A

20224 **120 MINUTES**

1. Let $[\epsilon_0]$ denote the dimensional formula of the permittivity of vaccum. If M = mass, L = length, T = time and I = electric current, then

   A) $[\epsilon_0] = [M^{-1}L^{-3}T^2I]$ B) $[\epsilon_0] = [M^{-1}L^{-3}T^4I^2]$

   C) $[\epsilon_0] = [M^{-1}L^2T^{-1}I^{-2}]$ D) $[\epsilon_0] = [M^{-1}L^2T^{-1}I]$

2. When a soap bubble is given an electric charge:
   A) It contracts
   B) It expands
   C) Its size remain the same
   D) It expands or contracts depending upon whether the charge is positive or negative

3. An electron moving around the nucleus with an orbital angular momentum $\vec{L}$ has a magnetic moment:
   A) $\frac{e}{m}\vec{L}$ B) $\frac{e}{2m}\vec{L}$ C) $\frac{2e}{m}\vec{L}$ D) $\frac{e}{2\pi m}\vec{L}$

4. A charged particle is projected along the direction of uniform magnetic field, then its velocity:
   A) increases B) decreases
   C) remain unchanged D) None of these

5. The instantaneous magnitude of the electric field (E) and the magnetic field (B) vectors in an electromagnetic wave propagating in vaccum are related as:
   A) $E = \frac{B}{c}$ B) $E = c\,B$ C) $E = \frac{B}{c^2}$ D) $E = c^2B$

6. If λ_v , λ_x and λ_m represent the wavelengths of visible light, x-rays and microwaves respectively (in a given medium), then
   A) $\lambda_m > \lambda_x > \lambda_v$ B) $\lambda_m > \lambda_v > \lambda_x$

   C) $\lambda_v > \lambda_x > \lambda_m$ D) $\lambda_v > \lambda_m > \lambda_x$

7. A rocket ship is 100 m long on the ground. When it is in flight, its length is 99 m to an observer on the ground. What is its speed?
   A) 4.2 x $10^7 ms^{-1}$ B) 4.2 x $10^6 ms^{-1}$
   C) 4.2 x $10^5 ms^{-1}$ D) 3 x $10^8 ms^{-1}$

8. A proton has a kinetic energy of m_0c^2. What is its momentum in units of Mev|c.
   A) 1630 B) 1400 C) 1260 D) 1170

9. The propagation constant K of the deBroglie waves associated with a body of rest mass 'm_0' moving with velocity 'v' is

A) $\frac{2\pi m_0 c^2}{h\sqrt{1-\frac{v^2}{c^2}}}$ B) $\frac{2\pi m_0 c}{h\sqrt{1-\frac{v^2}{c^2}}}$ C) $\frac{2\pi m_0 v}{h\sqrt{1-\frac{v^2}{c^2}}}$ D) $\frac{2\pi m_0 v^2}{h\sqrt{1-\frac{v^2}{c^2}}}$

10. The deBroglie wavelength of a 15 kev electron is:
A) 0.10 Å B) 0.20 Å C) 0.30 Å D) 0.40 Å

11. The wavelength of the photon emitted when a hydrogen atom goes from the n = 10 state to the ground state.
A) 1270 Å B) 920 Å C) 310 Å D) 12 Å

12. How many revolutions does an electron in the n = 2 state of a hydrogen atom make before dropping to the n = 1 state. [The average life time of an excited state is about 10^{-8} sec]
A) 6.4 x10^{21} rev B) 8.2 x 10^2 rev
C) 8.2 x 10^4 rev D) 8.2 x 10^6 rev

13. The lowest energy of a neutron confined to a box $10^{-14}m$ across is approximately:
A) 2 MeV B) 4 MeV C) 6 MeV D) 8 MeV

