PART 1 ::: NO OF 50 QUESTIONS

Q1. If a one dimensional potential of a physical system is $V(x)=\frac{x^2}{2}-\frac{x^4}{4}$, the unstable equilibrium of the system would be at:

(a) $x=0$ (b) $x=+1$ (c) $x=-1$ (d) $x=\pm1$

Q2. An example of a non-inertial reference frame is when:

(a) a frame of reference is stationary w.r.t. the other frame

(b) a frame of reference moves with a uniform velocity towards the other reference frame

(c) a reference frame moves away from the other reference frame with a uniform velocity

(d) a reference frame rotates with a uniform angular velocity w.r.t. the other frame

Q3. The change in the wavelength of the scattered light in the Compton scattering is equal to the Compton wavelength of the electron when:

(a) the deflection angle of photon is $\pi/2$

(b) the deflection angle of photon is 0

(c) the deflection angle of photon is $\pi/3$

(d) the deflection angle of photon is π

Q4. The maximum value of the change in the wavelength of the scattered light in the case of Compton scattering is:

(a) $0.024\overset{0}{\mathrm{A}}$ (b) $0.048\overset{0}{\mathrm{A}}$ (c) $0.0\overset{0}{\mathrm{A}}$ (d) $72\overset{0}{\mathrm{A}}$

Q5. Raman scattering experiment is important because it leads to give information about

(a) the quantum nature of light

(b) the quantum nature of the molecule

(c) the quantum nature of atom

(d) the quantum nature of molecule as well as light

Q6. In an electron-positron annihilation experiment, two photons are produced travel back-to-back. The speed of one photon w.r.t. the other photon would be equal to

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

Q7. In a Compton scattering experiment, the recoil electron has to be:

(a) relativistic (b) non-relativistic

(c) Sometimes relativistic (d) Sometimes non-relativistic

Q8. In the phenomenon of the photo electric effect, the ejected electrons are:

(a) most of the times relativistic (b) most of the times non-relativistic

(c) always relativistic (d) most of the times stationary

Q9. The de Broglie wavelength, associated with a light of wavelength (λ) is:

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

Q10. In the case of Rutherford scattering, if the impact parameter is zero, the deflection of the α - particle would be by the:

(a) Angle $\pi/2$ (b) Angle $\pi/4$ (c) Angle π (d) Angle 2π

Q11. The de Broglie wavelength, associated with a neutron at temperature 27^0C, is nearly equal to

(a) 2.77 Meter (b) 1.77 Angstrom

(c) 2.77 Micrometer (d) 1.77 Nanometer

Q12. The de Broglie wavelength associated with $2eV$ photon and electron are:

(a) $\approx 6200\overset{0}{A}$ and $20\overset{0}{A}$, respectively (b) $\approx 7200\overset{0}{A}$ and $9\overset{0}{A}$, respectively

(c) $\approx 6200\overset{0}{A}$ and $9\overset{0}{A}$, respectively (d) $\approx 7200\overset{0}{A}$ and $20\overset{0}{A}$, respectively

Q13. The energy required to dislodge a bound electron from Sodium is $2.3eV$. The threshold wavelength of the light for the photo electric effect to occur is:

(a) 5380 meter (b) 5380 micrometer

(c) 5380 nanometer (d) 5380 angstrom

Q14. If the incident photon has a wavelength equal to $2\overset{0}{A}$ and its angle of deflection is 90^0, the kinetic energy of the recoil electron in the Compton scattering would be:

(a) 1.17×10^{-17} ergs (b) 1.17×10^{-17} jouls

(c) 1.17×10^{-17} KeV (d) 1.17×10^{-17} eV

Q15. The energy equivalent of the root mass of a position is:

(a) $0.511 GeV$ (b) $0.511 KeV$ (c) $0.511 MeV$ (d) $0.511 eV$

Q16. Threshold wavelength of a photon that is capable of generating photoelectric effect in a metal, is:

(a) the minimal value (b) the maximum value

(c) the average value (d) the root square mean value

Q17. One of the following is not consistent with the basic concepts of special theory of relativity:

(a) Maxwell's electromagnetic theory (b) Lorentz transformations

(c) Galilean transformations (d) Michelson-Morley experiment

Q18. The electric and magnetic fields of Maxwell's theory remain invariant under:

(a) Gauge transformations (b) Lorentz transformations

(c) Parity transformations (d) Galilean transformations

Q19. Two electrons move in the opposite directions each with speed $0.9C$. The relative velocity of one with respect to the other is:

(a) $1.80C$ (b) $0.99C$ (c) $0.88C$ (d) $0.77C$

Q20. Rutherford scattering is important because it sheds light on:

