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PHD-EE-2023-24

Physics

10029

Sr. No. .....

Time : **1¼ Hours** Max. Marks : **100** Total Questions : **100**

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SEAL

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1. The directional derivative of $\varphi = x^2yz + 2xz^3$ at (1, 1, −1) in the direction $2\hat{i} - 2\hat{j} + \hat{k}$ is :

(1) $\frac{2}{3}$ (2) $-\frac{2}{3}$

(3) $\frac{5}{3}$ (4) $\frac{1}{3}$

2. The angle between the surfaces $x^2 + y^2 + z^2 = 1$ and $z = x^2 + y^2 - 1$ at the point (1, +1, −1) is :

(1) 15.76° (2) 1.75°

(3) 2.53° (4) 25.23°

3. A G.M. counter records 4,900 background counts in 100 min. with a radioactive source in position, the same total number of counts are recorded in 20 min. The percentage of S.D. with net counts due to the source is :

(1) 5.5% (2) 1.8%

(3) 0.5% (4) 2.5%

4. The alpha ray activity of a material is measured after equal successive intervals (hours), in terms of its initial activity as unity to the 0.835; 0.695; 0.580; 0.485; 0.405 and 0.335. Assuming that the activity obeys an exponential decay law, the half-life is :

(1) 5.63 h (2) 8.05 h

(3) 2.15 h (4) 3.82 h

5. A thin uniform annular disc of mass M has outer radius $4R$ and inner radius $3R$. The work required to take a unit mass from point P on its axis to infinity is :

(1) $\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$ (2) $-\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$

(3) $\frac{GM}{4R}$ (4) $\frac{2GM}{5R}\left(\sqrt{2}-1\right)$

6. Two masses m_1 and m_2 connected by a spring of spring constant k rest on a frictionless surface. If the masses are pulled apart and let go, the time period of oscillation is :

(1) $T = 2\pi\sqrt{\frac{1}{k}\left(\frac{m_1 m_2}{m_1 + m_2}\right)}$ (2) $T = 2\pi\sqrt{k\left(\frac{m_1 + m_2}{m_1 m_2}\right)}$

(3) $T = 2\pi\sqrt{\frac{m_1}{k}}$ (4) $T = 2\pi\sqrt{\frac{m_2}{k}}$

7. Two particles of rest mass m_0 approach each other with equal and opposite velocity v, in the laboratory frame. The total energy of one particle as measured in the rest frame of other is :

(1) $E = m_o c^2$ (2) $E = 2m_o c^2$

(3) $E = 3m_o c^2$ (4) $E = 1/2 m_o c^2$

8. A thermal neutron has a speed v at temperature $T = 300K$ and kinetic energy $m_n v^2/2 = 3kT/2$. The de-Broglie wavelength of thermal neutron is :

(1) 0.27 $\mathring{A}$ (2) 1.37 $\mathring{A}$

(3) 2.27 $\mathring{A}$ (4) 3.17 $\mathring{A}$

9. Using the uncertainty principle, the ground state energy of a linear oscillator is expressed by :

(1) $\frac{1}{2}\hbar\omega$ (2) $\hbar\omega$ (3) $\frac{3}{2}\hbar\omega$ (4) $2\hbar\omega$

10. An electron is trapped in an infinitely deep potential well of width $L = 106$ *fm*. The wavelength of photon emitted from the transition $E_4 \rightarrow E_3$ is :

(1) 3.453 nm (2) 4.665 nm

(3) 1.435 nm (4) 0.453 nm

11. A particle of mass m_e trapped in an infinite depth well of width $L = 1$ nm. Consider the transition from the excited state $n = 2$ to the ground state $n = 1$. The wavelength of light emitted is :

(1) 1234 nm (2) 8864 nm (3) 4321 nm (4) 8790 nm

12. A particle of mass m and charge q oscillating with frequency ω is subjected to a uniform electric field E parallel to the direction of oscillation. The stationary energy levels is :

(1) $\left(n+\frac{1}{2}\right)\hbar\omega$ (2) $\frac{1}{2}\hbar\omega$

(3) $\left(n^2+\frac{1}{2}\right)\hbar\omega$ (4) $\hbar\omega$

13. The rms velocity of hydrogen molecules at NTP and at 127° C is :

(1) 148 *m/s* (2) 2134 *m/s* (3) 876 *m/s* (4) 3149 *m/s*

14. The fraction of the oxygen molecule with velocities between 199 m/s and 201 m/s at 27°C :

(1) 1.29×10^{-3} (2) 2.29×10^{-2}

(3) 2.29×10^{-3} (4) 5.29×10^{-2}

15. If 1 g of water freezes into ice, the change in its specific volume is 0.091 cc. The pressure required to be applied to freeze 10 g of water at –1°C.

(1) 3.345 atm (2) 0.254 atm (3) 2.24 atm (4) 2.587 atm

16. A 50 Ω resistor carrying a constant current of 1*A* is kept at a constant temperature of 300 K by a stream of cooling water. In a time interval of 1 sec, the change in entropy of the resistor is :

(1) Zero (2) $10\ JK^{-1}$ (3) $1000\ JK^{-1}$ (4) Infinity

17. Consider six distinguishable particles are distributed over three nondegenerate energy levels. Level 1 is at zero energy; level 2 has an energy ϵ; and level 3 has energy 2ϵ. The total number of microstates for the system is :

(1) 10 (2) 1168 (3) 555 (4) 729

18. An ideal Fermi gas is at rest at absolute temperature zero and has a Fermi energy ϵ. The mass of each particle is m. If v denotes the velocity of a molecule, then $\overline{v}_x^2$ is :

(1) $2\epsilon/5m$ (2) $5\epsilon/2m$ (3) $2m/5\epsilon$ (4) $5m/2\epsilon$

19. The temperature at which an ideal gas whose molecules have an average kinetic energy of 1 eV is :

(1) 10345 K (2) 11594 K

(3) 1234 K (4) 4532 K

20. The classical value of molar specific heat is :

(1) $R_u/2$ (2) $3R_u$

(3) R_u (4) $3R_u/2$

21. The change of melting point of naphthalene per atmospheric change of pressure, given melting point = 80°C, latent heat = 35.5 cal/g, density of solid = 1.145 g/cc and density of liquid = 0.981 g/cc is :

(1) 100 K (2) 300 K

(3) 273 K (4) 273.0346 K

22. The amount of heat (in eV) must be added to a system at 27°C for the number of accessible states to increase by a factor of 10^8 is :

(1) 0.477 eV (2) 1.235 eV

(3) 1.874 eV (4) 2.365 eV

23. A wire of length 1m and radius 1mm is heated via an electric current to produce 1 kW of radiant power. Treating the wire as a perfect blackbody and ignoring any end effects, the temperature of the wire is :

(1) 1358 K (2) 1294 K (3) 273 K (4) 8569 K

24. A blackbody has its cavity of cubical shape. The number of modes of vibration per unit volume in the wavelength region 4,990–5,010 Å is :

(1) $1.038 \times 10^{19}/m^3$ (2) $5.038 \times 10^{11}/m^3$

(3) $8.038 \times 10^{17}/m^3$ (4) $0.038 \times 10^{19}/m^3$

25. A common-emitter transistor has a typical value of gain (β) as 50 and the collector current is 10 mA. The emitter *current* is :

(1) 10.2 mA (2) 45.8 mA (3) 22.4 mA (4) 12.5 mA

26. A transistor has a collector current of 5 mA, when the emitter voltage is 20 mV. At 30 mV. At 30 mV, the current is 30 mA. At 50 mV, it is :

(1) 80 mA (2) 280 mA

(3) 480 mA (4) 1080 mA

27. The operating frequency of a Wien-bridge oscillator is given by :

(1) $\frac{1}{2\pi\sqrt{LC}}$ (2) $\frac{1}{4\pi\sqrt{LC}}$

(3) $\frac{1}{2\pi RC}$ (4) $\frac{1}{2\pi\sqrt{RC}}$

28. The reverse saturation current in a p-n diode :

(1) Increases (2) Decreases

(3) Remains constant (4) Oscillates

29. The phase difference between the input and output voltages of a transistor connected in common emitter arrangement is :

(1) 360° (2) 180° (3) 90° (4) 270°

30. The DC current gain of a common-base transistor is 0.956 and emitter current is 10 *mA*. The base current value is :

(1) 0.66 *mA* (2) 0.38 *mA*

(3) 0.25 *mA* (4) 0.44 *mA*

31. In the triode region, the $I_D - V_{DS}$ characteristics of a MOSFET are :

(1) Hyperbolic (2) Linear

(3) Quadratic (4) Exponential

32. The output of operational amplifier increases 5 *V* in 15 µs. The slew rate is :

(1) 90 V/µs (2) 0.333 V/µs

(3) 30 V/µs (4) 5 V/µs

33. The efficiency of a full-wave rectifier is :

(1) Same as half-wave rectifier (2) Double the half-wave rectifier

(3) One-half of half-wave rectifier (4) One-third of half-wave rectifier

34. The most unique property of laser :

(1) speed (2) directional

(3) coherence (4) wavelength

35. Which of the following is an example of optical pumping ?

(1) Ruby laser (2) Helium-Neon laser

(3) Semiconductor laser (4) Dye laser

36. The following type of laser can be used for generation of laser pulse :

(1) Nd-YAG laser (2) Carbon dioxide laser

(3) Helium neon laser (4) Ruby laser

37. What is the need to achieve population inversion ?

(1) To excite most of the atoms

(2) To bring most of the atoms to ground state

(3) To achieve stable condition

(4) To reduce the time of production of laser

38. Which of the following is used in atomic clocks ?

(1) Laser (2) Quartz (3) Maser (4) Helium

39. The shape of the Earth's orbit :

(1) eclipse with low excitability (2) eclipse with low eccentricity

(3) circle (4) ellipse with high eccentricity

40. The "Planetoids" are located between :

(1) Earth & Mars (2) Mars and Jupiter

(3) Saturn & Jupiter (4) Mercury and Venus

41. Which planet can never be seen on the meridian at midnight ?

(1) Jupiter (2) Mercury (3) Saturn (4) Mars

42. For an n-channel silicon FET with channel width of 3×10^{-4} cm and the dopant concentration of 10^{15} electrons/cm^3. The relative dielectric constant of silicon is 12 and the pinch of voltage is :

(1) 10 V (2) 13.5 V

(3) 6.8 V (4) 15.5 V

43. A half-wave rectifier is supplied with an AC supply of 120 V at 60 Hz through a step-down transformer having a turn ratio of 10 : 1. By assuming an ideal diode is used, the output DC voltage of diode is :

(1) 5.40 V (2) 7.8 V (3) 8.5 V (4) 3.3 V

44. Consider an ideal op-amplifier with infinite voltage gain. Let V_1 and V_2 be the values of independent voltage sources connected to the positive and negative input terminals, respectively, and let V_o be the output voltage. If $V_1 \neq V_2$, then V_o will be :

(1) Zero (2) Infinite

(3) Finite (4) Unpredictable

45. A differential amplifier has an open-circuit voltage again of 100. This amplifier has a common input signal of 3.2 V to both terminals and it results in an output signal of 26 mV, the CMRR is :

(1) 81.8 dB (2) 55.4 dB (3) 23.4 dB (4) 36.7 dB

46. The laser action is mainly characterized by :

(1) Spontaneous emission process (2) Stimulated emission process

(3) Thermionic emission process (4) Plasmonic process

47. The number of photons, from green light of mercury ($\lambda = 4961\ \mathring{A}$), required to do one joule of work :

(1) $4524.2\times10^{18}/m^3$ (2) $2.4961 \times 10^{18}/m^3$

(3) $2.4961/m^3$ (4) $2.4961/m$

48. The binding energy of the electron for the lowest energy level of the hydrogen atom is :

(1) $-3.399\ eV$ (2) $3.399\ meV$

(3) $-13.595\ eV$ (4) $-13595\ meV$

49. Sea water has a refractive index of 1.33 and absorbs 99.8% of red light of wavelength 500 nm in a depth of 10 m. The complex refractive dielectric constant at this wavelength is :

(1) $1.77 + i\,9.2 \times 10^{-8}$ (2) $3.37 + i\,4.1 \times 10^{-5}$

(3) $i\ 9.2 \times 10^{-8}$ (4) $2.23 + i\,1.2 \times 10^{-6}$

50. The Doppler broadening of the emission wavelength takes place in :

(1) He-Ne laser (2) Nd:YAG laser

(3) Nd:glass laser (4) Ruby laser

51. The wavelength of radiation emitted by an LED made up of a semiconducting material with band gap energy 2.8 eV :

(1) 2.8 $\mathring{A}$ (2) 4.3308 $\mathring{A}$

(3) 5548.4 $\mathring{A}$ (4) 4430.8 $\mathring{A}$

52. Goldilocks Zone means :

(1) Habitable Zone (2) Porridge Zone

(3) Ursa Major Zone (4) Just right distance from Jupiter

53. Hubble's Law enables astronomers to estimate the distance to a galaxy if they can determine the galaxy's :

(1) Spectral type (2) Mass

(3) Velocity of recession (4) Temperature

54. The cosmic microwave background radiation comes from :

(1) Quasars (2) The solar nebula

(3) The Big Bang (4) Radio galaxies

55. The lattice parameter and density for an fcc lattice of copper are 3.60 $\mathring{A}$ and 9055 kg/m^3 respectively. If the atomic weight of copper is 63.6, the number atoms per unit cell is :

