91124 120 MINUTES

1. The value of the closed surface integral $\int \mathbf{r}.d\mathbf{S}$ where **r** is the radius vector and d**S** is an element of vector area on a spherical surface of radius R is
   A) Zero
   B) The volume of the sphere
   C) Total surface area of the sphere
   D) 3 x volume of the sphere

2. The function cot (z) has
   A) An infinite number of poles each having a residue equal to 1
   B) One pole at z = 0 and the value is 1
   C) An infinite number of poles each having residue equal to 0
   D) Exactly one pole at $\pi/2$ with a residue equal to 1

3. A good example of a vector which is solenoidal is
   A) The magnetic field vector **B**
   B) The electric field vector **E**
   C) The current density vector **J**
   D) The velocity vector **V** of an electron in an atomic orbit

4. Consider the step function: $f(t) = +1$ for $0 \leq t \leq \pi/\omega$ and $f(t) = -1$ for $-\pi/\omega \leq t \leq 0$. Which of the following series gives the Fourier series representation of this function? (The summations are over n = 1 to ∞).
   A) $(4/\pi) \sum [\sin (n \omega t) / n]$ B) $(4/\pi) \sum [\sin \{(2n+1) \omega t\} /(2n+1)]$
   C) $(4/\pi) \sum [\cos (n \omega t) / n]$ D) $(4/\pi) \sum [\cos \{(2n+1) \omega t\} /(2n+1)]$

5. **A** and **B** are two arbitrary vectors. ε_{ijk} is the Levi-Civita symbol in 3 dimensions. Then what is the nature of the quantity $A_iB_j\varepsilon_{ijk}$?
   A) A scalar B) A tensor of 3rd rank
   C) A tensor of 5th rank D) A vector

6. If $dy/dx = (y / 2\sqrt{x})$, and y = 1 when x = 4, then
   A) $y = e^{\sqrt{x} - 2}$ B) $\ln y = \sqrt{(x - 2)}$
   C) $y = 4\sqrt{x} - 8$ D) $y = e^{\sqrt{x}}$

7. Which of the following is not a solution of the Laplace's equation in spherical polar co-ordinates?
   A) $1/r$ B) $ar^2 + b/r^2$
   C) $ar + b/r^2$ D) b/r^3

8. The Laplace transform of $e^{-at}t^n$ is
   A) $n!/(s+a)^{n+1}$ B) $n/(s+a)^n$
   C) $(s+a)^n$ D) as^n

9. The population of a city increases at a rate proportional to the population at a given time. It is seen that the population doubles every 50 years. After a period of 75 years what will be the ratio of the population P to that in the beginning of the period P_0?

A) 9 : 1 B) 5 : 2
C) $2\sqrt{2}$: 1 D) 4 : 1

10. The expression for the Bessel function of order n = -½ is

A) $\sqrt{(2/\pi x)}\sin(x)$ B) $\sqrt{(2/\pi x)}\cos(x)$
C) sin (x) / x D) cos (x) / x

11. If the defining relations of the generalized coordinates do not depend explicitly on time and the potential is not velocity dependent, then the Hamiltonian is given by (T is the kinetic energy and L is the Lagrangian)

A) H = T - V B) H = 2T - L
C) H = 2T + L D) H = L - 2T

12. An ^{16}O ion having an energy of 150 MeV is incident on a gold nucleus along a straight trajectory having an impact parameter of 10 fermis. If the angular momentum of the ion with respect to the nucleus is $l\hbar$, then the approximate value of l will be

A) 1 B) 100 C) 10 D) 60

13. What is the spring constant of a spring that stretches by 2 cm when a body of mass 0.6 kg is suspended from it?

A) 0.03 N/m B) 2.94 N/m C) 29.4 N/m D) 294 N/m

14. A point mass is subjected to two simultaneous sinusoidal displacements in x-direction, $x_1(t) = A \sin(t)$ and $x_2(t) = A \sin(t + 2\pi/3)$. Adding a third sinusoidal displacement $x_3(t) = B \sin(t + \varphi)$ brings the mass to a complete rest. The value of B and φ are

A) $\sqrt{2}\,A$, $3\pi/4$ B) A, $4\pi/3$
C) $\sqrt{3}\,A$, $5\pi/6$ D) A, $\pi/3$

