MSc Physics 2010 (BHU)

Q1. Which one of the following pairs does not represent quantities of identical dimension?

(a) Angular momentum and Planck's constant

(b) Moment of inertia and moment of force

(c) Work and torque

(d) Impulse and momentum

Q2. The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to

(a) charge of the particle (b) momentum of the particle

(c) energy of the particle (d) strength of the magnetic field

Q3. The equation $\vec{\nabla}\times\vec{B}=\mu_0\varepsilon_0 J(\vec{r},t)$, where $\vec{B}$ is the magnetic field and $\vec{J}(\vec{r},t)$ is the current density

(a) does not hold because it violates equation of continuity

(b) does not hold because magnetic monopoles do not exist

(c) will hold if $\vec{\nabla}\cdot\vec{J}(\vec{r},t)$ is constant

(d) will hold if $\vec{J}(\vec{r},t)$ is time independent

Q4. A 50 gm bullet moving with velocity $10\,m/\sec$ strikes a block of 950 gm at rest and gets embedded in it. The loss in kinetic energy will be

(a) 100% (b) 95% (c) 5% (d) zero

Q5. The escape velocity on the surface of the earth is v_0. If M and R are the mass and radius of the earth, respectively, then the escape velocity on another planet of mass 2M and radius $\frac{R}{2}$ will be

(a) $4v_0$ (b) $2v_0$ (c) v_0 (d) $\frac{v_0}{2}$

Q6. The earth's radius is $6.37\times10^6\,m$ and the earth is $1.5\times10^8\,km$ away from the sun. The fraction of the radiation emitted by sun as intercepted by the earth is

(a) 4.5×10^{-6} (b) 18.12×10^{-8} (c) 4.51×10^{-10} (d) 3.12×10^{-9}

Q7. A monochromatic light is travelling from one medium to another. Which of the following property remains unaltered?

(a) Velocity (b) Amplitude (c) Wavelength (d) Frequency

Q8. The time required for the light to travel 60 cm in a medium of refractive index $1\cdot 5$ is

(a) 1.2×10^{-8} sec (b) 3×10^{-9} sec (c) 2×10^{-10} sec (d) 7×10^{-12} sec

Q9. If the total energy of a particle is thrice its rest mass energy, then the velocity of particle in terms of velocity of light c is

(a) $\frac{c}{3}$ (b) $\frac{2c}{3}$ (c) $\frac{2\sqrt{2}}{3}c$ (d) $\frac{\sqrt{2}}{3}c$

Q10. The half life of certain particle in its rest frame is $36\ \mu\text{sec}$. Its half-life for an observer, moving at constant velocity of $0.8c\,0$ with respect to the particle will be

(a) 36μsec (b) 50μsec (c) 60μsec (d) 100μsec

Q11. If $\vec{F}$ is a conservation force, then

(a) $\vec{\nabla}\cdot\vec{F}=0$ (b) $\vec{\nabla}\times\vec{F}=0$ (c) $\nabla^2\vec{F}=0$ (d) $\vec{\nabla}\left(\vec{\nabla}\cdot\vec{F}\right)=0$

Q12. If $\phi=\frac{Q}{4\pi\varepsilon_0 r}$ where Q is the charge and r is the distance of the point from Q, then $\nabla^2\phi$ is

(a) zero (b) $\frac{Q}{2\pi\varepsilon_0 r^2}$ (c) $\frac{Q}{2\pi\varepsilon_0 r^3}$ (d) $\frac{Q}{4\pi\varepsilon_0}\frac{\vec{r}}{r^3}$

Q13. If ρ is the charge density in a closed volume having a surface $S,\vec{E}$ is the electric field and Q is the total charge on the surface, then the value of $\oint_S\int\vec{E}\cdot\vec{n}\,dS$ is

(a) ρ (b) $\frac{\rho}{\varepsilon_0}$ (c) $\frac{Q}{\varepsilon_0}$ (d) zero

Q14. Maxwell equation in a free medium $\vec{\nabla}\times\vec{E}$ is

(a) $\frac{\partial\vec{B}}{\partial t}$ (b) $\frac{1}{c}\frac{\partial\vec{B}}{\partial t}$ (c) $-\frac{1}{c}\frac{\partial\vec{H}}{\partial t}$ (d) $\frac{1}{c}\frac{\partial\vec{E}}{\partial t}$

Q15. In order to determine uniquely a vector field, it is necessary to specify

(a) its divergence only (b) curl of its curl

(c) its curl only (d) its divergence and curl both

Q16. If a matrix is $A = \begin{pmatrix} 1 & 3 \\ 2 & 1 \end{pmatrix}$, then A^{-1} will be

(a) $-\frac{1}{5}\begin{pmatrix} 1 & -3 \\ -2 & 1 \end{pmatrix}$ (b) $\frac{1}{5}\begin{pmatrix} 1 & 3 \\ 2 & 1 \end{pmatrix}$ (c) $\frac{1}{4}\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$ (d) $-\frac{1}{3}\begin{pmatrix} -1 & 3 \\ 2 & -1 \end{pmatrix}$