(1) 4 (2) 6 (3) 8 (4) 12

56. The potential energy of system of Na^+ and Cl^- ions when they are at 4 $\mathring{A}$ apart :

(1) $-8.5\ eV$ (2) $-3.6\ eV$

(3) $-2.5\ eV$ (4) -5.5 eV

57. The degeneracy of the quantum states with $\left(n_x^2+n_y^2+n_z^2\right)=6$ is :

(1) 12 (2) 24 (3) 48 (4) 8

58. At 0 K, the probability of finding an electron at energy level E is unity, when :

(1) $E=E_F$ (2) $E>E_F$

(3) $E<E_F$ (4) $E>>E_F$

59. The electric field required to accelerate an electron in cubic diamond having energy gap of 5.4 eV and lattice constant of 3.57 $\mathring{A}$ over a distance equal to the atomic radius is :

(1) 7×10^{10} (2) 1.4×10^{10} (3) 9×10^{10} (4) 2.5×10^{11}

60. The net magnetic moment of Fe atom in BCC crystal (a = 2.857 $\mathring{A}$) is 2.2μB. The saturation magnetization of Fe at $0K$ is :

(1) $100\ kA\ m^{-1}$ (2) $1750\ kA\ m^{-1}$

(3) $2500\ kA\ m^{-1}$ (4) $3520\ kA\ m^{-1}$

61. The critical magnetic field for aluminium is 7.9×10^3 A/m in which current flow through a long thin superconducting write of diameter 10^{-3}m. The critical current is found to be :

(1) $34\ A$ (2) $24.81\ A$ (3) $35.46\ A$ (4) $15.55\ A$

62. The transition from the ferromagnetic to the paramagnetic state is named after :

(1) Curie-Weiss (2) Neel (3) Debye (4) Curie

63. The magnetization of a superconductor is :

(1) Zero (2) –B (3) Constant (4) –H

64. The electrical power output of a photodiode is maximum when a :
(1) Small forward current flows through it irrespective of the bias
(2) Small forward bias exists across it
(3) Large reverse bias exists across it
(4) Small reverse bias exists across it

65. One of the allotropy of carbon is graphite whose crystal structure is hexagonal. Let the lattice parameters for graphite be a = 2.451 $\mathring{A}$; $c = 6.701\mathring{A}$ and with density of 2.2589 g/cm^3. An estimated number of atoms in their unit cell :
(1) 6 (2) 8 (3) 12 (4) 4

66. The packing efficiency of diamond cubic unit cell is :
(1) 0.34 (2) 0.52 (3) 0.68 (4) 0.74

67. In ionic solid if the radius of anion is r_a and of cation is r_c, then bond length is :
(1) $(r_c + r_a)$ (2) $\sqrt{3}(r_c + r_a)$
(3) $\sqrt{3}/2(r_c + r_a)$ (4) $(r_c - r_a)$

68. Calculate the energy difference between the two levels for which $n_x = n_y = n_z = 1$ and the next higher level for the free electron in a solid cube of side 10 mm :
(1) $1.13 \times 10^{-14}\ eV$ (2) $4.46 \times 10^{-15}\ eV$
(3) $5.86 \times 10^{-14}\ eV$ (4) $9.04 \times 10^{-13}\ eV$

69. Calculate the Fermi energy of monovalent bcc crystal whose lattice constant is 2.54 $\mathring{A}$.
(1) 1.035 eV (2) 4.567 eV
(3) 8.991 eV (4) 3.456 eV

70. The fraction of electrons excited across the energy gap in Germanium $(E_g = 0.7eV)$ at room temperature (300 K) is :
(1) 7×10^{-18} (2) 1.7×10^{-12}
(3) 4×10^{-12} (4) 1.3×10^{-6}

71. The BCC iron has lattice parameter of 2.87 $\mathring{A}$ and its saturation magnetization value of 2750 $kA\ m^{-1}$. The net magnetic moment per iron atom in the crystal :

(1) 4 (2) 3.5 (3) 7.4 (4) 6.3

72. Calculate the wavelength of the photon, which will be required to break a cooper pair in a superconductor like zirconium whose T_c is 0.56 K :

(1) 7.2×10^{-3} m (2) 1.5×10^{-4} m

(3) 4.3×10^{-5} m (4) 3.8×10^{-2} m

73. Laser-produced plasma consisting of a 50 μm diameter ball of radiates very strongly at a wavelength of 5 nm. At a distance of 0.75 m from the source, the spatial coherence resulting from light emitted from opposite sides of the plasma is :

(1) $5 \times 10^{-5}\ m$ (2) $0.55 \times 10^{-5}\ m$

(3) $1.2 \times 10^{-5} m$ (4) $7.5 \times 10^{-5}\ m$

74. Consider the two-level system with $E_1 = -13.6\ eV, E_2 = -3.4 eV$ and the co-efficient $A_{21} = 6 \times 10^8 s^{-1}$. The frequency of light emitted due to transition from E_2 and E_1 is :

(1) 8.2×10^{17} Hz (2) 4.5×10^{16} Hz

(3) 2.5×10^{15} Hz (4) 6.5×10^{14} Hz

75. A solid-state laser emits radiation of wavelength of 6000 $\mathring{A}$ and the life time, $\tau_{sp} = 10^{-6}$ s. Assume that the refractive index of the medium is one and the co-efficient of stimulated emission is :

(1) 1.3×10^{19} m/kg (2) 1.3×10^{19} m/g

(3) 6.6×10^{19} cm/kg (4) 6.6×10^{19} m/g

76. The ratio of spontaneous emission to stimulation emission for a cavity of temperature 50 K and wavelength of $10^{-5}\ m$:

(1) 3.218×10^{10} (2) 3.218×10^{12}

(3) 3.218×10^{14} (4) 3.218×10^{16}

77. One of the following type of galaxies do ***not*** fall on Hubble's tuning fork diagram :

(1) Barred spiral galaxies (2) Peculiar galaxies

(3) Elliptical galaxies (4) Spiral galaxies

78. A Michelson interferometer is used to determine the apparent diameter of a star. The fringe pattern disappears when the adjustable mirrors are at a separation of 10 m and wavelength of light used is 7×10^{-4} mm. The angular diameter of the star is :

(1) 8.54×10^{-8} radians (2) 3.54×10^{-9} radians

(3) 1.34×10^{-8} radians (4) 1.22×10^{-8} radians

79. The proton proton chain reaction :

(1) Produces chains of protons which are then broken apart to produce the Sun's energy

(2) Is a three-step process which converts some mass to energy as helium nuclei are formed

(3) Is the runaway reaction that produces the fission of iron during a supernova explosion

(4) adds protons together until a massive carbon nucleus is produced at the core of the sun

80. An approximate diameter of Milky Way :

(1) 1000 light years (2) 100000 light years

(3) 10000 light years (4) 1000000 light years

81. A beam of protons of 5MeV kinetic energy traverses a gold foil, one particle in 5×10^6 is scattered so as to hit a surface 0.5 cm^2 in area at a distance 10 cm from the foil and in a direction making an angle of 60° with the initial direction of the beam and the tickness of the foil is :

(1) 1.31 μm (2) 2.1 μm (3) 5.31 μm (4) 7.31 μm

82. If the radius of silver nucleus (Z = 47), is 7×10^{-15} m, the minimum energy that the particle should have to just reach it is :

(1) 9.34 *MeV* (2) 1.34 *MeV* (3) 4.34 *MeV* (4) 19.34 *MeV*

83. The binding energy of the nuclei $^{56}_{26}Fe$ in units of MeV :

(1) 492.26 MeV (2) 42.16 MeV

(3) 592.06 MeV (4) 402.26 MeV

84. A given coin has a mass of 3.0 g. The nuclear energy that would be required to separate all the neutrons and protons from each other is (assume that the coin is entirely made of $^{63}_{29}Cu$ atoms) :

(1) 4.6×10^{24} MeV (2) 1.6×10^{25} MeV

(3) 5.6×10^{28} MeV (4) 5.3×10^{22} MeV

85. The effective radius of deuteron can be taken to be 2 fm. The hight of potential barrier for head-on collision of two deuterons is :

(1) 104 keV (2) 100 keV (3) 180 keV (4) 380 keV

86. The energy released by fission of 1.0 kg of ^{235}U in a fission reactor is :

(1) 6.1×10^{22} MeV (2) 3.1×10^{25} MeV

(3) 0.1×10^{21} MeV (4) 5.1×10^{26} MeV

87. The electric field in a region is radically outward with magnitude of E = Ar. The charge contained in a sphere of radius, r centred at the origin is (A = 100 V/m^2 and r = 20 cm) :

(1) 2.389×10^{-7} C (2) 1.89×10^{-9} C

(3) 5.32×10^{-4} C (4) 8.89×10^{-9} C

88. A charge Q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre of the plate is 10 V/m. If the plate is replaced by a copper plate of the same geometrical dimensions and carrying the same charge Q, the electric field at the point P will become :

(1) Zero (2) 5 V/m (3) 10 V/m (4) 20 V/m

89. A metallic particle having no net charge is placed near a finite metal plate carrying a positive charge. The electric force on the particle will be :

(1) towards the plate
(2) Away from the plate
(3) Parallel to the plate
(4) zero

90. The magnitude of the electric field at a point 4 cm away from a line charge of density 2×10^{-6}/m is :

(1) 3.0×10^{3} N/C
(2) 9.0×10^{5} N/C
(3) 4.0×10^{7} N/C
(4) 9.0×10^{9} N/C

91. A parallel plate capacitor having plate area 100 cm^2 and separation 1mm holds a charge of 0.12 μC when connected to a 120 V battery. The dielectric constant of the material filling the gap is equal to :

(1) 11.3 (2) 7 (3) 15 (4) 20

92. The energy density in the electric field created by a point charge falls off with the distance from the point charge is :

(1) $\frac{1}{r}$ (2) $\frac{1}{r^2}$ (3) $\frac{1}{r^3}$ (4) $\frac{1}{r^4}$

93. An electron moves in a circle of radius 10 cm with a constant speed of 4×10^{6} m/s. The electric current at a point on the circle is :

(1) $3.0 \times 10^{-10} A$
(2) $1.0 \times 10^{-12} A$
(3) $4.0 \times 10^{-13} A$
(4) $5.0 \times 10^{-11} A$

94. A capacitor is connected to a 12 V battery through a resistance of 10 W. It is found that the potential difference across the capacitor rises to 4.0 V in 1 μs. The capacitance of the capacitor is :

(1) 1.25 μF (2) 4.25 μF (3) 3.25 μF (4) 0.25 μF

95. Two resistors R and 2R are connected in series in an electric circuit. The thermal energy developed in R and 2R are in the ratio :

(1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 1 : 3

96. A circular loop of area 1 cm^2, carrying a current of 10 A. is placed in a magnetic field of 0.1. T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is :

(1) Zero (2) 10^{-4} Nm (3) 10^{-3} Nm (4) 10^{-2} Nm

97. Which of the following particles will experience a maximum magnetic force (magnitude) when projected with the same velocity perpendicular to a magnetic field ?

(1) Electron (2) Proton (3) He^+ (4) Li^{++}

98. The magnetic field B due to a current carrying circular loop radius 12 cm at its centre is 0.50×10^{-4}T. The magnetic field due to this loop at a point on the axis at a distance of 5.0 cm from the centre is :

(1) $1.9 \times 10^{-7}\ T$ (2) 3.9×10^{-5} T

(3) 5.9×10^{-4} T (4) 0.9×10^{-3} T

99. The magnetic moment of the assumed dipole at the earth's centre is 8.0×1022 A m^2. The magnetic-field B at the geomagnetic poles of the earth is (radius of earth is 6400 km) :

(1) 60 μT (2) 120 μT (3) 240 μT (4) 480 μT

100. The sunlight reaching the earth has maximum electric field of 810 V/m. The maximum magnetic field in this light is :

(1) 6 μT (2) 120 μT

(3) 2.7 μT (4) 33 μT

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Physics

10030

Sr. No. .....

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1. Which planet can never be seen on the meridian at midnight ?