15. Two balls, one more massive than the other, are released from rest at the top of an inclined plane. At the instant of release, the more massive ball will have a greater

A) Kinetic energy B) Potential energy
C) Speed D) Momentum

16. A huge rotating cloud of particles and dust in interstellar space gravitate together to form an increasingly denser object. As it shrinks in size the cloud

A) Rotates faster B) Rotates slower
C) Rotates at same speed D) Ceases to rotate

17. A moon orbits a distant planet in an elliptical orbit. The distance covered by the moon each day
    A) Is greatest when the moon is nearest to the planet
    B) Is greatest when the moon is farthest to the planet
    C) Remains the same irrespective of its distance from the planet
    D) Remains the same irrespective of its distance from the sun

18. A transformation is effected from (q,p) to (Q,P) so that $Q = aq + bp$ and $P = cq + dp$, where a,b,c and d are constants. This transformation will be canonical if
    A) $ad - bc = 0$ B) $ad - bc = 1$ C) $ad + bc = 0$ D) $ad + bc = 1$

19. Two electrons, each with a velocity of 0.8c to an observer, are moving towards each other. The relative velocity of one with respect to the other is :
    A) 1.6 c B) 1.2 c C) 0.976 c D) 0

20. A particle in a potential has its Lagrangian given by $L = \frac{1}{2}m(dr/dt)^2 - k(x^2+y^2)^{1/2}$. Identify the constant of the motion.
    A) Z component of the velocity
    B) Z component of the linear momentum
    C) Z component of the anngular momentum
    D) Potential energy

21. A particle has a kinetic energy equal to its rest mass energy. Its velocity will be
    A) 0.5c B) 0.866c C) 0.75c D) $\sqrt{2}c$

22. In one cycle of the radio frequency field a proton in a cyclotron is forced to follow a circular trajectory of radius 1 m by the application of a force of 10 Newtons by applying a suitable magnetic field. The work done on the proton in one cycle is
    A) 10 J B) 62.8 J C) Zero D) 62.8 W

23. The Poisson bracket for $[L_x, L_y]$ is
    A) iL_z B) L_z C) 0 D) L_xL_y

24. A hypothetical tunnel with frictionless walls is built connecting two spots on the Earth that follows a straight trajectory through the interior, but does not intersect the center of the Earth. An object is dropped into the tunnel from one end. Assume that the Earth is a uniform spherical mass M with radius R, and that the medial point of the tunnel passes to within a distance d of the center ($d << R$). Then
    A) It will execute simple harmonic motion with a period equal to $2\pi(\sqrt{(R^3/GM)}$
    B) It will execute simple harmonic motion with a period equal to $2\pi(\sqrt{(d^3/GM)}$
    C) It will execute simple harmonic motion with a period equal to $2\pi(\sqrt{(dR^2/GM)}$
    D) It will stop at the centre of the tunnel

25. As a coil is removed from a magnetic field, an emf is induced in the coil which causes a current to flow in it. This current interacts with the magnetic field producing a force which
A) Acts at right angles to the direction of motion
B) Acts in the direction of the motion of the coil
C) Acts in the direction opposite to the direction of motion of the coil
D) Causes the coil to flip over

26. A solid metal block is placed in an external electric field. Which statement is correct regarding the electric field inside the block?
A) The interior field points at right angles to the direction of the external field
B) The interior field points in the direction opposite to that of the external field
C) The interior field points in a direction parallel to that of the external field
D) There is no electric field inside the block

27. Electric field lines
A) Circulate clockwise around positive charges
B) Radiate outward from positive charges
C) Radiate outward from negative charges
D) Circulate counter-clockwise around positive charges

28. Magnetic permeability has units as
A) Wb / m^2 B) $Wb / A.m$
C) A / m D) $Tesla / m$

29. Magnetic susceptibility of diamagnetic materials is of the order of (SI units)
A) $+10^{-5}$ B) -10^{-5}
C) $+10^{5}$ D) -10^{-4} to $+10^{-2}$

30. An electromagnetic wave has an electric field with peak value 250 N/C. What is the average intensity of the wave?
A) $0.66\ W/m^2$ B) $0.89\ W/m^2$
C) $83\ W/m^2$ D) $120\ W/m^2$

