

PG/INTEGRATED PG ENTRANCE EXAMINATION, APRIL 2023

PHYSICS/RADIATION PHYSICS/PHYSICS (NANO SCIENCE)

Time : Two Hours

Maximum : 400 Marks

*Each question carries 4 marks.**1 mark will be deducted for each wrong answer.*

1. Classical mechanics describes the motion of :
 - (a) Microscopic objects.
 - (b) Macroscopic objects.
 - (c) None of the above.
 - (d) Both (a) and (b).
2. The mass that determines the acceleration of a body under the action of a given force is called :
 - (a) First mass.
 - (b) Inertial mass.
 - (c) Reference mass.
 - (d) Non-inertial mass.
3. Angular momentum is conserved if the net torque acting on a body is :
 - (a) Maximum.
 - (b) Zero.
 - (c) Uniform.
 - (d) None of these.
4. The number of independent ways in which a mechanical system can move without violating any constraint is called :
 - (a) Constraint.
 - (b) Number of freedoms.
 - (c) Degrees of freedom.
 - (d) Generalized co-ordinates.
5. A force whose line of action is always directed towards a fixed point is known as :
 - (a) Central force.
 - (b) Elliptical force.
 - (c) Both (a) and (b).
 - (d) None of these.
6. The nature of an orbit depends on :
 - (a) Radius.
 - (b) Eccentricity.
 - (c) Origin.
 - (d) Angle.

Turn over

7. Potential energy $V = 0$ for :
- (a) Free particle. (b) Bound particle.
(c) Harmonic oscillator. (d) Quartic oscillator.
8. Poisson's bracket is :
- (a) Invariant under canonical transformation.
(b) Variant under canonical transformation.
(c) Both (a) and (b).
(d) None of these.
9. A conservative force is the one :
- (a) Which never do work.
(b) Work done in a close path is zero.
(c) Work done is independent of the path.
(d) Both (b) and (c)
10. The unit vectors are perpendicular to each other in :
- (a) Cartesian co-ordinates.
(b) Spherical polar co-ordinates.
(c) Cylindrical Co-ordinates.
(d) All of the above.
11. A sphere of radius R is uniformly charged with charge density ρ_0 . The magnitude of the electric field at a distance r ($r < R$) from the centre of the sphere is :
- (a) $\frac{3\rho_0 r}{\epsilon_0}$. (b) $\frac{\rho_0 r}{\epsilon_0}$.
(c) $\frac{\rho_0 r}{3\epsilon_0}$. (d) $\frac{6\rho_0 r}{\epsilon_0}$.

12. If $\vec{E}_1 = xy\hat{i} + 2yz\hat{j} + 3xz\hat{k}$ and $\vec{E}_2 = y^2\hat{i} + (2xy + z^2)\hat{j} + 2yz\hat{k}$ then :

- (a) Both are impossible electrostatic fields.
- (b) Both are possible electrostatic fields.
- (c) Only E_1 is a possible electrostatic field.
- (d) Only E_2 is a possible electrostatic field.

13. Force on a stationary charged particle in a electromagnetic field is :

- (a) qE .
- (b) qEB .
- (c) $q(E + B)$.
- (d) $q(E - B)$.

14. Electron at rest produces :

- (a) Magnetic field.
- (b) Electric field.
- (c) Time varying field.
- (d) None.

15. Curl of magnetic vector potential gives :

- (a) \vec{E} .
- (b) \vec{J} .
- (c) \vec{B} .
- (d) None.

16. Negative gradient of a scalar potential gives :

- (a) \vec{E} .
- (b) \vec{J} .
- (c) \vec{B} .
- (d) None.

17. Lorentz force is given by :

- (a) $\vec{F} = q(\vec{V} \times \vec{B})$.
- (b) $\vec{F} = q(\vec{E})$.
- (c) $\vec{F} = q(\vec{E} + \vec{V} \times \vec{B})$.
- (d) $\vec{F} = (\vec{E} + \vec{V} \times \vec{B})$.