Q17. If a matrix is $A = \begin{pmatrix} 3 & 1 \\ 2 & 2 \end{pmatrix}$, its eigenvalues are

(a) 1 and 2 (b) 2 and 4 (c) 1 and 3 (d) 1 and 4

Q18. Consider the solution $y(t)$ of the equation

$$\frac{d^2y}{dt^2} + 2k\frac{dy}{dt} + k^2 y = \exp(-kt)$$

where k is a constant and whose value and derivative with respect to t are zero at $t = 0$. Then $y(t)$ is

(a) $\frac{1}{2}\exp(-kt)$ (b) $\frac{1}{2}t\exp(-kt)$ (c) $\frac{1}{2}t^2\exp(-kt)$ (d) $\frac{1}{2}\exp(-kt^2)$

Q19. If a Lagrangian of a system is $L = \frac{1}{2}q\dot{q}^2$, then solution of Lagrange's equation yields (if $q = 0$ at $t = 0$)

(a) $q \propto t$ (b) $q \propto t^{1/2}$ (c) $q \propto t^2$ (d) $q \propto t^{3/2}$

Q20. A particle of mass m moves along x-axis under the action of a force $F = \frac{-2k}{x^3}$. Its motion is described by the Lagrangian

(a) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 + \frac{k}{x^2}$ (b) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 + \frac{-2k}{x^3}$

(c) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 - \frac{k}{x^2}$ (d) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 - \frac{2k}{x^3}$

Q21. Lagrangian for a charged particle with charge e and mass m moving in an electromagnetic field with scalar potential $\phi(x, y, z)$ and vector potential $\vec{A}(x, y, z)$ is given as

$$\vec{L} = \frac{1}{2}mv^2 - e\phi + \frac{e}{c}\vec{A}\cdot\vec{v}$$

Expression for generalized momentum is

(a) zero (b) $m\vec{v}$ (c) $m\vec{v} + \frac{e}{c}\vec{A}$ (d) $m\vec{v} - e\phi + \frac{e}{c}\vec{A}$

Q22. The Lagrangian of a system is given as $L = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2 + \dot{z}^2) - mgz$, then system has symmetry about

(a) x axis only (b) y axis only (c) z axis only (d) x and y axes both

Q23. If u_1 and u_2 are eigenstates corresponding to energy eigenvalues E_1 and $E_2 (E_1 \neq E_2)$ of a Hamiltonian, then in the state space

(a) u_1 and u_2 are parallel

(b) u_1 and u_2 are orthogonal

(c) u_1 and u_2 are at an angle θ such that $\cos\theta = \frac{E_1}{E_2}$

(d) u_1 and u_2 are degenerate states

Q24. If an operator satisfies the equation $\hat{O}\psi = a\psi$, then measurement of $\hat{O}$ will give

(a) a in the state ψ

(b) the value $= \int \psi^* O \psi d^3x$ in the state ψ

(c) any value of several values greater than a

(d) zero

Q25. The value of the commutation relation $[\hat{p}, (\hat{x}^2 + \hat{p}^2)]$ is

(a) $-i\hbar$ (b) $-i\hbar\,\hat{x}$ (c) $-i\hbar(\hat{x} + \hat{p})$ (d) $-2i\hbar\,\hat{x}$

Q26. A free particle Schrödinger equation is written as $-\frac{\hbar^2}{2m}\nabla^2\psi = E\psi$. Then the energy of the particle E is

(a) $\frac{n^2\pi^2\hbar^2}{2mL^2}$

(b) $n\hbar$

(c) $n\hbar\omega$

(d) E varies continuously from zero to infinity

Q27. If ψ_1, ψ_2 are eigenvectors of an operator $\hat{A}$ with eigenvalues as $\frac{1}{2}$ and $-\frac{1}{2}$ respectively, then $a\psi_1 + b\psi_2$ (where a, b are complex numbers) is an

(a) eigenvector of $\hat{A}$ with eigenvalue $\frac{a-b}{2}$

(b) eigenvector of $\hat{A}$ with eigenvalue zero

(c) eigenvector of $\hat{A}^2$ with eigenvalue $\frac{a+b}{2}$

(d) eigenvector of $\hat{A}^2$ with eigenvalue $\frac{1}{4}$

Q28. If wave function in coordinate space is $\psi(x) = \delta(x)$ then momentum space wave function is

(a) $\frac{1}{\sqrt{2\pi}}$ (b) $\delta(p)$ (c) $\frac{1}{\sqrt{2\pi}}\delta(p)$ (d) zero

Q29. The Hamiltonian H of a system having two states ψ_1 and ψ_2 is such that $H\psi_1 = iE\psi_2$ and $H\psi_2 = -iE\psi_1$. The lowest energy of the system corresponds to the state

(a) $\frac{1}{\sqrt{2}}(\psi_2 - i\psi_1)$ (b) $\frac{1}{\sqrt{2}}(\psi_2 - \psi_1)$ (c) $\frac{1}{\sqrt{2}}(\psi_2 + i\psi_1)$ (d) $\frac{1}{\sqrt{2}}(\psi_2 + \psi_1)$

