# BOUND STATES II

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(2/23/2010)
Supplementary Material for
PHY 3305 (Modern Physics)
Harris, Ch. 5.6-5.9

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- Review of last class
- SWEs
- Particle in a box
  - The finite well
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# REVIEW

- We reviewed stationary states
- We discussed the time-independent SWE
- We solved our first problem involving forces
  - the infinite square well

# The Shroedinger Wave Equation (SWE)

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

# TIME-INDEPENDENT SWE

Assume:

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

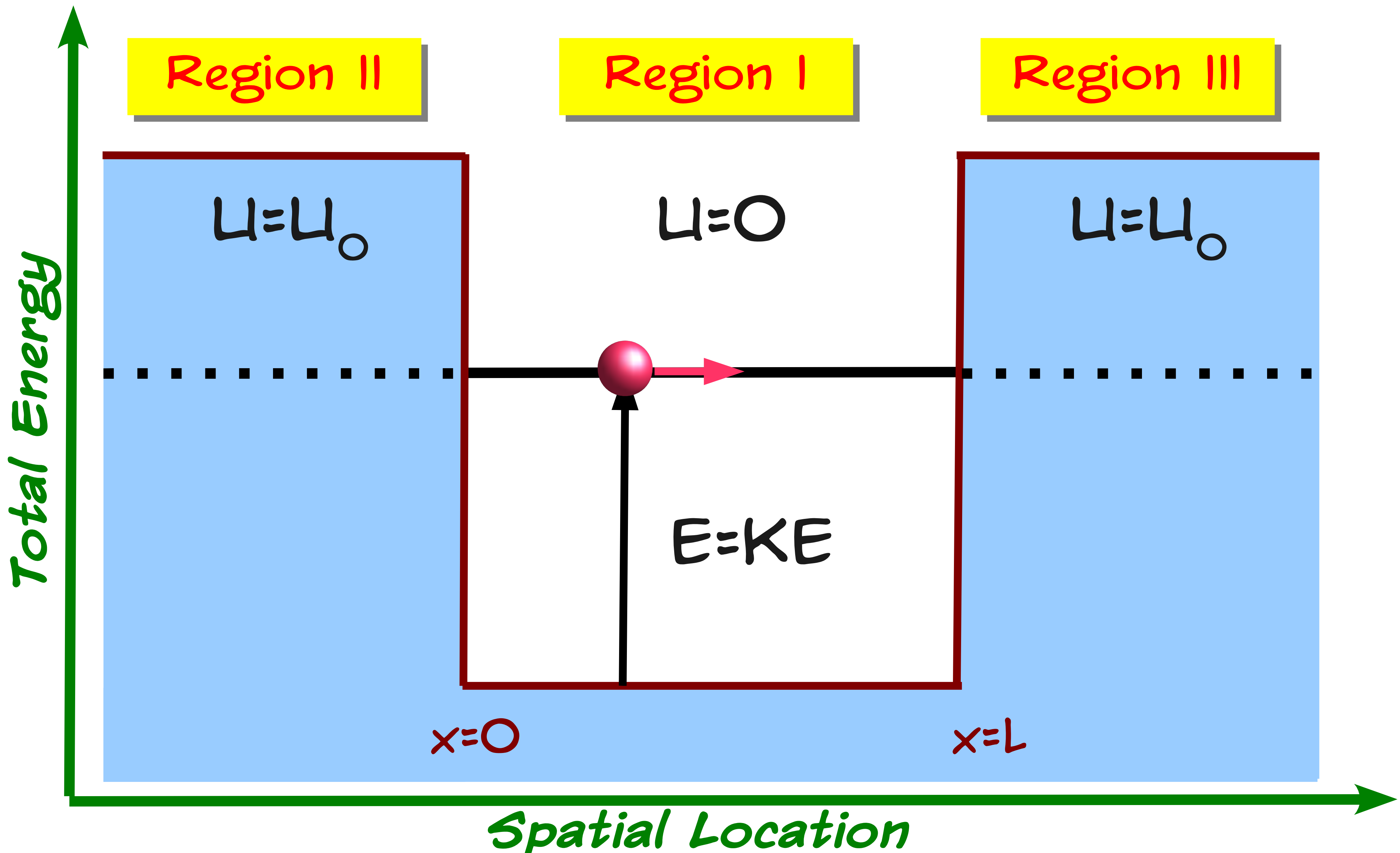
you get...

