BOUND STATES

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Supplementary Material for PHY 3305 (Modern Physics)

Harris, Ch. 5.2-5.5

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MID-TERM EXAM

- Guidelines were handed out on Tuesday (see website for a copy)
- Goals of the exam:
  - test your conceptual and quantitative grasp of the material
- Questions:
  - at the level of the homework
  - a bonus question will be given, but with severe constraints:
    - I will only accept work on the bonus question if you have shown work for ALL other questions first
    - The bonus question is at a higher level than the homework
    - The bonus question is ALL OR NOTHING
    - The bonus question will be worth +15 points

When is Fast Fast-Enough?

- When is a problem to be treated "relativistically"?
  - short answer: always start with relativity but check γ_v to see how close it is to 1.0

$$\gamma_v \approx 1 + \frac{1}{2}(v/c)^2 + \ldots$$

(Binomial Expansion of γ_v)

  - rule of thumb: $v < 0.05c$ = non-relativistic
  - Be careful! Remember the GPS satellites go less than 0.05c but the precision of the system is affected by special relativity!

REVIEW

- We began to explore the implications of a wave-description of nature
- We discussed the uncertainty principle
- We began to think more deeply about the wave function
- We added forces to the SWE

The Shroedinger Wave Equation (SWE)

$$\frac{-\hbar^2}{2\mathrm{m}}\frac{\partial^2\Psi(x,t)}{\partial x^2}+U(x)\Psi(x,t)=i\hbar\frac{\partial\Psi(x,t)}{\partial t}$$

TIME-INDEPENDENT SWE

Assume:

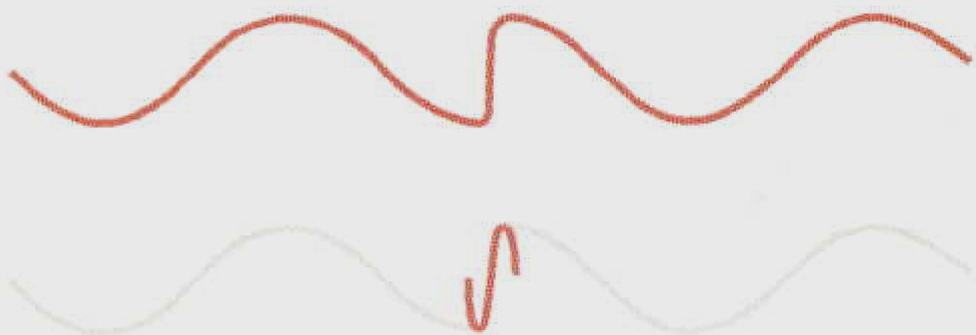
$$\Psi(x,t) = \psi(x)\phi(t)$$

you get...

