Classical:

\[ v = 0 \quad t = 0 \]
\[ x(t = 0) = x_0 \]
\[ \Psi(x, t = 0) \]
\[ x = 0 \quad t > 0 \]
\[ \Delta x \quad \Delta p = \frac{\hbar}{2} \]

The ‘x-p’ or phase space plot of the falling electron:

Quantum:

\[ x = x_0 \]
\[ v \]
\[ \Delta x \quad \Delta p = 2\hbar \]
[area]

The probability in phase space: it is a sharp spike at a precise position and momentum because we know the particle is exactly there.

The quantum plot looks similar: the particle still falls, and its average position decreases from \( x_0 \) towards 0, and its average momentum becomes more negative as it accelerates downward.

BUT: the position and momentum of the particle are NOT independent variables that can be defined simultaneously; instead measurement of the particle position and momentum yields spreads \( \Delta x \) and \( \Delta p \) that represent a finite area \( \frac{\hbar}{2} \) for the quantum particle!

This is an intrinsic property of quantum particles, not an ‘uncertainty’ or ‘measurement error.’