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

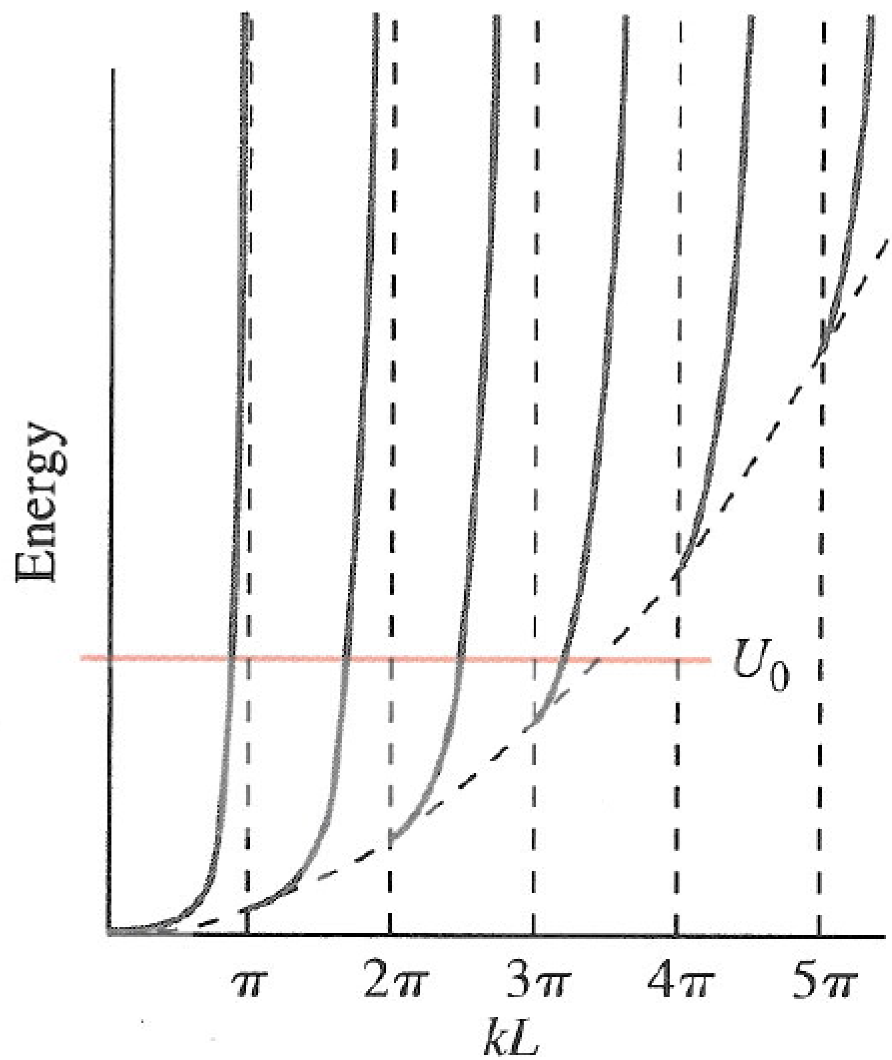
# SOLVING PROBLEMS

- Identify the player(s) in the problem
  - what particles?
- Identify constraints
  - what forces (potentials)?
- Solve for the wave function
  - solve differential equation, use smoothness and normalization (physicality constraints)
  - smoothness = "continuity of wave function and first derivative of the wave function"
- Predict outcomes based on the wave function
  - We'll begin to attack this later today