31. Which one of the following statements concerning the wavelength of an electromagnetic wave is true?
A) The wavelength is independent of the speed of the wave for a fixed frequency
B) The wavelength is inversely proportional to the speed of the wave
C) The wavelength is the same for all types electromagnetic waves
D) The wavelength is inversely proportional to the frequency of the wave

32. Maxwell's equation $\nabla.\mathbf{B} = 0$ predicts that
A) Magnetic monopoles do not exist
B) Magnetic multipoles do not exist
C) Magnetic flux lines are closed curves just like electric flux lines
D) Magnetic flux lines are closed curves unlike electric flux lines

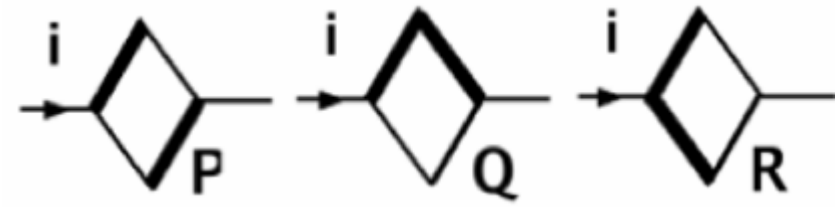
33. Which of the following types of electromagnetic waves cannot propagate in a hollow wave guide?

A) TE waves B) TM waves
C) TEM waves D) Both TE and TM waves

34. At an interface between two media, which of the following components are continuous?

A) Normal component of **B** and tangential component of **E**
B) Normal component of **D** and tangential component of **H**
C) Normal component of **H** and tangential component of **D**
D) Normal component of **E** and tangential component of **B**

35. Two thick wires and two thin wires, all of same material and same length, form a square in three different ways P, Q and R as shown in the figure:



With correct connections shown, the magnetic field due to the current flow i, at the centre of the loop will be zero in the case of

A) Q and R only B) P only
C) P and Q only D) P and R only

36. Energy is transported in an electromagnetic wave in a direction

A) Along that of the electric field
B) Along that of the magnetic field
C) In the plane of the electric and magnetic fileds
D) Along the perpendicular to both the fields

37. A student obtains the following expressions for two flux lines in a given electric field in the XY plane : $y = 2x^2-3x+5$ and $y = 2x^2-2x+3$. Which of the following statements is true about his result?

A) The result is correct since the flux lines can be represented by any two dimensional curves
B) The result is wrong since the flux lines are always parallel to one another
C) The result is wrong since the flux lines can never intersect at any point
D) The result is wrong since these flux lines are not straight lines

38. An isolated parallel plate capacitor C with air as the dielectric has a potential V across the plates. The space in between the plates is now filled with a dielectric with K = 5. Which quantity will remain unchanged?

A) Potential on the plates B) Capacitance
C) Charge on the plates D) Energy stored in the capacitor

39. An electromagnetic wave passing through a medium of refractive index n is represented by $E = 20 \sin [4\pi \text{ X } 10^{-4}(x - 2.25 \text{ X } 10^{9}t)]$. Here x is in Å and t is in nano seconds. What are the values of the wavelength and n?

A) 5000 Å and 4/3 B) $0.2 \text{ X } 10^{-3}$ Å and 1

C) 800 Å and 4/3 D) 5000 Å and 3/4

40. The magnetization of a paramagnetic salt is

A) Proportional to both the magnetic field and the temperature

B) Proportional to the magnetic field and inversely proportional to the temperature

C) Proportional to the temperature and inversely proportional to the magnetic field

D) Does not depend on the temperature

41. In a purely inductive circuit, the current

A) Lags behind the emf by 90^{o}

B) Leads the emf by 90^{o}

C) Is in phase with the emf

D) Sometimes lags behind and sometimes leads the emf

42. The peak in the intensity distribution of a certain emitting surface occurs at λ = 4000 Å at a temperature of 4000^{o} C. What is the corresponding wavelength at a temperature of 5000^{o} C?

A) 5000 Å B) 3200 Å C) 3000 Å D) 6250 Å

43. Sunlight falls on the surface of the earth at the rate of 1370 Watts m^{-2}. Assuming the earth to be a perfect absorber of sun's radiations, what will be the pressure exerted by the radiations on the earth?