Q30. The probability of drawing two aces in succession from a pack of 52 cards is

(a) $\frac{2}{26}$ (b) $\frac{2}{13}$ (c) $\frac{1}{221}$ (d) $\frac{1}{169}$

Q31. Two non-interacting particles are distributed in three distinct states. Let P_c be the probability for both of them in the same state in case particles are distinguishable and P_b the probability for them to be in the same state in case they are indistinguishable bosons. The ratio $\frac{P_c}{P_b}$ is

(a) $\frac{3}{2}$ (b) 1 (c) $\frac{2}{3}$ (d) $\frac{1}{3}$

Q32. A perfect mono-atomic gas undergoes reversible adiabatic expansion. The relationship between its volume V and the internal energy U at any stage of expansion is given by

(a) $UV^{1/3} = \text{constant}$ (b) $UV = \text{constant}$

(c) $UV^{2/3} = \text{constant}$ (d) $UV^{4/3} = \text{constant}$

Q33. A system A interacting with a reservoir R undergoes a reversible transformation of its thermodynamic state. If ΔS_A is the change of entropy of A and ΔS_R that of R during the transformation, then in general

(a) $\Delta S_A = \Delta S_R = 0$ (b) $\Delta S_A = \Delta S_R$ (c) $\Delta S_A = -\Delta S_R$ (d) $\Delta S_A = 0, \Delta S_R > 0$

Q34. Compared with the ionization potential of the hydrogen atom, the ionization potential of the deuterium atom is

(a) lower by a factor of 2 (b) exactly same

(c) slightly lower (d) slightly higher

Q35. When the Zeeman lines are observed perpendicular to the magnetic field, they will be

(a) plane polarized (b) circularly polarized

(c) elliptically polarized (d) unpolarized

Q36. A generator produces 100 A of current at 4000 V. By using a transformer, the voltage is stepped up to 2.4×10^5 V so that it can be sent to a village on high voltage lines. If the effective resistance of the line is 30 ohms, the power lost in communication is

(a) 63.7 W (b) 83.7 W (c) 33.7 W (d) 93.7 W

Q37. A $40\mu F$ capacitor is connected to a 50Ω resistor and a generator whose r.m.s. output is 30 volts at 60 Hz. The r .m. s. current is

(a) 0.182 A (b) 0.061 A (c) 0.361 A (d) 0.421 A

Q38. The energy density in the electric field created by a point charge falls off with the distance from the point charge as

(a) $\frac{1}{r}$ (b) $\frac{1}{r^2}$ (c) $\frac{1}{r^3}$ (d) $\frac{1}{r^4}$

Q39. A hydrogen and a helium nucleus moving with equal kinetic energy enter separately and perpendicularly into a magnetic field. The ratio of radii of circular paths i.e., $\frac{r_H}{r_{He}}$ will be

(a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) $\frac{1}{\sqrt{2}}$ (d) 1

Q40. The work done in carrying a charge q around a circle of radius r with a charge Q at the centre is

(a) $\frac{qQ}{4\pi\varepsilon_0}\frac{1}{r}$ (b) $\frac{qQ}{4\pi\varepsilon_0}\frac{1}{\pi r}$ (c) $\frac{qQ}{2\varepsilon_0}\frac{1}{r}$ (d) zero

Q41. The magnetic field inside a current-carrying solenoid is B. If its radius is doubled and the current through it also doubled, the magnetic field will be

(a) B (b) $2B$ (c) $4B$ (d) $\frac{B}{2}$

Q42. A positively charged particle of mass m kg and charge Q coulomb travels from rest through a potential difference of V volts. Its kinetic energy in Joules is

(a) $\frac{mQ}{V}$ (b) mQV (c) $\frac{mV}{Q}$ (d) QV

Q43. A charged capacitor of $0.1\mu F$ is discharged through a resistance of 10^7 ohms. The charge will reduce to 36.8% of the original value in a time of

(a) 4 sec (b) 3 sec (c) 2 sec (d) I sec

Q44. A charge q is placed at the centre of the line joining two equal charges Q. The system of these charges will be in equilibrium if q is equal to

(a) $\frac{Q}{2}$ (b) $-\frac{Q}{2}$ (c) $\frac{Q}{4}$ (d) $-\frac{Q}{4}$

Q45. In a purely inductive a.c. source circuit $L = 25mH$. The inductive reactance of the circuit when the frequency of a.c. source is 60 Hz, will be

(a) 9.43Ω (b) 6.31Ω (c) 7.31Ω (d) 3.62Ω

Q46. The electric field vector of a plane wave in free space is given by $\vec{E} = \cos(\omega t - kz)\cdot\left[\hat{e}x E_{0x} + \hat{e}y E_{0y}\right]$. Its magnetic field vector will be given as

(a) $\vec{B} = \frac{1}{c}\sin(\omega t - kz)\left[-E_{0y}\hat{e}x + E_{0x}\hat{e}y\right]$ (b) $\vec{B} = \frac{1}{c}\cos(\omega t - kz)\left[-E_{0y}\hat{e}x + E_{0x}\hat{e}y\right]$

