

Hlutapróf 1, 20. september, 8:20-9:50

Leyfð hjálpargögn: reiknivél og ein A4 blaðsíða sem hver nemandi hefur skrifað sjálfur.

Problem 1:

Consider a particle of mass m in a box where the potential is zero between $x = 0$ and $x = a$, but infinite elsewhere. The system is prepared in such a way that the wavefunction is

$$\psi(x) = N \left(2 \sin \left(\frac{2\pi x}{a} \right) + \sin \left(\frac{4\pi x}{a} \right) \right).$$

- (a) Find the value of the normalization constant, N .
- (b) What is the expectation value of the total energy in the state $\psi(x)$?
- (c) Assume that a measurement of the total energy is made and the value found is the energy of the first excited state. What is the wavefunction describing the system after the measurement?
- (d) Give an expression for the energy needed to excite the particle from the ground state to the first excited state.
- (e) Assume a measurement is carried out to determine whether the particle is in the left half of the box, $[0, \frac{a}{2}]$, and the outcome of the experiment is negative, i.e. it is not found there, what would be a reasonable estimate of the wavefunction for the system after the experiment (sketch the wavefunction)?
- (f) What is the probability that a measurement of the total energy of the system described by the wave function $\psi(x)$ (given above) will give the ground state energy? Explain your answer.