PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Potential Well - CSIR NET Physics PYQs

Quantum Mechanics . All PYQs (2015-2025) with answer key

13 questions . Answer key included

www.physicsbyaaryan.com . www.csirnetphysics.com
Contact: 9501976811

Q1. [June 2015] . 3.5 marks
Quantum Mechanics > Potential Well

CSIR NET	2015 June	3.5 M

The ratio of the energy of the first excited state E_1, to that of the ground state E_0, of a particle in a three-dimensional rectangular box of sides L, L and $L/2$, is

I. 3:2

2. $2:1$

3. $4:1$

4. $4:3$

Q2. [June 2016] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2016 June	3.5M

The state of a particle of mass m in a one-dimensional rigid box in the interval 0 to L is given by the normalised wavefunction

$\psi(x) = \sqrt{\frac{2}{L}}\left(\frac{3}{5}\sin\left(\frac{2\pi x}{L}\right) + \frac{4}{5}\sin\left(\frac{4\pi x}{L}\right)\right)$. If its energy is measured, the possible outcomes and the average value of energy are, respectively

1. $\frac{h^2}{2mL^2}, \frac{2h^2}{mL^2}$ and $\frac{73}{50}\frac{h^2}{mL^2}$

2. $\frac{h^2}{8mL^2}, \frac{h^2}{2mL^2}$ and $\frac{19}{40}\frac{h^2}{mL^2}$

3. $\frac{h^2}{2mL^2}, \frac{2h^2}{mL^2}$ and $\frac{19}{10}\frac{h^2}{mL^2}$

4. $\frac{h^2}{8mL^2}, \frac{2h^2}{mL^2}$ and $\frac{73}{200}\frac{h^2}{mL^2}$

Q3. [June 2017] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2017 June	3.5M

Consider a potential barrier A of height V_0 and width b, and another potential barrier B of height $2V_0$ and the same width b. The ratio T_A/T_B of tunnelling probabilities T_A and T_B, through barriers A and B respectively, for a particle of energy $V_0/100$ is best approximated by

1. $\exp\left[\left(\sqrt{1.99}-\sqrt{0.99}\right)\sqrt{8mV_0b^2/\hbar^2}\right]$
2. $\exp\left[\left(\sqrt{1.98}-\sqrt{0.98}\right)\sqrt{8mV_0b^2/\hbar^2}\right]$
3. $\exp\left[\left(\sqrt{2.99}-\sqrt{0.99}\right)\sqrt{8mV_0b^2/\hbar^2}\right]$
4. $\exp\left[\left(\sqrt{2.98}-\sqrt{0.98}\right)\sqrt{8mV_0b^2/\hbar^2}\right]$

Q4. [Dec 2018] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2018 Dec	3.5M

Three identical spin $\frac{1}{2}$ particles of mass m are confined to a one-dimensional box of length L, but are otherwise free. Assuming that they are non-interacting, the energies of the lowest two energy eigen states, in units of $\frac{\pi^2\hbar^2}{2mL^2}$, are

1. 3 and 6
2. 6 and 9
3. 6 and 11
4. 3 and 9

Q5. [June 2018] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2018 June	3.5M

In A particle of mass m is confined in a three-dimensional box by the potential

$$V(x,y,z)=\begin{cases}0, & 0\le x,y,z\le a\\ \infty & \text{otherwise}\end{cases}$$

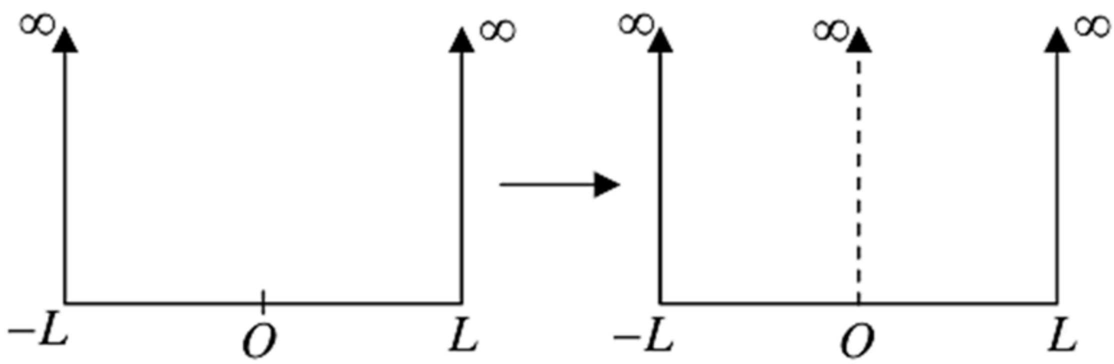
The number of eigenstates of Hamiltonian with energy $\frac{9\hbar^2\pi^2}{2ma^2}$ is

