial frames nor the non-inertial frames
36. The Lorentz transformation equations hold for :
- (1) non-relativistic speeds only
 - (2) relativistic speeds only
 - (3) all speeds : relativistic as well as non-relativistic
 - (4) mass-less particles only
37. If λ is the wavelength of electrons (in Å), which have been accelerated from rest through a potential difference of V (in Volts), then the value of product $\lambda\sqrt{V}$ is approximately equal to :
- (1) 13.60
 - (2) 10.16
 - (3) 12.26
 - (4) None of the above

38. For a particle in a one dimensional box, the wave function is given by

$$\Psi(x) = N \sin \frac{3\pi x}{L} \quad 0 < x < L,$$

$$= 0 \quad x < 0 \text{ \& } x > L.$$

The normalization constant N is given by :

(1) $\sqrt{\frac{1}{L}}$

(2) $\sqrt{\frac{2}{L}}$

(3) $\sqrt{\frac{3}{L}}$

(4) None of the above

39. For a particle inside a box lying between $x = 0$ and $x = L$, the potential is maximum at $x =$

(1) L

(2) $2L$

(3) $L/2$

(4) $3L$

40. Energy of the 2nd excited state for a simple harmonic oscillator is equal to :

(1) $(\hbar\omega)$

(2) $(3\hbar\omega/2)$

(3) $(5\hbar\omega/2)$

(4) $(2\hbar\omega)$

41. Choose the *correct* option about the experimentally observed Hall voltage of an intrinsic Silicon specimen. :

(1) Hall voltage will be negative

(2) Hall voltage will be positive

(3) Hall voltage will be zero

(4) Sign of Hall voltage would depend upon the magnitude of the measuring current

42. The number of atoms per unit cell in the Diamond crystal structure is :

(1) 2

(2) 4

(3) 6

(4) 8

43. Which of the following is structure sensitive property of a type-II superconductor ?

- (1) Critical Transition temperature
- (2) Upper Critical field
- (3) Lower Critical field
- (4) Critical Current density

44. The heat capacity C_V of a solid at very low temperature takes the form, given by :

$$(1) C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{T}{\theta}\right)^3$$

$$(2) C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{T}{\theta}\right)^3$$

$$(3) C_V = \left(\frac{12\pi^4}{5}\right) Nk_B \left(\frac{\theta}{T}\right)^3$$

$$(4) C_V = \left(\frac{12\pi^4}{7}\right) Nk_B \left(\frac{\theta}{T}\right)^3$$

45. Which one of the following is a Frankel defect ?

- (1) One Mg vacancy and one Mg Interstitial in MgO
- (2) One Zn vacancy and one oxygen vacancy in ZnO
- (3) Na at potassium site in KCl
- (4) None of the above

46. In the radioactive transformation, ${}_{15}\text{P}^{30} \rightarrow {}_{14}\text{Si}^{30} + \text{X}$, the emitted particle X is a/an :

- (1) Positron
- (2) Proton
- (3) Electron
- (4) Neutron

47. The Neutrinos are the particles having following properties :

- (1) Uncharged and Spin-less
- (2) Uncharged and have Spin
- (3) Charged and Spin-less
- (4) Charged and have Spin

48. The Nuclear-fission process is best explained by :
- (1) Liquid-Drop model
 - (2) Proton-proton model
 - (3) Quark model
 - (4) Independent particle model of the nucleus
49. Choose the particle that is *not* made by quarks :
- (1) Positron (2) Proton (3) Neutron (4) Electron
50. The Nuclear forces are :
- (1) Spin independent
 - (2) Both charge and spin independent
 - (3) Spin dependent but charge independent
 - (4) Charge dependent
51. The Poisson bracket $\{x, xp_x - yp_y + ax^2 + by^2\}$, where a and b are constants, is equal to :
- (1) x (2) y (3) p_x (4) p_y
52. The Jacobi's method is also known as :
- (1) Displacement method
 - (2) Simultaneous displacement method
 - (3) Simultaneous method
 - (4) Diagonal method
53. Suppose P , Q and R be functions of phase space variables (coordinates and momenta of a mechanical system). If $\{ , \}$ represents the Poisson bracket, then the value of $\{P, \{Q, R\}\} - \{\{P, Q\}, R\}$ will be :
- (1) 0 (2) $\{Q, \{R, P\}\}$ (3) $\{P, \{R, Q\}\}$ (4) $\{\{R, P\}, Q\}$

