Chemistry 2720 Fall 2003 Quiz 7 Solutions

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\begin{aligned}
m &= (4.002\,603\,\text{amu})(1.660\,539\times10^{-27}\,\text{kg/amu}) = 6.646\,478\times10^{-27}\,\text{kg}.\\
K &= \frac{1}{2}mv^2.\\
\therefore v &= \sqrt{\frac{2K}{m}} = \sqrt{\frac{2(2\times10^{-22}\,\text{J})}{6.646\,478\times10^{-27}\,\text{kg}}} = 245\,\text{m/s}.\\
\therefore p &= mv = (6.646\,478\times10^{-27}\,\text{kg})(245\,\text{m/s}) = 1.63\times10^{-24}\,\text{kg m}^{-1}\text{s}^{-1}.\\
\therefore \lambda &= \frac{h}{p} = \frac{6.626\,069\times10^{-34}\,\text{J/Hz}}{1.63\times10^{-24}\,\text{kg m/s}} = 4.1\times10^{-10}\,\text{m}.
\end{aligned}
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How we interpret this number depends on the kind of experiment we have in mind. If we were imagining following the paths of individual helium atoms, then we would conclude that quantum mechanical effects were important at this temperature since the wavelength is similar to the size of an atom.

If on the other hand we were imagining a helium gas in a large container (several centimetres across), then we might conclude that quantum mechanical effects are unimportant since the wavelength is so much smaller than the size of any reasonably sized container.