(1) Jupiter (2) Mercury (3) Saturn (4) Mars

2. For an n-channel silicon FET with channel width of 3×10^{-4} cm and the dopant concentration of 10^{15} electrons/cm^3. The relative dielectric constant of silicon is 12 and the pinch of voltage is :

(1) 10 V (2) 13.5 V

(3) 6.8 V (4) 15.5 V

3. A half-wave rectifier is supplied with an AC supply of 120 V at 60 Hz through a step-down transformer having a turn ratio of 10 : 1. By assuming an ideal diode is used, the output DC voltage of diode is :

(1) 5.40 V (2) 7.8 V (3) 8.5 V (4) 3.3 V

4. Consider an ideal op-amplifier with infinite voltage gain. Let V_1 and V_2 be the values of independent voltage sources connected to the positive and negative input terminals, respectively, and let V_o be the output voltage. If $V_1 \neq V_2$, then V_o will be :

(1) Zero (2) Infinite

(3) Finite (4) Unpredictable

5. A differential amplifier has an open-circuit voltage again of 100. This amplifier has a common input signal of 3.2 V to both terminals and it results in an output signal of 26 mV, the CMRR is :

(1) 81.8 dB (2) 55.4 dB (3) 23.4 dB (4) 36.7 dB

6. The laser action is mainly characterized by :

(1) Spontaneous emission process (2) Stimulated emission process

(3) Thermionic emission process (4) Plasmonic process

7. The number of photons, from green light of mercury ($\lambda = 4961\ \mathring{A}$), required to do one joule of work :

(1) $4524.2\times10^{18}/m^3$ (2) $2.4961\times10^{18}/m^3$

(3) $2.4961/m^3$ (4) $2.4961/m$

8. The binding energy of the electron for the lowest energy level of the hydrogen atom is :

(1) $-3.399\ eV$ (2) $3.399\ meV$

(3) $-13.595\ eV$ (4) $-13595\ meV$

9. Sea water has a refractive index of 1.33 and absorbs 99.8% of red light of wavelength 500 nm in a depth of 10 m. The complex refractive dielectric constant at this wavelength is :

(1) $1.77 + i\,9.2\times10^{-8}$ (2) $3.37 + i\,4.1\times10^{-5}$

(3) $i\ 9.2\times10^{-8}$ (4) $2.23 + i\,1.2\times10^{-6}$

10. The Doppler broadening of the emission wavelength takes place in :

(1) He-Ne laser (2) Nd:YAG laser

(3) Nd:glass laser (4) Ruby laser

11. The BCC iron has lattice parameter of 2.87 $\mathring{A}$ and its saturation magnetization value of 2750 $kA\ m^{-1}$. The net magnetic moment per iron atom in the crystal :

(1) 4 (2) 3.5 (3) 7.4 (4) 6.3

12. Calculate the wavelength of the photon, which will be required to break a cooper pair in a superconductor like zirconium whose T_c is 0.56 K :

(1) 7.2×10^{-3} m (2) 1.5×10^{-4} m

(3) 4.3×10^{-5} m (4) 3.8×10^{-2} m

13. Laser-produced plasma consisting of a 50 µm diameter ball of radiates very strongly at a wavelength of 5 nm. At a distance of 0.75 m from the source, the spatial coherence resulting from light emitted from opposite sides of the plasma is :

(1) $5\times10^{-5}\ m$ (2) $0.55\times10^{-5}\ m$

(3) $1.2\times10^{-5} m$ (4) $7.5\times10^{-5}\ m$

14. Consider the two-level system with $E_1 = -13.6\ eV, E_2 = -3.4 eV$ and the co-efficient $A_{21} = 6 \times 10^8 s^{-1}$. The frequency of light emitted due to transition from E_2 and E_1 is :

(1) 8.2×10^{17} Hz (2) 4.5×10^{16} Hz

(3) 2.5×10^{15} Hz (4) 6.5×10^{14} Hz

15. A solid-state laser emits radiation of wavelength of 6000 $\mathring{A}$ and the life time, $\tau_{sp} = 10^{-6}$ s. Assume that the refractive index of the medium is one and the co-efficient of stimulated emission is :

(1) 1.3×10^{19} m/kg (2) 1.3×10^{19} m/g

(3) 6.6×10^{19} cm/kg (4) 6.6×10^{19} m/g

16. The ratio of spontaneous emission to stimulation emission for a cavity of temperature 50 K and wavelength of 10^{-5} m :

(1) 3.218×10^{10} (2) 3.218×10^{12}

(3) 3.218×10^{14} (4) 3.218×10^{16}

17. One of the following type of galaxies do ***not*** fall on Hubble's tuning fork diagram :

(1) Barred spiral galaxies (2) Peculiar galaxies

(3) Elliptical galaxies (4) Spiral galaxies

18. A Michelson interferometer is used to determine the apparent diameter of a star. The fringe pattern disappears when the adjustable mirrors are at a separation of 10 m and wavelength of light used is 7×10^{-4} mm. The angular diameter of the star is :

(1) 8.54×10^{-8} radians (2) 3.54×10^{-9} radians

(3) 1.34×10^{-8} radians (4) 1.22×10^{-8} radians

19. The proton proton chain reaction :

(1) Produces chains of protons which are then broken apart to produce the Sun's energy

(2) Is a three-step process which converts some mass to energy as helium nuclei are formed

(3) Is the runaway reaction that produces the fission of iron during a supernova explosion

(4) adds protons together until a massive carbon nucleus is produced at the core of the sun

20. An approximate diameter of Milky Way :

(1) 1000 light years (2) 100000 light years

(3) 10000 light years (4) 1000000 light years

21. A parallel plate capacitor having plate area 100 cm^2 and separation 1mm holds a charge of 0.12 μC when connected to a 120 V battery. The dielectric constant of the material filling the gap is equal to :

(1) 11.3 (2) 7 (3) 15 (4) 20

22. The energy density in the electric field created by a point charge falls off with the distance from the point charge is :

(1) $\frac{1}{}$ (2) $\frac{1}{2}$ (3) $\frac{1}{3}$ (4) $\frac{1}{4}$

23. An electron moves in a circle of radius 10 cm with a constant speed of 4×10^6 m/s. The electric current at a point on the circle is :

(1) $3.0 \times 10^{-10} A$ (2) $1.0 \times 10^{-12} A$

(3) $4.0 \times 10^{-13} A$ (4) $5.0 \times 10^{-11} A$

24. A capacitor is connected to a 12 V battery through a resistance of 10 W. It is found that the potential difference across the capacitor rises to 4.0 V in 1 μs. The capacitance of the capacitor is :

(1) 1.25 μF (2) 4.25 μF (3) 3.25 μF (4) 0.25 μF

25. Two resistors R and 2R are connected in series in an electric circuit. The thermal energy developed in R and 2R are in the ratio :

(1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 1 : 3

26. A circular loop of area 1 cm^2, carrying a current of 10 A. is placed in a magnetic field of 0.1. T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is :

(1) Zero (2) 10^{-4} Nm (3) 10^{-3} Nm (4) 10^{-2} Nm

27. Which of the following particles will experience a maximum magnetic force (magnitude) when projected with the same velocity perpendicular to a magnetic field ?

(1) Electron (2) Proton (3) He^+ (4) Li^{++}

28. The magnetic field B due to a current carrying circular loop radius 12 cm at its centre is 0.50×10^{-4}T. The magnetic field due to this loop at a point on the axis at a distance of 5.0 cm from the centre is :

(1) $1.9 \times 10^{-7}\ T$ (2) 3.9×10^{-5} T

(3) 5.9×10^{-4} T (4) 0.9×10^{-3} T

29. The magnetic moment of the assumed dipole at the earth's centre is 8.0×1022 A m^2. The magnetic-field B at the geomagnetic poles of the earth is (radius of earth is 6400 km) :

(1) 60 μT (2) 120 μT (3) 240 μT (4) 480 μT

30. The sunlight reaching the earth has maximum electric field of 810 V/m. The maximum magnetic field in this light is :

(1) 6 μT (2) 120 μT

(3) 2.7 μT (4) 33 μT

31. The directional derivative of $\varphi = x^2yz + 2xz^3$ at (1, 1, –1) in the direction $2\hat{i} - 2\hat{j} + \hat{k}$ is :

(1) $\frac{2}{3}$ (2) $-\frac{2}{3}$

(3) $\frac{5}{2}$ (4) $\frac{1}{2}$

32. The angle between the surfaces $x^2 + y^2 + z^2 = 1$ and $z = x^2 + y^2 - 1$ at the point (1, +1, –1) is :

(1) 15.76° (2) 1.75°

(3) 2.53° (4) 25.23°

33. A G.M. counter records 4,900 background counts in 100 min. with a radioactive source in position, the same total number of counts are recorded in 20 min. The percentage of S.D. with net counts due to the source is :

(1) 5.5% (2) 1.8%

(3) 0.5% (4) 2.5%

34. The alpha ray activity of a material is measured after equal successive intervals (hours), in terms of its initial activity as unity to the 0.835; 0.695; 0.580; 0.485; 0.405 and 0.335. Assuming that the activity obeys an exponential decay law, the half-life is :

(1) 5.63 h (2) 8.05 h

(3) 2.15 h (4) 3.82 h

35. A thin uniform annular disc of mass M has outer radius $4R$ and inner radius $3R$. The work required to take a unit mass from point P on its axis to infinity is :

(1) $\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$ (2) $-\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$

(3) $\frac{GM}{4R}$ (4) $\frac{2GM}{5R}\left(\sqrt{2}-1\right)$

36. Two masses m_1 and m_2 connected by a spring of spring constant k rest on a frictionless surface. If the masses are pulled apart and let go, the time period of oscillation is :

(1) $T=2\pi\sqrt{\frac{1}{k}\left(\frac{m_1m_2}{m_1+m_2}\right)}$ (2) $T=2\pi\sqrt{k\left(\frac{m_1+m_2}{m_1m_2}\right)}$

(3) $T=2\pi\sqrt{\frac{m_1}{k}}$ (4) $T=2\pi\sqrt{\frac{m_2}{k}}$

37. Two particles of rest mass m_0 approach each other with equal and opposite velocity v, in the laboratory frame. The total energy of one particle as measured in the rest frame of other is :

(1) $E = m_o c^2$ (2) $E = 2m_o c^2$

(3) $E = 3m_o c^2$ (4) $E = 1/2 m_o c^2$

38. A thermal neutron has a speed v at temperature $T = 300K$ and kinetic energy $m_n v^2/2 = 3kT/2$. The de-Broglie wavelength of thermal neutron is :

(1) 0.27 $\mathring{A}$ (2) 1.37 $\mathring{A}$

(3) 2.27 $\mathring{A}$ (4) 3.17 $\mathring{A}$

39. Using the uncertainty principle, the ground state energy of a linear oscillator is expressed by :

(1) $\frac{1}{2}\hbar\omega$ (2) $\hbar\omega$ (3) $\frac{3}{2}\hbar\omega$ (4) $2\hbar\omega$

40. An electron is trapped in an infinitely deep potential well of width $L = 106\ fm$. The wavelength of photon emitted from the transition $E_4 \rightarrow E_3$ is :

(1) 3.453 nm (2) 4.665 nm

(3) 1.435 nm (4) 0.453 nm

41. The wavelength of radiation emitted by an LED made up of a semiconducting material with band gap energy 2.8 eV :

(1) 2.8 $\mathring{A}$ (2) 4.3308 $\mathring{A}$

(3) 5548.4 $\mathring{A}$ (4) 4430.8 $\mathring{A}$

42. Goldilocks Zone means :

(1) Habitable Zone (2) Porridge Zone

(3) Ursa Major Zone (4) Just right distance from Jupiter

43. Hubble's Law enables astronomers to estimate the distance to a galaxy if they can determine the galaxy's :

(1) Spectral type (2) Mass

(3) Velocity of recession (4) Temperature

44. The cosmic microwave background radiation comes from :

(1) Quasars (2) The solar nebula

(3) The Big Bang (4) Radio galaxies

45. The lattice parameter and density for an fcc lattice of copper are 3.60 $\mathring{A}$ and 9055 kg/m^3 respectively. If the atomic weight of copper is 63.6, the number atoms per unit cell is :

(1) 4 (2) 6 (3) 8 (4) 12

46. The potential energy of system of Na^+ and Cl^- ions when they are at 4 $\mathring{A}$ apart :

(1) $-8.5\ eV$ (2) $-3.6\ eV$ (3) $-2.5\ eV$ (4) -5.5 eV

47. The degeneracy of the quantum states with $\left(n_x^2+n_y^2+n_z^2\right)=6$ is :

(1) 12 (2) 24 (3) 48 (4) 8

48. At 0 K, the probability of finding an electron at energy level E is unity, when :

(1) $E=E_F$ (2) $E>E_F$ (3) $E<E_F$ (4) $E>>E_F$

49. The electric field required to accelerate an electron in cubic diamond having energy gap of 5.4 eV and lattice constant of 3.57 $\mathring{A}$ over a distance equal to the atomic radius is :

(1) 7×10^{10} (2) 1.4×10^{10} (3) 9×10^{10} (4) 2.5×10^{11}

50. The net magnetic moment of Fe atom in BCC crystal (a = 2.857 $\mathring{A}$) is 2.2μB. The saturation magnetization of Fe at $0K$ is :