A) 4.63 Pa

B) 4.63 $N.m^{-2}$

C) $4.63 \text{ x } 10^{-6}$ $N.m^{-2}$

D) Not possible to calculate unless area is specified

44. A statistical energy distribution N(E)dE gives the number of gas molecules having energies lying in the range from E to E + dE. Then the expression for the average kinetic energy over a collection of N molecules will be

A) $(1/N)\int_{0}^{\infty} N(E)dE$ B) $(1/N)\int_{0}^{\infty} EN(E)dE$

C) $(1/N)\int_{-\infty}^{\infty} EN(E)dE$ D) $(1/N)\int_{-\infty}^{\infty} EdE$

45. Two samples of gas initially at the same temperature and pressure are compressed to half their original volumes, one adiabatically and the other isothermally. The final pressure is

A) Greater for adiabatic compression

B) Greater for isothermal compression

C) Same for both

D) Half the original pressure for isothermal compression and same as original pressure for the adiabatic compression.

46. Which of the following Maxwell's relations is (are) not true?

1. $(\partial S/\partial V)_T = (\partial P/\partial S)_V$
2. $(\partial S/\partial P)_T = -(\partial V/\partial T)_P$
3. $(\partial T/\partial V)_S = -(\partial P/\partial S)_V$
4. $(\partial T/\partial P)_S = (\partial V/\partial S)_P$

Choose the correct answer :

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

47. A famous problem that helped lead to the development of quantum mechanics was the so- called "ultraviolet catastrophe." The "catastrophe" refers to the failure of classical physics to explain what phenomenon?

A) The photoelectric effect.
B) Electron diffraction.
C) Young's double-slit experiment.
D) The spectrum of hot, glowing objects.

48. An operator U is related to the Hamiltonian operator H through the relation U = exp(iaH) where H is Hermitian and a is real . Then U will be

A) Real B) Unitary
C) Diagonal D) Hermitian

49. A and B are two non-commuting operators with [A,B] = iC, then C will be

A) Real B) Unitary
C) Diagonal D) Hermitian

50. An excited state of the hydrogen atom is specified by the wave function $A(x+iy)^2e^{-ar}$. This will be an eigen state of L_z having an eigen value of

A) $\hbar$ B) $-\hbar$ C) $2\hbar$ D) $-2\hbar$

51. A particle in an infinite square well is subjected to an additional constant potential V_o. What will be the first order shift in the energy levels?

A) V_o B) $-V_o$ C) $\frac{1}{2} V_o$ D) 0

52. The probability density ρ and probability current density **J** are related via one of the following relations. Which one is the correct one?

A) $\mathbf{J} = -\nabla\rho$ B) $\nabla . \mathbf{J} + \partial \rho /\partial t = 0$
C) $\mathbf{J} = -D\nabla\rho$ D) $\nabla\rho + \partial\mathbf{J}/\partial t = 0$

53. An electron has the same De Broglie wave length as a proton. Then

A) Both have the same linear momentum and have energies in inverse ratio to their masses
B) Both have the same linear momentum, but their energies are in the same ratio as their masses
C) Both have the same energies, but their linear momenta are in the same ratio as their masses
D) Both have the same energies, but their linear momenta are in inverse ratio to their masses

54. The magnetic quantum number of an orbital defines
A) The shape of the orbital
B) The energy level of the orbital
C) The spatial orientation of the orbital
D) The spin of the electrons in the orbital

55. In the infinite square well problem, the wave function and its first spatial derivative are:
A) Both continuous at the boundaries.
B) Continuous and discontinuous at the boundaries, respectively.
C) Both discontinuous at the boundaries.
D) Discontinuous and continuous at the boundaries, respectively

56. Treating the gravitational interaction between the proton and the electron in a hydrogen atom as a perturbation, the first order correction to the ground state energy of the atom will be
A) Of the same order as the energy of the ground state itself.
B) Less than the energy of the ground state by a factor equal to the fine structure constant
C) Proportional to $<1/r>$
D) Proportional to $<1/r^2>$

57. A hydrogen atom is subjected to an electric field of 10 kV/m. The second order Stark shift in the ground state energy of the atom is observed to 0.001 eV. When the electric field is doubled, the shift will change to
A) 0.002 eV B) 0.004 eV
C) Remains the same D) 0.0005 eV

58. The De Broglie wavelength of the electrons in the first Bohr orbit in a hydrogen atom is
A) 3.14 Å
B) 1.0 Å
C) Same as the first Bohr radius a_o
D) Equal to the size of the atom