14. The permitted energy values of a particle confined to a box of width L is given by:

A) $E_n = \frac{nh^2}{8mL^2}$ where n = 1, 2, 3,----

B) $E_n = \frac{n^2h}{8mL}$ where n = 1, 2, 3,----

C) $E_n = \frac{n^2h^2}{8mL^2}$ where n = 1, 2, 3,----

D) $E_n = \frac{n^2h^2}{8m^2L^2}$ where n = 1, 2, 3,----

15. The magnetic moment μ_J of an atom in which L S coupling holds has the magnitude:
[μ_B = Bohr magneton , g_J = Lande 'g' factor]

A) $\mu_J = \sqrt{J(J+1)}\,/\,g_J\,\mu_B$ B) $\mu_J = \sqrt{J(J+1)}\,g_J\,\mu_B$

C) $\mu_J = \sqrt{J(J+1)}\;g_J\,/\,\mu_B$ D) $\mu_J = \sqrt{J(J+1)}\;\mu_B\,/\,g_J$

16. Identify the nuclei that result from the positive beta decay of $_{19}K^{38}$
A) $_{20}Ca^{39}$ B) $_{18}Ar^{39}$ C) $_{20}Ca^{38}$ D) $_{18}Ar^{38}$

17. Which of the following molecule would show microwave rotational spectrum, Br_2, HBr, CS_2 ?

A) Br_2 and HBr B) HBr and CS_2 C) HBr only D) Br_2 and CS_2

18. If A and B are Hermitian operators:

A) (AB + BA) is Hermitian and (AB - BA) is not Hermitian
B) (AB + BA) is not Hermitian and (AB - BA) is Hermitian
C) (AB + BA) and (AB - BA) are Hermitian
D) (AB + BA) and (AB - BA) are not Hermitian

19. For the ground state of the hydrogen atom, the wave function is $\psi_{100} = \frac{1}{\sqrt{\pi}}\left(\frac{1}{a_0}\right)^{3/2} e^{-r/a_0}$. The expectation value of the radius vector of the electron is given by:

A) $< r >= a_0$ B) $< r >= \frac{a_0}{2}$

C) $< r >= \frac{3}{2}a_0$ D) $< r >= \frac{2}{3}\ a_0$

20. Evaluate $\int_c \frac{z-3}{z^2+2z+5} dz$ when c is the circle | z | = 1

A) 1 B) π C) 0 D) i + ½

21. Unit vector normal to the surface $xy^3z^2 = 4$ at the point (-1, -1, 2) is:

A) $-\frac{1}{\sqrt{11}}\left(4\hat{\imath} - 12\hat{\jmath} + 4\hat{k}\right)$ B) $-\frac{1}{\sqrt{11}}\left(\hat{\imath} + 3\hat{\jmath} - \hat{k}\right)$

C) $-\frac{1}{\sqrt{11}}(-3\hat{\imath} + 4\hat{\jmath} + 4\hat{k})$ D) $-\frac{1}{\sqrt{11}}(\hat{\imath} + \hat{\jmath} - \hat{k})$

22. The transition temperature of mercury is nearly equal to:

A) 1 K B) 1.4 K C) 4.12 K D) 9.2 K

23. Two states with energy difference 4.83 x 10^{-17} Jules occur with relative Boltzmann probability e^2, calculate the temperature. Given Boltzmann's Constant K = 1.38 x 10^{-23}J/ K

A) 1.75 x 10^6 K B) 2.50 x 10^6 K C) 6.2 x 10^6 K D) 11.4 x 10^6 K

24. The sum of the residues of the function $f(z) = \frac{Sin\ z}{Z\ Cos\ z}$ at its poles inside the circle | z | = 2 is:

A) 1 B) $\frac{\pi}{2}$ C) $\frac{2}{\pi}$ D) zero

25. Laplace transform of e^{at}, when $s >$ a is:

A) $\frac{1}{S+a}$ B) $\frac{1}{S-a}$ C) $\frac{1}{S^2+a^2}$ D) $\frac{1}{S^2-a^2}$