1. 1
2. 6
3. 3
4. 4

Q6. [June 2019] . 3.5 marks
Quantum Mechanics > Potential Well

CSIR NET	2019 June	3.5M

A quantum particle of mass m in one dimension, confined to a rigid box as shown in the figure, is in its ground state. An infinitesimally thin wall is very slowly raised to infinity at the centre of the box, in such a way that the system remains in its ground state at all times. Assuming that no energy is lost in raising the wall, the work done on the system when the wall is fully raised, eventually separating the original box into two compartments, is



1. $\frac{3\pi^2\hbar^2}{8mL^2}$
2. $\frac{\pi^2\hbar^2}{8mL^2}$
3. $\frac{\pi^2\hbar^2}{2mL^2}$
4. 0

Q7. [June 2019] . 3.5 marks
Quantum Mechanics > Potential Well

CSIR NET	2019 June	3.5M

The wavefunction of a free particle of mass m, constrained to move in the interval $-L \le x \le L$, is $\psi(x) = A(L+x)(L-x)$, where A is the normalization constant. The probability that the particle will be found to have the energy $\frac{\pi^2\hbar^2}{2mL^2}$ is

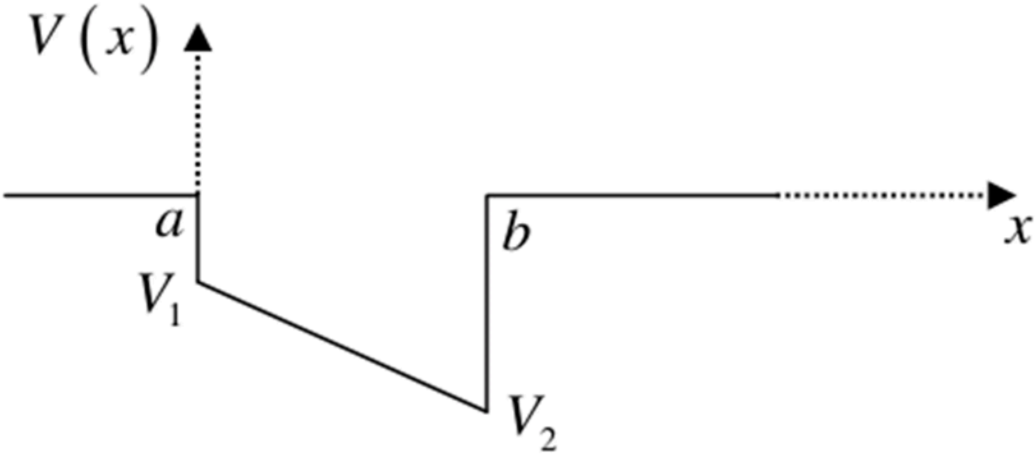
1. 0
2. $\frac{1}{\sqrt{2}}$
3. $\frac{1}{2\sqrt{3}}$
4. $\frac{1}{\pi}$

Q8. [June 2019] . 3.5 marks

Quantum Mechanics > Potential Well

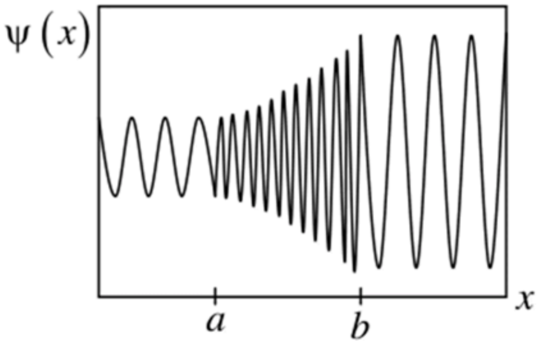
CSIR NET	2019 June	3.5M

A particle of mass in and energy $E > 0$. in one dimension is scattered by the potential below.