(1) $100\ kA\ m^{-1}$ (2) $1750\ kA\ m^{-1}$

(3) $2500\ kA\ m^{-1}$ (4) $3520\ kA\ m^{-1}$

51. The critical magnetic field for aluminium is 7.9×10^3 A/m in which current flow through a long thin superconducting write of diameter 10^{-3}m. The critical current is found to be :

(1) 34 A (2) 24.81 A (3) 35.46 A (4) 15.55 A

52. The transition from the ferromagnetic to the paramagnetic state is named after :

(1) Curie-Weiss (2) Neel (3) Debye (4) Curie

53. The magnetization of a superconductor is :

(1) Zero (2) –B (3) Constant (4) –H

54. The electrical power output of a photodiode is maximum when a :

(1) Small forward current flows through it irrespective of the bias
(2) Small forward bias exists across it
(3) Large reverse bias exists across it
(4) Small reverse bias exists across it

55. One of the allotropy of carbon is graphite whose crystal structure is hexagonal. Let the lattice parameters for graphite be a = 2.451 $\mathring{A}$; $c = 6.701\mathring{A}$ and with density of 2.2589 g/cm^3. An estimated number of atoms in their unit cell :

(1) 6 (2) 8 (3) 12 (4) 4

56. The packing efficiency of diamond cubic unit cell is :

(1) 0.34 (2) 0.52 (3) 0.68 (4) 0.74

57. In ionic solid if the radius of anion is r_a and of cation is r_c, then bond length is :

(1) $(r_c + r_a)$ (2) $\sqrt{3}(r_c + r_a)$
(3) $\sqrt{3}/2(r_c + r_a)$ (4) $(r_c - r_a)$

58. Calculate the energy difference between the two levels for which $n_x = n_y = n_z = 1$ and the next higher level for the free electron in a solid cube of side 10 mm :

(1) 1.13×10^{-14} eV (2) 4.46×10^{-15} eV
(3) 5.86×10^{-14} eV (4) 9.04×10^{-13} eV

59. Calculate the Fermi energy of monovalent bcc crystal whose lattice constant is 2.54 $\mathring{A}$.

(1) 1.035 eV (2) 4.567 eV

(3) 8.991 eV (4) 3.456 eV

60. The fraction of electrons excited across the energy gap in Germanium $(E_g = 0.7eV)$ at room temperature (300 K) is :

(1) 7×10^{-18} (2) 1.7×10^{-12}

(3) 4×10^{-12} (4) 1.3×10^{-6}

61. The change of melting point of naphthalene per atmospheric change of pressure, given melting point = 80°C, latent heat = 35.5 cal/g, density of solid = 1.145 g/cc and density of liquid = 0.981 g/cc is :

(1) 100 K (2) 300 K

(3) 273 K (4) 273.0346 K

62. The amount of heat (in eV) must be added to a system at 27°C for the number of accessible states to increase by a factor of 10^8 is :

(1) 0.477 eV (2) 1.235 eV

(3) 1.874 eV (4) 2.365 eV

63. A wire of length 1m and radius 1mm is heated via an electric current to produce 1 kW of radiant power. Treating the wire as a perfect blackbody and ignoring any end effects, the temperature of the wire is :

(1) 1358 K (2) 1294 K (3) 273 K (4) 8569 K

64. A blackbody has its cavity of cubical shape. The number of modes of vibration per unit volume in the wavelength region 4,990–5,010 Å is :

(1) $1.038 \times 10^{19}/m^3$ (2) $5.038 \times 10^{11}/m^3$

(3) $8.038 \times 10^{17}/m^3$ (4) $0.038 \times 10^{19}/m^3$

65. A common-emitter transistor has a typical value of gain (β) as 50 and the collector current is 10 mA. The emitter *current* is :

(1) 10.2 mA (2) 45.8 mA (3) 22.4 mA (4) 12.5 mA

66. A transistor has a collector current of 5 mA, when the emitter voltage is 20 mV. At 30 mV. At 30 mV, the current is 30 mA. At 50 mV, it is :

(1) 80 mA (2) 280 mA

(3) 480 mA (4) 1080 mA

67. The operating frequency of a Wien-bridge oscillator is given by :

(1) $\frac{1}{2\pi\sqrt{LC}}$ (2) $\frac{1}{4\pi\sqrt{LC}}$

(3) $\frac{1}{2\pi RC}$ (4) $\frac{1}{2\pi\sqrt{RC}}$

68. The reverse saturation current in a p-n diode :

(1) Increases (2) Decreases

(3) Remains constant (4) Oscillates

69. The phase difference between the input and output voltages of a transistor connected in common emitter arrangement is :

(1) 360° (2) 180°

(3) 90° (4) 270°

70. The DC current gain of a common-base transistor is 0.956 and emitter current is 10 mA. The base current value is :

(1) 0.66 mA (2) 0.38 mA

(3) 0.25 mA (4) 0.44 mA

71. A particle of mass m_e trapped in an infinite depth well of width $L = 1$ nm. Consider the transition from the excited state $n = 2$ to the ground state $n = 1$. The wavelength of light emitted is :

(1) 1234 nm (2) 8864 nm (3) 4321 nm (4) 8790 nm

72. A particle of mass m and charge q oscillating with frequency ω is subjected to a uniform electric field E parallel to the direction of oscillation. The stationary energy levels is :

(1) $\left(n+\frac{1}{2}\right)\hbar\omega$ (2) $\frac{1}{2}\hbar\omega$

(3) $\left(n^2+\frac{1}{2}\right)\hbar\omega$ (4) $\hbar\omega$

73. The rms velocity of hydrogen molecules at NTP and at 127° C is :

(1) 148 *m/s* (2) 2134 *m/s* (3) 876 *m/s* (4) 3149 *m/s*

74. The fraction of the oxygen molecule with velocities between 199 m/s and 201 m/s at 27°C :

(1) 1.29×10^{-3} (2) 2.29×10^{-2}

(3) 2.29×10^{-3} (4) 5.29×10^{-2}

75. If 1 g of water freezes into ice, the change in its specific volume is 0.091 cc. The pressure required to be applied to freeze 10 g of water at –1°C.

(1) 3.345 atm (2) 0.254 atm (3) 2.24 atm (4) 2.587 atm

76. A 50 Ω resistor carrying a constant current of 1*A* is kept at a constant temperature of 300 K by a stream of cooling water. In a time interval of 1 sec, the change in entropy of the resistor is :

(1) Zero (2) 10 JK^{-1} (3) 1000 JK^{-1} (4) Infinity

77. Consider six distinguishable particles are distributed over three nondegenerate energy levels. Level 1 is at zero energy; level 2 has an energy $\in$; and level 3 has energy $2\in$. The total number of microstates for the system is :

(1) 10 (2) 1168 (3) 555 (4) 729

78. An ideal Fermi gas is at rest at absolute temperature zero and has a Fermi energy $\in$. The mass of each particle is m. If v denotes the velocity of a molecule, then $\overline{v}_x^2$ is :

(1) $2\in/5m$ (2) $5\in/2m$ (3) $2m/5\in$ (4) $5m/2\in$

79. The temperature at which an ideal gas whose molecules have an average kinetic energy of 1 eV is :

(1) 10345 K (2) 11594 K

(3) 1234 K (4) 4532 K

80. The classical value of molar specific heat is :

(1) $R_u/2$ (2) $3R_u$ (3) R_u (4) $3R_u/2$

81. A beam of protons of 5MeV kinetic energy traverses a gold foil, one particle in 5×10^6 is scattered so as to hit a surface 0.5 cm^2 in area at a distance 10 cm from the foil and in a direction making an angle of 60° with the initial direction of the beam and the tickness of the foil is :

(1) 1.31 μm (2) 2.1 μm (3) 5.31 μm (4) 7.31 μm

82. If the radius of silver nucleus (Z = 47), is 7×10^{-15} m, the minimum energy that the particle should have to just reach it is :

(1) 9.34 MeV (2) 1.34 MeV (3) 4.34 MeV (4) 19.34 MeV

83. The binding energy of the nuclei $^{56}_{26}Fe$ in units of MeV :

(1) 492.26 MeV (2) 42.16 MeV

(3) 592.06 MeV (4) 402.26 MeV

84. A given coin has a mass of 3.0 g. The nuclear energy that would be required to separate all the neutrons and protons from each other is (assume that the coin is entirely made of $^{63}_{29}Cu$ atoms) :

(1) $4.6 \times 10^{24}\ MeV$ (2) $1.6 \times 10^{25}\ MeV$

(3) $5.6 \times 10^{28}\ MeV$ (4) $5.3 \times 10^{22}\ MeV$

85. The effective radius of deuteron can be taken to be 2 fm. The hight of potential barrier for head-on collision of two deuterons is :

(1) 104 *keV* (2) 100 *keV* (3) 180 *keV* (4) 380 *keV*

86. The energy released by fission of 1.0 kg of ^{235}U in a fission reactor is :

(1) $6.1 \times 10^{22}\ MeV$ (2) $3.1 \times 10^{25}\ MeV$

(3) $0.1 \times 10^{21}\ MeV$ (4) $5.1 \times 10^{26}\ MeV$

87. The electric field in a region is radically outward with magnitude of E = Ar. The charge contained in a sphere of radius, r centred at the origin is (A = 100 V/m^2 and r = 20 cm) :

(1) 2.389×10^{-7} C (2) 1.89×10^{-9} C

(3) 5.32×10^{-4} C (4) 8.89×10^{-9} C

88. A charge Q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre of the plate is 10 V/m. If the plate is replaced by a copper plate of the same geometrical dimensions and carrying the same charge Q, the electric field at the point P will become :

(1) Zero (2) 5 V/m (3) 10 V/m (4) 20 V/m

89. A metallic particle having no net charge is placed near a finite metal plate carrying a positive charge. The electric force on the particle will be :

(1) towards the plate (2) Away from the plate

(3) Parallel to the plate (4) zero

90. The magnitude of the electric field at a point 4 cm away from a line charge of density 2×10^{-6}/m is :

(1) 3.0×10^{3} N/C
(2) 9.0×10^{5} N/C
(3) 4.0×10^{7} N/C
(4) 9.0×10^{9} N/C

91. In the triode region, the $I_D - V_{DS}$ characteristics of a MOSFET are :

(1) Hyperbolic
(2) Linear
(3) Quadratic
(4) Exponential

92. The output of operational amplifier increases 5 V in 15 µs. The slew rate is :

(1) 90 V/µs
(2) 0.333 V/µs
(3) 30 V/µs
(4) 5 V/µs

93. The efficiency of a full-wave rectifier is :

(1) Same as half-wave rectifier
(2) Double the half-wave rectifier
(3) One-half of half-wave rectifier
(4) One-third of half-wave rectifier

94. The most unique property of laser :

(1) speed
(2) directional
(3) coherence
(4) wavelength

95. Which of the following is an example of optical pumping ?

(1) Ruby laser
(2) Helium-Neon laser
(3) Semiconductor laser
(4) Dye laser

96. The following type of laser can be used for generation of laser pulse :

(1) Nd-YAG laser
(2) Carbon dioxide laser
(3) Helium neon laser
(4) Ruby laser

97. What is the need to achieve population inversion ?

(1) To excite most of the atoms

(2) To bring most of the atoms to ground state

(3) To achieve stable condition

(4) To reduce the time of production of laser

98. Which of the following is used in atomic clocks ?

(1) Laser (2) Quartz (3) Maser (4) Helium

99. The shape of the Earth's orbit :

(1) eclipse with low excitability

(2) eclipse with low eccentricity

(3) circle

(4) ellipse with high eccentricity

100. The "Planetoids" are located between :

(1) Earth & Mars

(2) Mars and Jupiter

(3) Saturn & Jupiter

(4) Mercury and Venus

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C

SET-Y

PHD-EE-2023-24

Physics

Sr. No. 10027

Time : **1¼ Hours** Max. Marks : **100** Total Questions : **100**

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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.*

1. The change of melting point of naphthalene per atmospheric change of pressure, given melting point = 80°C, latent heat = 35.5 cal/g, density of solid = 1.145 g/cc and density of liquid = 0.981 g/cc is :

(1) 100 *K* (2) 300 *K*

(3) 273 *K* (4) 273.0346 *K*

2. The amount of heat (in *eV*) must be added to a system at 27°C for the number of accessible states to increase by a factor of 10^8 is :

(1) 0.477 *eV* (2) 1.235 *eV*

(3) 1.874 *eV* (4) 2.365 *eV*

3. A wire of length 1m and radius 1mm is heated via an electric current to produce 1 kW of radiant power. Treating the wire as a perfect blackbody and ignoring any end effects, the temperature of the wire is :

(1) 1358 *K* (2) 1294 *K* (3) 273 *K* (4) 8569 *K*

4. A blackbody has its cavity of cubical shape. The number of modes of vibration per unit volume in the wavelength region 4,990–5,010 Å is :

