Estimate the electron transition energy and wavelength of decapentaene using the particle-in-a-box model. Assume that decapentaene is a ten-carbon polyene dye that can be modeled as a box of length 15.1 Å.

Solution: The particle-in-a-box model for a polyene assumes that electrons are paired in each quantum level. Thus, 10 electrons will fill the first 5 levels and the first transition will be from level 5 → 6. The ground state quantum number will be $n_g = 5$ and the excited state quantum number will be $n_e = 6$.
$\Delta E = h^2/8ma^2(n_e^2 - n_g^2) = (6.626 \text{ x } 10\text{-}34 \text{ Js})^2/8/9.1 \text{ x } 10^{-31} \text{ kg}/(15.1 \text{ x } 10^{-10} \text{ m})^2 (6^2 - 5^2) = 2.9 \text{ x } 10^{-19} \text{ J} = 14{,}670 \text{ cm}^{-1}$.
The wavelength can be obtained from
$\Delta E = hc/\lambda$ or $\lambda = hc/\Delta E = (6.626 \text{ x } 10^{-34} \text{ Js})(2.99 \text{ x } 10^8 \text{ m})/(2.9 \text{ x } 10^{-19} \text{ J}) = 681$ nm.
Transition energy = 14,670 cm^{-1}.
Transition wavelength = 681 nm.

Transition energy = _____.

Transition wavelength = _____.