PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Variational Principle - CSIR NET Physics PYQs

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

5 questions . Answer key included

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Q1. [Dec 2015] . 3.5 marks

Quantum Mechanics > Variational Principle

CSIR NET	2015 Dec	3.5 M

The ground state energy of a particle of mass m in the potential $V(x) = V_0 \cosh\left(\frac{x}{L}\right)$, where L and V_0 are constants (with $V_0 \gg \frac{\hbar^2}{2ml^2}$) is approximately

1. $V_0 + \frac{\hbar}{L}\sqrt{\frac{2V_0}{m}}$
2. $V_0 + \frac{\hbar}{L}\sqrt{\frac{V_0}{m}}$
3. $V_0 + \frac{\hbar}{4L}\sqrt{\frac{V_0}{m}}$
4. $V_0 + \frac{\hbar}{2L}\sqrt{\frac{V_0}{m}}$

Q2. [Dec 2015] . 5.0 marks

Quantum Mechanics > Variational Principle

CSIR NET	2015 Dec	5 M

The ground state energy of a particle in potential $V(x) = g|x|$, estimated using the trail wavefunction

$$\psi(x) = \begin{cases} \sqrt{\frac{c}{a^5}}(a^2 - x^2), & x < |a| \\ 0, & x \geq |a| \end{cases}$$

(where g and c are constants) is

1. $\frac{15}{16}\left(\frac{\hbar^2 g^2}{m}\right)^{1/3}$
2. $\frac{5}{6}\left(\frac{\hbar^2 g^2}{m}\right)^{1/3}$
3. $\frac{3}{4}\left(\frac{\hbar^2 g^2}{m}\right)^{1/3}$
4. $\frac{7}{8}\left(\frac{\hbar^2 g^2}{m}\right)^{1/3}$

Q3. [June 2016] . 5.0 marks

Quantum Mechanics > Variational Principle

CSIR NET	2016 June	5M

The ground state energy of a particle of mass m in the potential $V(x) = \frac{\hbar^2\beta}{6m}x^4$, estimated using the normalized trial wavefunction

$\psi(x) = \left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha x^2/2}$, is

[Use $\sqrt{\frac{\alpha}{\pi}}\int_{-\infty}^{\infty} dx x^2 e^{-\alpha x^2} = \frac{1}{2\alpha}$

and $\sqrt{\frac{\alpha}{\pi}}\int_{-\infty}^{\infty} dx x^4 e^{-\alpha x^2} = \frac{3}{4\alpha^2}$].

1. $\frac{3}{2m}\hbar^2\beta^{1/3}$
2. $\frac{8}{3m}\hbar^2\beta^{1/3}$
3. $\frac{2}{3m}\hbar^2\beta^{1/3}$
4. $\frac{3}{8m}\hbar^2\beta^{1/3}$

Q4. [June 2017] . 5.0 marks

Quantum Mechanics > Variational Principle

CSIR NET	2017 June	5M

Using the trial function

$$\psi(x) = \begin{cases} A(a^2 - x^2), & -a < x < a \\ 0 & \text{otherwise} \end{cases}$$

the ground state energy of a one-dimensional harmonic oscillator is

1. $\hbar\omega$
2. $\sqrt{\frac{5}{14}}\hbar\omega$
3. $\frac{1}{2}\hbar\omega$
4. $\sqrt{\frac{5}{7}}\hbar\omega$

Q5. [June 2024] . 5.0 marks

Quantum Mechanics > Variational Principle

CSIR NET	2024 June	5M

Using a normalized trial wavefunction $\psi(x) = \sqrt{\alpha}e^{-\alpha|x|}$ (α is a positive real constant) for a particle of mass m in the potential $V(x) = -\lambda\delta(x), (\lambda > 0)$, the estimated ground state energy is

1. $-\frac{m\lambda^2}{\hbar^2}$
2. $\frac{m\lambda^2}{\hbar^2}$
3. $\frac{m\lambda^2}{2\hbar^2}$
4. $-\frac{m\lambda^2}{2\hbar^2}$

Answer Key

5 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Quantum Mechanics	Variational Principle	**4**
Q2	Quantum Mechanics	Variational Principle	**1**
Q3	Quantum Mechanics	Variational Principle	**4**
Q4	Quantum Mechanics	Variational Principle	**2**
Q5	Quantum Mechanics	Variational Principle	**4**

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