(1) $1.038 \times 10^{19}/m^3$ (2) $5.038 \times 10^{11}/m^3$

(3) $8.038 \times 10^{17}/m^3$ (4) $0.038 \times 10^{19}/m^3$

5. A common-emitter transistor has a typical value of gain (β) as 50 and the collector current is 10 *mA*. The emitter *current* is :

(1) 10.2 *mA* (2) 45.8 *mA* (3) 22.4 *mA* (4) 12.5 *mA*

6. A transistor has a collector current of 5 *mA*, when the emitter voltage is 20 *mV*. At 30 *mV*. At 30 *mV*, the current is 30 *mA*. At 50 *mV*, it is :

(1) 80 *mA* (2) 280 *mA*

(3) 480 *mA* (4) 1080 *mA*

7. The operating frequency of a Wien-bridge oscillator is given by :

(1) $\frac{1}{2\pi\sqrt{LC}}$

(2) $\frac{1}{4\pi\sqrt{LC}}$

(3) $\frac{1}{2\pi RC}$

(4) $\frac{1}{2\pi\sqrt{RC}}$

8. The reverse saturation current in a p-n diode :

(1) Increases

(2) Decreases

(3) Remains constant

(4) Oscillates

9. The phase difference between the input and output voltages of a transistor connected in common emitter arrangement is :

(1) 360°

(2) 180°

(3) 90°

(4) 270°

10. The DC current gain of a common-base transistor is 0.956 and emitter current is 10 mA. The base current value is :

(1) 0.66 mA

(2) 0.38 mA

(3) 0.25 mA

(4) 0.44 mA

11. The wavelength of radiation emitted by an LED made up of a semiconducting material with band gap energy 2.8 eV :

(1) 2.8 $\mathring{A}$

(2) 4.3308 $\mathring{A}$

(3) 5548.4 $\mathring{A}$

(4) 4430.8 $\mathring{A}$

12. Goldilocks Zone means :

(1) Habitable Zone

(2) Porridge Zone

(3) Ursa Major Zone

(4) Just right distance from Jupiter

13. Hubble's Law enables astronomers to estimate the distance to a galaxy if they can determine the galaxy's :

(1) Spectral type (2) Mass

(3) Velocity of recession (4) Temperature

14. The cosmic microwave background radiation comes from :

(1) Quasars (2) The solar nebula

(3) The Big Bang (4) Radio galaxies

15. The lattice parameter and density for an fcc lattice of copper are 3.60 $\mathring{A}$ and 9055 kg/m^3 respectively. If the atomic weight of copper is 63.6, the number atoms per unit cell is :

(1) 4 (2) 6 (3) 8 (4) 12

16. The potential energy of system of Na^+ and Cl^- ions when they are at 4 $\mathring{A}$ apart :

(1) –8.5 eV (2) –3.6 eV (3) –2.5 eV (4) –5.5 eV

17. The degeneracy of the quantum states with $\left(n_x^2 + n_y^2 + n_z^2\right) = 6$ is :

(1) 12 (2) 24 (3) 48 (4) 8

18. At 0 K, the probability of finding an electron at energy level E is unity, when :

(1) $E = E_F$ (2) $E > E_F$

(3) $E < E_F$ (4) $E >> E_F$

19. The electric field required to accelerate an electron in cubic diamond having energy gap of 5.4 eV and lattice constant of 3.57 $\mathring{A}$ over a distance equal to the atomic radius is :

(1) 7×10^{10} (2) 1.4×10^{10} (3) 9×10^{10} (4) 2.5×10^{11}

20. The net magnetic moment of Fe atom in BCC crystal (a = 2.857 $\mathring{A}$) is 2.2μB. The saturation magnetization of Fe at $0K$ is :

(1) 100 $kA\ m^{-1}$ (2) 1750 $kA\ m^{-1}$

(3) 2500 $kA\ m^{-1}$ (4) 3520 $kA\ m^{-1}$

21. A beam of protons of 5MeV kinetic energy traverses a gold foil, one particle in 5×10^6 is scattered so as to hit a surface 0.5 cm^2 in area at a distance 10 cm from the foil and in a direction making an angle of 60° with the initial direction of the beam and the tickness of the foil is :

(1) 1.31 μm (2) 2.1 μm (3) 5.31 μm (4) 7.31 μm

22. If the radius of silver nucleus (Z = 47), is 7×10^{-15} m, the minimum energy that the particle should have to just reach it is :

(1) 9.34 *MeV* (2) 1.34 *MeV* (3) 4.34 *MeV* (4) 19.34 *MeV*

23. The binding energy of the nuclei $^{56}_{26}Fe$ in units of *MeV* :

(1) 492.26 *MeV* (2) 42.16 *MeV* (3) 592.06 *MeV* (4) 402.26 *MeV*

24. A given coin has a mass of 3.0 g. The nuclear energy that would be required to separate all the neutrons and protons from each other is (assume that the coin is entirely made of $^{63}_{29}Cu$ atoms) :

(1) 4.6×10^{24} *MeV* (2) 1.6×10^{25} *MeV* (3) 5.6×10^{28} *MeV* (4) 5.3×10^{22} *MeV*

25. The effective radius of deuteron can be taken to be 2 fm. The hight of potential barrier for head-on collision of two deuterons is :

(1) 104 *keV* (2) 100 *keV* (3) 180 *keV* (4) 380 *keV*

26. The energy released by fission of 1.0 kg of ^{235}U in a fission reactor is :

(1) 6.1×10^{22} *MeV* (2) 3.1×10^{25} *MeV*

(3) 0.1×10^{21} *MeV* (4) 5.1×10^{26} *MeV*

27. The electric field in a region is radically outward with magnitude of E = Ar. The charge contained in a sphere of radius, r centred at the origin is (A = 100 V/m^2 and r = 20 cm) :

(1) 2.389×10^{-7} C (2) 1.89×10^{-9} C

(3) 5.32×10^{-4} C (4) 8.89×10^{-9} C

28. A charge Q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre of the plate is 10 V/m. If the plate is replaced by a copper plate of the same geometrical dimensions and carrying the same charge Q, the electric field at the point P will become :

(1) Zero (2) 5 V/m (3) 10 V/m (4) 20 V/m

29. A metallic particle having no net charge is placed near a finite metal plate carrying a positive charge. The electric force on the particle will be :

(1) towards the plate (2) Away from the plate

(3) Parallel to the plate (4) zero

30. The magnitude of the electric field at a point 4 cm away from a line charge of density 2×10^{-6}/m is :

(1) 3.0×10^{3} N/C (2) 9.0×10^{5} N/C

(3) 4.0×10^{7} N/C (4) 9.0×10^{9} N/C

31. The BCC iron has lattice parameter of 2.87 $\mathring{A}$ and its saturation magnetization value of 2750 kA m^{-1}. The net magnetic moment per iron atom in the crystal :

(1) 4 (2) 3.5 (3) 7.4 (4) 6.3

32. Calculate the wavelength of the photon, which will be required to break a cooper pair in a superconductor like zirconium whose T_c is 0.56 K :

(1) 7.2×10^{-3} m (2) 1.5×10^{-4} m

(3) 4.3×10^{-5} m (4) 3.8×10^{-2} m

33. Laser-produced plasma consisting of a 50 μm diameter ball of radiates very strongly at a wavelength of 5 nm. At a distance of 0.75 m from the source, the spatial coherence resulting from light emitted from opposite sides of the plasma is :

(1) $5 \times 10^{-5}\ m$ (2) $0.55 \times 10^{-5}\ m$

(3) $1.2 \times 10^{-5} m$ (4) $7.5 \times 10^{-5}\ m$

34. Consider the two-level system with $E_1 = -13.6\ eV, E_2 = -3.4\ eV$ and the co-efficient $A_{21} = 6 \times 10^8 s^{-1}$. The frequency of light emitted due to transition from E_2 and E_1 is :

(1) 8.2×10^{17} Hz (2) 4.5×10^{16} Hz

(3) 2.5×10^{15} Hz (4) 6.5×10^{14} Hz

35. A solid-state laser emits radiation of wavelength of 6000 $\mathring{A}$ and the life time, $\tau_{sp} = 10^{-6}$s. Assume that the refractive index of the medium is one and the co-efficient of stimulated emission is :

(1) 1.3×10^{19} m/kg (2) 1.3×10^{19} m/g

(3) 6.6×10^{19} cm/kg (4) 6.6×10^{19} m/g

36. The ratio of spontaneous emission to stimulation emission for a cavity of temperature 50 K and wavelength of $10^{-5}\ m$:

(1) 3.218×10^{10} (2) 3.218×10^{12} (3) 3.218×10^{14} (4) 3.218×10^{16}

37. One of the following type of galaxies do ***not*** fall on Hubble's tuning fork diagram :

(1) Barred spiral galaxies (2) Peculiar galaxies

(3) Elliptical galaxies (4) Spiral galaxies

38. A Michelson interferometer is used to determine the apparent diameter of a star. The fringe pattern disappears when the adjustable mirrors are at a separation of 10 m and wavelength of light used is 7×10^{-4} mm. The angular diameter of the star is :

(1) 8.54×10^{-8} radians (2) 3.54×10^{-9} radians

(3) 1.34×10^{-8} radians (4) 1.22×10^{-8} radians

39. The proton proton chain reaction :

(1) Produces chains of protons which are then broken apart to produce the Sun's energy

(2) Is a three-step process which converts some mass to energy as helium nuclei are formed

(3) Is the runaway reaction that produces the fission of iron during a supernova explosion

(4) adds protons together until a massive carbon nucleus is produced at the core of the sun

40. An approximate diameter of Milky Way :

(1) 1000 light years (2) 100000 light years

(3) 10000 light years (4) 1000000 light years

41. A particle of mass m_e trapped in an infinite depth well of width $L = 1$ nm. Consider the transition from the excited state $n = 2$ to the ground state $n = 1$. The wavelength of light emitted is :

(1) 1234 nm (2) 8864 nm (3) 4321 nm (4) 8790 nm

42. A particle of mass m and charge q oscillating with frequency ω is subjected to a uniform electric field E parallel to the direction of oscillation. The stationary energy levels is :

(1) $\left(n+\frac{1}{2}\right)\hbar\omega$ (2) $\frac{1}{2}\hbar\omega$

(3) $\left(n^2+\frac{1}{2}\right)\hbar\omega$ (4) $\hbar\omega$

43. The rms velocity of hydrogen molecules at NTP and at 127° C is :

(1) 148 *m/s* (2) 2134 *m/s* (3) 876 *m/s* (4) 3149 *m/s*

44. The fraction of the oxygen molecule with velocities between 199 m/s and 201 m/s at 27°C :

(1) 1.29×10^{-3} (2) 2.29×10^{-2}

(3) 2.29×10^{-3} (4) 5.29×10^{-2}

45. If 1 g of water freezes into ice, the change in its specific volume is 0.091 cc. The pressure required to be applied to freeze 10 g of water at –1°C.

(1) 3.345 atm (2) 0.254 atm

(3) 2.24 atm (4) 2.587 atm

46. A 50 Ω resistor carrying a constant current of $1A$ is kept at a constant temperature of 300 K by a stream of cooling water. In a time interval of 1 sec, the change in entropy of the resistor is :

(1) Zero
(2) $10\ JK^{-1}$
(3) $1000\ JK^{-1}$
(4) Infinity

47. Consider six distinguishable particles are distributed over three nondegenerate energy levels. Level 1 is at zero energy; level 2 has an energy $\in$; and level 3 has energy $2\in$. The total number of microstates for the system is :

(1) 10 (2) 1168 (3) 555 (4) 729

48. An ideal Fermi gas is at rest at absolute temperature zero and has a Fermi energy $\in$. The mass of each particle is m. If v denotes the velocity of a molecule, then $\overline{v}_x^2$ is :

(1) $2\in/5m$ (2) $5\in/2m$ (3) $2m/5\in$ (4) $5m/2\in$

49. The temperature at which an ideal gas whose molecules have an average kinetic energy of 1 eV is :

(1) 10345 K
(2) 11594 K
(3) 1234 K
(4) 4532 K

50. The classical value of molar specific heat is :

(1) $R_u/2$
(2) $3R_u$
(3) R_u
(4) $3R_u/2$

51. In the triode region, the $I_D - V_{DS}$ characteristics of a MOSFET are :

(1) Hyperbolic
(2) Linear
(3) Quadratic
(4) Exponential

52. The output of operational amplifier increases 5 V in 15 µs. The slew rate is :

(1) 90 V/µs (2) 0.333 V/µs

(3) 30 V/µs (4) 5 V/µs

53. The efficiency of a full-wave rectifier is :

(1) Same as half-wave rectifier (2) Double the half-wave rectifier

(3) One-half of half-wave rectifier (4) One-third of half-wave rectifier

54. The most unique property of laser :

(1) speed (2) directional

(3) coherence (4) wavelength

55. Which of the following is an example of optical pumping ?

(1) Ruby laser (2) Helium-Neon laser

(3) Semiconductor laser (4) Dye laser

56. The following type of laser can be used for generation of laser pulse :

(1) Nd-YAG laser (2) Carbon dioxide laser

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(3) circle (4) ellipse with high eccentricity