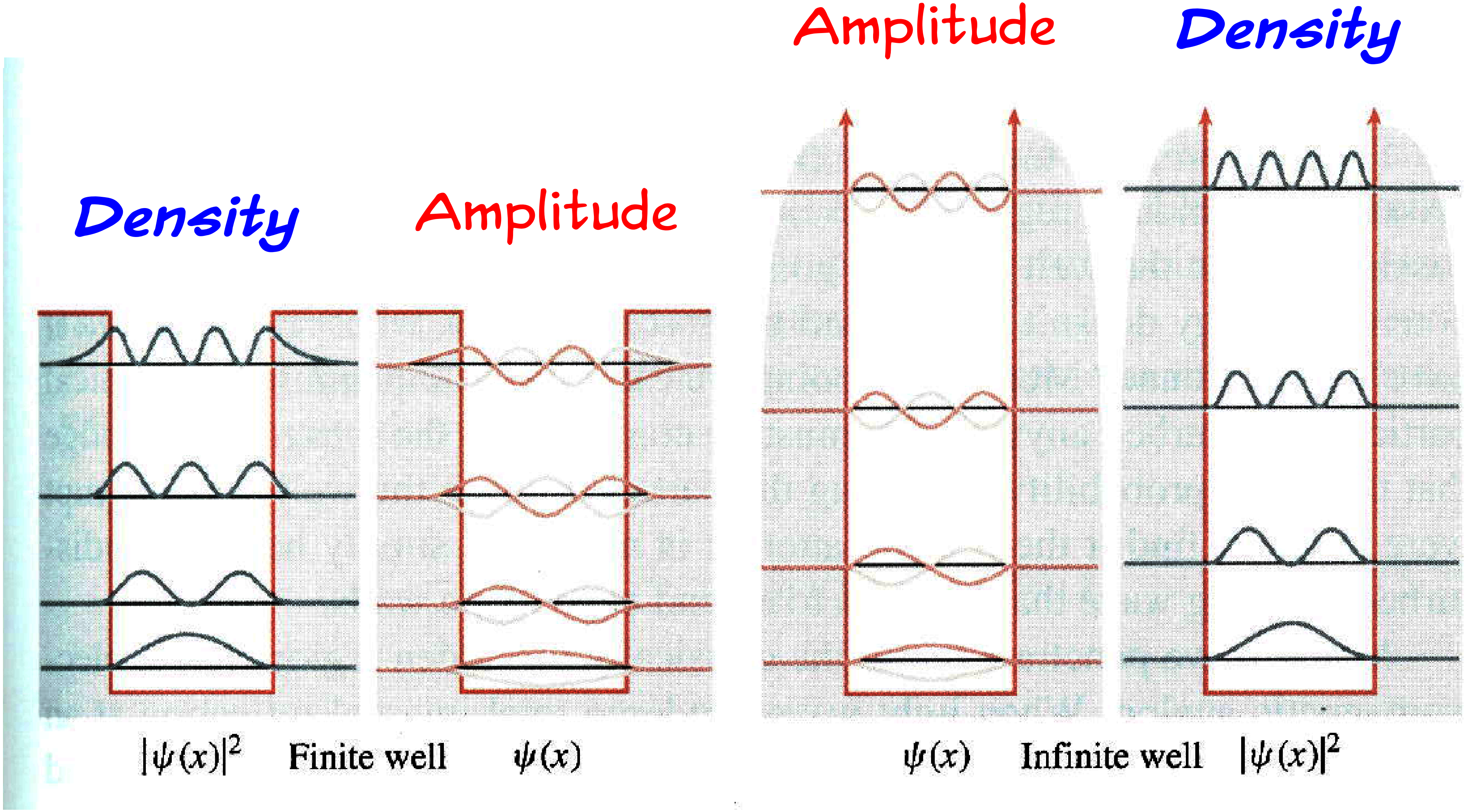
# PARTICLE IN A BOX - "FINITE SQUARE WELL"



