PHY-101: End-Sem Odd Semester 2022

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Your answer

A particular radiating cavity has the maxima of its spectral distribution of radiated power at a wavelength of 27 μm. The temperature is then changed so that the total power radiated by the cavity is 16 times higher. At what wavelength does the new spectral distribution maxima will appear ? 1 point

- 13.0 μm
- 14.5 μm
- 13.5 μm
- 14.0 μm

What is the probability of finding the particle in the intervals x = [0, L/3] and x = [L/3, 2L/3] for a particle in a box in n=4 state, respectively? * 1 point

- 0.299 and 0.402
- 0.289 and 0.407
- 0.303 and 0.421
- 0.333 and 0.3334

Find the probability that a particle in a box L wide can be found between x=0 and x=L/n when it is in the n state * 1 point

- 1/n
- 1/2n
- 1/(1+n)
- 1/(1-n)

A cavity is maintained at a temperature of 1650 K. At what rate does energy escape from the interior of the cavity through a hole in its wall of diameter 1.00 mm? 1 point

- 1 W
- 0.55 W
- 0.44 W
- 0.33W

1 point

The wave function $\psi(x) = A \exp(-ax^2/2)$, where A and a are real constants, is a normalized eigenfunction of the Schrodinger equation for a particle of mass m and energy E in a one-dimensional potential V(x) such that V(x) = 0 at x = 0. Which of the following is correct?

$V = \hbar^2 a/2m$, $E = a\hbar^2/8m$

Option 1

$V = \hbar^2 a x^2/4m$, $E = a\hbar^2/4m$

Option 2

$V = \hbar^2 a x^2/2m$, $a\hbar^2/2m$

Option 3

$V = \hbar^2 a x^2/8m$, $a\hbar^2/2m$

Option 4

* 1 point

A particle moving freely in an infinite potential well of length a, has the time independent wave function at given by ψ(x) = A/$\sqrt{a}$ *sin(πx/a) + $\sqrt{3/(5a)}$ sin(3πx/a) + $\sqrt{1/(5a)}$ sin(5πx/a). What is 'A' such that this wave function is normalized?

$\sqrt{6/5}$

Option 1

$\sqrt{5/6}$

Option 2

$\sqrt{3/5}$

Option 3

$\sqrt{5/3}$

Option 4

Question *

1 point

In the reference frame **K** two particles, A and B seen to have velocities of different magnitude but exact opposite directions. The total energy for each of these these particles as seen from this reference frame is $5\,mc^2$. The same pair of particles were observed from a reference frame **S**, where the particle A is at rest and have a total energy of $3\,mc^2$. From another reference frame **P** the particle B is at rest and have a total energy of $4\,mc^2$. What is the total energy of the particle B in reference frame **S**?

$$\frac{37}{3}mc^2$$

Option 1

$$9mc^2$$

Option 2

$$2\sqrt{37}\,mc^2$$

Option 3

None of the other options are true

1 point

Ratio of the transmission coefficient of an α-particle and electron across a barrier of V_o = 2eV, E=1eV and barrier width is 1 Å is approximately

e^{-85}

Option 1

e^{-70}

Option 2

e^{-75}

Option 3

e^{-80}

Option 4

*

1 point

An electron of mass m = 0.9×10^{-30} Kg and charge q = 1.6×10^{-19} Coulombs, is confined to move freely in 1-dimension of length 0.5 nm (nm=nanometer). Let the electron make a transition from state $n \rightarrow 1$. Find `n' such that the emitted photon has the minimum energy required to ionize a Hydrogen atom.

- 3
- 4
- 5
- 2

If a beam of electrons impinges on an energy barrier of height 5 eV and of infinite width. The fraction of electrons reflected and transmitted at the barrier if the energy of the incident electron is 7 eV

1 point

- 0.09,0.91
- 0.06,0.94
- 0.07,0.93
- 0.50,0.50

*

1 point

A beam of particle of energy $2V_0$ is incident on a piecewise constant potential from the left:

$$V(x) = \begin{cases} -V_0 & \text{if } x < 0 \\ V_0 & \text{if } x >= 0 \end{cases} .$$

What is the radio of the probability of reflection to transmission?

$$\frac{1}{\sqrt{3}} - \frac{1}{2}$$

Option 1

$$\frac{1-2\sqrt{2}}{4\sqrt{2}}$$

Option 2

$$\frac{4}{\sqrt{3}} - \frac{2}{3}$$

Option 3

$$\frac{2-1\sqrt{2}}{4\sqrt{2}}$$

Option 4

A one-dimension wavefunction is given by $\psi(x) = A*x*\exp(-kx)$, for all $x \geq 0$, and 0 (zero) otherwise. Here $A, k > 0$ are real constants. What is the uncertainty in the position of a quantum mechanical particle in this state? * 1 point