60. The "Planetoids" are located between :

(1) Earth & Mars (2) Mars and Jupiter

(3) Saturn & Jupiter (4) Mercury and Venus

61. The directional derivative of $\varphi = x^2yz + 2xz^3$ at (1, 1, –1) in the direction $2\hat{i} - 2\hat{j} + \hat{k}$ is :

(1) $\frac{2}{3}$ (2) $-\frac{2}{3}$

(3) $\frac{5}{3}$ (4) $\frac{1}{3}$

62. The angle between the surfaces $x^2 + y^2 + z^2 = 1$ and $z = x^2 + y^2 - 1$ at the point (1, +1, –1) is :

(1) 15.76° (2) 1.75° (3) 2.53° (4) 25.23°

63. A G.M. counter records 4,900 background counts in 100 min. with a radioactive source in position, the same total number of counts are recorded in 20 min. The percentage of S.D. with net counts due to the source is :

(1) 5.5% (2) 1.8% (3) 0.5% (4) 2.5%

64. The alpha ray activity of a material is measured after equal successive intervals (hours), in terms of its initial activity as unity to the 0.835; 0.695; 0.580; 0.485; 0.405 and 0.335. Assuming that the activity obeys an exponential decay law, the half-life is :

(1) 5.63 h (2) 8.05 h

(3) 2.15 h (4) 3.82 h

65. A thin uniform annular disc of mass M has outer radius $4R$ and inner radius $3R$. The work required to take a unit mass from point P on its axis to infinity is :

(1) $\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$ (2) $-\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$

(3) $\frac{GM}{4R}$ (4) $\frac{2GM}{5R}\left(\sqrt{2}-1\right)$

66. Two masses m_1 and m_2 connected by a spring of spring constant k rest on a frictionless surface. If the masses are pulled apart and let go, the time period of oscillation is :

(1) $T=2\pi\sqrt{\frac{1}{k}\left(\frac{m_1m_2}{m_1+m_2}\right)}$ (2) $T=2\pi\sqrt{k\left(\frac{m_1+m_2}{m_1m_2}\right)}$

(3) $T=2\pi\sqrt{\frac{m_1}{k}}$ (4) $T=2\pi\sqrt{\frac{m_2}{k}}$

67. Two particles of rest mass m_0 approach each other with equal and opposite velocity v, in the laboratory frame. The total energy of one particle as measured in the rest frame of other is :

(1) $E=m_oc^2$ (2) $E=2m_oc^2$

(3) $E=3m_oc^2$ (4) $E=1/2m_oc^2$

68. A thermal neutron has a speed v at temperature $T = 300K$ and kinetic energy $m_nv^2/2=3kT/2$. The de-Broglie wavelength of thermal neutron is :

(1) $0.27\ \mathring{A}$ (2) $1.37\ \mathring{A}$ (3) $2.27\ \mathring{A}$ (4) $3.17\ \mathring{A}$

69. Using the uncertainty principle, the ground state energy of a linear oscillator is expressed by :

(1) $\frac{1}{2}\hbar\omega$ (2) $\hbar\omega$ (3) $\frac{3}{2}\hbar\omega$ (4) $2\hbar\omega$

70. An electron is trapped in an infinitely deep potential well of width $L = 106\ fm$. The wavelength of photon emitted from the transition $E_4 \rightarrow E_3$ is :

(1) 3.453 nm (2) 4.665 nm

(3) 1.435 nm (4) 0.453 nm

71. Which planet can never be seen on the meridian at midnight ?

(1) Jupiter (2) Mercury (3) Saturn (4) Mars

72. For an n-channel silicon FET with channel width of 3×10^{-4} cm and the dopant concentration of 10^{15} electrons/cm^3. The relative dielectric constant of silicon is 12 and the pinch of voltage is :

(1) 10 V (2) 13.5 V

(3) 6.8 V (4) 15.5 V

73. A half-wave rectifier is supplied with an AC supply of 120 V at 60 Hz through a step-down transformer having a turn ratio of 10 : 1. By assuming an ideal diode is used, the output DC voltage of diode is :

(1) 5.40 V (2) 7.8 V (3) 8.5 V (4) 3.3 V

74. Consider an ideal op-amplifier with infinite voltage gain. Let V_1 and V_2 be the values of independent voltage sources connected to the positive and negative input terminals, respectively, and let V_o be the output voltage. If $V_1 \neq V_2$, then V_o will be :

(1) Zero (2) Infinite

(3) Finite (4) Unpredictable

75. A differential amplifier has an open-circuit voltage again of 100. This amplifier has a common input signal of 3.2 V to both terminals and it results in an output signal of 26 mV, the CMRR is :

(1) 81.8 dB (2) 55.4 dB (3) 23.4 dB (4) 36.7 dB

76. The laser action is mainly characterized by :

(1) Spontaneous emission process (2) Stimulated emission process

(3) Thermionic emission process (4) Plasmonic process

77. The number of photons, from green light of mercury ($\lambda = 4961\ \mathring{A}$), required to do one joule of work :

(1) $4524.2\times10^{18}/m^3$ (2) $2.4961\times10^{18}/m^3$

(3) $2.4961/m^3$ (4) $2.4961/m$

78. The binding energy of the electron for the lowest energy level of the hydrogen atom is :

(1) $-3.399\ eV$ (2) $3.399\ meV$ (3) $-13.595\ eV$ (4) $-13595\ meV$

79. Sea water has a refractive index of 1.33 and absorbs 99.8% of red light of wavelength 500 nm in a depth of 10 m. The complex refractive dielectric constant at this wavelength is :

(1) $1.77 + i\,9.2\times10^{-8}$ (2) $3.37 + i\,4.1\times10^{-5}$

(3) $i\ 9.2\times10^{-8}$ (4) $2.23 + i\,1.2\times10^{-6}$

80. The Doppler broadening of the emission wavelength takes place in :

(1) He-Ne laser (2) Nd:YAG laser

(3) Nd:glass laser (4) Ruby laser

81. A parallel plate capacitor having plate area 100 cm^2 and separation 1mm holds a charge of 0.12 μC when connected to a 120 V battery. The dielectric constant of the material filling the gap is equal to :

(1) 11.3 (2) 7 (3) 15 (4) 20

82. The energy density in the electric field created by a point charge falls off with the distance from the point charge is :

(1) $\frac{1}{r}$ (2) $\frac{1}{r^2}$ (3) $\frac{1}{r^3}$ (4) $\frac{1}{r^4}$

83. An electron moves in a circle of radius 10 cm with a constant speed of 4×10^6 m/s. The electric current at a point on the circle is :

(1) $3.0 \times 10^{-10}\,A$ (2) $1.0 \times 10^{-12}\,A$

(3) $4.0 \times 10^{-13}\,A$ (4) $5.0 \times 10^{-11}\,A$

84. A capacitor is connected to a 12 V battery through a resistance of 10 W. It is found that the potential difference across the capacitor rises to 4.0 V in 1 μs. The capacitance of the capacitor is :

(1) 1.25 μF (2) 4.25 μF (3) 3.25 μF (4) 0.25 μF

85. Two resistors R and 2R are connected in series in an electric circuit. The thermal energy developed in R and 2R are in the ratio :

(1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 1 : 3

86. A circular loop of area 1 cm^2, carrying a current of 10 A. is placed in a magnetic field of 0.1. T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is :

(1) Zero (2) 10^{-4} Nm (3) 10^{-3} Nm (4) 10^{-2} Nm

87. Which of the following particles will experience a maximum magnetic force (magnitude) when projected with the same velocity perpendicular to a magnetic field ?

(1) Electron (2) Proton (3) He^+ (4) Li^{++}

88. The magnetic field B due to a current carrying circular loop radius 12 cm at its centre is 0.50×10^{-4}T. The magnetic field due to this loop at a point on the axis at a distance of 5.0 cm from the centre is :

(1) $1.9 \times 10^{-7}\,T$ (2) 3.9×10^{-5} T

(3) 5.9×10^{-4} T (4) 0.9×10^{-3} T

89. The magnetic moment of the assumed dipole at the earth's centre is 8.0×1022 A m^2. The magnetic-field B at the geomagnetic poles of the earth is (radius of earth is 6400 km) :

(1) 60 μT (2) 120 μT (3) 240 μT (4) 480 μT

90. The sunlight reaching the earth has maximum electric field of 810 V/m. The maximum magnetic field in this light is :

(1) 6 μT (2) 120 μT

(3) 2.7 μT (4) 33 μT

91. The critical magnetic field for aluminium is 7.9×10^3 A/m in which current flow through a long thin superconducting write of diameter 10^{-3}m. The critical current is found to be :

(1) 34 *A* (2) 24.81 *A* (3) 35.46 *A* (4) 15.55 *A*

92. The transition from the ferromagnetic to the paramagnetic state is named after :

(1) Curie-Weiss (2) Neel (3) Debye (4) Curie

93. The magnetization of a superconductor is :

(1) Zero (2) –B (3) Constant (4) –H

94. The electrical power output of a photodiode is maximum when a :

(1) Small forward current flows through it irrespective of the bias

(2) Small forward bias exists across it

(3) Large reverse bias exists across it

(4) Small reverse bias exists across it

95. One of the allotropy of carbon is graphite whose crystal structure is hexagonal. Let the lattice parameters for graphite be $a = 2.451$ $\mathring{A}$; $c = 6.701\mathring{A}$ and with density of 2.2589 g/cm^3. An estimated number of atoms in their unit cell :

(1) 6 (2) 8 (3) 12 (4) 4

96. The packing efficiency of diamond cubic unit cell is :

(1) 0.34 (2) 0.52 (3) 0.68 (4) 0.74

97. In ionic solid if the radius of anion is r_a and of cation is r_c, then bond length is :

(1) $(r_c + r_a)$ (2) $\sqrt{3}(r_c + r_a)$

(3) $\sqrt{3}/2(r_c + r_a)$ (4) $(r_c - r_a)$

98. Calculate the energy difference between the two levels for which $n_x = n_y = n_z = 1$ and the next higher level for the free electron in a solid cube of side 10 mm :

(1) $1.13 \times 10^{-14}\ eV$ (2) $4.46 \times 10^{-15}\ eV$

(3) $5.86 \times 10^{-14}\ eV$ (4) $9.04 \times 10^{-13}\ eV$

99. Calculate the Fermi energy of monovalent bcc crystal whose lattice constant is 2.54 $\mathring{A}$.

(1) 1.035 eV (2) 4.567 eV

(3) 8.991 eV (4) 3.456 eV

100. The fraction of electrons excited across the energy gap in Germanium $(E_g = 0.7eV)$ at room temperature (300 K) is :

(1) 7×10^{-18} (2) 1.7×10^{-12}

(3) 4×10^{-12} (4) 1.3×10^{-6}

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D

SET-Y

PHD-EE-2023-24

Physics

Sr. No. 10028

Time : **1¼ Hours** Max. Marks : **100** Total Questions : **100**

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Date of Examination _____

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SEAL

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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.*

1. A parallel plate capacitor having plate area 100 cm^2 and separation 1mm holds a charge of 0.12 μC when connected to a 120 V battery. The dielectric constant of the material filling the gap is equal to :

(1) 11.3 (2) 7 (3) 15 (4) 20

2. The energy density in the electric field created by a point charge falls off with the distance from the point charge is :

(1) $\frac{1}{r}$ (2) $\frac{1}{r^2}$ (3) $\frac{1}{r^3}$ (4) $\frac{1}{r^4}$

3. An electron moves in a circle of radius 10 cm with a constant speed of 4×10^6 m/s. The electric current at a point on the circle is :

(1) $3.0 \times 10^{-10} A$ (2) $1.0 \times 10^{-12} A$

(3) $4.0 \times 10^{-13} A$ (4) $5.0 \times 10^{-11} A$

4. A capacitor is connected to a 12 V battery through a resistance of 10 W. It is found that the potential difference across the capacitor rises to 4.0 V in 1 μs. The capacitance of the capacitor is :

(1) 1.25 μF (2) 4.25 μF (3) 3.25 μF (4) 0.25 μF

5. Two resistors R and 2R are connected in series in an electric circuit. The thermal energy developed in R and 2R are in the ratio :

(1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 1 : 3

6. A circular loop of area 1 cm^2, carrying a current of 10 A. is placed in a magnetic field of 0.1. T perpendicular to the plane of the loop. The torque on the loop due to the magnetic field is :

(1) Zero (2) 10^{-4} Nm

(3) 10^{-3} Nm (4) 10^{-2} Nm

7. Which of the following particles will experience a maximum magnetic force (magnitude) when projected with the same velocity perpendicular to a magnetic field ?