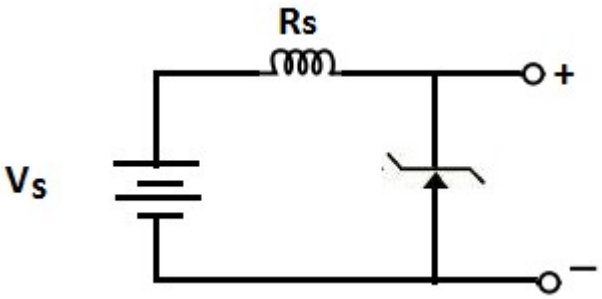
26. If n is the number of the electron in a hydrogen atom, the correct statement among the following is:

A) Electron energy increases as n increases
B) Electron energy decreases as n increases
C) Electron energy is zero for n = 1
D) Electron energy varies as n^2

27. In a full wave rectifier, what is the output frequency if the input frequency is 50 Hz?
A) 50 Hz B) 100 Hz C) 125 Hz D) 250 Hz

28. For a transistor common emitter amplifier, the voltage gain :
A) Remains constant for all frequencies
B) Is high at high and low frequencies and constant in the middle frequency range
C) Is low at high and low frequencies and constant at mid frequencies
D) Is irregular and no relation to frequencies

29.



The zener diode in the figure has a zener voltage of 15V and a power rating 0.5W. If $V_s = 40v,$ what is the minimum value of R_s that prevents the zener diode from being destroyed?
A) 751 Ω B) 682 Ω C) 541 Ω D) 201 Ω

30. For an Op- Amp slew rate is:
A) Maximum charging current divided by resistance
B) Maximum charging current divided by capacitance
C) Maximum charging current divided by induction
D) Maximum charging current multiplied by capacitance

31. For an Op-Amp the peak of output sine wave is 10v and slew rate 0.5v/ μs, the power Band width is:
A) 3.14 KHz B) 4.32 KHz C) 6.34 KHz D) 7.96 KHz

32. What is the frequency of an X-ray photon whose momentum is $1.0 \times 10^{-23}\ Kg\ m\ s^{-1}$?
A) $5.0 \times 10^{18}\ Hz$ B) $5.0 \times 10^{14}\ Hz$
C) $2.5 \times 10^{18}\ Hz$ D) $2.5 \times 10^{14}\ Hz$

33. A particle of mass m confined to a box of width L. The particle is assumed to move back and forth along a straight line between the walls of the box. The deBroglie wavelength of the trapped particle is (n = 1, 2, 3, …..)
A) $\frac{L}{n}$ B) $\frac{L}{n^2}$ C) $\frac{2L}{n}$ D) $\frac{2L}{n^2}$

34. The phase velocity of the de-Broglie waves of a particle of mass m and de- Broglie wavelength λ is:

A) $c\sqrt{1+\left(\frac{mc^2\lambda}{h}\right)^2}$ B) $c\sqrt{1+\left(\frac{mc\lambda}{h}\right)}$

C) $c\,[1+\frac{mc\lambda}{h}]^2$ D) $c\sqrt{1+\left(\frac{mc\lambda}{h}\right)^2}$

35. An eigen function of the operator $\frac{d^2}{dx^2}$ is $\psi = e^{2x}$. The corresponding eigen value is:

A) 1 B) 2 C) 3 D) 4

36. The expectation values $< px >$ and $< xp >$ are related by:

A) $< px > - < xp > = \frac{\hbar}{i}$ B) $< px > - < xp > = i\hbar$

C) $< px > - < xp > = \frac{i}{\hbar}$ D) $< px > - < xp > = i^2\hbar$

37. A student writes for the wave function of a free particle $\psi(x) = N \exp[i(kx^2 - \omega t)]$. This is not correct because:

A) It is not normalizable
B) It does not satisfy the wave equation
C) The sign of the first term in the exponent is wrong
D) It does not satisfy the required boundary conditions

38. The reason why at room temperature T, electrons in a metal do not have the same specific heat as normal gas molecules:

A) The Fermi level is much larger than KT
B) Electrons repel each other unlike gas molecules
C) Electrons are paired
D) Electrons are strongly bound in a metal

39. In Superconductors, electrons form cooper pairs. This pairing is due to:

A) Electrostatic forces
B) Magnetic interactions
C) Interactions of electron with lattice
D) Interactions of electrons with photons

