5.E: Translational States (Exercises)

Q5.1

Write the Schrödinger equation for a free particle in three-dimensional space.

Q5.2

Solve the Schrödinger equation to find the wavefunctions for a free particle in three-dimensional space.

Q5.3

Show that these functions are eigenfunctions of the momentum operator in three-dimensional space.

Q5.4

If you have not already done so, use vector notation for the wave vector and position of the particle.

Q5.5

Write the wavefunctions using vector notation for the wave vector and the position.

Q5.6

Write the momentum operator in terms of the del-operator, which is defined as $\hat{\nabla} = \vec{x}\frac{\partial}{\partial x} + \vec{y}\frac{\partial}{\partial y} + \vec{z}\frac{\partial}{\partial z}$ where the arrow caps on x, y, and z designate unit vectors.

Q5.7

Write the Laplacian operator in terms of partial derivatives with respect to x, y, and z. The Laplacian operator is defined as the scalar product of del with itself, $\hat{\partial}^2 = \hat{\partial} \cdot \hat{\partial}$.

Q5.8

Write the kinetic energy operator in terms of the Laplacian operator.

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