# ALLOWED ENERGIES

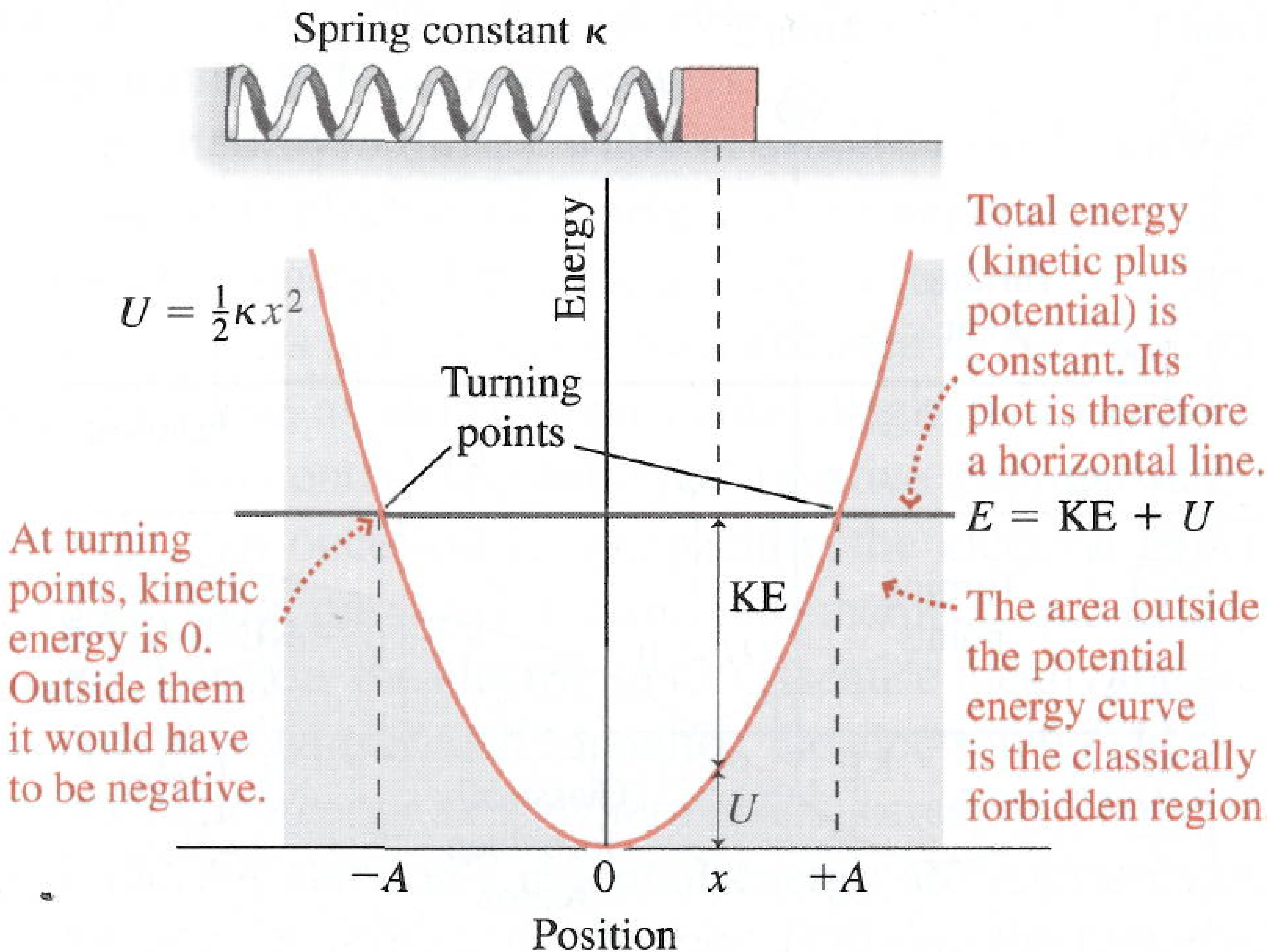


# SOLUTIONS



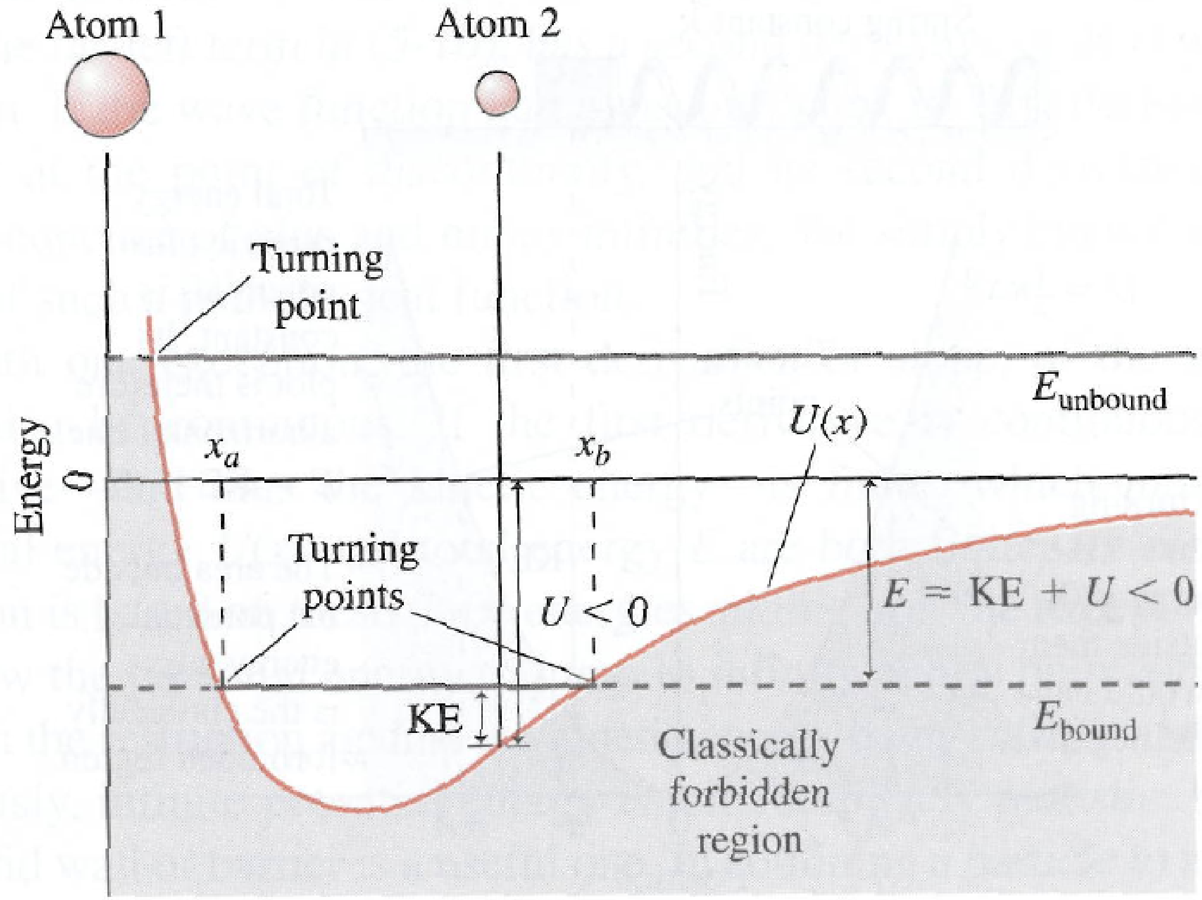
Density
Amplitude
Amplitude
Density
$|\psi(x)|^2$
Finite well
$\psi(x)$
$\psi(x)$
Infinite well
$|\psi(x)|^2$