- $\sqrt{3}/(2k)$
- $\sqrt{3}/k$
- $3/(2k)$
- $\sqrt{(3/k)}$

*

1 point

The Gaussian wave packet at a given time is denoted by the following function. The position and momentum uncertainty for this wave-packet are

$$\psi(x) = \left(\frac{m\alpha}{\pi\hbar^2}\right)^{1/4} \exp\left[-\frac{m\alpha}{2\hbar}x^2\right]$$

$$\sqrt{\frac{\hbar}{2m\alpha}}, \sqrt{\frac{m\alpha\hbar}{2}}$$

Option 1

$$\sqrt{\frac{\hbar}{m\alpha}}, \sqrt{m\alpha\hbar}/2$$

Option 2

$$\sqrt{\frac{2\hbar}{m\alpha}}, \sqrt{m\alpha\hbar}$$

Option 3

$$\sqrt{\frac{2\hbar}{m\alpha}}, \sqrt{\frac{m\alpha\hbar}{4}}$$

Option 4

*

1 point

A particle of mass m is confined to move in a potential V(x)=0 for $0 \leq x \leq a$ and $V(x) = \infty$ otherwise. The wave function of the particle is given as-

$$\Psi = A\ (2\sin\frac{\pi x}{a} + \sin\frac{3\pi x}{a})$$

What will be the value of normalization constant A?

$(2/5a)^{1/2}$

Option 1

$(2/5a)$

Option 2

$(2/5a)^{1/3}$

Option 3

$(1/2a)^{1/2}$

Option 4

Roll Number: *

Your answer

An electron beam is incident on a potential barrier of height 0.03 eV and of infinite width. Find the reflection coefficient (R) and transmission coefficient (T) at the barrier if the energy of the incident electron beam is 0.025 eV. * 1 point

- R= 0.1, T= 0.9
- R= 0.5, T= 0.5
- R= 1, T= 0
- R= 0, T= 1

* 1 point

Find the de Broglie wavelength of an electron, of mass m = 0.9×10^{-30} Kg, when its kinetic energy is 6 eV and 200 MeV.

- 0.45 nm and 6.1 fm
- 0.62 nm and 0.5 pm
- 0.58 nm and 0.6 fm
- 0.5 nm and 6.2pm

* 1 point

We have two electrons trapped in two different potential wells as defined by $V_1(x)$ and $V_2(x)$ below. For the lowest energy state where they both have the same energy, what is the ratio of probabilities $P1/P2$ to find the electrons in between $0 < x < L_0$.

$$V_1(x) = \begin{cases} 0 & \text{if } -3L_0 \le x \le L_0 \\ \infty & \text{if } \quad otherwize \end{cases} \quad , \quad V_2(x) = \begin{cases} 0 & \text{if } -L_0 \le x \le 2L_0 \\ \infty & \text{if } \quad otherwize \end{cases}$$

- 4/3
- 4
- 1/3
- 3/4

* 1 point

The speed of an electron is measured to within an uncertainty of 2.0×10^4 m/s. What is the size of the smallest region of space in which the electron can be confined?

- 5.8 nm
- 2 nm
- 4.8 nm
- 2.5 nm

Find the expectation value of momentum of a particle whose wavefunction in all space (i.e., from -∞ to +∞) is- * 1 point

$$\Psi = \mathrm{A}\ e^{\left(\frac{-x^2}{a^2}+ikx\right)}$$

- ik
- $\hbar$k
- 0
- ∞

Incident photons of energy 10.39 keV are Compton scattered, and the scattered beam is observed at 45(Degree) relative to the incident beam. (i) What is the energy of the scattered photons at that angle? and (ii) what is the kinetic energy of the scattered electrons? 1 point

- (i) 10.39 keV and (ii) 0
- (i) 0 and (ii) 10.39 keV
- (i) 10.33 keV and (ii) 0.06 keV
- (i) 0.06 keV and (ii) 10.33 keV

A proton and a photon has same energy of 2 G eV. What is the ratio of their wavelength? * 1 point

- 2 : √3
- 1 : 2
- 1 : √2
- 1 : 4

1 point

A wavefunction is given by $\Psi = A\,(a^2 - x^2)$ in the range $-a \leq x \leq a$ and Ψ is 0 otherwise. Normalization constant A and expectation value <x> are:

$(a^3/13)$, $a^5/2$

Option 4

$(a^5/15)^{1/2}$, 0

Option 1

$(a^2/15)^{1/2}$, a

Option 3

$(a^3/13)^{1/2}$, $a/2$

Option 2

Two particles have their masses in a ratio of α. If in a reference frame they both move with same non-relativistic energy, then the ratio of the de Broglie wavelength of the two particles is * 1 point

- $\sqrt{\alpha}$
- α
- $\hbar\alpha/2$
- $1/\alpha$

* 1 point

A beam of particle of mass m and energy $9\,V_0$ is incident from left in to the piecewise constant potential given by $V(x)$ below. What is the probability of transmission to large x?

$$V(x) = \begin{cases} 0 & \text{if } x < 0 \\ 5\,V_0 & \text{if } 0 \leq x \leq \frac{h}{\sqrt{2mV_0}} \\ 8\,V_0 & \text{if } \textit{otherwise} \end{cases}$$

$$\frac{16}{37 + 3\,\cos\left(4\alpha L_0\right)}$$

Option 1

$$\frac{16}{37}$$

Option 2

$$3/4$$

Option 3

$$0$$

Option 4

A photon of energy 3 k eV collides with an electron initially at rest. If the photon emerges at an angle of 60 degree , the kinetic energy of the recoiling electron and angle (In Degree) at which the electron recoils are : 1 point

- 8.7 eV, 60
- 7.7 eV , 60
- 8.0 eV, 40
- 7.2 eV, 50

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