59. In the early days a model for beta decay envisaged the existence of the electron inside the nucleus prior to its emission from the nucleus. Assuming the electron to be confined to within typical nuclear dimensions of 10 fermis and invoking the uncertainty principle, the energy of the emitted beta particle can be estimated to be
A) Of the order of 100 MeV B) Around 1 MeV
C) Less than 1 MeV D) About 1 keV

60. An electron is confined to a thin layer of thickness 1 nm on the surface of a metal by an infinite potential well. It absorbs incident radiation of wavelength 662 nm and jumps from state n to n+1. Identify the value of n
A) 1 B) 2 C) 3 D) 4

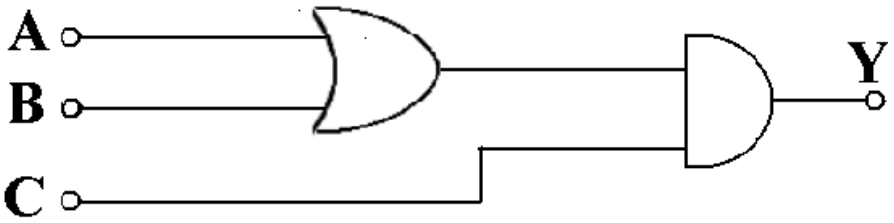
61. The energy corresponding to the first excited state of a quantum harmonic oscillator is

A) $_{1/2}\,\hbar\omega$ B) $_{5/2}\,\hbar\omega$ C) $\hbar\omega$ D) $_{3/2}\,\hbar\omega$

62. Which one of the following statements is FALSE ?

A) The resistance of intrinsic semiconductor decreases with increase of temperature
B) Pure Si doped with trivalent impurities gives a p-type semiconductor
C) Majority carriers in a n-type semiconductor are holes
D) Minority carries in a p-type semiconductor are electrons

63. To get an output $Y = 1$ from the circuit shown below, the input must be one of the following. Which one is it?



A) 1 0 0 B) 0 1 0 C) 0 0 1 D) 1 0 1

64. When a diode is forward biased, the voltage across it

A) Is directly proportional to the current
B) Is inversely proportional to the current
C) Is directly proportional to the source voltage
D) Remains approximately the same

65. The center frequency of a band-pass filter is always equal to the

A) Bandwidth
B) –3 dB frequency
C) Bandwidth divided by Q
D) Geometric average of the critical frequencies

66. In a transistor the width of the base region is smaller than those of the emitter and collector regions. This is provided

A) To ensure that the width of the base region is smaller than the diffusion length of minority carriers in that region
B) To minimize the overall dimensions
C) So that the emitter and collector are effectively at the same potential
D) So that the carriers can tunnel through the base region

67. A bipolar junction transistor is used as a switch. This means that in its operation it switches between

A) Cut-off and active region
B) Cut-off and saturation region
C) Active and saturation region
D) Two well separated points in the active region

68. The two's complement of the binary number 10010100 is

A) 01101011 B) 01101100
C) 11101100 D) 10001011

69. Which choice below best defines the purpose of a unity gain buffer circuit constructed with an op-amp?

A) To invert the input signal
B) To amplify the input signal
C) To invert *and* amplify the input signal
D) To isolate the input signal from the rest of the circuit

70. Full adder for two inputs can be developed with the help of

A) Two half adder on OR gate
B) One half adder and two OR gate
C) An EXOR gate and AND gate
D) Two AND gates and an OR gate

71. Which one of the following Boolean identities is correct? (Prime denotes complement).

A) $\overline{X}\,Y\,Z + Y\,Z + XZ = \overline{\left(\overline{(\overline{Y}\,\overline{Z})}\,.\,\overline{(\overline{X}\overline{Z})}\right)}$

B) $\overline{X}\,Y\,Z + Y\,Z + XZ = \overline{XY + XZ}$

C) $X\,Y + X\,Z = X\,Y + X\,Z + Y\,Z$

D) $X + X\,Y = X\,Y$

72. In a logic gate both positive and negative logic can be used as per convenience. Suppose in a given logic circuit, the logic of the levels is changed from positive to negative. Then an AND gate will change to

