Section - 1

Marks per question : 4 **Marks Scored : 8.0**

Q No.	Q. Type	Status	Marks	Comment
1	Multiple Choice - Single Answer	✔	4.0	-

Hide Answer

A particle of mass m is in the state $\Psi(x,t) = Ae^{-19a[(mx^2/\hbar)+it]}$, where A is the normalization constant.

The expectation value of the kinetic energy $<\hat{T}>$ for the state, Ψ, will be

Hint: You may use the Gaussian integral $\int_{-\infty}^{\infty} e^{-\alpha x^2+\beta x} dx = \sqrt{\frac{\pi}{\alpha}} e^{\left(\frac{\beta^2}{4\alpha}\right)}$

- 0
- $\frac{19a\hbar}{2}$
- $\frac{19a\hbar}{3}$
- $\frac{\sqrt{19a\hbar}}{2}$
- $\frac{19a\hbar}{4}$
- $\frac{19a\hbar}{\sqrt{2}}$

Q No.	Q. Type	Status	Marks	Comment
2	Multiple Choice - Single Answer	✔	4.0	-

Hide Answer

A state of the particle of mass m trapped in an infinite potential well of width L is characterized as the superposition of three energy eigen states, namely, first state (ψ_1), second state (ψ_2) and third state (ψ_3). The state is given as $\Psi(x, t=0) = A[4\psi_1 + 7\psi_2 - 5i\psi_3]$. Here A is the normalization constant. What will be the average energy of the system at time $t = 0$? Note that $\psi_n(x) = \sqrt{\frac{2}{L}} \sin(\frac{n\pi x}{L})$ and $E_n = \frac{n^2\pi^2\hbar^2}{2mL^2}$.

- $\frac{437}{90} \frac{\hbar^2\pi^2}{2mL^2}$
- $\frac{437}{90} \frac{\hbar^2\pi^2}{2mL^2}$
- $\frac{437}{\sqrt{90}} \frac{\hbar^2\pi^2}{2mL^2}$
- $\frac{189}{\sqrt{40}} \frac{\hbar^2\pi^2}{2mL^2}$
- $\frac{\hbar^2\pi^2}{2mL^2}$
- $\frac{-13}{90} \frac{\hbar^2\pi^2}{2mL^2}$

Q No.	Q. Type	Status	Marks	Comment
1	Multiple Choice - Single Answer	✔	4.0	-

Hide Answer

A particle in the infinite square potential well of width 'a' have the initial wave function given by

$$\Psi(x, t=0) = \begin{cases} A, & 0 < x < a/2 \\ 0, & \textbf{Otherwise} \end{cases}.$$

The probability that the particle is found in the second excited eigen state (n=3) of the infinite well would be

Hint: This question carries neagtive mark. For wrong answer, you will be deduced 1 mark.

- 0
- $\frac{4}{9\pi^2}$
- $\frac{1}{2}$
- $\frac{1}{\pi^2}$
- 1
- $\frac{2}{3\pi}$

Section - 3

Marks per question : 3 Marks Scored : 3.0 Negative marks per question : 33%

Q No.	Q. Type	Status	Marks	Comment
1	Multiple Choice - Single Answer	✔	3.0	-

Hide Answer

A particle of mass 'm' confined in the infinite square potential well of width 'a' have initial wave function as

$$\Psi(x, 0) = Ax(a-x)$$

What will be the expectation value of the energy $< \hat{H} >$ for the given state.

Hint: This question carries neagtive mark. For wrong answer, you will be deduced 1 mark.

- 0
- $\frac{5\hbar^2}{ma^2}$
- $\frac{\pi^2\hbar^2}{2ma^2}$
- $\frac{30\hbar^2}{ma^2}$
- $\frac{5\hbar^2 a^3}{6m}$
- $\frac{2\pi^2\hbar^2}{ma^2}$

Consider that at $t=0$ the particle of mass 'm' trapped in the harmonic potential is in the state

$$\psi(x)=\frac{1}{\sqrt{2}}[i\phi_0(x)+\phi_1(x)]$$

where, $\phi_0(x)=\left(\frac{m\omega}{\pi\hbar}\right)^{\frac{1}{4}}e^{-m\omega x^2/2\hbar}$ and $\phi_1(x)=\left(\frac{m\omega}{\pi\hbar}\right)^{\frac{1}{4}}\sqrt{\frac{2m\omega}{\hbar}}xe^{-m\omega x^2/2\hbar}$ are the stationary state energy eigenfunction corresponding to the ground and first excited state of the one-dimensional Harmonic oscillator respectively. Here ω is the angular frequency of the oscillation. The uncertainty in the energy ($\Delta E=\sqrt{<E^2>-<E>^2}$) of the particle at time $t=\pi/\omega$ would be equal to

Hint: This question carries neagtive mark. For wrong answer, you will be deduced 1 mark.

- $\frac{\hbar\omega}{4}$
- $\frac{\hbar\omega}{2}$
- 0
- 1
- $\frac{3\hbar\omega}{2}$
- Can not be determined.

Section - 5

Marks per question : 3 Marks Scored : 3.0 Negative marks per question : 33%

Q No.	Q. Type	Status	Marks	Comment	
1	Multiple Choice - Single Answer	✔	3.0	-	Hide Answer

Consider a state characterized by the wave function

$\Psi(x,t)=\left[ie^{2ipx/\hbar}+2e^{-2ipx/\hbar}\right]e^{-ip^2t/2m\hbar}$

where, p is the momentum. The probability current density of the state would be

Hint: This question carries neagtive mark. For wrong answer, you will be deduced 1 mark.

- $\frac{p}{m}$
- $-\frac{6p}{m}$
- $\frac{-p}{m}$
- $\frac{6p}{m}$
- $\frac{2p}{m}$
- 0

1	Fill in the Blanks	✖	3.0	Answer rounding issue	Hide Answer

A relativistic electron has the DeBroglie wavelength of $1.5 \times 10^{-12} m$ The phase velocity of the wave v_p= 1.176 Expected Solutions: 1.175 c and its group velocity is $v_g =$ 0.85 Expected Solutions: 0.851 .

Note that the answer must be in terms of the light velocity, c. It means for example if you get $0.345c$, you need to enter the numeric ONLY, as the term `c' is already given in the question.

Also report your result upto three decimal places after the necessary rounding. For example, if you get 0.3456, report as 0.346. Similarly, if you get 0.3454, report as 0.345.

Useful Constants: $h = 6.626 \times 10^{-34} JSec$, Rest mass of electron $m_e = 9.11 \times 10^{-31} Kg$.