Applications of SHM and Energy

Pre-reading: §14.1–14.3

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**Simple Harmonic Motion**

- Suppose the restoring force varies linearly with displacement from equilibrium:
  \[ F(t) = -k x(t) \]
- Then the displacement, velocity, and acceleration are all sinusoidal functions of time,
  - This defines Simple Harmonic Motion (SHM)
- Period/frequency depend only on \( k \) and \( m \) with
  \[ \omega = \sqrt{\frac{k}{m}} \]
  (does not depend on amplitude!)

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**Example 14.2**

- a) What is the force constant of the spring?
- b) What is the angular frequency, frequency, and period of oscillation?

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**Energy and SHM**

- Total energy in an SHM system is conserved
  - does not change with time
- Components of energy oscillate between kinetic and potential
  \[ E = \frac{1}{2} m v^2 + \frac{1}{2} k x^2 - \frac{1}{2} k x^2 = \text{constant} \]
- Offers alternative approach to find \( x, v, a \)

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**Example 14.4**

Same spring, \( k = 200 \text{ N/m} \)

- What is max/min velocity? acceleration?
- What is \( v, a \) when \( x = +0.010 \text{ m} \)?
- What is total, potential, and kinetic energy at \( x = +0.010 \text{ m} \)?

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**SHM: Vertical Springs**

- IMPORTANT: Set up coordinate system!!
- Motion of vertical spring is described by simple harmonic motion with
  \[ \omega = \sqrt{\frac{k}{m}} \]
Next lecture

Pendulums, and Resonance

Read §14.5–14.8