18. The unit of magnetic flux is :

- (a) Weber-meter square.
- (b) Weber/m.
- (c) Weber-m.
- (d) Weber.

Turn over

19. Identify the Poisson's equation :

(a) $\nabla^2\phi = -\frac{\rho}{\epsilon_0}$.

(b) $\nabla^2\phi = \frac{\rho}{\epsilon_0}$.

(c) $\nabla^2\phi = -\rho\epsilon_0$.

(d) None.

20. Microscopic ohms law is :

(a) $\vec{J} = \mu\vec{E}$.

(b) $\vec{J} = \sigma\vec{E}$.

(c) $\vec{J} = \epsilon\vec{E}$.

(d) $\vec{J} = \sigma\vec{B}$.

21. Free particle is an example of :

(a) Unbound system.

(b) Open system.

(c) Bound system.

(d) Isolated system.

22. It is impossible to determine simultaneously the position and velocity with accuracy of a small particle like electron. This statement is :

(a) Heisenberg's uncertainty principle.

(b) De Broglie principle.

(c) Planck's law.

(d) Aufbau's principle.

23. No two electrons in an atom can have same set of four identical quantum numbers. It is the statement of :

(a) Aufbau principle.

(b) Hund's rule.

(c) Pauli's exclusion principle.

(d) None of these.

24. The wavelength of the matter waves is independent of :

(a) Mass.

(b) Velocity.

(c) Charge.

(d) Momentum.

25. The equation for matter-wave was derived by :

(a) Heisenberg.

(b) Bohr.

(c) De-Broglie.

(d) Schrodinger.

26. The total probability of finding the particle in space must be :
- (a) Zero. (b) Unity.
(c) Infinity. (d) Double.
27. Any wave function having anti-symmetry property is said to be of _____ parity.
- (a) Zero. (b) Even.
(c) Odd. (d) Infinite.
28. If there exist only one eigen function corresponding to a given eigen value, then the eigen value is said to be :
- (a) Non-degenerate. (b) Degenerate.
(c) Discrete. (d) Continuum.
29. The walls of a particle in a box are supposed to be :
- (a) Small but infinitely hard.
(b) Infinitely large but soft.
(c) Soft and Small.
(d) Infinitely hard and infinitely large.
30. The energy of a particle in a box is proportional to :
- (a) n (b) n^{-1} .
(c) n^2 . (d) n^{-2} .
31. Which one of the following properties of light does not change with the nature of the medium ?
- (a) Velocity. (b) Wavelength.
(c) Amplitude. (d) Frequency.
32. The photoelectric effect was explained by :
- (a) Hertz. (b) Fresnel.
(c) Einstein. (d) Planck.
33. Longitudinal waves do not exhibit :
- (a) Reflection. (b) Refraction.
(c) Diffraction. (d) Polarization.

Turn over

34. Two sources of light are coherent if they emit rays of :
- (a) Same wavelength only.
 - (b) The same amplitude of vibration only.
 - (c) Same wavelength with a constant phase difference.
 - (d) Same amplitude and wavelength.
35. In Young double slit experiment, if white light is used :
- (a) Alternate dark and bright fringes will be seen.
 - (b) Coloured fringes will be seen.
 - (c) No interference fringes will be seen.
 - (d) Impossible to predict.
36. The blue colour of the sky is due to :
- (a) Diffraction.
 - (b) Reflection.
 - (c) Polarization.
 - (d) Scattering.
37. Light on passing through a polaroid is :
- (a) Plane polarized.
 - (b) Un-polarized.
 - (c) Circularly polarized.
 - (d) Elliptically polarized.
38. What is the angle between the incident ray and the emergent ray in a prism called ?
- (a) Angle of deviation.
 - (b) Angle of refraction.
 - (c) Angle of reflection.
 - (d) Angle of dispersion.
39. For a total internal reflection, which of the following is correct ?
- (a) Light travels from rarer to denser medium.
 - (b) Light travels from denser to rarer medium.
 - (c) Light travels in air only.
 - (d) Light travels in water only.

