Waves and Optics

A. Wave Motion (Including Sound & Simple Harmonic Motion) *(Ch 13 & 14)*

Simple Harmonic Motion:
Students should understand simple harmonic motion so they can:
- Sketch or identify a graph of displacement as a function of time, and determine from such a graph the amplitude, period, and frequency of the motion. *(13.5)*
- Write down an appropriate expression for displacement of the form $A \cdot \sin \varpi \cdot t$ or $A \cdot \cos \varpi \cdot t$ to describe the motion. *(13.5)*
- State the relations between acceleration, velocity, and displacement, and identify points in the motion where these quantities are zero or achieve their greatest positive and negative values. *(13.1 - 13.2, 13.6)*
- State and apply the relation between frequency and period. *(13.4)*
- State how the total energy of an oscillating system depends on the amplitude of the motion, sketch or identify a graph of kinetic or potential energy as a function of time, and identify points in the motion where this energy is all potential or all kinetic. *(13.2)*
- Calculate the kinetic and potential energies of an oscillating system as functions of time, sketch or identify graphs of these functions, and prove that the sum of kinetic and potential energy is constant. *(13.2)*

Simple Harmonic Motion in a Spring:
Students should be able to apply their knowledge of simple harmonic motion to the case of a mass on a spring, so they can:
- Apply the expression for the period of oscillation of a mass on a spring. *(13.4)*
- Analyze problems in which a mass hangs from a spring and oscillates vertically. *(13.1 - 13.2)*
- Analyze problems in which a mass attached to a spring oscillates horizontally. *(13.1 - 13.2)*

Simple Harmonic Motion in a Pendulum:
Students should be able to apply their knowledge of simple harmonic motion to the case of a pendulum, so they can:
- Apply the expression for the period of a simple pendulum. *(13.6)*
- State what approximation must be made in deriving the period. *(13.6)*

Equations – Simple Harmonic Motion *(Ch 13)*:

$$F_s = -k \cdot x \qquad U_s = \frac{1}{2} \cdot k \cdot x^2$$

$$T_s = 2 \cdot \pi \cdot \sqrt{\frac{m}{k}} \qquad T_p = 2 \cdot \pi \cdot \sqrt{\frac{L}{g}} \qquad T = \frac{1}{f}$$

A. Wave Motion (Including Sound & Simple Harmonic Motion) *(cont)*

Traveling Waves:
Students should understand the description of traveling waves so they can:
- Sketch or identify graphs that represent traveling waves and determine the amplitude, wavelength, and frequency of a wave from such a graph. *(13.10)*
- Apply the relation among wavelength, frequency, and velocity for a wave. *(13.10)*
- Understand qualitatively the Doppler effect for sound in order to explain why there is a frequency shift in both the moving-source and moving-observer cases. *(14.6)*
- Describe reflection of a wave from the fixed or free end of a string. *(13.13)*
- Describe qualitatively what factors determine the speed of waves on a string and the speed of sound. *(13.11 & 14.3)*

Wave Propagation:
Students should understand the inverse-square law so they can:
- Calculate the intensity of waves at a given distance from a source of specified power and compare the intensities at difference distances from the source. *(14.5)*

Standing Waves:
Students should understand the physics of standing waves so they can:
- Sketch possible standing wave modes for a stretched string that is fixed at both ends, and determine the amplitude, wavelength, and frequency of such standing waves. *(14.8)*
- Describe possible standing sound waves in a pipe that has either open or closed ends, and determine the wavelength and frequency of such standing waves. *(14.10)*

Superposition:
Students should understand the principle of superposition so they can:
- Apply it to traveling waves moving in opposite directions, and describe how a standing wave may be formed by superposition. *(13.12 & 14.8)*
- Describe the conditions under which the waves reaching an observation point from two or more sources will all interfere constructively, or under which the waves from two sources will interfere destructively. *(13.12)*
- Relative the amplitude produced by two or more sources that interfere constructively to the amplitude and intensity produced by a single source. *(13.12)*

Equations – Waves and Sound *(Ch 13 & 14)*:

$$v = f \cdot \lambda$$