In-class problem linked to lecture pages 38 – 46 :

Consider a proton moving in three dimensions whose position is confined to be within a nucleus whose radius is 2×10^{-15}m. Its momentum must have magnitude less than 3×10^{-19} kg-m/s. How many quantum states are available to this proton?

In-class problem linked to lecture pages 38-46

$$\#\text{states} = \frac{V_r V_p}{(h/2)^3}$$

$$V_r = \frac{4}{3}\pi r_0^3$$

$$V_p = \frac{4}{3}\pi p_0^3$$

$r_0 = 2\times10^{-15}\ m$

$p_0 = 3\times10^{-19}\ \frac{kg\ m}{s}$

$h = 1.06\times10^{-34}\ J\text{-}s$

$$\#\text{states} = \frac{\frac{4}{3}\pi(2\times10^{-15})^3 \cdot \frac{4}{3}\pi(3\times10^{-19})^3 \cdot 2^3}{(1.06\times10^{-34})^3} = \underline{25{,}456}$$

If we replace $\frac{h}{2} \rightarrow h$ we get $\underline{13}$