# MASS ON A SPRING

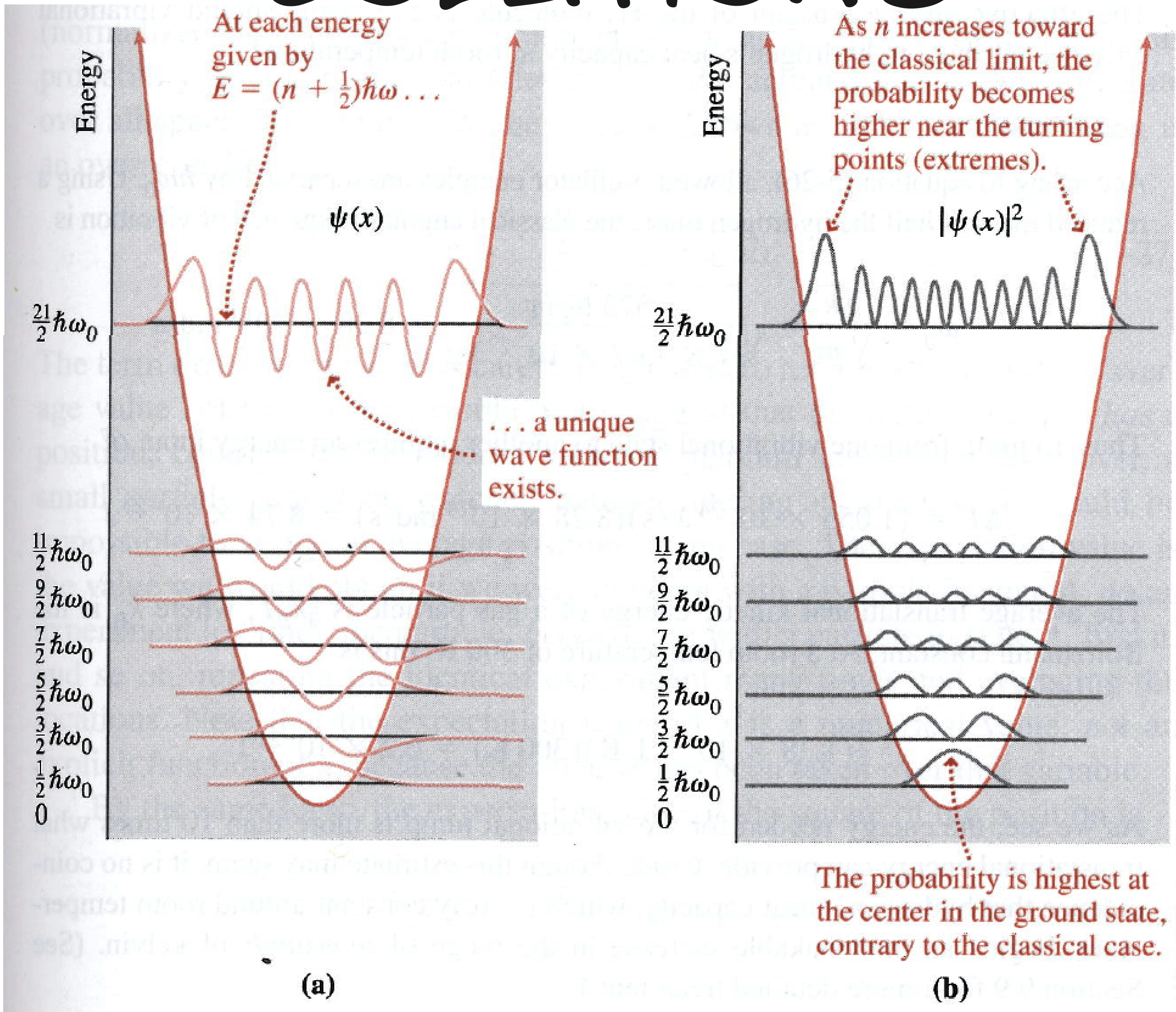


# ATOMIC BOUND STATES

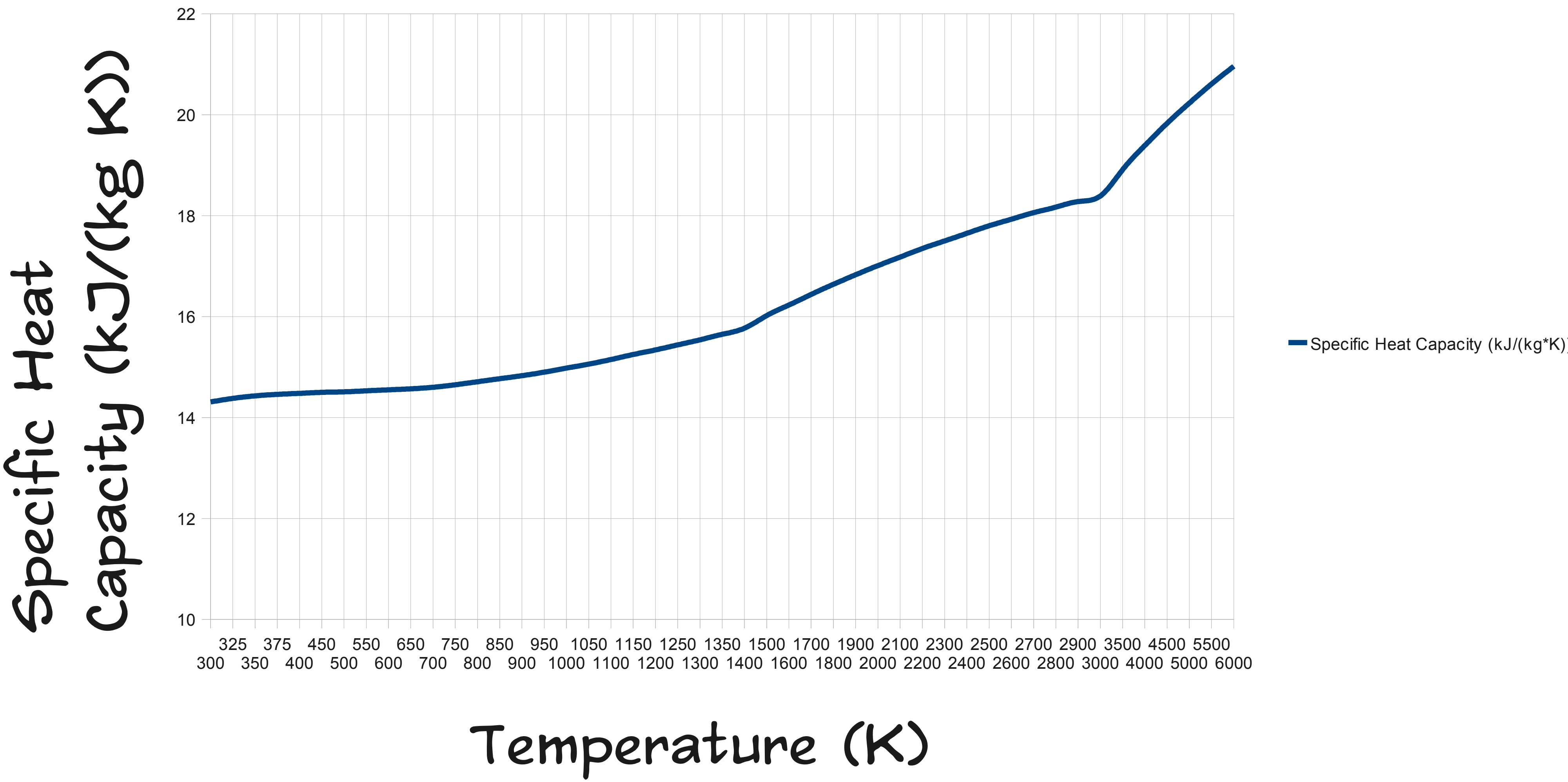
**Figure 5.3** Energy versus position for the interatomic force between a large atom fixed at the origin and a small one free to move.



# Harmonic Oscillator: Solutions



# SPECIFIC HEAT - $H_2$



# NEXT TIME

- Mid-term
- Coming up:
  - unbound states - barriers, tunneling, applications
  - why does nuclear decay take time? ("Alpha Radiation")
  - atomic spectra and "fine structure"