Assignment 19

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40. Inside a large nucleus, a nucleon with mass $939 MeVc^{-2}$ has Fermi momentum $1.40 fm^{-1}$ at absolute zero temperature. Its velocity is Xc , where the value of X is............. (up to two decimal places). (2018)

41. 4MeV γ - rays emitted by the de-excitation of ^{19}F are attributed, assuming spherical symmetry, to the transition of protons from $1d_{3/2}$ state to $1d_{5/2}$ state. If the contribution of spin-orbit term to the total energy is written as $C\langle \vec{l}.\vec{s}\rangle$ the magnitude of C is ....MeV (up to one decimal place). (2018)

42. An α particle is emitted by a $^{230}_{90}Th$ nucleus. Assuming the potential to be purely Coulombic beyond the point of separation, the height of the Coulomb barrier is............. MeV (up to two decimal places). (2018)

43. For the transformation

$$Q = \sqrt{2q}e^{-1+2\alpha}cosp, P = \sqrt{2q}e^{-1-\alpha}sinp$$

(where α is a constant) to be canonical, the value of α is .... (2018)

44. Given

$$\frac{d^2 f(x)}{dx^2} - 2\frac{df(x)}{dx} + f(x) = 0,$$

and boundary conditions $f(0) = 1$ and $f(1) = 0$, the value of the $f(0.5)$ is ....(upto 2 decimal places) (2018)

45. The absolute value of the integral

$$\frac{5z^3 + 3z^2}{z^2 - 4}dz$$

,over the circle $|z - 1.5| = 1$ in complex plane, is ....(upto 2 decimal places). (2018)

46. A uniform circular disc of mass m and radius R is rotating with angular speed ω about an axis passing through its centre and making an angle $\theta = 30°$ with the axis of the disc. If the kinetic energy of the disc is $\alpha m\omega^2 R^2$, the value of α is..............(up to two decimal places). (2018)
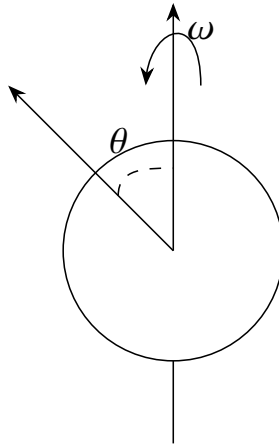
Fig. 0.1: 1

47. The ground state energy of a particle of mass m in an infinite potential well is E_0. It changes to $E_0\left(1 + \alpha \times 10^{-3}\right)$, when there is a small potential pump of height $V_0 = \frac{\pi^2 \hbar^2}{50mL^2}$ and width $a = \frac{L}{100}$, as shown in the figure. The value of α is .... (up to two decimal places). (2018)
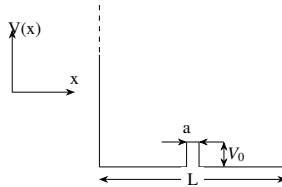

Fig. 0.2: 2

48. An electromagnetic plane wave is propagating with an intensity $I = 1.0 \times 10^5 Wm^{-2}$ in a medium with $\epsilon = 3\epsilon_0$ and $\mu = \mu_0$. The amplitude of the electric field inside the medium is .... $\times 0^3 Vm^{-1}$ (up to one decimal place). (2018)

49. A microcanonical ensemble consists of 12 atoms with each taking either energy 0 state, or energy ϵ state. Both states are non-degenerate. If the total energy of this ensemble is 4ϵ , its entropy will be .... k_B (up to one decimal place), where k_B is the Boltzmann constant. (2018)

50. A two-state quantum system has energy eigenvalues $\pm\epsilon$ corresponding to the normalized states $|\psi_\pm\rangle$. At time t = 0 , the system is in quantum state $\frac{1}{\sqrt{2}}[|\psi_+\rangle + |\psi_-\rangle]$. The probability that the system will be in the same state at $t = \frac{h}{6\epsilon}$ is .... (up to two decimal places). (2018)

51. An air-conditioner maintains the room temperature at 27°C while the outside temperature is 47°C . The heat conducted through the walls of the room from outside to inside due to temperature difference is 7000 W . The minimum work done by the

compressor of the air-conditioner per unit time is .... W .   (2018)

52. Two solid spheres A and B have same emissivity. The radius of A is four times the radius of B and temperature of A is twice the temperature of B . The ratio of the rate of heat radiated from A to that from B is ....   (2018)