40. If the electric flux entering and leaving an enclosed surface respectively is φ_1 and φ_2 , the electric charge inside the surface will be:

A) $(\varphi_2 - \varphi_1)/\varepsilon_0$ B) $(\varphi_1 + \varphi_2)\,\varepsilon_0$

C) $(\varphi_2 - \varphi_1)\varepsilon_0$ D) $(\varphi_1 + \varphi_2)/\varepsilon_0$

41. The dimension of $\frac{1}{2}\,\varepsilon_0 E^2$ (ε_0 = permittivity of free space: E= electric field) is

A) MLT^{-1} B) ML^2T^{-2} C) $ML^{-1}T^{-2}$ D) ML^2T^{-1}

42. The area enclosed by hysteresis loop should:
A) retentivity of the medium
B) coercivity of the medium
C) permeability of the specimen
D) energy loss per unit volume per cycle

43. If the susceptibility of dia, para and ferro magnetic meterials an $\chi_{d,}$, $\chi_{p,}$ χ_f respectively, Then:
A) $\chi_d < \chi_p < \chi_f$ B) $\chi_d < \chi_f < \chi_p$
C) $\chi_f < \chi_d < \chi_p$ D) $\chi_f < \chi_p < \chi_d$

44. The pressure exerted by an electromagnetic wave of intensity I(Watt/ m^2) on a non reflecting surface is (c is the velocity of light):
A) Ic B) Ic^2 C) I/c D) I/c^2

45. The electric field of an electromagnetic wave travelling through vaccum is given by the equation $E = \epsilon_0 \sin(kx - \omega t)$. The quantity that is independent of wavelength is:
A) $\frac{k}{\omega}$ B) kω C) ω D) k

46. In a series of five cricket matches, one of the captains calls " Tail" every time when the toss is taken. The probability that he will win 2 times and lose 3 times is:
A) $\frac{5}{16}$ B) $\frac{1}{32}$ C) $\frac{3}{16}$ D) $\frac{5}{8}$

47. The position and momentum of a 1 keV electron is simultaneously determined. If its position is located to within 1 Å, what is the approximate percentage of uncertainty in its momentum?
A) 6.2 % B) 3.1 % C) 9.3 % D) 12.4 %

48. A particle of mass m trapped in a two dimensional box L long and W side. The permitted energies of the particle are given by [a and b are positive integers]

A) $E = \frac{h^2}{8m}\left[\frac{a^2}{L^2} + \frac{b^2}{W^2}\right]$ B) $E = \frac{h}{8m^2}\left[\frac{a^2}{L^2} + \frac{b^2}{W^2}\right]$

C) $E = \frac{h^2}{8m^2}\left[\frac{a^2}{L^2} + \frac{b^2}{W^2}\right]$ D) $E = \frac{h}{8m}\left[\frac{a^2}{L^2} + \frac{b^2}{W^2}\right]$

49. The zero point energy of a harmonic oscillation is:
A) $\frac{1}{2}h\nu$ B) $\frac{1}{4}h\nu$ C) zero D) infinity

50. A beam of electrons enters a uniform magnetic field of flux density 1.2 webers/ m^2. The energy difference between electrons whose spins are parallel and antiparallel to the field are:
A) $4.8 \times 10^{-4}\ ev$ B) $1.4 \times 10^{-4}\ ev$
C) $4.8 \times 10^{-8}\ ev$ D) $1.4 \times 10^{-8}\ ev$

51. Relation between the energy and the statistical weight Ω (the thermodynamic probability) is ----. (K = Boltzmann constant)

A) $S = K\,\Omega$ B) $S = K ln\,\Omega$

C) $S = \ln(K\,\Omega)$ D) $S = \sqrt{K\,\Omega}$

52. Tritium (${}_1H^3$) has a half life of 12.5 years against Beta decay. What fraction of a sample of pure tritium will remain undecayed after 25 years?

