Chapter 13

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. simple harmonic motion
2. amplitude
3. frequency
4. angular frequency
5. period
6. vertical mass on a spring (that it can be treated as a harmonic oscillator by assuming that the unstretched length of the spring is the equilibrium length of the spring)
7. pendulum

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- x(t) for a harmonic oscillator

$$x = Acos(\omega t + \phi) \tag{1}$$

- angular frequency of a mass on a spring

$$\omega = \sqrt{\frac{k}{m}} \tag{2}$$

- angular frequency of a pendulum

$$\omega = \sqrt{\frac{g}{l}} \tag{3}$$

- frequency

$$f = \frac{\omega}{2\pi} \tag{4}$$

- period

$$T = \frac{1}{f} \tag{5}$$

- Total Energy

$$E = \frac{1}{2}kA^2 \tag{6}$$

- Potential Energy

$$PE = \frac{1}{2}kx^2 \tag{7}$$

- Kinetic Energy

$$KE = \frac{1}{2}mv^2 \tag{8}$$

Skills

1. Calculate the position of a harmonic oscillator at any instant t.
2. Understand the relationship of angular frequency and period to the properties of the harmonic oscillator (k and m for a mass on a spring and l and g for a pendulum) and how changing any of the properties of the oscillator will affect the frequency and period.
3. Use time data for many oscillations to calculate period and frequency.
4. Apply conservation of energy to a harmonic oscillator to calculate maximum speed.
5. Apply conservation of energy to a harmonic oscillator to calculate speed at any position.

Lab Skills

1. Interpret a graph of x vs. t to determine period.
2. Given a curve fit of the form$x = Acos(Bt + C)$, determine the amplitude and angular frequency.