(a) the structure of the molecule

(b) the size of the molecule

(c) the quantum nature of the molecule

(d) the structure of the atom

Q21. A rigid body is constrained to move freely on a plane. The number of degrees of freedom for this system is

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

Q22. The condition under which the following transformations (with constants $\alpha, \beta, \gamma, \delta$) $q \to Q = \gamma q + \delta p, p \to P = \alpha q + \beta p$ would be canonical is:

(a) $\alpha\delta - \beta\gamma = 1$ (b) $\alpha\gamma - \beta\delta = 0$ (c) $\alpha\gamma - \beta\delta = 1$ (d) $\alpha\delta - \beta^2 = 0$

Q23. The quark content of a proton is:

(a) udd (b) uud (c) uuu (d) ddd

Q24. The ground state of a deuteron is:

(a) A pure $^3S_1$ state (b) A pure $^3p_1$ state

(c) A mixture of $^3S_1$ and $^3P_1$ states (d) A mixture of $^3S_1$ and $^3D_1$ states

Q25. According to the nuclear shell-model, the spin and parity of the ground state of the nucleus $_{19}K^{39}$ would be:

(a) $\left(\frac{3}{2}\right)^+$ (b) $\left(\frac{1}{2}\right)^+$ (c) $\left(\frac{3}{2}\right)^-$ (d) $\left(\frac{1}{2}\right)^-$

Q26. Under the Lorentz transformations, one of the following does not remain invariant?

(a) Rest mass (b) Charge (c) Proper time (d) Total energy

Q27. The phase space trajectory of a linear oscillator, with fixed energy, is:

(a) An ellipse (b) A circle (c) A hyperbola (d) A parabola

Q28. A current of amount 1.6 Ampere flows through a bulb. The number of electrons that flow per second is:

(a) 10^{19} (b) 10^{16} (c) 10^{22} (d) 0

Q29. Number of generalized coordinates, required to describe the motion of a rolling cylinder (without slipping) on an inclined plane, is:

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

Q30. The constraints of a rigid body is:

(a) Conservative and rheonomic (b) Conservative and scleronomic

(c) Holonomic and rheonomic (d) Non-holonomic and scleronomic

Q31. A massive particle with total energy E is constrained to move on a finite plane under the influence of a potential $V(x, y) = x^2(x^2 + y^2)$. The average kinetic energy of the particle is:

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

Q32. A massive particle with unit mass moves under the influence of potential $V(x) = x^3 - 3x + 2$. The angular frequency of the small oscillation, about the minimum of the potential, is:

(a) $\sqrt{6}\,\sec^{-1}$ (b) $\sqrt{3}\,\sec^{-1}$ (c) $\frac{1}{\sqrt{3}}\sec^{-1}$ (d) $\frac{1}{\sqrt{6}}\sec^{-1}$

Q33. If A is 3×3 matrix with $Tr(A) = 3$, $\det A = 0$ and one of the eigenvalue 1, the other two eigenvalues are:

(a) 2 and 0 (b) 1 and 1 (c) 0 and 1 (d) 3 and -1

Q34. The following vector is orthogonal to the vector $a\hat{i} + b\hat{j}$ (with $a \neq b$)

(a) $a\hat{i} - b\hat{j}$ (b) $-a\hat{i} - b\hat{j}$ (c) $-b\hat{i} + a\hat{j}$ (d) $-b\hat{i} - a\hat{j}$

Q35. If $\vec{r}$ is a position vector, the value of $\vec{\nabla}^2(\vec{r}.\vec{r}) = \vec{\nabla}^2 r^2$ is equal to:

(a) 6 (b) 0 (c) 3 (d) -3

Q36. An $a.c.$ voltage source (with $120V$ and $60\,Hz$) is connected across a $2\mu F$ capacitor. The power loss in the capacitor is:

(a) 0.000 Watt (b) 10.800 Watt

(c) 1.080 Watt (d) 0.972 Watt

Q37. A particle is described by the Lagrangian $L(x, y, \dot{x}, \dot{y}, t) = \frac{m}{2} e^{-\alpha t}\left(\dot{x}^2 + \dot{y}^2\right) - \frac{1}{2}kx^2$ where α and k are constants. One of the following statements is correct:

(a) p_x is conserved (b) total energy is conserved

(c) p_y is conserved (d) L_z is conserved

Q38. If q_1 and q_2 are generalized coordinates and p_1 and p_2 are corresponding generalized momenta, the Poisson-bracket $\{q_1^2 + q_2^2, 2p_1 + p_2\}$ is equal to:

(a) 0 (b) $2(q_1 + 2q_2)p_1$

(c) $3(q_1^2 + q_2^2)$ (d) $2(2q_1 + q_2)$

Q39. One of the following operator is hermitian:

