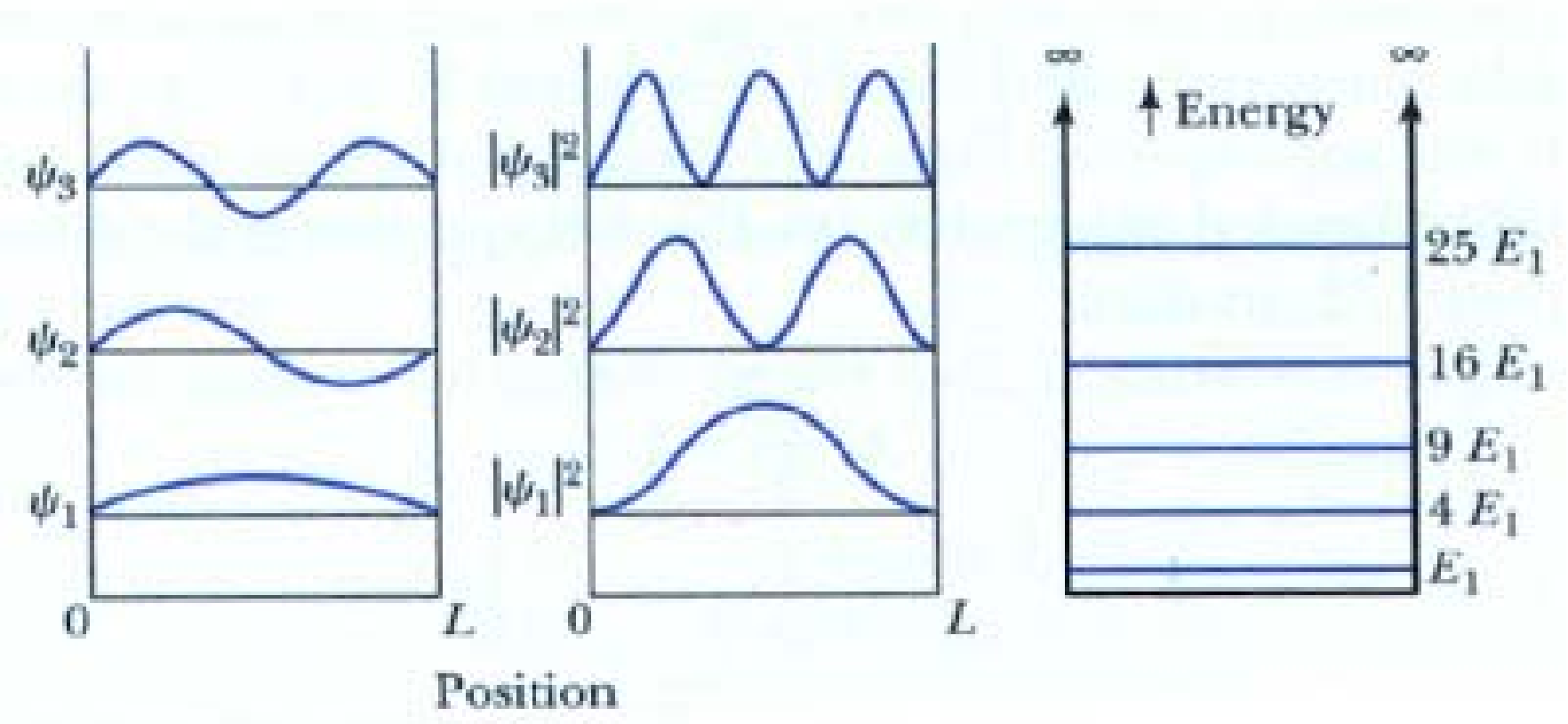
- Superposition and Expectation values (example also covered in class)
- Free Particle
- Particle in a one-dimensional (1-D) box

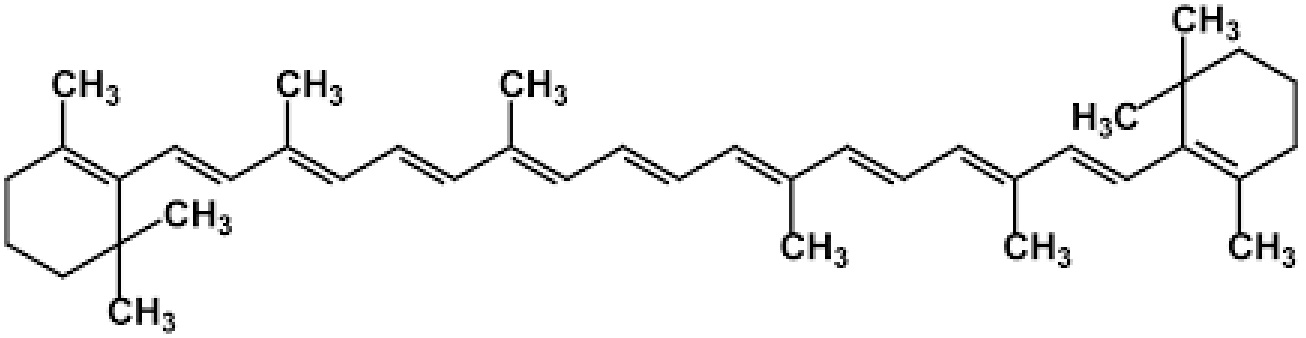
Wavefunctions and Probability Density



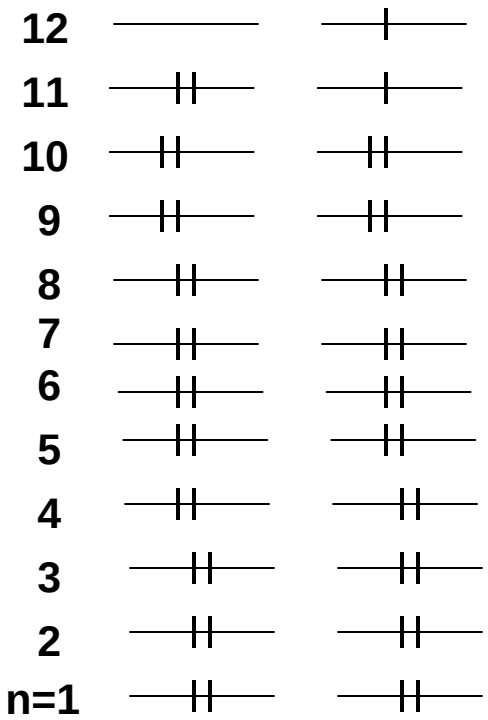
- **Think what might happen to the probability density when the quantum number *n* is very high**

Particle in a box

- β-carotene is a linear polyene as shown below. It has 11 double bonds along a chain of 22 carbon atoms.



- Consider each C-C bong length to be 140 pm
- Question: Estimate the wavelength of light needed for excitation from ground state to the next excited state.



$\Delta E = hc/\lambda$

- Number of π e-s = 22
- $\Delta E = E_{12} - E_{11}$

$$E_{12} = \frac{12^2 h^2}{8 m_e L^2}$$

$$E_{11} = \frac{11^2 h^2}{8 m_e L^2}$$

$$\Delta E = \frac{\left(12^2 - 11^2\right) h^2}{8 m_e L^2}$$

- $m_e = 9.109 \times 10^{-31}$ kg
- $h = 6.626 \times 10^{-34}$ J.s
- L = length of box
  = 21 x 140 pm = 2.94 nm