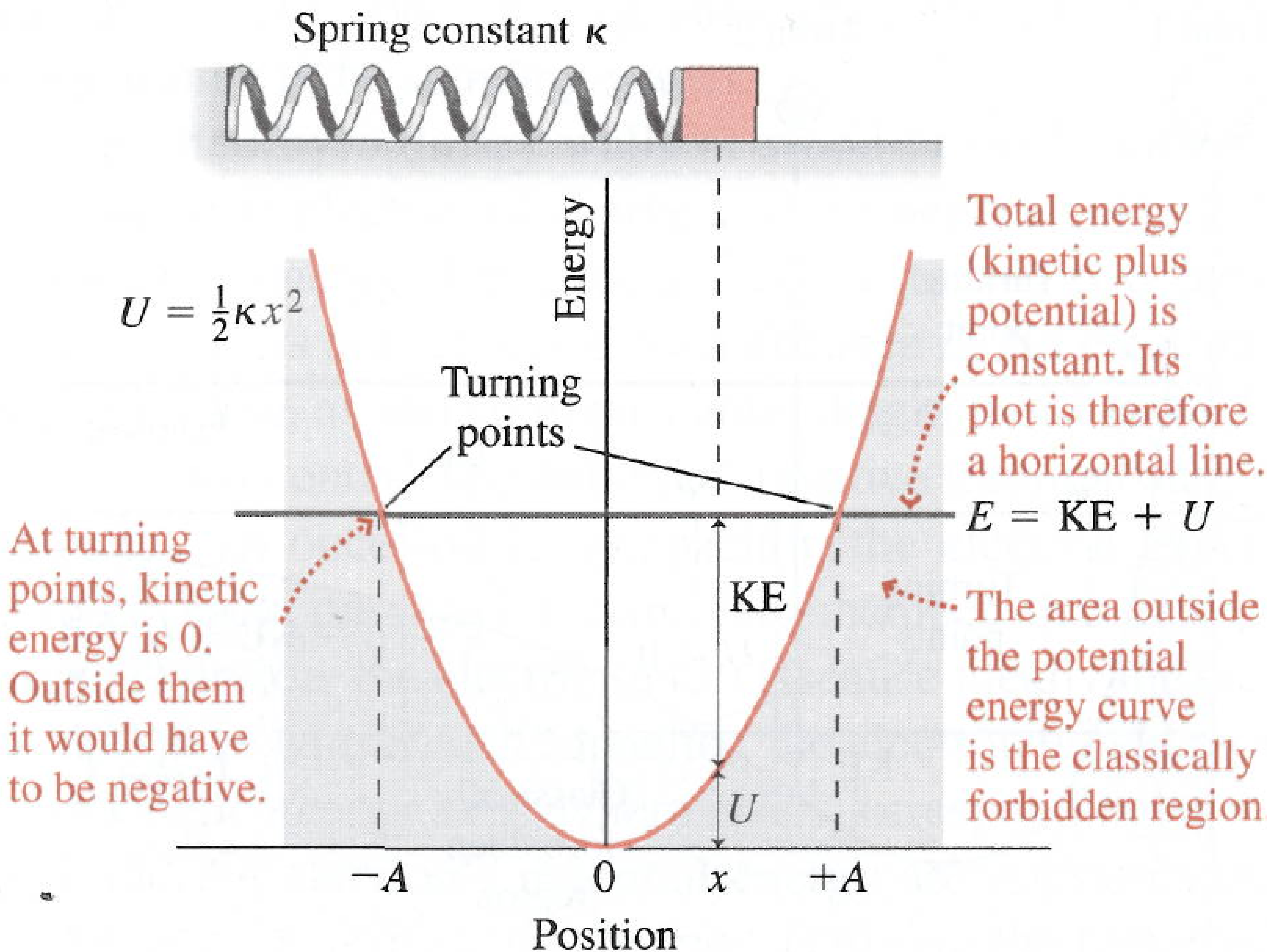
$$\frac{-\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + U(x)\psi(x) = E\psi(x)$$

SMOOTHNESS

Figure 5.1 An abrupt jump acts like a very short wavelength.