A) $\frac{1}{2}$ B) $\frac{1}{4}$ C) $\frac{1}{3}$ D) $\frac{1}{6}$

53. The most probable distance for an electron of hydrogen atom in the Schrodinger theory is equal to:

A) Bohr radius B) Twice the Bohr radius

C) Half of Bohr radius D) Square root of Bohr radius

54. In rotational spectra, the change in the rotational constant *B* when hydrogen is replaced by deuterium in the hydrogen molecule:

A) $\frac{B}{2}$ B) $2\,B$ C) $4\,B$ D) $6\,B$

55. A harmonic oscillation is in the ground state. What is the value of maximum probability density:

A) $\left(\frac{\pi\hbar}{mw}\right)^{\frac{1}{2}}$ B) $\left(\frac{mw}{\pi\hbar}\right)^{\frac{1}{2}}$ C) $\frac{mw}{\pi\hbar}$ D) $\frac{\pi\hbar}{mw}$

56. The width of the energy gap of a superconductor is maximum at:

A) 0 K B) 0^0C

C) Transition temperature D) Room temperature

57. The magnetic dipole moment is the product of current in the loop and ---

A) flux through the loop B) square of area of the loop

C) area of the loop D) mass of the loop

58. The value of the integral

$$\int_{-\infty}^{+\infty} \frac{x^2 dx}{(x^2+1)(x^2+4)}$$ is

A) $\frac{\pi}{3}$ B) $\frac{\pi}{4}$ C) π D) $\frac{\pi}{2}$

59. Electromagnetic wave with wavelength

1. λ_1 are used to treat mascular strain
2. λ_2 are absorbed by the ozone layer of atmosphere

Identify λ_1 and λ_2

A) $\lambda_1 \rightarrow$ infra red , $\lambda_2 \rightarrow$ x-rays

B) $\lambda_1 \rightarrow$ infra red , $\lambda_2 \rightarrow$ ultraviolet

C) $\lambda_1 \rightarrow$ micro waves , $\lambda_2 \rightarrow$ x-rays

D) $\lambda_1 \rightarrow$ ultra violet , $\lambda_2 \rightarrow$ infra red

60. The ratio of velocity of light rays of wavelength 400 nm and 800 nm in vaccum is:
A) $\frac{1}{2}$ B) 2 C) 1 D) $\frac{3}{2}$

61. For a given Kinetic energy, which of the following has the smallest de-Broglie wavelength?
A) Electron B) Proton C) Neutron D) α- particle

62. In a CE Amplifier if the base current is increased by 20 μA, the collector current change from 4 mA to 5 mA. The current amplification is:
A) 200 B) 50 C) 125 D) 250

63. The device used for detecting optical signal is:
A) Zener diode B) Photo diode
C) LED D) Optical fiber

64. A 100 PF capacitor has a maximum charging current of 150 μA. What is the slew rate?
A) $1.5\ v/\mu s$ B) $15\ v/\mu s$ C) $150\ v/\mu s$ D) $0.15\ v/\mu s$

65. The frequency of an X-ray photon whose momentum is 1.1 x $10^{-23}\ kgms^{-1}$ is
A) 5.0 x $10^{16}\ Hz$ B) 5.0 x $10^{21}\ Hz$
C) 5.0 x $10^{18}\ Hz$ D) 5.0 x $10^{9}\ Hz$

66. A positron collides head on with an electron and both are annihilated. Each particle had a Kinetic energy of 1.00 MeV the wave length of the resulting photon is:
A) 0.82 pm B) 0.41 pm C) 0.82 nm D) 0.41 nm

67. The Schwarzschild radius R_s of a body of mass M is:
A) $R_s = \frac{GM}{c^2}$ B) $R_s = \frac{GM}{2c^2}$ C) $R_s = \frac{2GM}{c^2}$ D) $R_s = \frac{2GM}{c}$

68. A photon that through a height H in a gravitational field gains energy just as a stone does. This gain in energy is manifested as an increase in frequency from v to v'. Then
A) $v' = v\left[1 + \frac{gH}{c^2}\right]$ B) $v' = v\left[1 - \frac{gH}{c^2}\right]$
C) $v' = v\left[1 + \frac{c^2}{gH}\right]$ D) $v' = v\left[1 - \frac{c^2}{gH}\right]$