(c) $\vec{B} = \frac{1}{c}\sin(\omega t - kz)\left[-E_{0x}\hat{e}x + E_{0y}\hat{e}y\right]$ (d) $\vec{B} = \frac{1}{c}\cos(\omega t - kz)\left[-E_{0x}\hat{e}x + E_{0y}\hat{e}y\right]$

Q47. If V_p is the sinusoidal peak voltage in the secondary of the transformer, the average d.c. output voltage of half-wave rectifier is

(a) $\frac{V_p}{2}$ (b) $\frac{2V_p}{3.14}$ (c) $\frac{V_p}{3.14}$ (d) $3.14V_p$

Q48. Characteristic impedance of a transmission line in high frequency region is

(a) $\left(\frac{L}{C}\right)^{1/2}$ (b) $\left(\frac{C}{L}\right)^{1/2}$ (c) $(LC)^{1/2}$ (d) $\left(\frac{L}{C}\right)^{2}$

Q49. When a $P-N$ junction is formed what happens in the P and N regions?

(a) The top of valence bands are aligned

(b) The bottom of conduction bands are aligned

(c) The majority carrier concentrations are equalized

(d) The Fermi levels are aligned

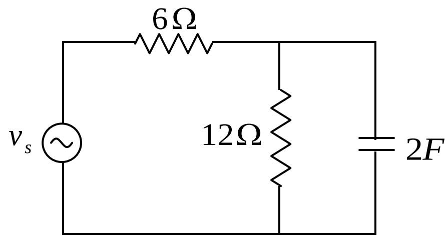
Q50. If two 100 W bulbs are connected in series across 230 V supply, then total power consumed by both the bulbs is

(a) 200 W (b) 100 W (c) 50 W (d) 25 W

Q51. If two coils having self-inductances L_1 and L_2 and mutual inductance M are connected in series with opposite polarity, then the total inductance of the series combination is

(a) $L_1 + L_2 + 2M$ (b) $L_1 - L_2 + 2M$ (c) $L_1 + L_2 - 2M$ (d) $L_1 - L_2 - 2M$

Q52. In the network of figure shown below, $v_s = 6V$. The time constant of the network is



(a) 8 sec (b) 12 sec (c) 24 sec (d) 36 sec

Q53. Following cannot be used as a core of a transformer

(a) Air (b) Steel (c) Aluminium (d) Ferrite

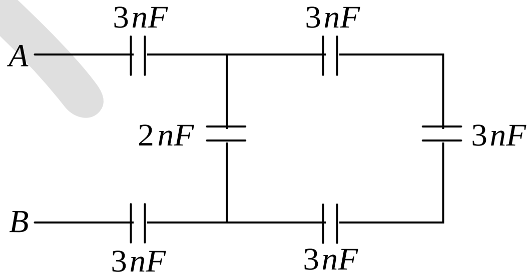
Q54. A vector field $\vec{A}$ is said to be non-conservative if

(a) $\oint \vec{A} \cdot \vec{dl} = 0$ (b) $\vec{\nabla} \times \vec{A} = 0$ (c) $\vec{A} = \vec{\nabla} f$ (d) $\vec{\nabla} \cdot \vec{A} = 0$

Q55. If the common base current amplification factor α is $0 \cdot 98$, its common emitter current amplification factor β is

(a) 100 (b) 98 (c) 50 (d) 49

Q56. Capacitance between A and B in the following circuit is



(a) $9nF$ (b) $3nF$ (c) $2nF$ (d) $1nF$

Q57. In the nuclear process $n \rightarrow p + e^{-} + X$, X stands for

(a) neutrino (b) antineutrino (c) γ-rays (d) positron

Q58. In Compton scattering, wavelength shift is towards

(a) shorter wavelength

(b) longer wavelength

(c) shorter or longer depending on the angle of scattering

(d) shorter or longer side depending on photon energy

Q59. The annihilation of electron and positron in vacuum produces

(a) a neutron (b) a neutrino (c) a photon (d) two photons

Q60. Nuclear fission in reactors is sustained by

(a) fission fragments (b) Gamma rays

(c) charged particles (d) neutrons

Q61. The reaction $\pi^{-} p \rightarrow \Lambda^{o} \pi^{o}$ in strong interaction is not possible because

(a) it does not conserve charge (b) it does not conserve baryon number

(c) it does not conserve strangeness (d) it does not conserve isospin

Q62. Electromagnetic force between two electrons does not depend on

(a) electronic charge (b) fine structure constant α

(c) photon exchange (d) pion exchange

Q63. The common property between neutron and gamma radiation to induce nuclear reaction is

(a) zero Coulomb barrier

(b) low cross-section

(c) high cross-section

(d) formation of same compound nucleus

Q64. Which of the following is not true?