54. Choose the *correct* statement about group velocity in a dispersive medium :
- (1) Group velocity is less than the phase velocity only
 - (2) Group velocity is more than the phase velocity
 - (3) Group velocity is equal to the phase velocity only
 - (4) Group velocity can be both more than or less than the phase velocity depending upon the nature of dispersive medium
55. Wave guide can be regarded as :
- (1) Low-pass filter
 - (2) High-pass filter
 - (3) Band-pass filter
 - (4) Both low pass as well as high-pass filter
56. If for a transmission line, $\frac{L}{C} = \frac{R}{G}$, then which one of the following would be *correct* ?
- (1) The transmission line will be loss-less
 - (2) The transmission is called as distortion-less
 - (3) $Z_0^2 = \frac{R}{G}$
 - (4) The attenuation constant will be imaginary
57. The reason why Northern Lights only occur in the North and Southern Lights occur in South is :
- (1) Charged particles from the Sun follow the axis of rotation of the Earth
 - (2) Charged particles from the Sun deviate from the electric field lines near the poles
 - (3) Charged particles from the Sun penetrate the Earth's magnetic field near the poles
 - (4) Charged particles from the Sun are trapped in the Earth's magnetic field near the poles

58. Which auxiliary function is useful in solving the radiation problem involving evaluation of the E & H fields from the sources J & M ?
- (1) Scalar potentials
 - (2) Vector potentials
 - (3) Divergence potentials
 - (4) Gradient potentials
59. To properly account for the fine structure of the spectrum of hydrogen atom one must consider :
- (1) Spin angular momentum
 - (2) Orbital angular momentum
 - (3) Principal quantum number n
 - (4) Coulomb potential of the hydrogen-nuclei
60. Consider a particle of mass m is scattered by a potential $V(r) = g\delta^3(r)$. The differential cross-section as per Born Approximation will be :
- | | |
|---------------------------------------|---------------------------------------|
| (1) $\frac{m^2 g^2}{4\pi^2 \hbar^2}$ | (2) $\frac{3m^2 g^2}{4\pi^2 \hbar^2}$ |
| (3) $\frac{3m^2 g^2}{2\pi^2 \hbar^2}$ | (4) $\frac{m^2 g^2}{2\pi^2 \hbar^2}$ |
61. Choose the active filter out of the following :
- (1) Band pass filter
 - (2) RC filter
 - (3) Butterworth filter
 - (4) Notch filter

62. The input impedance of a quarter wave transformer required for matching a load impedance of 100 Ohm to a transmission line having characteristic impedance of 50 Ohm will be :
- (1) 2 Ohm (2) 0.5 Ohm
(3) 200 Ohm (4) 25 Ohm
63. Out of the following, choose the 'guarding arm(s)' :
- (1) a parallel RC combination
(2) a series RC combination
(3) a parallel LC combination
(4) all of the above
64. What will be the Fourier Transform of $e^{-\frac{x^2}{2}}$?
- (1) $\frac{1}{2}e^{-\frac{\omega^2}{2}}$ (2) $\frac{\pi}{2}$
(3) $\sqrt{\pi}$ (4) $e^{-\frac{\omega^2}{2}}$
65. At high magnetic field, the splitting of the spectral lines in a spectrum of an atom gets disturbed. This is the case of :
- (1) Anomalous Zeeman effect
(2) Paschen-back effect
(3) Inverse Zeeman effect
(4) Stark effect
66. The electromagnetic spectrum in which nuclear magnetic resonance occurs is :
- (1) Microwave region
(2) Radio frequency region
(3) Infrared region
(4) Ultraviolet region

67. Which of the following is determined using the IR spectroscopy ?
- (1) Molecular formula of a compound
 - (2) Types of bonds in a compound
 - (3) Molecular weight of a compound
 - (4) The number of atoms in a unit-cell of a compound
68. The Raman effect is related to scattering of :
- (1) Atoms
 - (2) Electrons
 - (3) Protons
 - (4) Photons
69. The absorbance corresponding to $\%T = 80$ is :
- (1) 0.087
 - (2) 0.091
 - (3) 0.094
 - (4) 0.097
70. The Q value due to the dielectric loss in a rectangular waveguide having a loss tangent of 0.0004 will be :
- (1) 1250
 - (2) 2500
 - (3) 5000
 - (4) 4000
71. Choose the *correct* option about energy distribution in the black body spectrum :
- (1) As the wavelength increases, the energy emitted also increases
 - (2) As temperature of the black body increases, the energy associated with the radiation of a specific wavelength increases
 - (3) As temperature of the black body increases, the intensity of its radiation also increases
 - (4) All of the above options are correct
72. If error in the measurement of radius of a spherical ball is 2%, then the error in the calculated value of the surface area of the ball will be :
- (1) 2%
 - (2) 4%
 - (3) 6%
 - (4) 8%