40. A person is six feet tall. Minimum length of a plane mirror required so that he is able to see his entire length is ?
- (a) 3 ft. (b) 4.5 ft.
(c) 7.5 ft. (d) 6 ft.
41. In thermodynamic processes which of the following statements is not correct :
- (a) In an isobaric process pressure remains constant.
(b) In an adiabatic process the system is insulated from the surroundings.
(c) In an isochoric process pressure remains constant.
(d) In an isothermal process the temperature remains constant.
42. The second law of thermodynamics is concerned essentially with :
- (a) Nature of heat flow. (b) Amount of heat flow.
(c) Direction of heat flow. (d) Speed of heat flow.
43. The unit of temperature in S.I. units is :
- (a) Centigrade. (b) Celsius.
(c) Fahrenheit. (d) Kelvin.
44. Kinetic theory of gases assumes that the collisions between the molecules are :
- (a) Perfectly elastic. (b) Perfectly inelastic
(c) Partly elastic. (d) Partly inelastic.
45. The pressure' of a gas in terms of its mean energy per unit volume E is equal to :
- (a) $E/3$. (b) $E/2$.
(c) $3E/4$. (d) $2E/3$.
46. Intensive property of a system is one whose value :
- (a) Depends on the mass of the system, like volume.
(b) Does not depend on the mass of the system, like temperature, pressure, etc.
(c) Is not dependent on the path followed but on the state.
(d) Is dependent on the path followed and not on the state.

Turn over

47. An isolated system is one in which :

- (a) Mass does not cross boundaries of the system, though energy may do so.
- (b) Neither mass nor energy crosses the boundaries of the system.
- (c) Both energy and mass cross the boundaries of the system.
- (d) Mass crosses the boundary but not the energy.

48. The temperature of the system reduces in an :

- (a) Adiabatic Compression.
- (b) Isothermal Expansion.
- (c) Isothermal Compression.
- (d) Adiabatic Expansion.

49. The quantity of energy transferred from one system to another is known as :

- (a) Specific heat.
- (b) Internal energy.
- (c) Thermodynamic work.
- (d) None of these.

50. Heat is transfer of energy due to difference in :

- (a) Time.
- (b) Volume.
- (c) Pressure.
- (d) Temperature.

51. A micro canonical ensemble represents :

- (a) A system in contact with a heat reservoir
- (b) An isolated system in equilibrium
- (c) A system that can exchange particles with its surroundings
- (d) A system under a constant external pressure

52. A system of N non interacting and distinguishable particles of spin 1 is in thermodynamic equilibrium. The entropy of the system is :

- (a) $2 k_B \ln N$.
- (b) $3 k_B \ln N$.
- (c) $N k_B \ln 2$.
- (d) $N k_B \ln 3$.

53. Two identical systems at the same temperature and each having the initial entropy S are placed in thermal contact. The entropy of the combined system will be :

- (a) S^2 .
- (b) S .
- (c) S^4 .
- (d) $2S$.

54. Consider a system of 3 fermions which can occupy any of the 4 available energy states with equal probability. The entropy of the system is :

- (a) $k \ln 2$. (b) $2 k \ln 2$.
(c) $2 k \ln 4$. (d) $k \ln 3$.

55. A system of N non interacting classical point particles are constrained to move on the 2D surfaced sphere. The internal energy of the system is :

- (a) $\frac{3}{2} NkT$. (b) $\frac{1}{2} NkT$.
(c) NkT . (d) $\frac{5}{2} NkT$.

56. The mean internal energy of a one dimensional classical harmonic oscillator in equilibrium with heat bath at temperature T is :

- (a) $\frac{1}{2} k_B T$. (b) $k_B T$.
(c) $\frac{3}{2} k_B T$. (d) $3k_B T$.