69. The expectation value $< x >$ of the positron of a particle trapped in a box L wide is:
A) $\frac{L}{4}$ B) $\frac{L}{3}$ C) L D) $\frac{L}{2}$

70. Two coherent source of intensity ratio 100 : 1 interface. The ratio of the intensity between maxima and minima in the interference pattern is:
A) $\frac{11}{9}$ B) $\frac{121}{81}$ C) $\frac{9}{11}$ D) $\frac{81}{121}$

71. What will be the effect on the fringes of Young's double slit experimental set up if the whole set up is immersed in water.
A) The fringe width decreases B) The fringe width increases
C) No change in fringe width D) Fringes disappear

72. The angle of incidence at which reflected light is totally polarized from air to glass (refraction index = n) is:

A) $sin^{-1}(n)$ B) $sin^{-1}(\frac{1}{n})$ C) $tan^{-1}(\frac{1}{n})$ D) $tan^{-1}(n)$

73. In a single slit difference pattern, the condition for n^{th} secondary minimum is:

A) $\theta = \frac{n\lambda}{a}$ B) $\theta = (n + \frac{1}{2})\frac{\lambda}{a}$

C) $\theta = (n + 1)\frac{\lambda}{a}$ D) $\theta = (2n + 1)\frac{\lambda}{a}$

74. In Young's double slit experiment, the separation between the slits is halved and the distance between the slits and the screen is doubled. The fringe width will

A) doubled B) quadrupled

C) remain the same D) halved

75. What must be the angle between $\vec{A}$ and $\vec{B}$ if the magnitude of $\vec{A} + \vec{B}$ equals the magnitude of $\vec{A} - \vec{B}$?

A) 45^0 B) 90^0 C) 180^0 D) 0^0

76. If P is pressure and V is volume the product (PV) has the dimensions

A) $M\,L^{-1}\,T^{-2}$ B) $M\,L^{2}\,T^{-1}$ C) $M\,L^{2}\,T^{-3}$ D) $M\,L^{2}\,T^{-2}$

77. A voltage of 5.0 μv is applied across a Josephson junction. The frequency of the radiation emitted by the junction is:

A) 2.4 GHz B) 2.4 MHz C) 1.2 GHz D) 1.2 MHz

78. The strangeness number's' of up and down quarks are:

A) S = 0 for up and S = -1 for down

B) S = 0 for up and S = 0 for down

C) S = 0 for up and S = $+1$ for down

D) S = -1 for up and S = 0 for down

79. A μ^- muon collides with a proton and a neutron plus another particle are created. What is the other particle?

A) electron B) π^+(charged pi on)

C) ν_μ (mu- neutrino) D) π^0 (neutral pi on)

80. The wavelength of light coming from a sodium source is 589 nm. Its wavelength in water is -------. (Refractive index of water is $\frac{4}{3}$).

A) 442 nm B) 282 nm C) 785 nm D) 925 nm

81. In a wave, the path difference corresponding to a phase difference of ϕ is:

A) $\frac{\pi}{2\lambda}\phi$ B) $\frac{\pi}{2}\phi$ C) $\frac{\lambda}{2\pi}\phi$ D) $\frac{\lambda}{\pi}\phi$

82. The displacement of a particle is represented by the equation $y = 3\cos\left[\frac{\pi}{4} - 2\omega t\right]$
The motion of a particle is;
A) Simple harmonic with period $\frac{2\pi}{\omega}$
B) Simple harmonic with period $\frac{\pi}{\omega}$
C) Periodic but not simple harmonic
D) Non-periodic

83. A particle executing S H M has a maximum speed of 30 ms^{-1} and a maximum acceleration of 60 ms^{-1}. The period of oscillation is:
A) πs B) $\frac{\pi}{2}s$ C) $2\pi s$ D) $\frac{\pi}{4}s$

84. A point charge +q is placed at the centre of a circle of side L. The electric flux emerging from the cube is:
A) $\frac{q}{\varepsilon_0}$ B) zero C) $\frac{6qL^2}{\varepsilon_0}$ D) $\frac{\varepsilon_0}{6qL^2}$

