

$$\Psi(x, t) = \frac{1}{\sqrt{2\pi\hbar k}} \int_{-\infty}^{\infty} e^{ipx/\hbar} \Phi(p, t) dp$$

$$\langle x \rangle = \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\hbar k}} \int_{-\infty}^{\infty} e^{-ip'x/\hbar} \Phi^*(p', t) dp' \quad x \int_{-\infty}^{\infty} e^{ipx/\hbar} \Phi(p, t) dp dx$$

$$= \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\hbar k}} \int_{-\infty}^{\infty} e^{-ip'x/\hbar} \Phi^*(p', t) dp' \int_{-\infty}^{\infty} x e^{ipx/\hbar} \Phi(p, t) dp dx$$

$$= \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\hbar k}} \int_{-\infty}^{\infty} e^{-ip'x/\hbar} \Phi^*(p', t) dp' \int_{-\infty}^{\infty} -i\hbar \frac{\partial}{\partial p} e^{ipx/\hbar} \Phi(p, t) dp dx$$

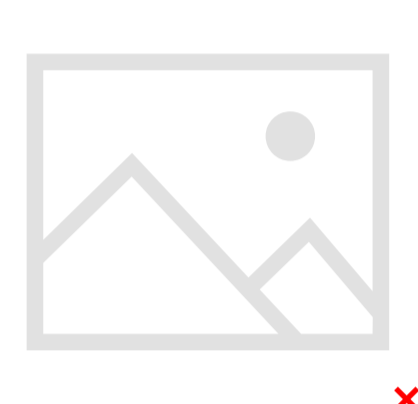
$$= \int_{-\infty}^{\infty} \frac{1}{\sqrt{2\pi\hbar k}} \int_{-\infty}^{\infty} e^{-ip'x/\hbar} \Phi^*(p', t) dp' \int_{-\infty}^{\infty} -i\hbar \frac{\partial}{\partial p} e^{ipx/\hbar} \Phi(p, t) dp dx$$

$$= \frac{1}{\sqrt{2\pi\hbar k}} \int_{-\infty}^{\infty}$$

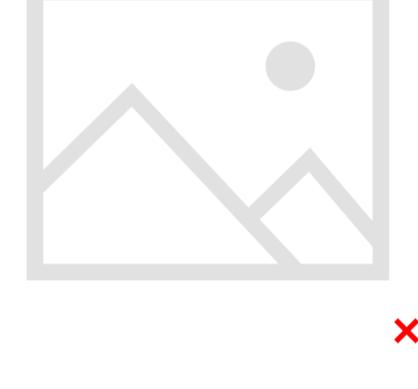


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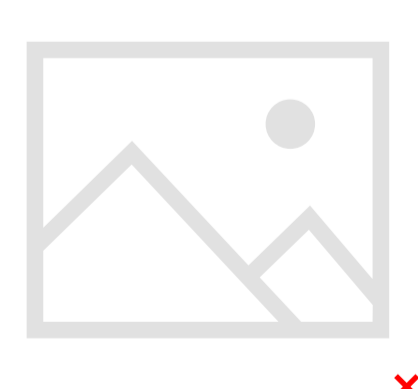
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