(1) Electron (2) Proton (3) He^+ (4) Li^{++}

8. The magnetic field B due to a current carrying circular loop radius 12 cm at its centre is 0.50×10^{-4}T. The magnetic field due to this loop at a point on the axis at a distance of 5.0 cm from the centre is :

(1) $1.9 \times 10^{-7}\ T$ (2) 3.9×10^{-5} T

(3) 5.9×10^{-4} T (4) 0.9×10^{-3} T

9. The magnetic moment of the assumed dipole at the earth's centre is 8.0×1022 A m^2. The magnetic-field B at the geomagnetic poles of the earth is (radius of earth is 6400 km) :

(1) 60 μT (2) 120 μT

(3) 240 μT (4) 480 μT

10. The sunlight reaching the earth has maximum electric field of 810 V/m. The maximum magnetic field in this light is :

(1) 6 μT (2) 120 μT

(3) 2.7 μT (4) 33 μT

11. In the triode region, the $I_D - V_{DS}$ characteristics of a MOSFET are :

(1) Hyperbolic (2) Linear

(3) Quadratic (4) Exponential

12. The output of operational amplifier increases 5 V in 15 μs. The slew rate is :

(1) 90 V/μs (2) 0.333 V/μs

(3) 30 V/μs (4) 5 V/μs

13. The efficiency of a full-wave rectifier is :

(1) Same as half-wave rectifier
(2) Double the half-wave rectifier
(3) One-half of half-wave rectifier
(4) One-third of half-wave rectifier

14. The most unique property of laser :

(1) speed
(2) directional
(3) coherence
(4) wavelength

15. Which of the following is an example of optical pumping ?

(1) Ruby laser
(2) Helium-Neon laser
(3) Semiconductor laser
(4) Dye laser

16. The following type of laser can be used for generation of laser pulse :

(1) Nd-YAG laser
(2) Carbon dioxide laser
(3) Helium neon laser
(4) Ruby laser

17. What is the need to achieve population inversion ?

(1) To excite most of the atoms
(2) To bring most of the atoms to ground state
(3) To achieve stable condition
(4) To reduce the time of production of laser

18. Which of the following is used in atomic clocks ?

(1) Laser (2) Quartz (3) Maser (4) Helium

19. The shape of the Earth's orbit :

(1) eclipse with low excitability
(2) eclipse with low eccentricity
(3) circle
(4) ellipse with high eccentricity

20. The "Planetoids" are located between :

(1) Earth & Mars
(2) Mars and Jupiter
(3) Saturn & Jupiter
(4) Mercury and Venus

21. The BCC iron has lattice parameter of 2.87 $\mathring{A}$ and its saturation magnetization value of 2750 $kA\ m^{-1}$. The net magnetic moment per iron atom in the crystal :

(1) 4
(2) 3.5
(3) 7.4
(4) 6.3

22. Calculate the wavelength of the photon, which will be required to break a cooper pair in a superconductor like zirconium whose T_c is 0.56 K :

(1) 7.2×10^{-3} m
(2) 1.5×10^{-4} m
(3) 4.3×10^{-5} m
(4) 3.8×10^{-2} m

23. Laser-produced plasma consisting of a 50 μm diameter ball of radiates very strongly at a wavelength of 5 nm. At a distance of 0.75 m from the source, the spatial coherence resulting from light emitted from opposite sides of the plasma is :

(1) $5 \times 10^{-5}\ m$
(2) $0.55 \times 10^{-5}\ m$
(3) $1.2 \times 10^{-5} m$
(4) $7.5 \times 10^{-5}\ m$

24. Consider the two-level system with $E_1 = -13.6\ eV, E_2 = -3.4 eV$ and the co-efficient $A_{21} = 6 \times 10^8 s^{-1}$. The frequency of light emitted due to transition from E_2 and E_1 is :

(1) 8.2×10^{17} Hz
(2) 4.5×10^{16} Hz
(3) 2.5×10^{15} Hz
(4) 6.5×10^{14} Hz

25. A solid-state laser emits radiation of wavelength of 6000 $\mathring{A}$ and the life time, $\tau_{sp} = 10^{-6}$ s. Assume that the refractive index of the medium is one and the co-efficient of stimulated emission is :

(1) 1.3×10^{19} m/kg
(2) 1.3×10^{19} m/g
(3) 6.6×10^{19} cm/kg
(4) 6.6×10^{19} m/g

26. The ratio of spontaneous emission to stimulation emission for a cavity of temperature 50 K and wavelength of 10^{-5} m :

(1) 3.218×10^{10} (2) 3.218×10^{12}

(3) 3.218×10^{14} (4) 3.218×10^{16}

27. One of the following type of galaxies do ***not*** fall on Hubble's tuning fork diagram :

(1) Barred spiral galaxies (2) Peculiar galaxies

(3) Elliptical galaxies (4) Spiral galaxies

28. A Michelson interferometer is used to determine the apparent diameter of a star. The fringe pattern disappears when the adjustable mirrors are at a separation of 10 m and wavelength of light used is 7×10^{-4} mm. The angular diameter of the star is :

(1) 8.54×10^{-8} radians (2) 3.54×10^{-9} radians

(3) 1.34×10^{-8} radians (4) 1.22×10^{-8} radians

29. The proton proton chain reaction :

(1) Produces chains of protons which are then broken apart to produce the Sun's energy

(2) Is a three-step process which converts some mass to energy as helium nuclei are formed

(3) Is the runaway reaction that produces the fission of iron during a supernova explosion

(4) adds protons together until a massive carbon nucleus is produced at the core of the sun

30. An approximate diameter of Milky Way :

(1) 1000 light years (2) 100000 light years

(3) 10000 light years (4) 1000000 light years

31. The change of melting point of naphthalene per atmospheric change of pressure, given melting point = 80°C, latent heat = 35.5 cal/g, density of solid = 1.145 g/cc and density of liquid = 0.981 g/cc is :

(1) 100 K (2) 300 K

(3) 273 K (4) 273.0346 K

32. The amount of heat (in eV) must be added to a system at 27°C for the number of accessible states to increase by a factor of 10^8 is :

(1) 0.477 eV (2) 1.235 eV (3) 1.874 eV (4) 2.365 eV

33. A wire of length 1m and radius 1mm is heated via an electric current to produce 1 kW of radiant power. Treating the wire as a perfect blackbody and ignoring any end effects, the temperature of the wire is :

(1) 1358 K (2) 1294 K (3) 273 K (4) 8569 K

34. A blackbody has its cavity of cubical shape. The number of modes of vibration per unit volume in the wavelength region 4,990–5,010 Å is :

(1) $1.038 \times 10^{19}/m^3$ (2) $5.038 \times 10^{11}/m^3$

(3) $8.038 \times 10^{17}/m^3$ (4) $0.038 \times 10^{19}/m^3$

35. A common-emitter transistor has a typical value of gain (β) as 50 and the collector current is 10 mA. The emitter *current* is :

(1) 10.2 mA (2) 45.8 mA (3) 22.4 mA (4) 12.5 mA

36. A transistor has a collector current of 5 mA, when the emitter voltage is 20 mV. At 30 mV. At 30 mV, the current is 30 mA. At 50 mV, it is :

(1) 80 mA (2) 280 mA

(3) 480 mA (4) 1080 mA

37. The operating frequency of a Wien-bridge oscillator is given by :

(1) $\frac{1}{2\pi\sqrt{LC}}$ (2) $\frac{1}{4\pi\sqrt{LC}}$

(3) $\frac{1}{2\pi RC}$ (4) $\frac{1}{2\pi\sqrt{RC}}$

38. The reverse saturation current in a p-n diode :

(1) Increases (2) Decreases

(3) Remains constant (4) Oscillates

39. The phase difference between the input and output voltages of a transistor connected in common emitter arrangement is :

(1) 360° (2) 180° (3) 90° (4) 270°

40. The DC current gain of a common-base transistor is 0.956 and emitter current is 10 *mA*. The base current value is :

(1) 0.66 *mA* (2) 0.38 *mA*

(3) 0.25 *mA* (4) 0.44 *mA*

41. The critical magnetic field for aluminium is 7.9×10^3 A/m in which current flow through a long thin superconducting write of diameter 10^{-3}m. The critical current is found to be :

(1) 34 *A* (2) 24.81 *A* (3) 35.46 *A* (4) 15.55 *A*

42. The transition from the ferromagnetic to the paramagnetic state is named after :

(1) Curie-Weiss (2) Neel (3) Debye (4) Curie

43. The magnetization of a superconductor is :

(1) Zero (2) –B (3) Constant (4) –H

44. The electrical power output of a photodiode is maximum when a :

(1) Small forward current flows through it irrespective of the bias

(2) Small forward bias exists across it

(3) Large reverse bias exists across it

(4) Small reverse bias exists across it

45. One of the allotropy of carbon is graphite whose crystal structure is hexagonal. Let the lattice parameters for graphite be a = 2.451 $\mathring{A}$; $c = 6.701\mathring{A}$ and with density of 2.2589 g/cm^3. An estimated number of atoms in their unit cell :

(1) 6 (2) 8 (3) 12 (4) 4

46. The packing efficiency of diamond cubic unit cell is :

(1) 0.34 (2) 0.52 (3) 0.68 (4) 0.74

47. In ionic solid if the radius of anion is r_a and of cation is r_c, then bond length is :

(1) $(r_c + r_a)$ (2) $\sqrt{3}(r_c + r_a)$

(3) $\sqrt{3}/2(r_c + r_a)$ (4) $(r_c - r_a)$

48. Calculate the energy difference between the two levels for which $n_x = n_y = n_z = 1$ and the next higher level for the free electron in a solid cube of side 10 mm :

(1) $1.13 \times 10^{-14}\ eV$ (2) $4.46 \times 10^{-15}\ eV$

(3) $5.86 \times 10^{-14}\ eV$ (4) $9.04 \times 10^{-13}\ eV$

49. Calculate the Fermi energy of monovalent bcc crystal whose lattice constant is 2.54 $\mathring{A}$.

(1) 1.035 eV (2) 4.567 eV

(3) 8.991 eV (4) 3.456 eV

50. The fraction of electrons excited across the energy gap in Germanium $(E_g = 0.7eV)$ at room temperature (300 K) is :

(1) 7×10^{-18} (2) 1.7×10^{-12}

(3) 4×10^{-12} (4) 1.3×10^{-6}

51. A beam of protons of 5MeV kinetic energy traverses a gold foil, one particle in 5×10^6 is scattered so as to hit a surface 0.5 cm^2 in area at a distance 10 cm from the foil and in a direction making an angle of 60° with the initial direction of the beam and the tickness of the foil is :

(1) 1.31 μm (2) 2.1 μm (3) 5.31 μm (4) 7.31 μm

52. If the radius of silver nucleus (Z = 47), is 7×10^{-15} m, the minimum energy that the particle should have to just reach it is :

(1) 9.34 *MeV* (2) 1.34 *MeV* (3) 4.34 *MeV* (4) 19.34 *MeV*

53. The binding energy of the nuclei $^{56}_{26}Fe$ in units of *MeV* :

(1) 492.26 *MeV* (2) 42.16 *MeV* (3) 592.06 *MeV* (4) 402.26 *MeV*

54. A given coin has a mass of 3.0 g. The nuclear energy that would be required to separate all the neutrons and protons from each other is (assume that the coin is entirely made of $^{63}_{29}Cu$ atoms) :

(1) 4.6×10^{24} *MeV* (2) 1.6×10^{25} *MeV*

(3) 5.6×10^{28} *MeV* (4) 5.3×10^{22} *MeV*

55. The effective radius of deuteron can be taken to be 2 fm. The hight of potential barrier for head-on collision of two deuterons is :

(1) 104 *keV* (2) 100 *keV* (3) 180 *keV* (4) 380 *keV*

56. The energy released by fission of 1.0 kg of ^{235}U in a fission reactor is :

(1) 6.1×10^{22} *MeV* (2) 3.1×10^{25} *MeV*

(3) 0.1×10^{21} *MeV* (4) 5.1×10^{26} *MeV*

57. The electric field in a region is radically outward with magnitude of E = Ar. The charge contained in a sphere of radius, r centred at the origin is (A = 100 V/m^2 and r = 20 cm) :

(1) 2.389×10^{-7} C (2) 1.89×10^{-9} C

(3) 5.32×10^{-4} C (4) 8.89×10^{-9} C

58. A charge Q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre of the plate is 10 V/m. If the plate is replaced by a copper plate of the same geometrical dimensions and carrying the same charge Q, the electric field at the point P will become :

(1) Zero (2) 5 V/m (3) 10 V/m (4) 20 V/m

59. A metallic particle having no net charge is placed near a finite metal plate carrying a positive charge. The electric force on the particle will be :

(1) towards the plate (2) Away from the plate

(3) Parallel to the plate (4) zero

60. The magnitude of the electric field at a point 4 cm away from a line charge of density 2×10^{-6}/m is :

(1) 3.0×10^{3} N/C (2) 9.0×10^{5} N/C

(3) 4.0×10^{7} N/C (4) 9.0×10^{9} N/C

61. Which planet can never be seen on the meridian at midnight ?

(1) Jupiter (2) Mercury (3) Saturn (4) Mars

62. For an n-channel silicon FET with channel width of 3×10^{-4} cm and the dopant concentration of 10^{15} electrons/cm^3. The relative dielectric constant of silicon is 12 and the pinch of voltage is :