85. The electric potential at any point (x, y, z) in metre, is given by $v = 3x^2$. The electric field at a point (2m, 0, 1m) is:
A) 12 Vm^{-1} B) 6 Vm^{-1} C) $-6\,Vm^{-1}$ D) $-12\,Vm^{-1}$

86. The largest wavelength present in the Balmer Series of hydrogen, corresponding to H_α line:
A) 328 nm B) 656 nm C) 984 nm D) 1312 nm

87. An electron collides with a hydrogen atom in its ground state and exists it to a state of n = 3. How much energy was given to the hydrogen atom in this inelastic collision?
A) 12 ev B) 8 ev C) 6 ev D) 4 ev

88. At what temperature will the average molecular Kinetic energy in gaseous hydrogen equal the binding energy of a hydrogen atom?
A) $10^3\ K$ B) $10^4\ K$ C) $10^5\ K$ D) $10^6\ K$

89. The most probable speed of an ideal gas molecule is:
A) $\sqrt{\frac{3KT}{m}}$ B) $\sqrt{\frac{KT}{2m}}$ C) $\sqrt{\frac{3}{2}\frac{KT}{m}}$ D) $\sqrt{\frac{2KT}{m}}$

90. The Fermi energy in silver is 5.51 ev. The average energy of the free electrons in silver at 0 K is:
A) 3.3 ev B) 3.3 kev C) 3.3 Mev D) 606 ev

91. Which of the following quantities is not a vector?
A) Torque B) Linear momentum
C) Angular momentum D) Moment of inertia

92. The density of $_8O^{16}$ nuclei is:
A) 2.4 x $10^{11} Kg\ m^{-3}$ B) 2.4 x $10^{7}\ Kg\ m^{-3}$
C) 2.4 x $10^{17} Kg\ m^{-3}$ D) 2.4 x $10^{241} Kg\ m^{-3}$

93. The electrical conductivity of a semiconductor is:

A) e $(n_e \mu_e + n_h \mu_h)$ B) e E $(n_e \mu_e + n_h \mu_h)$

C) e $(n_e \mu_e - n_h \mu_h)$ D) e E$(n_e \mu_e - n_h \mu_h)$

94. The Lagrangian for a charged particle in an electromagnetic field can be expressed as, where T-kinetic energy, q-charge, ϕ-electric potential, v-velocity, E-electric field and A-magnetic vector potential

A) L=T- qϕ + q(**v**.**A**)/c B) L=T- qϕ

C) L=T- qϕ + q(**v**x**A**) D) L=T- qϕ + q**E**

95. The Hamilton's principle can be expressed as:

A) $\delta \int_{t1}^{t2} Ldt = 0$ B) $\delta \int_{t1}^{t2} Ldt > > 0$

C) $\delta \int_{t1}^{t2} Ldt < < 0$ D) $\delta \int_{t1}^{t2} (T+V)dt = 0$

96. For a particle moving under central force field the effective potential in which radial motion occurs can be represented by (k – force constant, l – angular momentum):

A) kr^2 B) $l^2/2m\ r^2$

C) $[kr^2/2] + [l^2/2m\ r^2]$ D) 0

97. Two electrons move towards each other with speed 0.9c each in a Galilean frame of reference. Their speed relative to each other is

A) 0.995c B) 0.95c C) 0.98c D) 0.18c

98. The Lagrangian of a simple pendulum is:

A) $[ml^2\omega^2/2] - [mgl(1-\cos\Theta)]$ B) $[ml^2\omega^2/2] - [mgl\cos\Theta]$

C) $[ml^2\omega^2/2] - [mgl]$ D) $ml^2\omega^2$

99. According to WKB approximation the probability density depends on velocity as:

A) V B) V^2 C) $1/V^2$ D) 1/V

100. In Dirac's notation the condition for orthogonality of two state vectors is:

A) < alb > =1 B) < alb > = 0 C) < alb >= h D) None of these

101. In terms of partition function Q, the Helmholtz free energy A can be expressed as:

A) A=-KTQ B) A=-KT ln(Q)