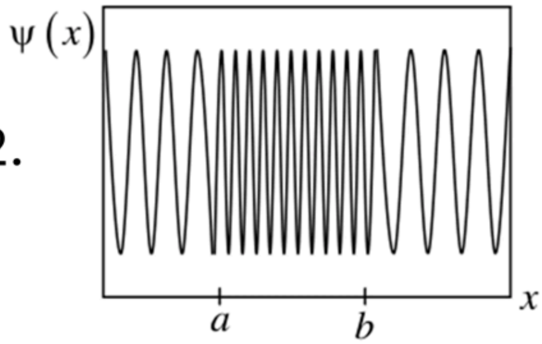


If the particle was moving from $x = -\infty$ to $x = \infty$, which of the following graphs gives the best qualitative representation of the wave function of this particle?

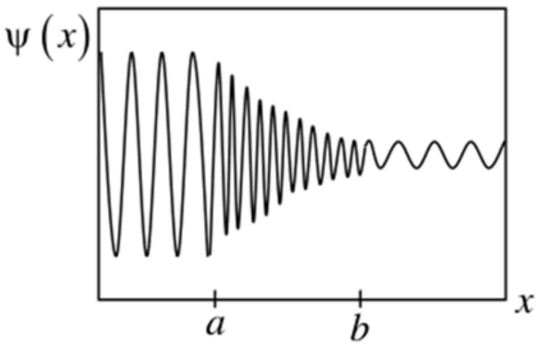
1\.



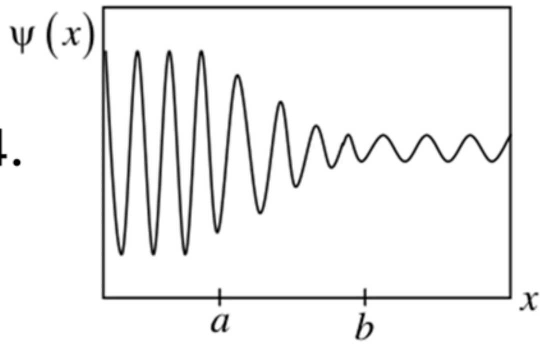
2\.



3\.



4\.



Q9. [June 2021] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2021 June	3.5M

A particle of mass m is in a one dimensional infinite potential well of length L, extending from $x = 0$ to $x = L$. When it is in the energy Eigen-state labelled by $n, (n = 1,2,3,..)$ the probability of finding in the interval $0 \leq x \leq L/8$ is $1/8$. The minimum value of n for which this is possible is

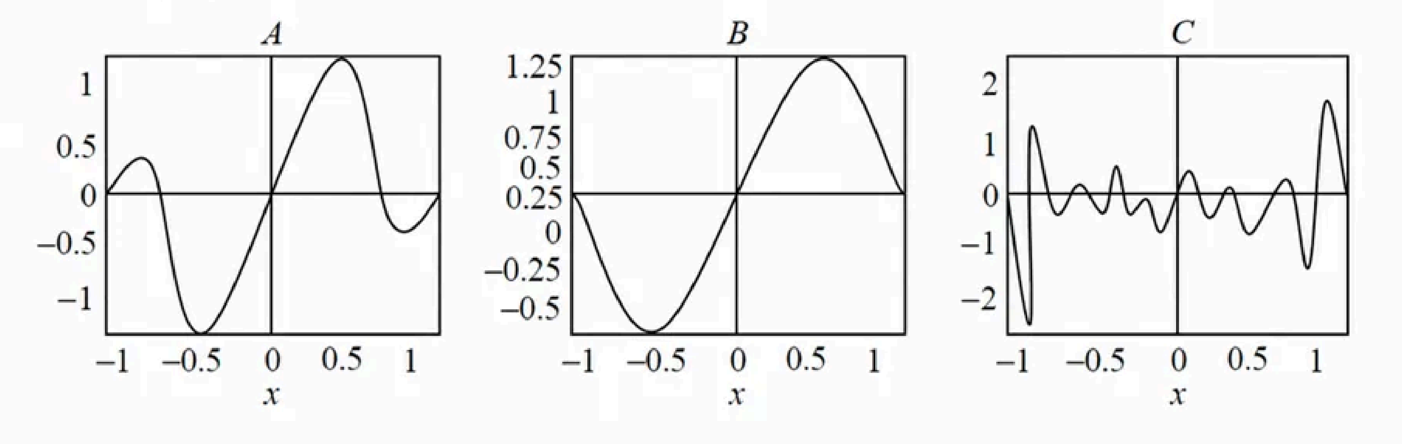
1. 4
2. 2
3. 6
4. 8

Q10. [June 2021] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2021 June	3.5M

The figures below depict three different wave functions of a particle confined to a one dimensional box $-1 \le x \le 1$.