57. Choose the correct alternative :

Two particles are said to be distinguishable when,

- (a) The average distance between them is larger than de Broglie wavelength.
(b) The average distance between them is smaller than de Broglie wavelength.
(c) They have overlapping wave packets.
(d) If the wave functions are symmetric.

58. If the number density of a free electron gas in three dimensions is increased eight times, its Fermi temperature will :

- (a) Increase by a factor of 4. (b) Decrease by a factor of 4.
(c) Increase by a factor of 8. (d) Decrease by a factor of 8.

Turn over

59. Laser is intense because :

- (a) It has a very less number of photons that are in phase.
- (b) It has a very less number of photons that are not in phase.
- (c) It has a very large number of photons that are in phase.
- (d) It has a very large number of photons that are not in phase.

60. Presence of a meta stable state is essential for :

- (a) Spontaneous emission.
- (b) Stimulated emission.
- (c) Stimulated absorption.
- (d) Non-radioactive transition.

61. An anti proton is an atomic particle that has :

- (a) The mass of a proton and the charge of an electron.
- (b) The mass of an electron and the charge of a proton.
- (c) The mass of a neutron and the charge of a proton.
- (d) The mass of a proton and the charge of a neutron.

62. In quantum electrodynamics (QED), electromagnetic forces are mediated by :

- (a) The interaction of electrons
- (b) Hadrons.
- (c) Action at a distance.
- (d) The exchange of virtual photons.

63. Conservation laws that describe events involving the elementary particles include the conservation of :

- (a) Energy.
- (b) Linear and angular momentum.
- (c) Electric charge.
- (d) All of these are correct.

64. The cosmic microwave background radiation is :

- (a) Radiation from the quasars that is redshifted.
- (b) Produced from processes going on all over the present universe.
- (c) Radiation from the Sun.
- (d) Radiation after the Big Bang.

65. Particles that participate in the strong nuclear interaction are called :

- (a) Neutrinos. (b) Hadrons.
(c) Leptons. (d) Electrons.

66. Which of the given is the source of energy in stars ?

- (a) Helium changes to oxygen.
(b) Helium changes to hydrogen.
(c) Hydrogen changing to helium.
(d) ~~Hydrogen changes to oxygen.~~

67. Which of the given elements is radioactive ?

- (a) Uranium. (b) Aluminium.
(c) Magnesium. (d) Cobalt.

68. Which of the given fuels is used in nuclear reactors in India ?

- (a) Uranium-238. (b) Uranium-340.
(c) Uranium-270. (d) Uranium-500.

69. Which of the given rays are emitted by radioactive substances ?

- (a) Alpha rays. (b) Beta rays.
(c) Gamma rays. (d) All of the above.

70. The sum of the number of protons and neutrons are called :

- (a) Atomic number. (b) Mass number.
(c) Isotopes. (d) None of these.

71. A semiconductor is formed by _____ bonds.

- (a) Covalent. (b) Electrovalent.
(c) Co-ordinate. (d) None of the above.

72. The most commonly used semiconductor is :

- (a) Germanium. (b) Silicon.
(c) Carbon. (d) Sulphur.

Turn over

73. When a pentavalent impurity is added to a pure semiconductor, it becomes :
- (a) An insulator.
 - (b) An intrinsic semiconductor.
 - (c) *p*-type semiconductor.
 - (d) *n*-type semiconductor.
74. The reverse current in a diode is of the order of :
- (a) Kilo Ampere.
 - (b) Milli Ampere.
 - (c) Micro Ampere.
 - (d) Ampere.
75. The leakage current in a diode is due to :
- (a) Minority carriers.
 - (b) Majority carriers.
 - (c) Junction capacitance.
 - (d) None of the above.
76. A zener diode is used as :
- (a) An amplifier.
 - (b) A voltage regulator.
 - (c) A rectifier.
 - (d) A multivibrator.
77. In a pnp transistor, the current carriers are :
- (a) Acceptor ions.
 - (b) Donor ions.
 - (c) Free electrons.
 - (d) Holes.
78. The most commonly used transistor is :
- (a) Common emitter.
 - (b) Common base.
 - (c) Common collector.
 - (d) None of the above.
79. A heat sink is generally used with a transistor to :
- (a) Increase the forward current.
 - (b) Decrease the forward current.
 - (c) Compensate for excessive doping.
 - (d) Prevent excessive temperature rise.