C) A=-KT/Q D) A=-KT

102. Polonium-212 emits alpha particles of 8.776MeV. The disintegration energy is:

A) 8.945MeV B) 89.45MeV C) 0.8945MeV D) 17.8 MeV

103. The charge of an up quark is:
A) -2e/3 B) 2e/3 C) e/3 D) -e/3

104. For an electron the lepton number is:
A) -1 B) 1 C) 0 D) 2

105. The agent for strong interaction is:
A) photon B) boson C) graviton D) pion

106. The condition for diffraction by a crystal is, S being scattering vector and R the reciprocal lattice vector
A) S = R B) S > R C) S < R D) S = 0

107. Near absolute zero the specific heat of solids is proportional to temperature as:
A) T B) 1/T C) T^3 D) T^2

108. For the Zeeman splitting of an unpaired electron in a magnetic field of 0.34 T, the transition between energy states occur at a frequency of----- MHz, given g for electron is 2.0023:
A) 953 B) 9530 C) 95.3 D) 9.53

109. The nuclear spin of an isolated C^{13} nucleus is:
A) half integer B) zero
C) integer D) can't be predicted

110. The selection rules for a vibrating diatomic molecule under harmonic approximation in terms of vibrational quantum number V is:
A) $\Delta V = 0$ B) $\Delta V = \pm 1$
C) $\Delta V = \pm 1, \pm 2, \pm 3$--- D) $\Delta V = 0, \pm 1, \pm 2$---

111. A molecular vibration is not Raman active only if there is a change in:
A) magnitude of polarizability B) direction of polarizability
C) polarizability is zero D) either A or B

112. A long cylinder carries a charge density which is proportional to distance from the axis as kr for some constant k. The electric field intensity inside the cylinder can be expressed as:
A) $kr^2\rho/3\ \varepsilon_0$ B) $kr\rho/3\ \varepsilon_0$ C) $kr^2\rho^2/3\ \varepsilon_0$ D) $k\rho/3\ \varepsilon_0$

113. The Laplace's equation can be expressed as:
A) $\nabla(\nabla.V) = \rho/\varepsilon_0$ B) $\nabla(\nabla.V) = q/\varepsilon_0$ C) $\nabla(\nabla.V) = 0$ D) $(\nabla.V) = 0$

114. Which of the following regarding curl of B is true?
A) $\boldsymbol{\nabla X B} = \mu_0\mathbf{I}$ B) $\boldsymbol{\nabla X B} = \mu_0\mathbf{J}$ C) $\boldsymbol{\nabla X B} = \mu_0\mathbf{r}$ D) None of these

115. Faraday's law of electromagnetic induction in differential form is:
A) $\boldsymbol{\nabla X E} = -\frac{\boldsymbol{dB}}{dt}$ B) $\boldsymbol{\nabla X E} = -\frac{\boldsymbol{dE}}{dt}$ C) $\boldsymbol{\nabla X E} = 1$ D) $\boldsymbol{\nabla X E} = 0$

116. Which of the following is not true about a FET?
A) current controlled device B) voltage controlled device
C) unipolar device D) greater thermal stability than BJT

117. A mod-8 counter has:
A) one binary output B) two clock trigger input
C) can count from 0 to 7 D) two binary output

118. Which of the following material can't be used for making LED?
A) Ge B) GaAs C) GaAsP D) GaP

119. Which of the following is not a step in A/D conversion?
A) sampling B) quantization
C) coding D) None of these

120. What vector must be added to the resultant of the vectors $\mathbf{i}-2\mathbf{j}+2\mathbf{k}$ and $2\mathbf{i}+\mathbf{j}-\mathbf{k}$ so that the resultant is a unit vector?
A) $-2\mathbf{i}+\mathbf{j}+\mathbf{k}$ B) $-\mathbf{i}+\mathbf{j}+\mathbf{k}$ C) $-2\mathbf{i}+\mathbf{j}-\mathbf{k}$ D) $-2\mathbf{i}-\mathbf{j}-\mathbf{k}$