

Unbound States

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1 Free Particle Eigenstates

1.1 Energy Eigenstates

For a free particle, the potential energy function $V(x)$ is 0 everywhere. Free particles do not have quantized energy.

1.2 Momentum Eigenstates

With a wavelength λ , the **particular momentum eigenvalue** is

$$p = \frac{h}{\lambda}$$

which gives the **de Broglie wavelength** of a particle with momentum p to be

$$\lambda_{deBroglie} = \frac{h}{p}$$

For a free particle, energy and momentum are related by

$$E = \frac{p^2}{2m}$$

and so a given energy state does not have a definite momentum, but is a superposition of 2 momentum states with opposite momentums, so the energy state is **degenerate** with respect to momentum.