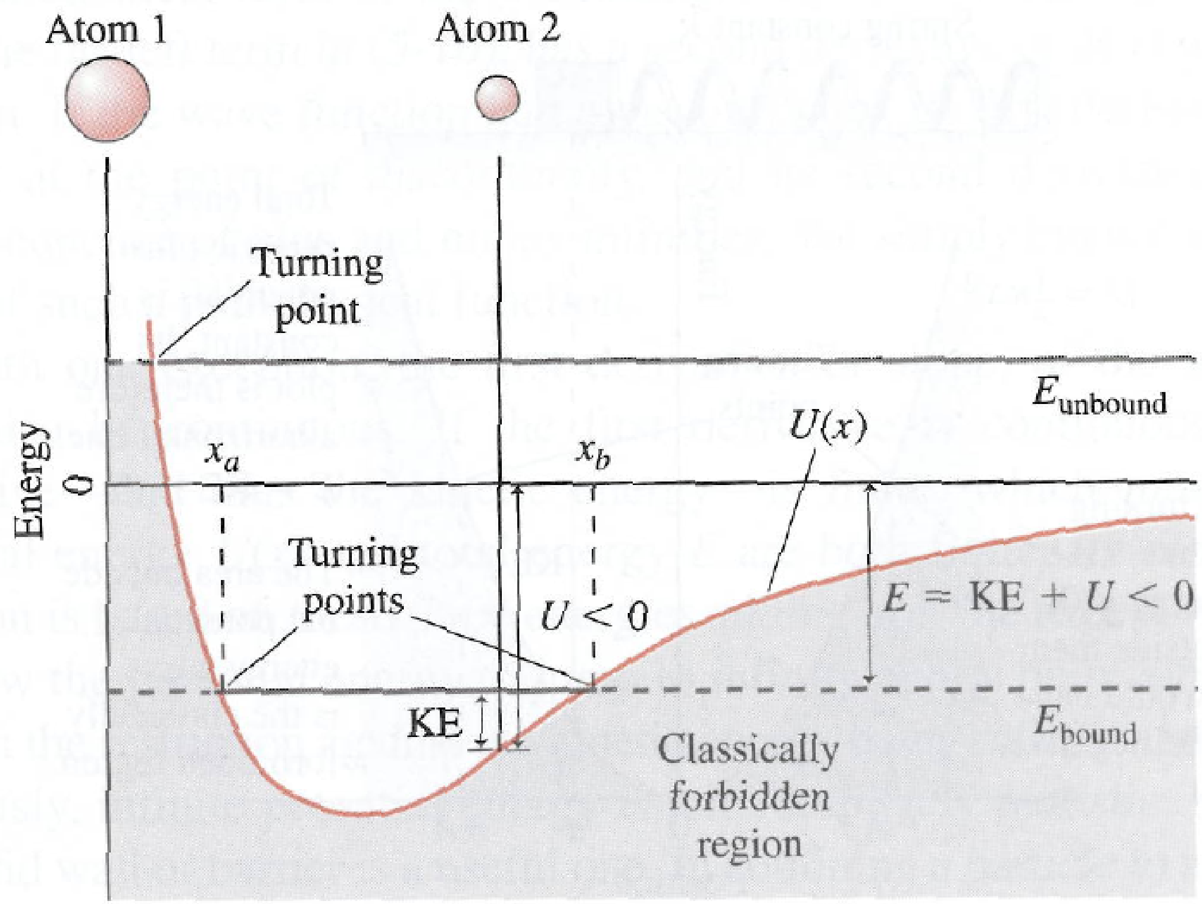


MASS ON A SPRING

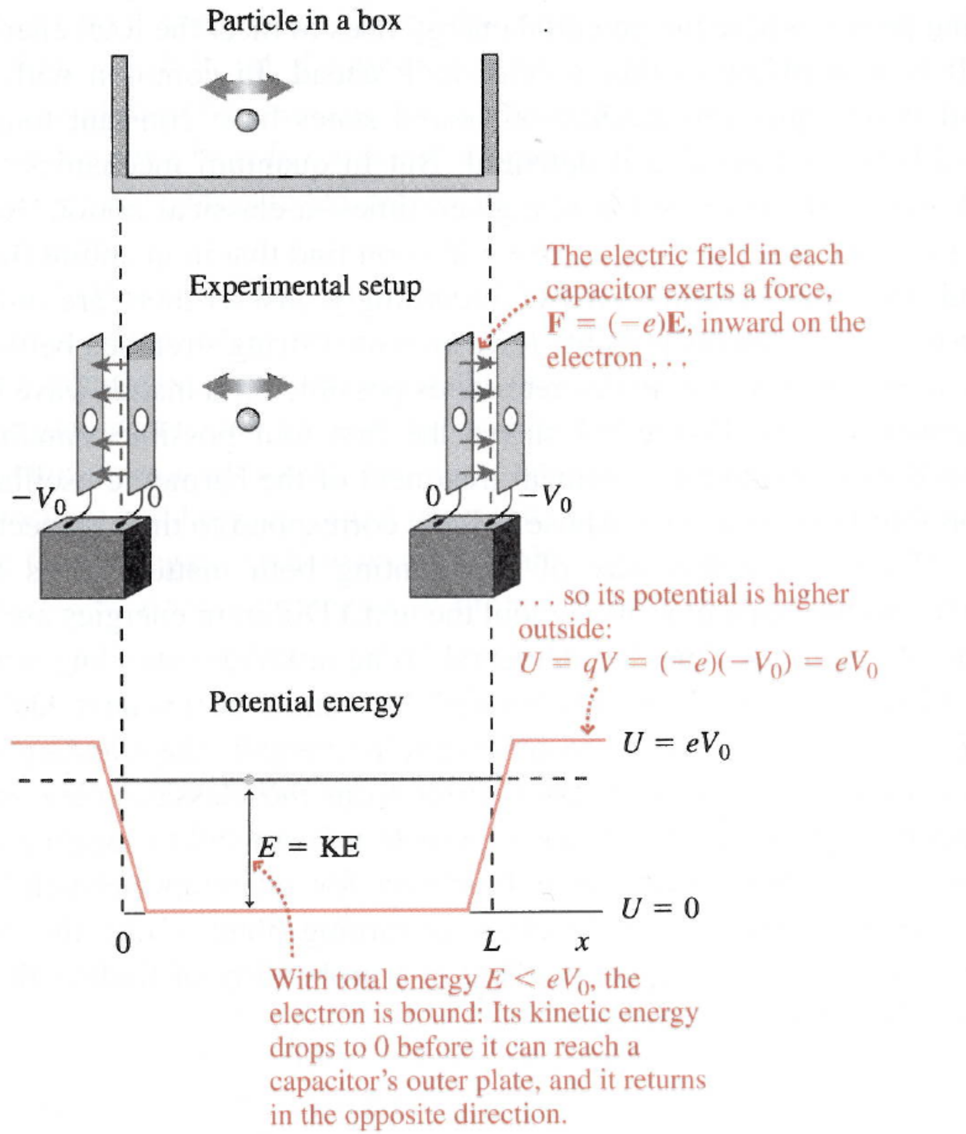


ATOMIC BOUND STATES

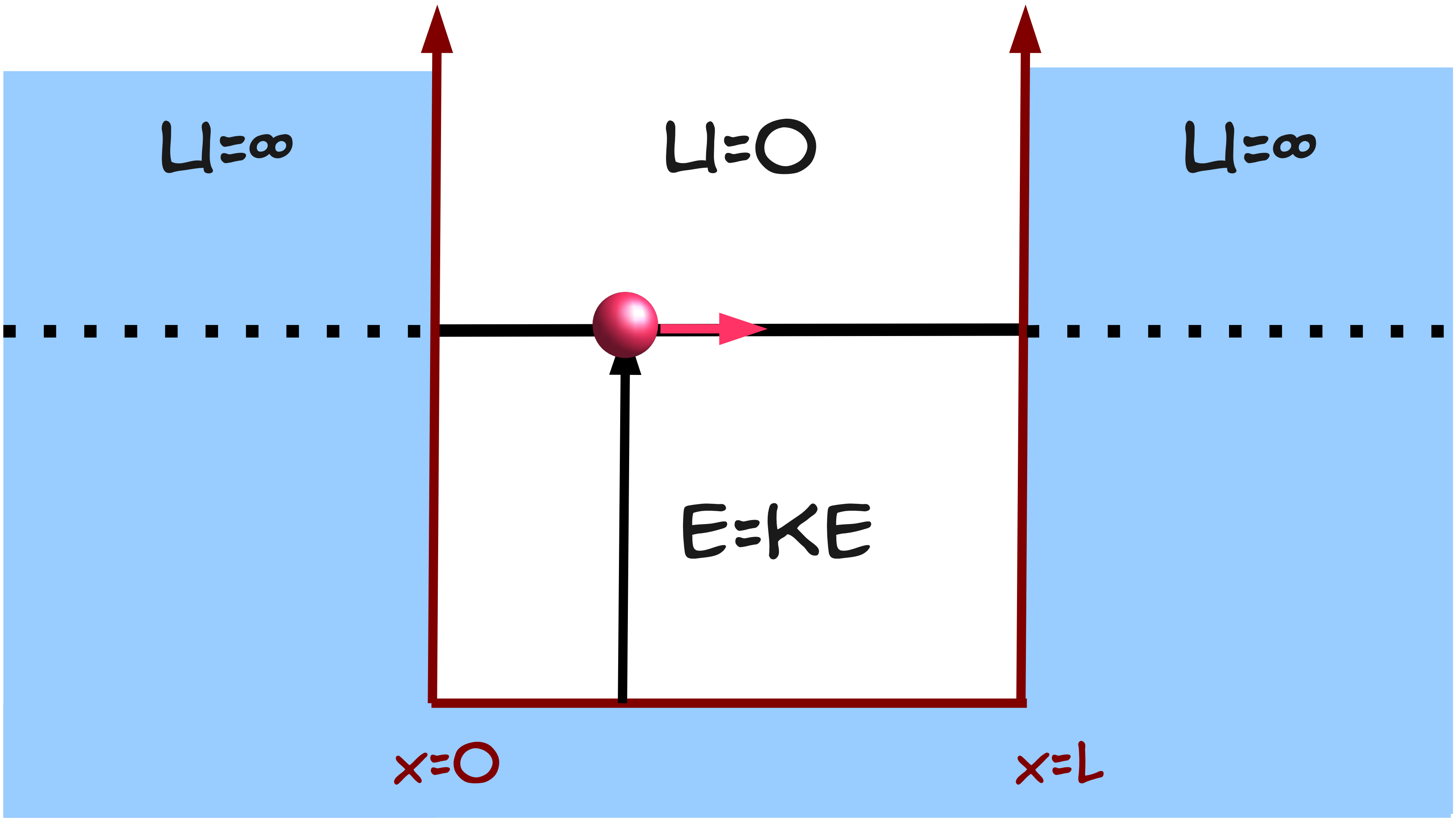
Figure 5.3 Energy versus position for the interatomic force between a large atom fixed at the origin and a small one free to move.



