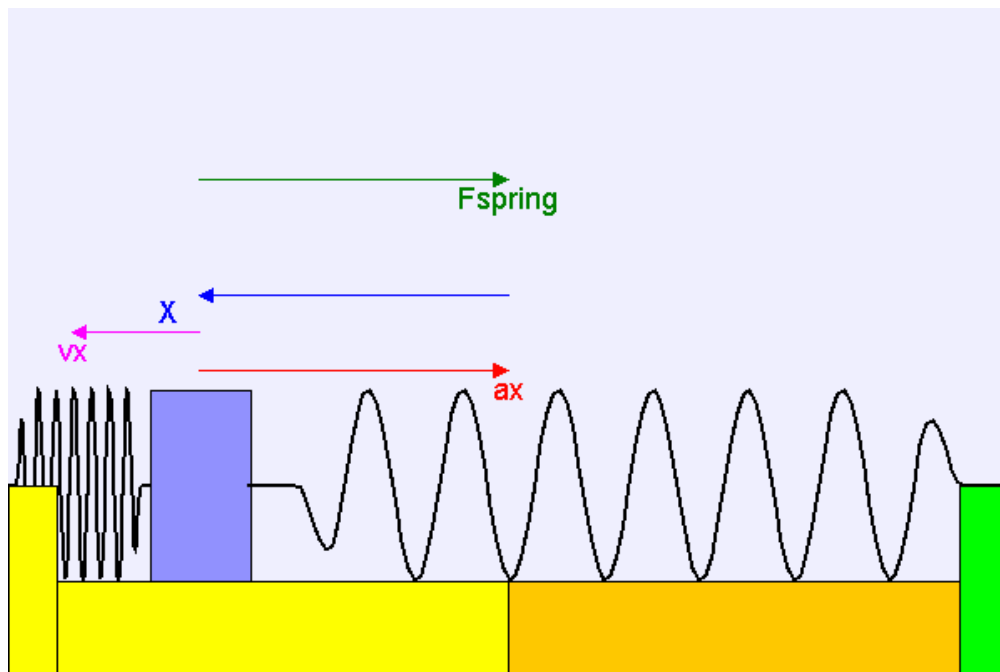# <u>Simple Harmonic Motion</u>

Playground swings, guitar strings, a pendulum, and a metal block are all examples of back and forth vibrational motion.

Simple Harmonic Motion

Fspring

X

vx

ax

Whenever the object is pulled away from its equilibrium position, a force in the system pulls it back toward equilibrium.

*If a restoring force varies linearly with the displacement, the motion that results is **simple harmonic motion***

The motion can be described by two quantities, period and amplitude.

Looking back at the block and spring...

The spring exerts a restoring force, a force that acts to oppose the force that caused it to become stretched or compressed.

The force (F_{spring}) increases linearly with the amount the string is stretched or compressed (x). The acceleration (a_x) toward equilibrium also decreases as the distance is smaller and increases the further away the object is from equilibrium.

The speed (v_x) is the largest when the acceleration is zero, which occurs at equilibrium.

In the pendulum example the object is suspended by a string of length, *l*. The object swings back and forth.
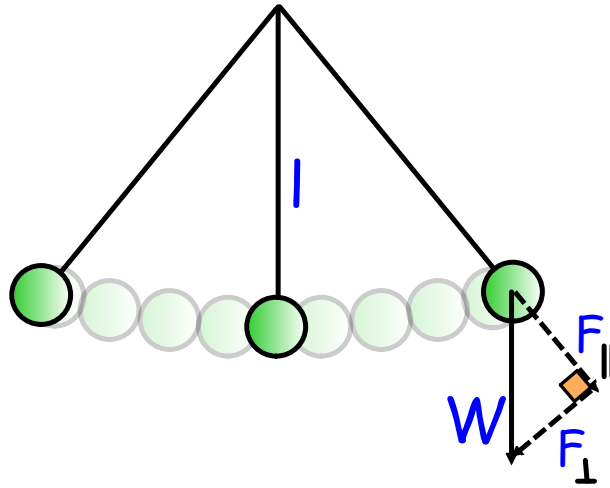
The weight, $\vec{W}$, of the object can be broken down into two components

When the object is pulled to the right, $\vec{F_\perp}$ is to the left. Similarly, when the object is pulled to the left, $\vec{F_\perp}$ is to the right. $\vec{F_\perp}$ is a restoring force.

For small angles (θ less than 15^0) the magnitude of $\vec{F_\perp}$ is proportional to the displacement of the object.

The period of the simple pendulum of length, l, is given by:

$$T = 2\pi \sqrt{\frac{l}{g}} \qquad T = 2\Pi \sqrt{\frac{m}{K}}$$

Lastly, the frequency of a pendulum is the number of complete cycles of motion in one second. It can be found from the period using $f = 1/T$

Example

On top of a mountain a pendulum 1.55m long has a period of 2.51 seconds. What is the acceleration due to gravity at this location?

2. A 4.00 Kg mass is hung from a spring that has a K value of 100.0 N/m. The mass is pulled downward a short distance and then released.

   a) What is the period?

   b) If the 4.00 Kg mass is replaced by a 1.00 Kg mass, what change takes place in the period?