A) OR gate B) NAND gate C) NOR gate D) NOT gate

73. A third order Butterworth low pass filter has upper cut off frequency of 1KHz. If frequency is increased to 2KHz the gain of the filter will drop by

A) 6 db B) 18 db C) 20 db D) 60 db

74. In a 4 bit weighted-resistor D/A converter, the resistor value corresponding to the MSB is 2 kΩ. The resistor value corresponding to the LSB

A) 1 kΩ B) 2 kΩ C) 4 kΩ D) 16 kΩ

75. A square wave with a period of 10 micro sec drives a flip flop. The period of the output will be

A) 10 micro sec B) 5 micro sec
C) 20 micro sec D) 100 micro sec

76. A basic differentiator circuit fails to work at

A) Low frequencies B) High frequencies
C) Middle frequencies D) At selected discrete frequencies

77. The mid frequency gain of an op-amp amplifier without feedback is 100 and the 3 dB frequencies are 200 Hz and 375 kHz. Negative feedback is introduced with a β of 0.1. The new mid frequency gain and bandwidth are respectively

A) 1100 and 34.1 kHz B) 9.1 and 4.12 MHz
C) 1100 and 4.12 MHz D) 9.1 and 34.1 kHz

78. An operational amplifier with a CMRR of 200 gives an output of 5 Volts when the inputs are 99 mV and 101 mV. What will be the output when the inputs are increased to 100 mV and 102 mV respectively?

A) Same as 5.0 V since the difference signal is the same.
B) 15 V
C) 5.01 V
D) Cannot calculate unless the difference gain also is given

79. The muon is an elementary particle with the same charge as the electron, but its mass is 206 times larger. Suppose that a muon and a proton come together to form a "muonic hydrogen atom". What will be the ionization energy of muonic hydrogen?

A) 2801 eV B) 0.95 eV C) 0.066 eV D) 13.6 eV

80. Given the following term symbols for atoms:

1. $^4S_1$ 2. $^3P_0$ 3. $^2P_{3/2}$ 4. $^2D_{5/2}$

Which ones are correct?

A) 1 and 2 only B) 1 and 4 only C) 2, 3 and 4 D) All

81. An ESR spectrometer operates at 20 GHz frequency. What magnetic field should be used for its correct operation?

A) 0.713 T B) 7.13 T C) 0.0713 T D) 713 G

82. Homonuclear diatomic molecules give rise to

A) No microwave or IR spectra, but only Raman spectra
B) No Raman spectra but microwave or IR spectra
C) Both Raman spectra and microwave or IR spectra
D) Neither Raman spectra nor microwave or IR spectra

83. In the anomalous Zeeman effect in sodium atom,

A) D_1 line and D_2 line split into four lines each
B) D_1 line splits into six lines and D_2 line splits into four lines
C) D_1 line splits into four lines and D_2 line splits into six lines
D) D_1 line splits into four lines and D_2 line remains unaltered

84. In the Raman effect of a given sample, the exciting line has a wavelength of 453.8 nm and a Stokes line is observed at 445.8 nm. At what wavelength does one expect to see the corresponding Anti Stokes line?

A) 461.8 nm B) 462.1 nm C) 437.8 nm D) 8 nm

85. The ratio of the frequencies of the light emitted during the n = 3 to n = 1 transitions in a Be^{3+} ion and a hydrogen atom is :

A) 3 : 1 B) 4 : 1 C) 16 : 1 D) 9 : 1

86. In a gas 10% of the atoms are in the first excited state at a given temperature. Raman scattering is observed from the gas. What will be the ratio of the intensities of the Stokes and Anti Stokes lines?

A) 1 : 1 B) 1 : 9 C) 3 : 1 D) 9 : 1

87. $_{26}Fe^{57}$ has an excited level at 14.4 keV. In a given environment inside a lattice, this level is shifted by 10^{-7} eV. What is the velocity of the Mossbauer drive required to bring this into resonance?

A) 2.08 mm/s B) 2.08 cm /s C) 4.8 m/s D) 4.8 mm/s

88. If a hydrogen atom undergoes a transition from the n=4 to the n=3 state, it will:

A) Emit a 0.85 eV photon B) Emit a 0.66 eV photon
C) Absorb 0.66 eV of energy D) Emit a 13.6 eV photon

89.. An excited state having a half life of 1 ns decays to the ground state emitting a photon of wavelength 6000 Å in the process. The width of the spectral line will be

A) 0.012 Å B) 0.361 Å
C) 0.00361 Å D) 3.61 Å

90. The K_α X ray line from an unknown atom is seen to have the same wavelength as the shortest wavelength component of the bremsstrahlung emitted when 57.523 keV electrons bombard a metallic target. Which element is it?