(a) Photon is a boson (b) Proton is a fermion

(c) K-meson is a boson (d) μ-meson is a boson

Q65. A sample contains N number of atoms a whose nuclei decay to stable nuclei b. If the half-life of a is T, then the number of nuclei b at the end of time $3T$ will be

(a) zero (b) $2N/3$ (c) $7N/8$ (4) $9N/10$

Q66. Bohr radius for hydrogen is 0.53 Å. The ground state Bohr radius for He^{+} is

(a) 1.06 Å (b) 0.53 Å (c) 0.265 Å (d) 0.134 Å

Q67. In the hydrogen atom ground state, the velocity of electron in terms of fine structure constant α and velocity of light c is

(a) $\alpha^2 c$ (b) αc (c) $2\alpha c$ (d) $\frac{\alpha^2 c}{4}$

Q68. The number of photons of ultraviolet light with wavelength $\lambda = 3\times10^{-7}$ m which will have same energy as one gamma ray photon of $\lambda = 1.5\times10^{-13}$ m, is

(a) 3×10^5 (b) 2×10^6 (c) 4×10^4 (d) 5×10^5

Q69. Two electrons leave a radioactive sample in opposite directions each having a speed of $0.5c$ with respect to the sample. The speed of one electron relative to the other is

(a) c (b) $\frac{4}{5}c$ (c) $\frac{3}{4}c$ (d) $\frac{c}{2}$

Q70. The kinetic energy of an electron moving with speed of $0.6c$ and rest mass energy 0.511 MeV, is

(a) 0.224 MeV (b) 0.128 MeV (c) 0.64 MeV (d) 0.540 MeV

Q71. Momentum of a photon of frequency f and rest mass zero is

(a) hf (b) hf/c^2 (c) hf/c (d) zero

Q72. If two deuterons are at a distance of 10^{-12} cm, the nuclear force between them just overcomes the repulsive electrostatic force. The height of the electrostatic potential barrier is

(a) zero (b) 0.14 MeV (c) 0.31 MeV (d) 0.49 MeV

Q73. A transformer is used to change

(a) power (b) frequency (c) inductance (d) voltage

Q74. The SI unit of inductance times capacitance is

(a) second (b) ohm (c) hertz (d) square second

Q75. Which one of the following is a constant for light waves of different frequencies in vacuum?

(a) $\frac{f}{\lambda}$ (b) $f^2\lambda$ (c) $f\lambda$ (d) $\lambda^2 f$

Q76. The ratio of repulsive Coulomb force and the attractive gravitational force between two protons is

(a) 1.24×10^{36} (b) 2.31×10^{39} (c) 3.21×10^{26} (d) 1.91×10^{32}

Q77. The approximate ratio of the radius of $^{252}_{98}\mathrm{Cf}$ to the radius of $^{56}_{26}Fe$ is

(a) 2.12 (b) 1.65 (c) 0.62 (d) 3.19

Q78. Naturally occurring gallium contains two isotopes $^{71}_{31}\mathrm{Ga}$ and $^{69}_{31}\mathrm{Ga}$ with relative abundance of 40% and 60% respectively. The average number of neutrons in a mixture of gallium nucleus is

(a) 39.2 (b) 37.8 (c) 38.8 (d) 40

Q79. The magnetic vector potential is given by

$$\vec{A} = e^y \cos x\vec{e}_x + \left(1+\sin^2 x\right)\vec{e}_y$$

$\vec{e}_x$ and $\vec{e}_y$ are unit vectors along x and y - axes. The magnetic field $\vec{B}$ at the origin is

(a) $-\vec{e}_x$ (b) $-\vec{e}_y$ (c) $-\vec{e}_z$ (d) zero

Q80. An ideal gas undergoes a process during which $P\sqrt{V} =$ constant, where P is the pressure and V is the volume of the gas. If volume of the gas decreases, the temperature will

(a) remain constant (b) increase

(c) decrease (d) increase and then become constant

Q81. If 100 gm of steam at 150°C is cooled and frozen into 100 gm of ice at 0 °C. Specific heat of steam is 2.01 kJ/kg K and specific heat of water is 4.18 kJ/kg K. The total heat removed during the process is

(a) 211 kJ (b) 311 kJ (c) 351 kJ (d) 401 kJ

Q82. A patient is asked to remove his clothes in an examination room at 16°C by his physician. If the emissivity is 0.80, his skin temperature is 34 °C and his body surface area is $1.6\,m^2$. The rate of heat loss by radiation is

(a) 100 W (b) 120 W (c) 140 W (d) 160 W

Q83. The photon energy for light of wavelength 3.1×10^{-7} m is [$hc = 1.24\times10^{-6}$ eV m]

(a) 3.1 eV (b) 6.2 eV (c) 2.4 eV (d) 4.0 eV

Q84. Two light waves having same frequency but intensity in the ratio 4:1 interfere. The ratio of maximum to minimum intensity in the resulting interference pattern will be

(a) 9:1 (b) 5:3 (c) 25:9 (d) 25:16

Q85. The width of diffraction pattern due to a single narrow slit is

(a) independent of slit width

(b) directly proportional to the slit width

(c) directly proportional to the square of slit width

(d) inversely proportional to slit width

Q86. Unpolarized light is incident on a polarizer. The ratio of transmitted to incident intensity will be

