

- 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  $\infty$  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).  
 $(m_p = 1.67 \times 10^{-27} kg, h = 6.626 \times 10^{-34} Js, e = 1.602 \times 10^{-19} C, c = 3 \times 10^8 ms^{-1})$   
 [Gate 2017]
- 4) Which one of the following conservation laws is violated in the decay  $\tau^+ \rightarrow \mu^+ \mu^+ \mu^-$  [Gate 2017]
 

a) Angular momentum
c) Electric charge

b) Total Lepton number
d) Tau number
- 5) Electromagnetic interactions are: [Gate 2017]
 

a)  $C$  non-conserving but  $CP$  conserving
ing

b)  $C$  conserving
d)  $CPT$  non-conserving

c)  $CP$  non-conserving but  $CPT$  conserving
- 6) A one dimensional simple harmonic oscillator with Hamiltonian  $H_0 = \frac{p^2}{2m} + \frac{1}{2}kx^2$  is subjected 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  $\beta$ 
b)  $\alpha$  and  $\gamma$ 
c)  $\alpha$  and  $\beta$ 
d) only  $\gamma$
- 7) For the Hamiltonian  $H = a_0 I + \vec{b} \cdot \vec{\sigma}$  where  $a_0 \in \mathbb{R}$ ,  $\vec{b}$  is a real vector,  $I$  is the  $2 \times 2$  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 coefficient 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 atom is  $-13.6\text{eV}$ . The highest possible electronic energy eigenstate has an energy equal to [Gate 2017]
- a) 0                      b)  $1\text{eV}$                       c)  $+13.6\text{eV}$                       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  $^{13}\text{C}_6 + \nu_e \rightarrow ^{13}\text{N}_7 + X$ , 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  $1\text{m}$  as shown in the figure. The component of the electric dipole moment about the marked origin along the  $\hat{y}$  direction is \_\_\_\_\_  $\text{Cm}$ . [Gate 2017]