73. Five measurements are performed at different time to measure the length of a rod. The readings (in some units) are 101, 102, 98, 99 and 100. The precision of 4th measurement will be :
- (1) 0.01 (2) 0.90 (3) 0.10 (4) 0.99
74. Choose the technology which was used by Intel for designing its first 8-bit microprocessor ?
- (1) HMOS (2) NMOS (3) PMOS (4) TTL
75. The Schmitt trigger circuit is a modification of one of the following multivibrators. Choose the *correct* option :
- (1) Astable multivibrator (2) Bistable multivibrator
(3) Universal multivibrator (4) Monostable multivibrator
76. The electrical characteristics, which is *not* exhibited by an ideal op-amp, is :
- (1) Infinite bandwidth (2) Infinite voltage gain
(3) Infinite slew rate (4) Infinite output resistance
77. How many flip-flops are required to construct an 8-bit Shift register ?
- (1) 8 (2) 16 (3) 4 (4) 2
78. Which of the following diodes exhibits negative resistance in its characteristics ?
- (1) Tunnel diode (2) Schottky diode
(3) Varactor diode (4) Zener diode
79. If a voltmeter is connected across the forward-biased Si-diode, it will read a voltage which would approximately be equal to :
- (1) Bias battery voltage (2) Zero V
(3) Diode barrier potential (4) 1.1 V

80. Find the value of the current limiting resistor required for connecting three LEDs (rating 3V and 3 mA) in series with a 15 volt DC source.
- (1) 1 kohm (2) 2 kohm
(3) 3 kohm (4) 5 kohm
81. The function representing matter waves :
- (1) can only be complex
(2) can only be a real
(3) can be either complex or real
(4) must be a Dirac-delta function
82. Which of the following transitions in a hydrogen atom emits the photon of the lowest frequency ?
- (1) $n = 2$ to $n = 1$ (2) $n = 3$ to $n = 1$
(3) $n = 4$ to $n = 2$ (4) $n = 4$ to $n = 3$
83. If an object, which is rotating about a fixed point P, has a kinetic energy E and angular momentum L, then :
- (1) $L \propto E^2$ (2) $L \propto E$
(3) $L \propto E^{-1}$ (4) $L \propto E^{1/2}$
84. Which of the following experiments first detected the spin of an electron ?
- (1) Davison and Germer experiment
(2) Stern and Gerlach experiment
(3) Zeeman Effect
(4) Frank and Hertz experiment

85. A charge 'q' is enclosed by a Gaussian spherical surface of radius 'R'. If the radius is increased to '3R', then the outward electric flux will :
- (1) remain unchanged
 - (2) increase by a factor of 3
 - (3) decrease by a factor of 9
 - (4) increase by a factor of 9
86. The Poisson equation for electric potential V for an isotropic and homogeneous medium having charge density ρ and dielectric constant ϵ is given by :
- (1) $\nabla^2 V = -\frac{\rho}{\epsilon}$
 - (2) $\nabla^2 V = \frac{\rho}{\epsilon}$
 - (3) $\nabla \cdot V = -\frac{\rho}{\epsilon}$
 - (4) $\nabla \cdot V = \frac{\rho}{\epsilon}$
87. A long wire carrying a current produces a magnetic field of strength 0.8 T at a distance of 0.5 cm from it. The magnetic field at a distance of 2 cm from the wire will be :
- (1) 0.40 T
 - (2) 0.20 T
 - (3) 0.16 T
 - (4) 0.10 T
88. What is the nature of light ?
- (1) Matter
 - (2) Wave like
 - (3) Particle like
 - (4) Dual
89. In the Fleming's left-hand rule, the middle finger points in the direction of :
- (1) Current in the wire conductor
 - (2) Magnetic field
 - (3) Force on the wire conductor
 - (4) Length of the wire conductor
90. If the magnetic flux linked with a coil is given to be $\phi = 5t^2 + 2t + 3$, then the magnitude of emf induced in the coil at 4 sec will be :
- (1) 42 V
 - (2) 91 V
 - (3) 20.2 V
 - (4) None of the above

91. If 'm' is the mean of a Poisson distribution, then the standard deviation is given by :
- (1) \sqrt{m} (2) m^2 (3) m (4) $m/2$
92. One of the eigen values for the following 2×2 matrix, $\begin{bmatrix} 1 & 8 \\ 2 & 1 \end{bmatrix}$, is :
- (1) 4 (2) 5 (3) 6 (4) 8
93. If $f(x) = 1$, then its Laplace Transform $F(y)$ is given by :
- (1) Does not exist (2) y
(3) $1/y$ (4) 1
94. Let $u = \sin y + i \cos 2y$ and $v = \cos y - i \sin 2y$. Then for what values of y, the u and v will be conjugate of each other ?
- (1) $n\pi$ (2) $(n+1/2)\pi$
(3) 0 (4) no value of y
95. The divergence of the vector function $F = (x^3y)i + (3xy^2z)j + (3zx)k$ is :
- (1) $3x^2y + 3y^2z + 3z$
(2) $x^3 + 6xyz$
(3) $3xy^2 + 3x$
(4) $3x^2y + 6xyz + 3x$
96. The first two terms of the Taylor series about $a = 3$ for the function $f(x) = 2x + 5$ will be :
- (1) $11 - 2(x - 3)$
(2) $11 + 2(x - 3)$
(3) $11 - 7(x - 3)$
(4) $11 + 7(x - 3)$