(a) zero (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) 1

Q87. Visible light passing through a circular hole forms a diffraction disc of radius 0.1 mm on a screen. If X-rays are passed through the same set-up, the radius of the diffraction disc will be

(a) zero (b) greater than 0.1 mm

(c) 0.1 mm (4) less than 0.1 mm

Q88. A ray of unpoiarized light is incident on a plane surface at the Brewster angle. The reflected light is

(a) polarized with its electric vector perpendicular to the plane of incidence

(b) polarized with its electric vector in the plane of incidence

(c) unpolarized

(d) extinguished

Q89. A spherical air bubble is embedded in a glass slab. It will behave like a

(a) positive spherical lens (b) negative spherical lens

(c) positive cylindrical lens (d) negative cylindrical lens

Q90. Stern-Gerlach apparatus breaks up the atomic beam of silver atoms into following number of components

(a) One (b) Two (c) Three (d) Four

Q91. The ground state of nitrogen atom would be

(a) ${}^4S_{3/2}$ (b) ${}^2D_{3/2}$ (c) ${}^2D_{5/2}$ (d) ${}^2P_{3/2}$

Q92. The fine structure splitting will be highest in the state

(a) 3^2D (b) 3^2P (c) 3^2S (d) 4^2P

Q93. Infrared spectrum of a molecule arises due to

(a) a change in molecular polarizability

(b) a change in the shape of molecule

(c) a change in the size of molecule

(d) a change in the dipole moment

Q94. Rotational Raman spectra will show an alternation of intensity in the case of

(a) HD (b) D_2 (c) OH (d) NO

Q95. For precise measurements of wavelengths which laser will be more useful?

(a) Ruby laser (b) Nitrogen laser

(c) He-Ne laser (d) Semiconductor laser

Q96. Zeeman effect for a line arising in the following transitions would show a normal triplet

(a) ${}^1P \to {}^1S$ (b) ${}^2P \to {}^2S$ (c) ${}^2D \to {}^2P$ (d) ${}^3P \to {}^3S$

Q97. Microwave spectrum of a molecule is usually attributed to the following type of energy levels of the molecule

(a) Electronic (b) Vibrational (c) Rotational (d) Vibronic

Q98. Which of the following transitions is allowed?

(a) ${}^2S_{1/2} \to {}^2D_{3/2}$ (b) ${}^2P_{1/2} \to {}^2D_{3/2}$ (c) ${}^2S_{1/2} \to {}^2S_{1/2}$ (d) ${}^2D_{5/2} \to {}^2P_{1/2}$

Q99. Lasers are more suitable for holography because they have

(a) brightness (b) directionality (c) coherence (d) monochromaticity

Q100. The most important cause for the width of spectral line broadening in absorption experiments is

(a) Doppler broadening (b) natural broadening

(c) pressure broadening (d) Stark broadening

Q101. The sky is blue. It is explained by

(a) Raman effect (b) Rayleigh scattering

(c) Bohr's theory (d) Planck's theory

Q102. A monochromatic light wave is travelling from one medium to another. Which one of the following remains unchanged?

(a) Velocity (b) Amplitude (c) Wavelength (d) Frequency

Q103. If a Brownian particle executing a random motion in a liquid travels a distance R in time t. then

(a) $R \propto t^{1/2}$ (b) $R \propto t$ (c) $R \propto \frac{1}{t}$ (d) $R \propto t^2$

Q104. Three identical particles are distributed in three different energy levels. For bosons this is possible in following number of ways

(a) 10 (b) 8 (c) 6 (d) 3

Q105. A visible light does not pass through a metal because

(a) phonons absorb light

(b) metal atoms absorb light

(c) the light frequency is higher than the metal plasma frequency

(d) the light frequency is lower than the metal plasma frequency

Q106. The reciprocal lattice of an hexagonal crystal is

(a) f.c.c. (b) b.c.c. (c) hexagonal (d) orthorhombic

Q107. Bragg's law of X-ray diffraction is based on

(a) reflection of X-rays (b) interference of X-rays

(c) particle nature of X-rays (d) coherence of X-rays

Q108. If there are N atoms in a monatomic solid vibrating with frequency v, its specific heat at high temperature would be

(a) $3Nk_B/2$ (b) $3Nk_B$ (c) $5Nk_B$ (d) $5Nk_B/2$

Q109. Two solids A and B are such that a structural unit of A contributes an even number of valence electrons whereas that of B contributes odd number of electrons. In that case which of the following is true?