A) Helium (Z = 2) B) Lithium (Z = 3)
C) Titanium (Z = 22) D) Tantalum (Z = 73)

91. The free electrons of a metal

A) Do not collide with each other
B) Are free to escape through the surface
C) Are free to fall into the nuclei
D) Are free to move anywhere inside the metal

92. Debye temperature is

A) The temperature at which the highest frequency modes (and hence all modes) are excited in a solid.
B) A cut off temperature for the vibrations in the solid
C) The same as Einstein temperature
D) A threshold temperature above which only vibrations can exist inside a solid

93. The energy of the photo electron depends upon the following factor

A) Intensity of incident radiation
B) Quality of the photocathode
C) Frequency of incident radiation
D) Type of the incident light source

94. A metal crystallizes in 2 cubic phases : fcc and bcc whose unit cell lengths are 3.5 A^o and 3.0 A^o respectively. The ratio of their densities is :

A) 3.12 B) 2.04
C) 1.26 D) 0.72

95. In a given cubic crystal the lattice parameter is 318 pm. The d spacing for the (110) plane is

A) 225 pm B) 284 pm
C) 318 pm D) 390 pm

96. In the X-ray diffraction of a set of planes in a crystal with a d spacing of 0.18 nm first order reflection is observed at 22^o. What is the energy of the radiations?

A) 92.1 eV B) 9.21 eV
C) 92.1 keV D) 9.21 keV

97. In the Meissner effect in a type I superconductor

A) The material changes into normal state suddenly at the critical field
B) The material changes into normal state gradually beyond the critical field
C) The induced field is in the direction of the external field
D) The induced field is always the same as the applied field

98. An experimental measurement of the Hall effect gives information on

A) The type of majority carriers and their concentration
B) The type of majority carriers only
C) The concentration of the majority carriers
D) The mobility of the majority carriers

99. In Curie's law pertaining to paramagnetism, the constant of proportionality depends

A) Only on the magnetic moment of the ions
B) Only on the temperature
C) Both on the magnetic moment of the ions and their concentration
D) Both on the magnetic moment of the ions and the temperature

100. The effective mass of the electron in a semiconductor is

A) Always the same as its actual mass
B) Always less than its actual mass
C) Depends on the curvature of the energy as a function of the wave vector
D) Always larger than its actual mass

101. The volume of a unit cell in the reciprocal lattice is

A) Inverse of the lattice unit cell volume
B) Equal to the lattice unit cell volume
C) Not related to the lattice unit cell volume
D) Always smaller than the lattice unit cell volume

102. Parallelohedron is a crystal class
A) Belonging to the Triclinic system referred to three unequal axes and has a 1-fold symmetry axis
B) Belonging to the Triclinic system referred to three mutually perpendicular axes and has a 2-fold symmetry axis
C) Belonging to the Monoclinic system referred to three mutually perpendicular axes and has a 2-fold symmetry axis
D) Belonging to the Monoclinic system referred to three unequal axes and has a 1-fold symmetry axis

103. Bloch's theorem asserts that the wave function of electrons in periodic potential
A) Is an exponentially falling function
B) Is an exponentially increasing function
C) Is in the form of pure plane waves
D) Has the form of a plane wave multiplied by a function with the periodicity of the potential

104. GaAs has a band gap energy of 1.43 eV. This means that the maximum wavelength of the photons that can be absorbed by this semiconductor is
A) 867 Å B) 867 nm C) 1.43 nm D) 1430 nm

105. Phonons in aluminium have an energy of 1 eV. The velocity of sound in aluminium is 6400 ms^{-1}. What will be the momentum carried by these phonons ?
A) 0.04678 eV /c and is smaller than the momentum carried by photons of same energy
B) 0.04678 MeV / c and is much larger than the momentum of photons having same energy
C) 2.5×10^{-4} eV /c and is smaller than the momentum carried by photons of same energy
D) 1 eV / c and is equal to the momentum carried by photons of same energy