PARTICLE IN A BOX - "EXPERIMENT"

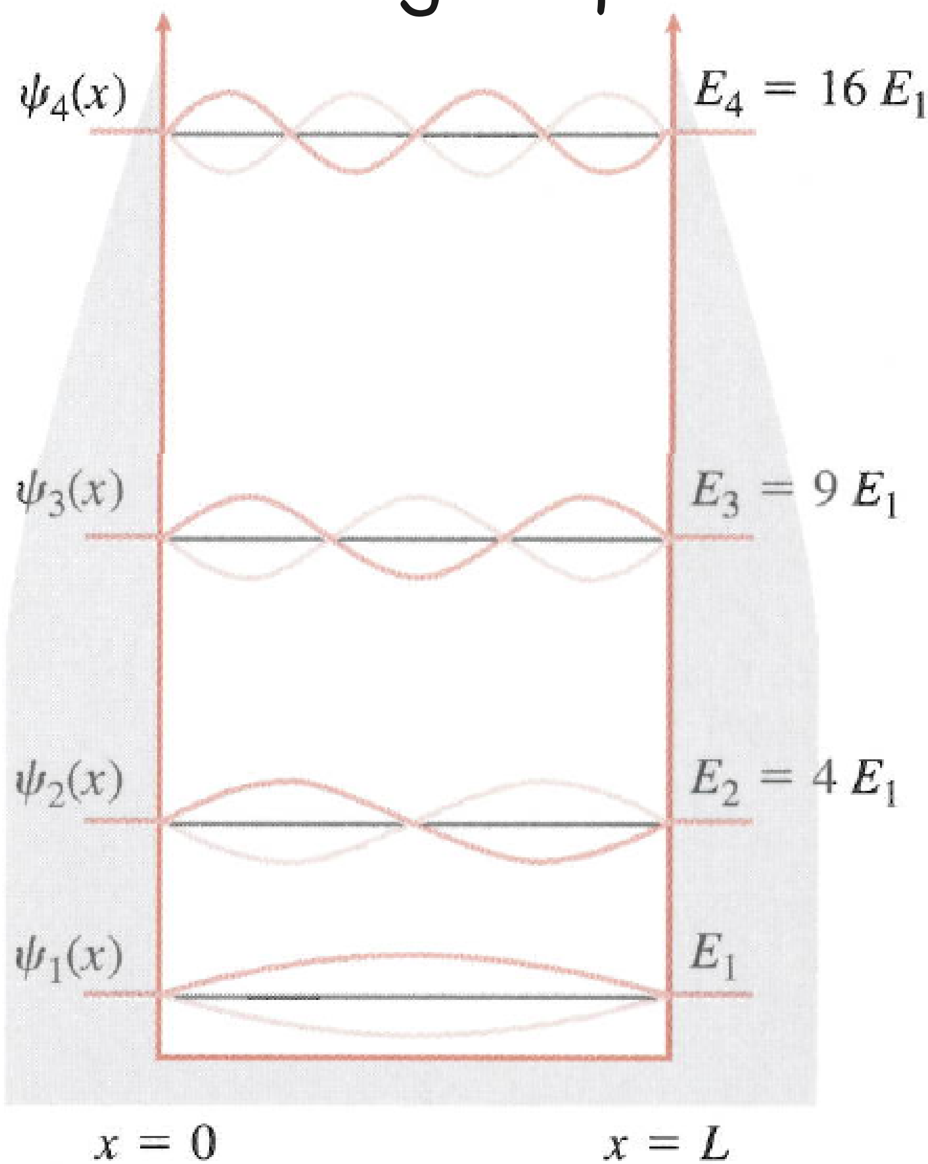


PARTICLE IN A BOX - "IDEALIZED"

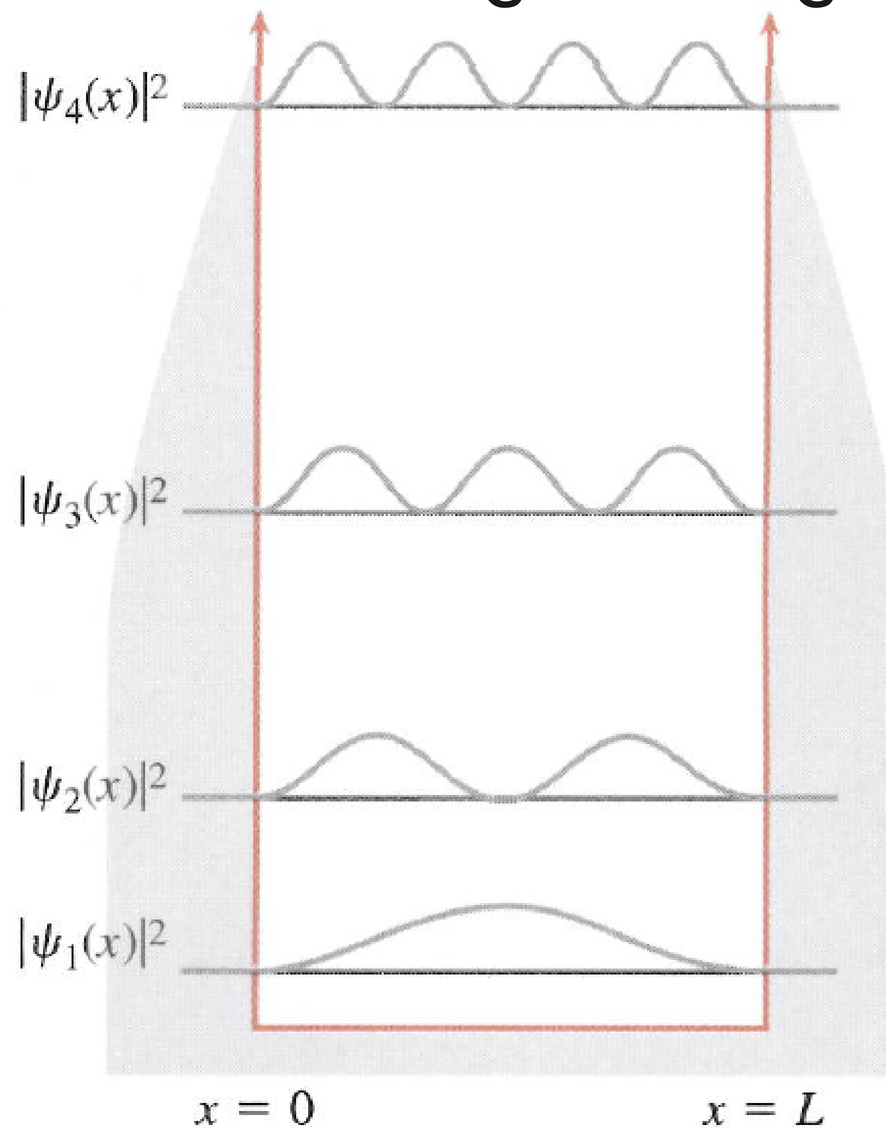


SOLUTIONS

Probability Amplitude



Probability Density



NEXT TIME

- The finite potential and the harmonic oscillator
- Coming up:
    - unbound states - barriers, tunneling, applications
    - why does nuclear decay take time? ("Alpha Radiation")
    - atomic spectra and "fine structure"