(a) Solid A is insulator (b) Solid B is metal

(c) Sold A is metal (d) Solid B is insulator

Q110. In an insulator, the Fermi level is

(a) at the bottom of conduction band

(b) on top of valence band

(c) in the middle of energy gap

(d) determined by carrier concentration

Q111. In intrinsic germanium at room temperature the numbers of

(a) electrons are more than holes (b) electrons and holes are equal

(c) holes are more than electrons (d) There are no holes and electrons

Q112. Meissner effect can be used to distinguish between

(a) metal and insulator (b) metal and semiconductor

(c) superconductor and perfect metal (d) semiconductor and insulator

Q113. A permanent magnet when heated above a critical temperature becomes

(a) diamagnetic (b) ferromagnetic (c) ferrimagnetic (d) paramagnetic

Q114. The Hall effect used to measure the sign of charge carriers, involves measurement of transverse voltage under application of

(a) electric field only

(b) magnetic field only

(c) mutually perpendicular electric and magnetic fields

(d) parallel electric and magnetic field

Q115. If the Debye temperature of a metal is 450 °K, the Debye frequency is

(a) $10^{13}\,Hz$ (b) $10^{20}\,Hz$ (c) $10^{10}\,Hz$ (d) $10^{23}\,Hz$

Q116. At lower temperatures, the lattice specific heat varies as

(a) T^3 (b) $\frac{1}{T^3}$ (c) T (d) $\frac{1}{T}$

Q117. Ohm's law relates to the electrical field $\vec{E}$, conductivity σ and current density $\vec{J}$ as

(a) $\vec{J}=\frac{\vec{E}}{\sigma}$ (b) $\vec{J}=\sigma^2\vec{E}$ (c) $\vec{J}=\sigma\vec{E}$ (d) $\vec{J}=\frac{\vec{E}}{\sigma^2}$

Q118. The general expression for the Fermi energy of a metal at 0 °K (if n is the number of free electrons/m^3) is

(a) $3.65\times10^{-19}n^{2/3}$ eV (b) $3.65\times10^{19}n^2$ eV

(c) $3.65\times10^{19}n^{1/3}$ eV (d) $3.65\times10^{19}n^{3/2}$ eV

Q119. The energy of a particle constrained to move in a cube of side a is given by

$$E=\frac{h^2}{8ma^2}\left(n_x^2+n_y^2+n_z^2\right)$$

if n_x, n_y, n_z may have either values out of 1, 2, 3; the degree of degeneracy of this energy level is

(a) 2 (b) 3 (c) 6 (d) 8

Q120. A proton and an alpha particle have the same kinetic energy. then the relation between their de Broglie wavelength is

(a) $\lambda_p=\frac{\lambda_a}{2}$ (b) $\lambda_p=\frac{\lambda_a}{4}$ (c) $\lambda_p=2\lambda_a$ (d) $\lambda_p=4\lambda_a$

Q121. X-rays are produced when an element of high atomic weight is bombarded by high energy

(a) protons (b) neutrons (c) photons (d) electrons

Q122. Which of the following metals crystalizes in f.c.c. structure?

(a) Aluminium (b) Zinc (c) Sodium (d) Caesium chloride

Q123. The Miller indices of the plane parallel to the x and y axes are

(a) (1,0,0) (b) (0,1,0) (c) (0,0, 1) (d) (1,1,1)

Q124. Which of the following elements is covalently bonded crystal?

(a) Aluminium (b) Sodium chloride

(c) Germanium (d) Lead

Q125. Kinetic energy of an electron in an atom is

(a) half of its potential energy (b) twice its potential energy

(c) equal to its potential energy (d) thrice its potential energy

Q126. If R_H is the Rydberg constant for hydrogen, the shortest wavelength of Balmer series in hydrogen spectrum is given as

(a) $\frac{1}{\lambda}=R_H\left(\frac{1}{4}-\frac{1}{9}\right)$ (b) $\frac{1}{\lambda}=R_H\left(\frac{1}{2}-\frac{1}{\infty}\right)$

(c) $\frac{1}{\lambda}=R_H\left(\frac{1}{1}-\frac{1}{\infty}\right)$ (d) $\frac{1}{\lambda}=R_H\left(\frac{1}{1}-\frac{1}{\infty}\right)$

Q127. The magnetic material in which permanent magnetic dipoles arising due to electron spins are already aligned due to bonding forces is mown as

(a) paramagnetic material (b) ferromagnetic material

(c) ferrimagnetic material (d) diamagnetic material

Q128. If X is the width of the depletion layer, the transition capacitance in a junction diode is proportional to

(a) $\frac{1}{X}$ (b) X (c) X^2 (d) $\frac{1}{X^2}$

Q129. The depletion region in an open circuited p-n junction contains

(a) electrons (b) holes

(c) neutralized impurity atoms (d) uncovered immobile impurity ions

Q130. Where a monatomic gas atom is placed in a uniform electric field E, the resulting induced dipole moment is proportional to

(a) E (b) E^2 (c) E^3 (d) independent of E

Q131. A proton of mass 1.67×10^{-27} kg and charge 1.6×10^{-19} C is accelerated from rest through an electrical potential of 400 kV. Its final velocity is

(a) 4.2×10^{6} m/sec (b) 8.8×10^{6} m/sec

(c) 6.6×10^{6} m/sec (d) 12.1×10^{6} m/sec

Q132. A 120 V motor draws a current of 2 A while lifting a load at a speed of 0·65 m/sec. If the efficiency of the motor for transforming electrical energy into mechanical energy is 62%, the mass being lifted is