The wave functions that correspond to the maximum expectation values $|\langle x \rangle|$ (absolute value of the mean position) and $\langle x^2 \rangle$, respectively, are

1. B and C
2. B and A
3. C and B
4. A and B

Q11. [June 2022] . 5.0 marks

Quantum Mechanics > Potential Well

CSIR NET	2022 June	5M

The energy/energies E of the bound state(s) of a particle of mass m in one dimension in the

potential $V(x) = \begin{cases} \infty, & x \le 0 \\ -V_0, & 0 < x < a \\ 0, & x \ge a \end{cases}$ (where $V_0 > 0$)

is/are determined by

1. $\cot^2\left(a\sqrt{\frac{2m(E+V_0)}{\hbar^2}}\right) = \frac{E-V_0}{E}$
2. $\tan^2\left(a\sqrt{\frac{2m(E+V_0)}{\hbar^2}}\right) = -\frac{E}{E+V_0}$
3. $\cot^2\left(a\sqrt{\frac{2m(E+V_0)}{\hbar^2}}\right) = -\frac{E}{E+V_0}$
4. $\tan^2\left(a\sqrt{\frac{2m(E+V_0)}{\hbar^2}}\right) = \frac{E-V_0}{E}$

Q12. [Dec 2024] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2024 Dec	3.5M

Two non-interacting identical spin $-\frac{1}{2}$ particles, each of mass m, are placed in a two-dimensional infinite square well of side L. The single-particle spatial wavefunction is given by

$$\varphi_{n_x,n_y}(x,y) = \frac{2}{L}\sin\left(\frac{n_x \pi x}{L}\right)\sin\left(\frac{n_y \pi y}{L}\right)$$

where n_x and n_y are positive integers. If the particles are in a total spin state $|j=1, m=0\rangle$, the lowest possible energy eigenvalue is

1. $\frac{5\hbar^2\pi^2}{2mL^2}$
2. $\frac{\hbar^2\pi^2}{mL^2}$
3. $\frac{2\hbar^2\pi^2}{mL^2}$
4. $\frac{7\hbar^2\pi^2}{2mL^2}$

Q13. [Dec 2024] . 3.5 marks

Quantum Mechanics > Potential Well

CSIR NET	2024 Dec	3.5M

A particle of mass m is in a cubic box of side a. The potential inside the box ($0 \leq x \leq a, 0 \leq y \leq a, 0, \leq z \leq a$) is zero and infinite outside. If the particle is in an energy eigenstate with $E = \frac{7\pi^2 h^2}{ma^2}$, a possible wavefunction is

1. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{\pi y}{a}\right) \sin\left(\frac{2\pi z}{a}\right)$
2. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{3\pi y}{a}\right) \sin\left(\frac{\pi z}{a}\right)$
3. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{2\pi y}{a}\right) \sin\left(\frac{3\pi z}{a}\right)$
4. $\psi = \left(\frac{2}{a}\right)^{3/2} \sin\left(\frac{\pi x}{a}\right) \sin\left(\frac{2\pi y}{a}\right) \sin\left(\frac{2\pi z}{a}\right)$

Answer Key

13 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Quantum Mechanics	Potential Well	**1**
Q2	Quantum Mechanics	Potential Well	**1**
Q3	Quantum Mechanics	Potential Well	**1**
Q4	Quantum Mechanics	Potential Well	**2**
Q5	Quantum Mechanics	Potential Well	**3**
Q6	Quantum Mechanics	Potential Well	**1**
Q7	Quantum Mechanics	Potential Well	**1**
Q8	Quantum Mechanics	Potential Well	**3**
Q9	Quantum Mechanics	Potential Well	**1**
Q10	Quantum Mechanics	Potential Well	**1**
Q11	Quantum Mechanics	Potential Well	**3**
Q12	Quantum Mechanics	Potential Well	**4**
Q13	Quantum Mechanics	Potential Well	**3**

Study with PhysicsByAaryan

Full CSIR NET / GATE / JEST / BARC Physics live batch by Aaryan Mehra Sir.
Concept-first teaching, complete PYQ coverage, daily doubt support.

Use coupon CONSISTENCY for Rs. 500 off

Visit
www.physicsbyaaryan.com
www.csirnetphysics.com

Contact
9501976811