80. The universal gate is :
- (a) NAND gate. (b) OR gate.
(c) AND gate. (d) None of the above.
81. The NAND gate is AND gate followed by :
- (a) NOT gate. (b) OR gate.
(c) AND gate. (d) None of the above.
82. The only function of NOT gate is to :
- (a) Stop signal. (b) Invert input signal.
(c) Act as a universal gate. (d) None of the above.
83. The basic storage element in a digital system is :
- (a) Flip-flop. (b) Counter.
(c) Multiplexer. (d) Encoder.
84. A digital circuit can be made by the repeated use of :
- (a) OR gates. (b) NOT gates.
(c) NAND gates. (d) None of the above.
85. The Op-amp can amplify :
- (a) a.c. signals only. (b) d.c. signals only.
(c) Both a.c. and d.c. signals. (d) Neither d.c. nor a.c. signals.
86. If $\vec{F} = \cos y\hat{i} - x \sin y\hat{j}$, the value of $\int_C \vec{F} \cdot d\vec{r}$ where C is the curve in the $x-y$ plane from $(2, 0)$ to $(0, 2)$ is :
- (a) 1. (b) -1.
(c) 2. (d) -2.
87. If $\vec{f} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3z^2 x\hat{k}$, the work done in moving a particle from $(1, -2, 1)$ to $(3, 1, 4)$ is :
- (a) 100. (b) 200.
(c) 300. (d) 400.

Turn over

88. If $\vec{A} = yz\hat{i} + zx\hat{j} + xy\hat{k}$ and C is the circle of unit radius in the plane defined by $z = 1$ with Centre on the z-axis. The value of $\oint_C \vec{A} \cdot d\vec{r}$ is :

- (a) $\pi/2$. (b) π .
 (c) $\pi/4$. (d) 0

89. Velocity is a _____ tensor.

- (a) Covariant. (b) Contra variant.
 (c) Mixed. (d) None of the above.

90. $P_{ij} X_j = Y_i$. Then P_{ij} is a :

- (a) 0th rank tensor. (b) Ist rank tensor.
 (c) IInd rank tensor. (d) IIIrd rank tensor.

91. The set $(1, -1, i, -i)$ forms a group under multiplication. Then who is the generator of the group :

- (a) 1. (b) -1 .
 (c) i . (d) None of these.

92. What is the inverse of $-i$. If $G = 1, -1, i, -i$ is group under multiplication ?

- (a) -1 . (b) i .
 (c) 1. (d) None of above.

93. The eigen value of $A = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ are :

- (a) Real and distinct. (b) Complex and distinct.
 (c) Complex and coinciding. (d) Real and coinciding.

94. A particle is constrained to move on the inner surface of a bowl. The number of degrees freedom are/is :
- (a) 1. (b) 2.
(c) 3. (d) 0.
95. Which of the following is the SI unit of force ?
- (a) Kg m. (b) Kgm².
(c) Kgm²/s. (d) Kgm/s².
96. Which of the following is a vector quantity ?
- (a) Density. (b) Mass.
(c) Volume. (d) Acceleration.
97. If the resultant of two equal forces has the same magnitude as either of the forces, then the angle between the two forces in degree is :
- (a) 30. (b) 60.
(c) 90. (d) 120.
98. One watt is equal to :
- (a) 0.1 joule/s. (b) 1 joule/s.
(c) 10 joules/s. (d) 100 joules/s.
99. The elastic scattering of photons is called as :
- (a) Atmospheric scattering. (b) Rayleigh Scattering.
(c) Conserved Scattering. (d) Raman Scattering.
100. Raman lines are generally :
- (a) Weak. (b) Strong.
(c) Curved. (d) Blurry.