2008 CE 52-68

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1) The wavefunction of which orbital is spherically symmetric: [Gate 2017]

a) p_x b) p_y c) s d) d_{xy}

2) The contour integral $\oint \frac{dz}{1+z^2}$ evaluated along a contour going from $-\infty$ to ∞ along the real axis and closed in the lower-half plane by a half circle is equal to _____.(up to two decimal places). [Gate 2017]

3) The compton wavelength of a proton is _____ fm.(up to two decimal places). $\left(m_p = 1.67 \times 10^{-27} kg, h = 6.626 \times 10^{-34} Js, e = 1.602 \times 10^{-19} C, c = 3 \times 10^8 ms^{-1}\right)$ [Gate 2017]

4) Which one of the following conservation laws is violated in the decay $\tau^+ \to \mu^+\mu^+\mu^-$

a) Angular momentum
b) Total Lepton number
c) Electric charge
d) Tau numeber

5) Electromagnetic interactions are: [Gate 2017]

a) C non-conserving but CP conserving
b) C conserving
c) CP non-conserving but CPT conserving
d) CPT non-conserving

6) A one dimensional simple harmonic oscillator with Hamiltonian $H_0 = \frac{p^2}{2m} + \frac{1}{2}kx^2$ is unjected to a small perturbation. $H_1 = \alpha x + \beta x^2 + \gamma x^4$. The first order correction to the ground state energy is dependent on [Gate 2017]

a) only β b) α and γ c) α and β d) only γ

7) For the Hamiltonian $H = a_0 I + \vec{b}.\vec{\sigma}$ where $a_0 \in \mathbb{R}$, $\vec{b}$ is a real vector, I is the 2×2 identity matrix, and $\vec{\sigma}$ are the Pauli matrices, the ground state energy is [Gate 2017]

a) $|b|$ b) $2a_0 - |b|$ c) $a_0 - |b|$ d) a_0

8) The cofficient of e^{ikx} in the Fourier expansion of $u(x) = A\sin^2(\alpha x)$ for $k = -2\alpha$ is [Gate 2017]

a) $A/4$ b) $-A/4$ c) $A/2$ d) $-A/2$

9) The degeneracy of the third energy level of a 3-dimensional isotropic quantum harmonic oscillator is [Gate 2017]

a) 6 b) 12 c) 8 d) 10

10) The electronic ground state energy of the Hydrogen aton is $-13.6eV$. The highest possible electronic energy eigenstate has an energy equal to [Gate 2017]

a) 0 b) $1eV$ c) $+13.6eV$ d) inf

11) A reversible Carnot engine is operated between temperatures T_1 and T_2 ($T_2 > T_1$) with a photon gas as the working substance. The efficiency of the engine is [Gate 2017]

a) $1 - \frac{3T_1}{4T_2}$ b) $1 - \frac{T_1}{T_2}$ c) $1 - \left(\frac{T_1}{T_2}\right)^{\frac{3}{4}}$ d) $1 - \left(\frac{T_1}{T_2}\right)^{\frac{4}{3}}$

12) In the nuclear reaction ${}^{13}C_6 + \nu_e \rightarrow {}^{13}N_7 + X$, the particle X is [Gate 2017]

a) an electron b) an anti-electron c) a muon d) a pion

13) Three charges $(2C, -1C, -1C)$ are placed at the vertices of an equilateral triangle of side $1m$ as shown in the figure. The component of the electric dipole moment about the marked origin along the $\hat{y}$ direction is _____ Cm. [Gate 2017]