(1) 10 V (2) 13.5 V

(3) 6.8 V (4) 15.5 V

63. A half-wave rectifier is supplied with an AC supply of 120 V at 60 Hz through a step-down transformer having a turn ratio of 10 : 1. By assuming an ideal diode is used, the output DC voltage of diode is :

(1) 5.40 V (2) 7.8 V (3) 8.5 V (4) 3.3 V

64. Consider an ideal op-amplifier with infinite voltage gain. Let V_1 and V_2 be the values of independent voltage sources connected to the positive and negative input terminals, respectively, and let V_o be the output voltage. If $V_1 \neq V_2$, then V_o will be :

(1) Zero
(2) Infinite
(3) Finite
(4) Unpredictable

65. A differential amplifier has an open-circuit voltage again of 100. This amplifier has a common input signal of 3.2 V to both terminals and it results in an output signal of 26 mV, the CMRR is :

(1) 81.8 dB (2) 55.4 dB (3) 23.4 dB (4) 36.7 dB

66. The laser action is mainly characterized by :

(1) Spontaneous emission process
(2) Stimulated emission process
(3) Thermionic emission process
(4) Plasmonic process

67. The number of photons, from green light of mercury ($\lambda = 4961\ \mathring{A}$), required to do one joule of work :

(1) $4524.2\times10^{18}/m^3$
(2) $2.4961 \times 10^{18}/m^3$
(3) $2.4961/m^3$
(4) $2.4961/m$

68. The binding energy of the electron for the lowest energy level of the hydrogen atom is :

(1) $-3.399\ eV$
(2) $3.399\ meV$
(3) $-13.595\ eV$
(4) $-13595\ meV$

69. Sea water has a refractive index of 1.33 and absorbs 99.8% of red light of wavelength 500 nm in a depth of 10 m. The complex refractive dielectric constant at this wavelength is :

(1) $1.77 + i\,9.2 \times 10^{-8}$
(2) $3.37 + i\,4.1 \times 10^{-5}$
(3) $i\ 9.2 \times 10^{-8}$
(4) $2.23 + i\,1.2 \times 10^{-6}$

70. The Doppler broadening of the emission wavelength takes place in :

(1) He-Ne laser (2) Nd:YAG laser

(3) Nd:glass laser (4) Ruby laser

71. The wavelength of radiation emitted by an LED made up of a semiconducting material with band gap energy 2.8 eV :

(1) 2.8 $\mathring{A}$ (2) 4.3308 $\mathring{A}$

(3) 5548.4 $\mathring{A}$ (4) 4430.8 $\mathring{A}$

72. Goldilocks Zone means :

(1) Habitable Zone (2) Porridge Zone

(3) Ursa Major Zone (4) Just right distance from Jupiter

73. Hubble's Law enables astronomers to estimate the distance to a galaxy if they can determine the galaxy's :

(1) Spectral type (2) Mass

(3) Velocity of recession (4) Temperature

74. The cosmic microwave background radiation comes from :

(1) Quasars (2) The solar nebula

(3) The Big Bang (4) Radio galaxies

75. The lattice parameter and density for an fcc lattice of copper are 3.60 $\mathring{A}$ and 9055 kg/m^3 respectively. If the atomic weight of copper is 63.6, the number atoms per unit cell is :

(1) 4 (2) 6 (3) 8 (4) 12

76. The potential energy of system of Na^+ and Cl^- ions when they are at 4 $\mathring{A}$ apart :

(1) –8.5 eV (2) –3.6 eV (3) –2.5 eV (4) –5.5 eV

77. The degeneracy of the quantum states with $\left(n_x^2+n_y^2+n_z^2\right)=6$ is :

(1) 12 (2) 24 (3) 48 (4) 8

78. At 0 K, the probability of finding an electron at energy level E is unity, when :

(1) $E = E_F$ (2) $E > E_F$ (3) $E < E_F$ (4) $E >> E_F$

79. The electric field required to accelerate an electron in cubic diamond having energy gap of 5.4 eV and lattice constant of 3.57 $\mathring{A}$ over a distance equal to the atomic radius is :

(1) 7×10^{10} (2) 1.4×10^{10} (3) 9×10^{10} (4) 2.5×10^{11}

80. The net magnetic moment of Fe atom in BCC crystal (a = 2.857 $\mathring{A}$) is 2.2μB. The saturation magnetization of Fe at $0K$ is :

(1) 100 $kA\ m^{-1}$ (2) 1750 $kA\ m^{-1}$ (3) 2500 $kA\ m^{-1}$ (4) 3520 $kA\ m^{-1}$

81. The directional derivative of $\varphi = x^2yz + 2xz^3$ at (1, 1, −1) in the direction $2\hat{i} - 2\hat{j} + \hat{k}$ is :

(1) $\frac{2}{3}$ (2) $-\frac{2}{3}$ (3) $\frac{5}{3}$ (4) $\frac{1}{3}$

82. The angle between the surfaces $x^2 + y^2 + z^2 = 1$ and $z = x^2 + y^2 - 1$ at the point (1, +1, −1) is :

(1) 15.76° (2) 1.75° (3) 2.53° (4) 25.23°

83. A G.M. counter records 4,900 background counts in 100 min. with a radioactive source in position, the same total number of counts are recorded in 20 min. The percentage of S.D. with net counts due to the source is :

(1) 5.5% (2) 1.8% (3) 0.5% (4) 2.5%

84. The alpha ray activity of a material is measured after equal successive intervals (hours), in terms of its initial activity as unity to the 0.835; 0.695; 0.580; 0.485; 0.405 and 0.335. Assuming that the activity obeys an exponential decay law, the half-life is :

(1) 5.63 h (2) 8.05 h (3) 2.15 h (4) 3.82 h

85. A thin uniform annular disc of mass M has outer radius $4R$ and inner radius $3R$. The work required to take a unit mass from point P on its axis to infinity is :

(1) $\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$ (2) $-\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$

(3) $\frac{GM}{4R}$ (4) $\frac{2GM}{5R}\left(\sqrt{2}-1\right)$

86. Two masses m_1 and m_2 connected by a spring of spring constant k rest on a frictionless surface. If the masses are pulled apart and let go, the time period of oscillation is :

(1) $T=2\pi\sqrt{\frac{1}{k}\left(\frac{m_1m_2}{m_1+m_2}\right)}$ (2) $T=2\pi\sqrt{k\left(\frac{m_1+m_2}{m_1m_2}\right)}$

(3) $T=2\pi\sqrt{\frac{m_1}{k}}$ (4) $T=2\pi\sqrt{\frac{m_2}{k}}$

87. Two particles of rest mass m_0 approach each other with equal and opposite velocity v, in the laboratory frame. The total energy of one particle as measured in the rest frame of other is :

(1) $E=m_oc^2$ (2) $E=2m_oc^2$

(3) $E=3m_oc^2$ (4) $E=1/2m_oc^2$

88. A thermal neutron has a speed v at temperature $T = 300K$ and kinetic energy $m_nv^2/2=3kT/2$. The de-Broglie wavelength of thermal neutron is :

(1) 0.27 $\mathring{A}$ (2) 1.37 $\mathring{A}$ (3) 2.27 $\mathring{A}$ (4) 3.17 $\mathring{A}$

89. Using the uncertainty principle, the ground state energy of a linear oscillator is expressed by :

(1) $\frac{1}{2}\hbar\omega$ (2) $\hbar\omega$ (3) $\frac{3}{2}\hbar\omega$ (4) $2\hbar\omega$

90. An electron is trapped in an infinitely deep potential well of width $L = 106\ fm$. The wavelength of photon emitted from the transition $E_4 \rightarrow E_3$ is :

(1) 3.453 nm (2) 4.665 nm

(3) 1.435 nm (4) 0.453 nm

91. A particle of mass m_e trapped in an infinite depth well of width $L = 1$ nm. Consider the transition from the excited state $n = 2$ to the ground state $n = 1$. The wavelength of light emitted is :

(1) 1234 nm (2) 8864 nm (3) 4321 nm (4) 8790 nm

92. A particle of mass m and charge q oscillating with frequency ω is subjected to a uniform electric field E parallel to the direction of oscillation. The stationary energy levels is :

(1) $\left(n+\frac{1}{2}\right)\hbar\omega$ (2) $\frac{1}{2}\hbar\omega$

(3) $\left(n^2+\frac{1}{2}\right)\hbar\omega$ (4) $\hbar\omega$

93. The rms velocity of hydrogen molecules at NTP and at 127° C is :

(1) 148 *m/s* (2) 2134 *m/s* (3) 876 *m/s* (4) 3149 *m/s*

94. The fraction of the oxygen molecule with velocities between 199 m/s and 201 m/s at 27°C :

(1) 1.29×10^{-3} (2) 2.29×10^{-2}

(3) 2.29×10^{-3} (4) 5.29×10^{-2}

95. If 1 g of water freezes into ice, the change in its specific volume is 0.091 cc. The pressure required to be applied to freeze 10 g of water at –1°C.

(1) 3.345 atm (2) 0.254 atm (3) 2.24 atm (4) 2.587 atm

96. A 50 Ω resistor carrying a constant current of $1A$ is kept at a constant temperature of 300 K by a stream of cooling water. In a time interval of 1 sec, the change in entropy of the resistor is :

(1) Zero (2) $10\ JK^{-1}$ (3) $1000\ JK^{-1}$ (4) Infinity

97. Consider six distinguishable particles are distributed over three nondegenerate energy levels. Level 1 is at zero energy; level 2 has an energy $\in$; and level 3 has energy $2\in$. The total number of microstates for the system is :

(1) 10 (2) 1168 (3) 555 (4) 729

98. An ideal Fermi gas is at rest at absolute temperature zero and has a Fermi energy $\in$. The mass of each particle is m. If v denotes the velocity of a molecule, then $\overline{v}_x^2$ is :

(1) $2\in/5m$ (2) $5\in/2m$ (3) $2m/5\in$ (4) $5m/2\in$

99. The temperature at which an ideal gas whose molecules have an average kinetic energy of 1 eV is :

(1) 10345 K (2) 11594 K

(3) 1234 K (4) 4532 K

100. The classical value of molar specific heat is :

(1) $R_u/2$ (2) $3R_u$

(3) R_u (4) $3R_u/2$

Answer keys of PHD-EE-2023-24 (PHYSICS) entrance exam dated 22.03.2024				
Q. NO.	A	B	C	D
1	2	2	4	1
2	1	3	1	4
3	2	1	2	2
4	4	2	3	4
5	1	1	1	1
6	1	2	4	1
7	3	2	3	4
8	2	3	3	2
9	1	1	2	1
10	1	1	4	3
11	2	2	4	3
12	1	1	1	2
13	4	4	3	2
14	3	3	3	3
15	3	1	1	1
16	1	2	2	4
17	4	2	2	1
18	1	1	3	3
19	2	2	1	2
20	2	2	2	2
21	4	1	1	2
22	1	4	4	1
23	2	2	1	4
24	3	4	2	3
25	1	1	3	1
26	4	1	4	2
27	3	4	4	2
28	3	2	3	1
29	2	1	1	2
30	4	3	2	2
31	3	2	2	4
32	2	1	1	1
33	2	2	4	2
34	3	4	3	3
35	1	1	1	1
36	4	1	2	4
37	1	3	2	3
38	3	2	1	3
39	2	1	2	2
40	2	1	2	4
41	2	4	2	2
42	3	1	1	4
43	1	3	4	4
44	2	3	3	2
45	1	1	3	3
46	2	2	1	1
47	2	2	4	1
48	3	3	1	1
49	1	1	2	3
50	1	2	2	4

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Answer keys of PHD-EE-2023-24 (PHYSICS) entrance exam dated 22.03.2024				
Q. NO.	A	B	C	D
51	4	2	3	1
52	1	4	2	4
53	3	4	2	1
54	3	2	3	2
55	1	3	1	3
56	2	1	4	4
57	2	1	1	4
58	3	1	3	3
59	1	3	2	1
60	2	4	2	2
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63	4	2	2	1
64	2	3	4	2
65	3	1	1	1
66	1	4	1	2
67	1	3	3	2
68	1	3	2	3
69	3	2	1	1
70	4	4	1	1
71	2	2	2	4
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73	4	4	1	3
74	3	3	2	3
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76	2	1	2	2
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82	4	4	4	1
83	1	1	2	2
84	2	2	4	4
85	3	3	1	1
86	4	4	1	1
87	4	4	4	3
88	3	3	2	2
89	1	1	1	1
90	2	2	3	1
91	1	3	2	2
92	4	2	4	1
93	2	2	4	4
94	4	3	2	3
95	1	1	3	3
96	1	4	1	1
97	4	1	1	4
98	2	3	1	1
99	1	2	3	2
100	3	2	4	2

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