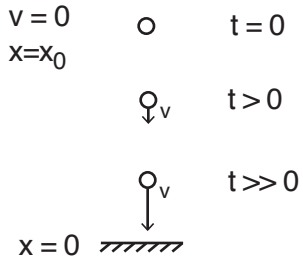
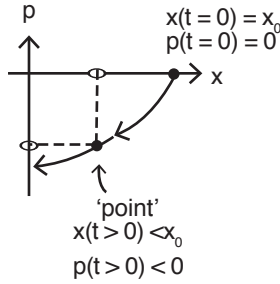


Board drawings for lecture #1

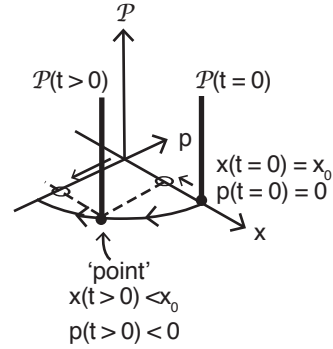
Classical:



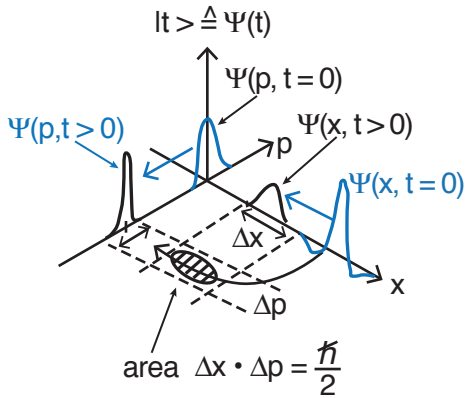
The 'x-p' or phase space plot of the falling electron:



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



Quantum:



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  $\hbar$  for the quantum particle!

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