106. The spin and parity of the ground state of $_3Li^7$ nucleus is
A) $(3/2)^-$ B) $(1/2)^+$ C) 0^- D) 1^+

107. Which of the following elementary particles is responsible for carrying away the missing energy and angular momentum in a nuclear beta decay process?
A) Electron B) Electron like neutrino
C) Muon like neutrino D) Neutron

108. One major difference between alpha decay and beta decay is that
A) The alpha particles emitted in alpha decay have continuous energies while the electrons emitted in beta decay have discrete energies.
B) The electrons emitted in beta decay can have continuous or discrete energies while the alpha particles emitted in alpha decay always have discrete energies.
C) The electrons emitted in beta decay have continuous energies while the alpha particles emitted in alpha decay have discrete energies.
D) The electrons emitted in beta decay always have continuous energies while the alpha particles emitted in alpha decay can have continuous or discrete energies.

109 The ground state of a nucleus has a spin parity of $\mathbf{(3/2)^-}$ and has an excited state with a spin-parity of $\mathbf{(1/2)^+}$. What are the possible types and multipolarities of the radiation emitted when the nucleus makes a transition from the excited level to the ground state (in the order of decreasing intensity)?

A) E2 and M1 B) M1 and E2
C) M2 and E1 D) E1 and M2

110. The saturation property of nuclear forces is corroborated by one of the following:

A) Nuclei have much smaller sizes as compared to atoms
B) The average binding energy per nucleon is more or less a constant.
C) The average binding energy per nucleon is a function of the atomic number
D) The nuclei with magic number of neutrons or protons have especially high stability

111. In a proton-proton scattering experiment, the scattered proton is detected in coincidence with the recoiling proton. If one detector is kept at 30^0 to the incident beam direction, at what angle should the second detector be placed so as to get genuine coincidence?

A) 100^0 B) 150^0
C) 90^0 D) 120^0

112. Nuclei with odd number of protons and neutrons are found to be far less in abundance in nature as compared to those with either or both of the numbers even. This is due to

A) The pairing energy B) The surface energy
C) Coulomb energy D) Asymmetry energy

113. If the aluminium nucleus $_{13}Al^{27}$ has nuclear radius of about 3.6 fm, then the tellurium nucleus $_{52}Te^{125}$ will have radius approximately equal to

A) 3.6 fm B) 14.4 fm
C) 7.2 fm D) 6.0 fm.

114. The function of the moderator in a nuclear reactor is

A) To absorb fast neutrons
B) To adjust the power output to moderate levels
C) To slow down fast neutrons
D) To absorb slow neutrons

115. Atoms which have isobaric nuclei have

A) Same mass numbers and same chemical properties
B) Different mass numbers and same chemical properties
C) Same mass numbers and different chemical properties
D) Different mass numbers and different chemical properties

116. In the compound nucleus theory of nuclear reactions, which of the following statements is not true?
   A) The life time of the compound nucleus is smaller than the time it takes the projectile to pass through the nucleus.
   B) The compound nucleus can decay in various ways.
   C) The compound nucleus does not remember the way in which it was formed
   D) There is complete equilibration of energy among all nucleons.

117. Within the nucleus, the charge distribution
   A) Is constant, but falls to zero sharply at the nuclear radius
   B) Increases linearly from the centre , but falls off exponentially at the surface
   C) Increases linearly from the centre , but falls to zero sharply at the nuclear radius
   D) Is constant, but falls off exponentially at the surface

118. Given the following nuclear masses : ; $_1H^1$: 938.783 MeV ; $_2He^4$: 3728.401 MeV; $_{13}Al^{27}$: 25133.142 and $_{14}Si^{30}$: 27920.387 MeV. Consider the reaction $_1H^1 + _{14}Si^{30}$ --> $_2He^4 + _{13}Al^{27}$. What is the minimum lab energy of protons that can cause the reaction to occur?
   A) 0 MeV B) 2.373 MeV
   C) The Coulomb barrier energy D) 2.452 MeV

119. An elementary particle whose energy is independent of its velocity is the
   A) Electron B) Proton
   C) Photon D) Pion

120. Thermonuclear reactions involve reactions between nuclei at energies
   A) Much less than the Coulomb barrier
   B) In the relativistic range
   C) Near the threshold energies
   D) Close to thermal energies of atoms in solids

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