97. When we throw a dice then what is the probability of getting the number greater than 5 ?
- (1) $1/3$ (2) $1/5$ (3) $1/6$ (4) $1/2$
98. The dimensional formula of viscosity is :
- (1) $ML^{-1}T^{-1}$ (2) MLT^{-1} (3) MLT^{-2} (4) $ML^{-1}T^{-2}$
99. A geostationary satellite is :
- (1) whose time period is same as that of Earth
(2) whose magnitude of the speed v is same as that of Earth, but have different time period
(3) whose time period and speed v both are same as that of Earth
(4) none of the above
100. The stability of a system means that :
- (1) Small changes in the system input do not result in large change in output conditions of the system
(2) Small changes in the system parameters do not result in large change in output conditions of the system
(3) Small changes in the initial conditions do not result in large change in output conditions of the system
(4) All of the above

Answer Key; Ph.D. Physics Entrance Exam - 2021-22

Dated 11.02.2022 at 2.30 pm to 3:45 pm

Sr. No.	Code A	Code B	Code C	Code D
1	1	1	4	4
2	2	2	2	3
3	3	1	4	3
4	4	1	3	1
5	4	2	2	2
6	2	3	4	1
7	3	3	1	3
8	1	2	1	2
9	1	1	3	2
10	4	3	2	2
11	1	1	1	2
12	2	4	4	2
13	1	4	4	2
14	1	1	2	3
15	2	1	1	4
16	3	1	1	3
17	3	2	2	1
18	2	1	4	3
19	1	4	1	2
20	3	3	1	2
21	1	4	1	1
22	4	3	2	4
23	4	3	3	4
24	2	1	4	2
25	1	2	4	1
26	1	1	2	1
27	2	3	3	2
28	4	2	1	4
29	1	2	1	1
30	1	2	4	1
31	1	2	1	1
32	4	2	4	2
33	4	2	4	1
34	2	3	1	1
35	1	4	1	2
36	1	3	1	3
37	2	1	2	3
38	4	3	1	2
39	1	2	4	1
40	1	2	3	3
41	4	1	1	1
42	2	4	2	4
43	4	4	4	4
44	3	2	1	1
45	2	1	2	1
46	4	1	1	1
47	1	2	4	2
48	1	4	2	1
49	3	1	1	4
50	2	1	1	3

[Signature]
11.02.2022 Sajjan

11.02.2022

[Signature]
11.02.2022

[Signature]
11.02.2022

Answer Key; Ph.D. Physics Entrance Exam - 2021-22

Dated 11.02.2022 at 2.30 pm to 3:45 pm

Sr. No.	Code A	Code B	Code C	Code D
51	2	1	1	1
52	2	4	4	2
53	2	4	4	4
54	3	2	2	1
55	4	1	1	2
56	3	1	1	1
57	1	2	2	4
58	3	4	4	2
59	2	1	1	1
60	2	1	1	1
61	1	4	4	3
62	2	2	3	4
63	4	4	3	2
64	1	3	1	4
65	2	2	2	2
66	1	4	1	2
67	4	1	3	2
68	2	1	2	4
69	1	3	2	4
70	1	2	2	2
71	4	1	3	4
72	3	2	4	2
73	3	4	2	4
74	1	1	4	3
75	2	2	2	2
76	1	1	2	4
77	3	4	2	1
78	2	2	4	1
79	2	1	4	3
80	2	1	2	2
81	3	1	1	1
82	4	2	2	4
83	2	3	1	4
84	4	4	1	2
85	2	4	2	1
86	2	2	3	1
87	2	3	3	2
88	4	1	2	4
89	4	1	1	1
90	2	4	3	1
91	1	3	2	1
92	4	4	2	2
93	4	2	2	3
94	1	4	3	4
95	1	2	4	4
96	1	2	3	2
97	2	2	1	3
98	1	4	3	1
99	4	4	2	1
100	3	2	2	4

[Signature]
11.02.2022

[Signature]
11/02/2022

[Signature]
11.02.2022

[Signature]
11/02/2022