NAME / Section #: _____ / _____	Exam III Problem #4 Phys270

4. [15 pts] A thin solid barrier occupying the entire xy-plane has a single 5-μm-diameter circular hole. An electron traveling in the +z-direction (with v_x =0 m/s and v_y =0 m/s) passes through the hole. Afterward, within what range is v_x likely to be? Assume all velocities are small enough to be considered non-relativistically.

On the other side of the hole the x position of the electron is uncertain by an amount $\Delta x \sim 5\ \mu m$.

From Heisenberg's principle then $\Delta p_x \sim \frac{h}{\Delta x} = \frac{6.625\times10^{-34}\ J\cdot s}{5\times10^{-6}\ m}$ (for momentum p_x along x direction). As because $p_x = m v_x$ we get

$$\Delta V_x \sim \frac{h}{m\,\Delta x} = \frac{6.625\times10^{-34}}{9.11\times10^{-31}\times 5\times10^{-6}}\ m/s$$

or, $\Delta v_x \approx 145\ m/s$.

This is the required uncertainty.

* We have neglected factors of $2/2\pi$ etc. So any answer of this order by similar means is correct.