(a) 33 kg (b) 23 kg (c) 42 kg (d) 50 kg

Q133. When the moon is near horizon, it appears bigger in size due to

(a) atmospheric refraction (b) diffraction

(c) scattering of light (d) reflection

Q134. The charge on one proton is 1.6×10^{-19} C and bond length of HCl molecule is 1.28 Å. Magnitude of its electrical dipole moment is

(a) 1.6×10^{-19} (b) 2.05×10^{-29} (c) 1.28×10^{-11} (d) 2.05×10^{-31}

Q135. One mole of a diatomic gas $\left(C_V=\frac{5}{2}R\right)$ and one mole of a monatomic gas $\left(C_V=\frac{3}{2}R\right)$ are mixed together. The value of $\gamma\left(=\frac{C_P}{C_V}\right)$ of the mixture is

(a) 1.33 (b) 1.4 (c) 1.5 (d) l.66

Q136. The sun's radius is 6.96×10^{8} m and it rotates with a period of 25.3 days. If the sun collapses into a neutron star of radius 5 km without any loss of mass, the new period of rotation is

(a) 1.5×10^{-9} days (b) 1.3×10^{-9} days (c) 2.4×10^{-9} days (d) 3.2×10^{-9} days

Q137. An electron enters a metallic cylindrical cavity that supports electromagnetic modes. To accelerate the electron along the axis of cavity, the cavity must support

(a) TE modes (b) TM modes (c) TEM (d) Any of the these

Q138. Width of any resonance

(a) is directly proportional to quality factor

(b) is inversely proportional to quality factor

(c) does not depend on the quality factor

(d) does not depend on the natural frequency of the vibrating object

Q139. Poynting vector in the electromagnetic field is

(a) $\frac{\vec{E}\cdot\vec{B}}{4\pi}$ (b) $\frac{\varepsilon\vec{E}^2}{2}$ (c) $\vec{E}\times\vec{B}$ (d) $\frac{\vec{E}\times\vec{B}}{\mu}$

Q140. The total outward electric flux going from a cube with $0\le x\le 1,\ 0\le y\le 1, 0\le z\le 1$ metres containing a volume charge density $\rho = 16xyz\ \mu C/m^3$, will be

(a) $16\,\mu C$ (b) $8\,\mu C$ (c) $4\,\mu C$ (d) $2\,\mu C$

Q141. The spiral galaxy is 2×10^9 km away from us. In light years, this distance is

(a) 2.1×10^6 (b) 2.6×10^6 (c) 3.2×10^6 (d) 4.2×10^6

Q142. If two non-null vectors $\vec{A}$ and $\vec{B}$ are such that $\left|\vec{A}+\vec{B}\right| = \left|\vec{A}-\vec{B}\right|$, then the angle between the two vectors is

(a) 0° (b) $\frac{\pi}{2}$ (c) π (d) $\frac{\pi}{3}$

Q143. The refractive index of a given piece of transparent quartz is largest for

(a) red light (b) violet light (c) yellow light (d) green light

Q144. A neutron is confined within a nucleus of radius 5×10^{-5} m. The minimum uncertainty in the momentum of nucleon [$m = 1.67\times 10^{-27}$ kg, $\hbar = 1.05\times 10^{-34}$ J sec] is

(a) 1.25×10^{-15} kg m/sec (b) 4.12×10^{-18} kg m/sec
(c) 1.05×10^{-28} kg m/sec (d) 1.65×10^{-21} kg m/sec

Q145. The wave function of a particle confined in a box of length L is

$$\psi(x) = \sqrt{\frac{2}{L}}\sin\frac{\pi x}{L}$$

The probability of finding the particle in the domain $0 < x < \frac{L}{2}$ is

(a) 1 (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) 0

Q146. The energy of a linear harmonic oscillator in third excited state is 0.1 eV. The frequency of vibration [$1\,\text{eV} = 1.6\times10^{-9}$ J and $h = 6.62\times10^{-34}$ J sec] is

(a) 3.3×10^{13} Hz (b) 2.8×10^{13} Hz (c) 3.9×10^{13} Hz (d) 4.2×10^{13} Hz

Q147. A neutrino has

(a) zero charge and zero spin (b) positive charge and zero spin

(c) zero charge and spin half (d) negative charge and spin half

Q148. A pulser is

(a) a rotating quasi-stable radio source (b) a rotating black hole

(c) a rotating white dwarf (d) a rotating neutron star

Q149. Electromagnetic field tensor is a tensor of rank

(a) four (b) three (c) two (d) one

Q150. Two successive Lorentz transformations with velocities v_1 and v_2 in same direction are equivalent to a single Lorentz transformation with a velocity

(a) $v_1 + v_2$ (b) $\dfrac{v_1+v_2}{1+\dfrac{v_1v_2}{c^2}}$ (c) $\dfrac{v_1+v_2}{1-\dfrac{v_1v_2}{c^2}}$ (d) $\dfrac{v_1-v_2}{1-\dfrac{v_1v_2}{c^2}}$