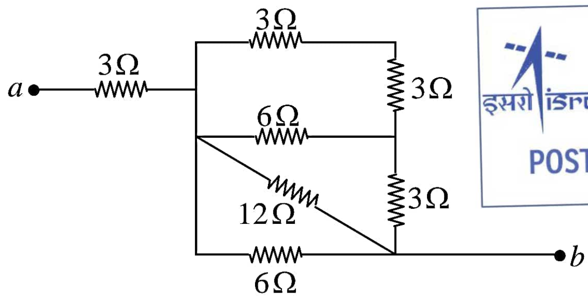
(a) $\hat{x}\hat{p}_x$ (b) $\left[\hat{x}, \hat{p}_x^2\right]$ (c) $-i\dfrac{d^2}{dx^2}$ (d) $\dfrac{d^2}{dx^2}$

Q40. One of the following is not an eigen state of the parity operator?

(a) $\cos x + x\sin x$ (b) $x(\cos x + \sin x)$

(c) $x\cos x + \sin x$ (d) $x\cos x \sin x$

Q41. The equivalent resistance in the following circuit between 'a' and 'b':



is as follows:

(a) 3.53Ω (b) 5.40 Ω (c) 0.36 Ω (d) 4.72 Ω

Q42. Degeneracy of the first excited state of an isolated hydrogen atom is:

(a) Two (b) Four (c) Six (d) Eight

Q43. The normalized ground state of a particle of mass m which is constrained to move inside a potential $V(a) = \begin{cases} 0 & -L \le x \le +L \\ \infty & \text{elsewhere} \end{cases}$ is given by:

(a) $\sqrt{\dfrac{2}{L}}\sin\dfrac{\pi x}{L}$ (b) $\sqrt{\dfrac{2}{L}}\cos\dfrac{\pi x}{L}$ (c) $\sqrt{\dfrac{1}{L}}\sin\dfrac{\pi x}{2L}$ (d) $\sqrt{\dfrac{1}{L}}\cos\dfrac{\pi x}{2L}$

Q44. The weak interaction violates the:

(a) Time reversal symmetry (b) Charge conjugation symmetry

(c) Space translational symmetry (d) Parity symmetry

Q45. The wave function of a particle $\psi = \dfrac{1}{\sqrt{2}}(\varphi_0 + i\varphi_1)$ is given in terms of the eigen state φ_0 and φ_1 corresponding to the ground state energy and the first excited state energy E_0 and E_1 respectively. The expectation value of the Hamiltonian in the state ψ is given by:

(a) $\dfrac{1}{2}E_0 + E_1$ (b) $\dfrac{E_0}{2} - E_1$ (c) $\dfrac{E_0 - 2E_1}{3}$ (d) $\dfrac{E_0 + 2E_1}{3}$

Q46. The energy eigenvalue corresponding to the bound state $\psi_{543}(r,\theta,\varphi)$ for a hydrogen like atom is:

(a) $0.544\,eV$ (b) $5.440\,eV$ (c) $-0.544\,eV$ (d) $-5.440\,eV$

Q47. Te gauge transformation between the scalar-vector potentials $(\varphi,\vec{A})$ and $(\varphi',\vec{A})$ is:

(a) $\varphi' = \varphi + \alpha x, \vec{A}^1 = \vec{A} + \alpha t\hat{k}$ (b) $\varphi' = \varphi + \alpha x, \vec{A}^1 = \vec{A} - \alpha t\hat{k}$

(c) $\varphi' = \varphi + \alpha x, \vec{A}^1 = \vec{A} + \alpha t\hat{i}$ (d) $\varphi' = \varphi + \alpha x, \vec{A}^1 = \vec{A} - \alpha t\hat{i}$

Q48. The electric field $\vec{E}$, corresponding to the potential, $\varphi(\vec{r},t) = 0, \vec{A}(\vec{r},t) = -\frac{1}{4\pi \in_0}\frac{qt}{r^2}\hat{r}$ is given by:

(a) $\vec{E} = 0$ (b) $E = -\frac{1}{4\pi \in_0}\frac{q\hat{r}}{r^2}$

(c) $\vec{E} = \frac{1}{4\pi \in_0}\frac{q\hat{r}}{r^2}$ (d) $\vec{E} = -\frac{1}{4\pi \in_0}\frac{qt}{r^2}\hat{r}$

Q49. The quark content of a neutron is:

(a) *uud* (b) *udd* (c) *uds* (d) $ud\,\bar{s}$

Q50. The weakest of the four fundamental interaction of nature is:

(a) Electromagnetic (b) Strong

(c) Gravitation (d) Weak